Export, Female Comparative Advantage and the Gender Wage Gap*

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Abstract

This paper studies the effect of firms' export activity on the gender wage gap among its workers. Using matched employer-employee data from Germany for the period between 1993 and 2007, we show that an increase in a firm's export widens the wage gap between male and female blue-collar workers, while it reduces it between male and female white collars. In particular, the former effect is stronger for workers in routine manual tasks, while the latter is driven by employees performing interactive tasks. This evidence is consistent with the hypothesis that serving foreign markets relies more on interpersonal skills, which reinforces female comparative advantage and reduces (widens) the gender wage gap in white-collar (blue-collar) occupations. Our results, identified out of the variation in wages within firm-worker pairs, are robust to controlling for a series of worker and firm characteristics, and a host of firm, sector, time and state fixed effects, and heterogeneous trends.

JEL Classification: F16, J16, J31.

Keywords: Trade, Comparative Advantage, Gender Wage Gap, Employer-employee Data.

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1 Introduction

The rise in income inequality and, more prominently, in the wage gap between men and women has been one of the major concerns among policy makers and the public opinion in recent years. While globalization has been commonly regarded as a possible driver of the increase in inequality (see Helpman, 2018 for a survey), its effects on the gender wage gap (GWG henceforth) have been somewhat overlooked. Since Stolper and Samuelson (1941), trade has been known to have redistributive effects depending on comparative advantage, whereby the factors that are intensively employed in the exporting sector benefit and the other factors lose. Most works following this line of research focused on comparative advantage based on education (college vs high school) and occupations (white vs blue collars), and consistent empirical evidence has been produced. However, the literature in labor economics has shown that comparative advantage may also arise from differences across genders in the ability to perform different tasks. Yet, how the interaction between this gender-based comparative advantage and trade may shape the GWG has not received much attention.[1]

This paper aims to fill this gap by studying how export activity affects the gender wage gap, and which is the role played by comparative advantage in shaping these effects. The main hypothesis originates from the evidence that women tend to have a comparative advantage in performing white-collar tasks, especially those intensive in interpersonal relations and in the use of computers, while they have a disadvantage in blue-collar, "brawn"-intensive occupations (see for example Spitz-Oener, 2006; Black and Spitz-Oener, 2010; Borghans, Weel and Weinberg, 2014; Ngai and Petrongolo, 2017; Cortes, Jaimovich and Siu, 2018). If export requires a more intensive use of "male" skills in production (e.g., because it changes the production line in a way that calls for more "brawn"), and of "female" skills in non-production tasks (e.g., because it takes more ability in interpersonal relations to deal with foreign customers), an expansion in foreign activities will increase (decrease) the demand for females in white-collar (blue-collar) occupations and their wages. This hypothesis is addressed by estimating the effect of export activity on the gender wage gap at the firm-worker level, allowing for heterogeneity across occupations and tasks. The main contribution is to show this effect to have opposite sign across blue-collar and white-collar workers, and to be likely driven by gender-specific comparative advantage in tasks that are specific to the interaction with customers and to brawn-intensive manual work.

To perform the analysis, we use a uniquely rich employer-employee dataset provided by the Research Data Centre (FDZ) of the German Federal Employment Agency (BA), matching social security data on all German private-sector workers with survey data on firms' estab-

[1] Among the few existing exceptions are Juhn, Ujhelyi and Villegas-Sanchez (2014) and Saure and Zoabi (2014).

lishments.[2] The database provides detailed information both on plants and on the individual workers they employ. The sample comprises yearly observations for over 3,6 million German workers matched with nearly 15,000 establishments from both manufacturing and service sectors, followed from 1993 to 2007.

At the heart of our empirical exercise lies the estimation of a wage equation where, in addition to standard firm's and worker's characteristics, we control for firm's export intensity, its interaction with a dummy for female workers and firm-worker fixed effects.[3] This specification allows us to estimate the effect of the annual variation in a plant's exports on the differential in wage earnings between any pair of male and female employees with the same experience and skills, controlling for a number of other workers' and firm's characteristics. Our tight identification strategy purges from the coefficients any effect of export on workers' selection within the firm, and at the same time alleviates concerns of endogeneity of export with respect to wages and employment composition, since it is unlikely that any single worker may affect firm's sales abroad. Additionally, controlling for state-time, sector-time and (in the most demanding specifications) for firm-time fixed effects allows us to address the potential simultaneity bias arising from confounders that may affect both export and the wage trajectory of workers.

Our first set of results, obtained on the full sample, suggest that export does not affect differently the wages of male and female employees, on average. Next we address heterogeneity across occupations by considering workers in white-collar and blue-collar occupations separately. Consistently with our hypothesis, we find strong evidence that an increase in firm's export significantly reduces the wage of female blue-collar employees relative to their male co-workers (thereby widening the gender wage gap), while it increases the wage of female white collars relative to their male peers (thereby narrowing the gap). This result proves robust also to controlling for firm's sales, whose effect on the gender wage gap is quite muted relative to that of export. We also show that this new stylized fact is not sensitive to the exclusion of recently hired workers, which may have been selected by the firm in order to improve export performance, nor is it driven by underlying trends in other firm-level variables, or by the censoring of wage data up to a social contribution limit. The fact that the gender wage gap reacts more to export than domestic sales is consistent with the notion that selling to foreign markets may require the firm to change the intensity in the use of certain skills in a way that makes women relatively more demanded in non-production tasks.

To further assess our hypothesis that on gender-based comparative advantage drives the

[2] Although our unit of observation is an establishment, henceforth, we will refer to establishments and firms interchangeably.

[3] As it will be clearer, we focus on the export share because our sample exhibits a substantial within firm variation of export share, while export status is mostly constant within firm.

heterogeneous effects of export across white-collar and blue-collar workers, we proceed in three steps. First, we estimate how export correlates with the share of women in white-collar and blue-collar employees at the firm level. Consistently, our results highlight a positive association between firms' export and the share of female employees in white-collar occupations, which is driven by new hires. No significant correlation can be established for blue collars.

Next, we investigate whether increasing export induces the firm to reward through promotion female white collars more than their male colleagues. To this end, we estimate a linear probability model for promotion at the firm-worker level and show that an increase in firm's export slightly raises the probability that any of its female white collars be promoted compared to male employees in the same occupations.

Finally, we take a step further and study whether the reduction in the gender wage gap for white-collar workers is driven by those performing tasks related to female comparative advantage, such as the non-routine interactive ones. Similarly, we investigate if the widening in the gap for blue collars is more pronounced for those employees in female comparative disadvantage tasks, such as the routine manual ones. In both cases, the estimation of our baseline specifications on the sub-samples for different types of tasks corroborates the hypothesis that gender-specific comparative advantage drives the effect of exports on wages.

Our paper makes a number of novel contributions. It is the first, to our knowledge, to show that export widens the gap between male and female blue-collar workers while it reduces it among white collars. The closest paper to ours is Bøler, Javorcik and Ulltveit-Moe (2018), who use a similar identification strategy on Norwegian matched employer-employee data. They find, however, that export increases the wage differentials between men and women, without distinguishing between white- and blue-collar workers. Their explanation is that export requires flexibility in working hours, and hence it penalizes women because they are typically more constrained by family duties. This hypothesis is nevetheless consistent with our proposed mechanism of export reinforcing female comparative (dis)advantage, which in their case stems from time flexibility.

More importantly, we probe deeper into the mechanism behind the heterogeneous effects of export on the gender wage gap and study whether this is due to female comparative advantage in tasks that are key when firms serve a foreign market. In particular, we show comparative advantage of women in interactive tasks to drive their wages up both in absolute term and relative to men, while comparative disadvantage in routine manual occupations pushes female wages down, thereby widening the gap with male co-workers. We are aware of two papers studying how trade may affect the gender wage gap in presence of female comparative advantage. Saure and Zoabi (2014) mainly address this issue theoretically and provide evidence based on U.S. export to Mexico in 58 sectors suggesting that trade may increase the gender wage gap. Juhn, Ujhelyi and Villegas-Sanchez (2014) use firm-level data from Mexico showing that export, combined with technological upgrading, contributed to reduce the gap between male and female blue-collar workers. The latter work is closer to ours, although it differs in a number of aspects, from the country of analysis to the identification strategy (within firm instead of within firm-worker variation). More importantly, we study more in detail comparative advantage at the task level.

This paper is related to a number of works spanning the fields of international trade and gender economics. An established literature has shown that trade may be partly responsible for the increase in different dimensions of wage inequality. By inducing reallocations across sectors and across different type of workers, international trade has been associated with a rise in the workers' skill premium in developed and developing countries (see among others Epifani and Gancia, 2008 and Helpman, 2018). Wage inequality between similar workers employed by different firms has also been shown to be influenced by international trade. Firms that engage in export and import are typically more productive and larger than domestic firms, and they pay higher wages. The opening of trade increases the number of exporters and the dispersion of firms revenues, thereby raising wage differentials between similar workers employed by different firms (see among others Helpman, Itskhoki and Redding, 2010; Amiti and Davis, 2012; Bonfilioli, Crino and Gancia, 2018).

More recently, a few papers have started highlighting the role of trade in shaping the gender wage gap. Some have looked at the effect of firms' export (see Aguayo-Tellez et al., 2014; Juhn, Ujhelyi and Villegas-Sanchez, 2014; Saure and Zoaby, 2014; and Bøler, Javorcik and Ulltveit-Moe, 2018) while others have focused on the effect of import competition, especially from China, on the gender gap in wage and employment at the local and sectoral level (see Black and Brainerd, 2004; Ederington, Minier and Troske, 2009; and Hakobyan and McLaren, 2017). Furthermore, related contributions show that globalization, by exposing countries to different gender equality norms, may affect gender-specific employment outcomes (Neumayer and de Soysa, 2011; Tang and Zhang 2017; Lennon and Schneebaum, 2020).

Yet, the evidence is mixed and the mechanism behind this link remains largely an open question. Our analysis contributes to the understanding of the role of gender-based comparative advantage in trade and income inequality and identifies it at the firm-worker-task level. An important implication of our results is that, as economies become more export oriented, it is crucial that women get trained for female comparative advantage occupation, in order to both improve export performance and reduce the gender wage gap.

A growing literature in gender economics has shown that women have a comparative advantage in occupations entailing non-routine interactive and analytical tasks (see Black and Spitz-Oener, 2010; Cortes, Jaimovich and Siu, 2018), which, combined with the structural transformation towards services and technological change, have contributed to reduce the gender wage gap (see Olivetti and Petrongolo, 2016,and references therein). Our results suggest that also globalization, combined with female comparative advantage, may have narrowed wage differentials between men and women, especially among non-production workers.

Related contributions in the same literature have also documented that women have worse career prospects than men and that over one half of the gender gap in life-time earnings is attributable to wage dynamics within the firm (see Goldin, 2014). Several explanations to this phenomenon have been put forward, including sorting into different type of firms, differences in productivity, bargaining power, frictions in the labor market (Card, Cardoso and Kline, 2015). Our results suggest that the rise in export at the firm level may significantly contribute to the reduction of this gap, especially for women in white-collar occupations

The remainder of the paper is organized as follows. Section 2 describes the employer-employee matched data used in the analysis and provides statistics on the gender and sectoral composition of our sample. In Section 3, we explain our empirical approach and the baseline results on the effect of export on the gender wage gap, first in general and then by occupations, highlighting the heterogeneous effects across white and blue-collar workers. Section 4 explores the mechanism related to female comparative advantage. Section 5 concludes. In the Appendix, we provide further details on the classification of occupations by tasks, we perform additional robustness analysis on the main stylized fact, and we show how our main results change if the estimation strategy only exploits within-sector or within-firm variation in wages.

2 Data Description

Our study is based on the LIAB matched employer-employee dataset provided by the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB). The LIAB dataset combines information on individuals, from the Integrated Employment Biographies (IEB) dataset, and on establishments, from the IAB Establishment Panel.[4]

The data on individuals cover all workers, trainees, job-seekers and benefits recipients, subject to social security any time in the period that goes from 1975 to 2014, excluding only civil servant and self-employed. The dataset contains detailed information on the workers' employment status (employed, non-employed), type of contract (full-time, part- time), occupation category classified according to the "Classification of Occupations 2010" (KldB2010) with 3-digit level of detail, (daily) wages up to a contribution limit and benefit receipts. Basic biographic information, like gender, age and education level of the workers, is also included. Additionally, the dataset reports the record of the workers' establishment identifier, along with some general information on the geographic location, sector of activity classified accord-

[4]Specifically, we use the up-to-date version of the dataset, called LIAB-QM2-9314.

ing to the standard NACE Rev.2 classification with 3-digit level of detail, median wage and basic employment structure characteristics (e.g number of full-time and part-time workers).

The IAB Establishment Panel is constructed from a yearly longitudinal survey based on a random sample of establishments with at least one employee liable to social security, stratified according to industry, federal state, and firm size.[5] The survey started in 1993 in West Germany, covering 4,265 plants, which account for 0.27% of all plants in western Germany and 11% of total employment. In 1996 it was expanded to East Germany, and currently it covers approximately 16,000 establishments.[6] The survey was conducted to provide the Federal Employment Agency with information on the demand side of the labor market. For this reason the dataset includes detailed information on the workforce composition, its characteristics and development over time. Additionally, it has rich information on business and investment activities, including the value of total sales and share of export on total sales, along with general information about the plant (e.g. age, location, industry).

The LIAB matched employer-employee data set is then created by linking information on plants and workers through the establishment identifier, available in both datasets. Specifically, all individuals from the IEB that have been employed in one of the IAB Establishment Panel plants on the 30th of June are selected to form the LIAB dataset. These individuals are followed throughout the sample period and all their records at the 30th of June of every year is made available. The linked dataset includes 59,913 establishments and 11,460,543 workers observed over the period between 1993 and 2014.

2.1 Estimation Sample

In LIAB, the largest connected set of individuals and establishments with information on the export activity refers to West-Germany in the years 1993-2007. For this reason, we only focus our study on this area and this time span. We further restrict the sample to 18-54 years old workers and to establishments with more than five employees. In case of multiple identical employment spells for the same worker in the same year, we keep the episode with the highest wage, and drop spells with wages below 10 Euros (in 2010 prices).

After applying these sample selection rules, we are left with a sample of 14,955 firms and 3,603,167 workers followed from 1993 to 2007, which we use in our econometric analysis.

Before presenting the most relevant descriptive statistics from the firms in our LIAB sample, we compare here the average export activity captured in our matched employer-employee dataset with that in the firm-level dataset. In line with the national statistics,

[5] The sample is disproportionately stratified. To correct for this issue, we follow the advice of the FDZ data centre and use controls for industry, federal state and firm size in the panel analysis.

[6] The unit of record of the dataset is the establishment. Notice that in the empirical analysis we use the word firm and establishment interchangeably.

22% of the 65,180 unmatched firms in the IAB Establishment Panel sample for the period 1993-2007 are exporters, and the average ratio of export to total sales is equal to 7%. These statistics are much higher when computed on the LIAB matched dataset, where 33% of firms are classified as exporters, with an average share of export in total sales of 31%, and exporting firms employ 68% of the total workforce. This indicates that exporting firms are larger and, therefore, are connected to more employees in the linked sample.

Furthermore, the data show that the establishment's decision to export is a long-term one, which defines the firm throughout the whole sample, given that only 5% of all firms switch status from exporter to non-exporter or viceversa, and on average firms that switch status do it only 1.9 times.

One limitation of the dataset is the lack of information on hours worked. Following common practice, we tackle this issue by only considering workers employed full time subject to social security as employed.

2.2 Descriptive Statistics

To illustrate the sectoral composition of our sample in terms of export activity and female employment, we report in Figure 1 the average shares of export in total sales (panel a) and of female employment (panel b) per firm by 2-digit sectors. In line with previous evidence, export is more prevalent in manufacturing sectors such as chemicals and machinery, where 85% of plants have exported for at least one year over the sample, although also service sectors like research and development and renting of machineries feature over 50% of plants selling abroad. At the same time, while the female employment share tends to be higher in services, manufacturing industries like wearing apparels and leather products also exhibit a large share female workers (around 80% and 40% respectively).[7]

Next, we report in Table 1 some descriptive statistics for exporting and non-exporting firms, where we also distinguish by male and female workers. In line with the literature, exporting firms are on average 3.5 times larger, have a 4 times higher volume of sales, and pay higher wages relative to non exporting firms (see for example Bernard, Jensen, Redding and Schott, 2007). Moreover, exporters employ a slightly higher share of female workers and pay the relatively better compared to male employees, as the unconditional gender wage gap is on average 23% and 25% in exporting and non-exporting firms, respectively.

Exporting and non-exporting firms employ workers with similar characteristics, in terms

[7]Differences in sectoral composition of export and possibly in female employment should not raise much concern for our analysis, since, as it will be clear from the next section, our identification strategy exploits time-varying export within the firm and wage variation at the firm-employee level, controlling for time-varying differences across sectors. Nevertheles, we show in Appendix B2 that the same results hold, both qualitatively and quantitatively, on the subsample of manufacturing firms only.

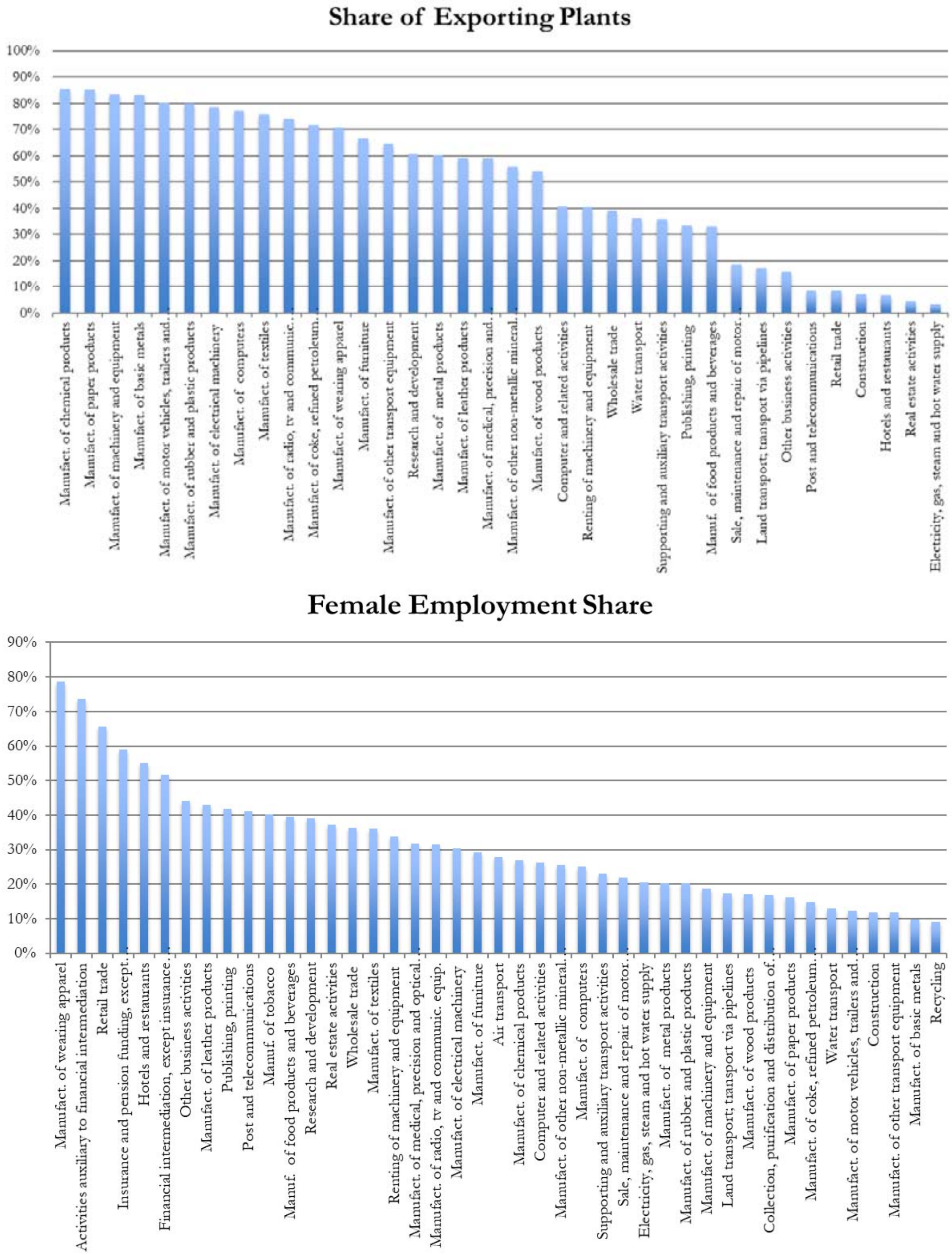

Figure 1: Exporters and Female Employment by Sector

Table 1: Descriptive Statistics - Exporters and Non Exporter (West Germany, 1993-2007)

	Non Exporters			Exporters		
	All	Male	Female	All	Male	Female
Firm Size	1,609			5,670		
Total sales (€ million)	351			1,450		
Female share or labor force	25%			28%		
Daily wage (in €)	93.7	98.2	77.9	102.0	105.6	85.9
Experience (years)	16.1	16.6	14.3	16.2	16.5	14.8
Age	37.7	37.9	37.2	38.0	38.2	37.1
Occupation						
White Collar	39%	23%	15%	27%	19%	8%
Blue collar	61%	54%	7%	73%	63%	10%
Contract						
Full time	90%	67%	23%	96%	78%	18%
Part time	10%	1%	9%	4%	1%	4%
Skills						
Low	18.6%	13.4%	5.2%	19.5%	13.7%	5.8%
Medium	72.2%	56.7%	15.5%	67.7%	56.8%	10.9%
High	9.2%	7.7%	1.6%	12.9%	11.4%	1.5%

Notes: All numbers refer to average values of the indicated variables for the sample of establishments operating in West-Germany during the years 1993-2007 and are computed on the linked dataset (LIAB). Firm size represents the average number of full time employees in the firm. Total sales refers to turnover in Euros (at 2000 prices). Daily wage is the average edaily wage of full-time employes subject to social security in Euros (at 2000 prices). Experience refers to the number of years of labour market experience. The establishments total sales and daily wages are converted in (Euro) 2000 prices using the German CPI index. Low, medium and high skills refer to workers with no vocational training, with vocational training and with a university degree, respectively.

of age and experience. The differences in the pattern of employment are more pronounced at the occupational level. In particular, exporters employ a relatively smaller share of white-collar workers (27% vs 39%), and within these workers a smaller fraction is accounted for by women (30% vs 39%). Finally, in terms of education, while exporters employ slightly more high-skill workers, both types of firms mainly employ medium-skill workers (accounting for about 70% of employment), and there are no striking differences between male and female workers' levels of education.[8]

3 Export and Gender Wage Gap: Empirical Evidence

In this section we first explore how firm's export activity affects wage differentials between men and women in general, and then we investigate whether it has heterogeneous impact on different groups of workers. We will specifically focus on white versus blue-collar workers, given that they engage in very different sets of tasks (for example "brawn" versus "brain" intensive tasks), that can be of different use to the firm when it decides to expand its sales on international markets.

[8] We define low skill the workers with no vocational training, medium skill the workers with vocational training and high skill the workers with university degree.

In our main specifications, we identify the correlation between firms' export and gender wage gap by exploiting variation of wages for any given worker who remains employed in the firm as its export intensity varies over time, and by controlling for possible firm-year specific shocks that can simultaneously affect export decisions and wages. As we will argue below, this strategy conceivably allows us to capture the causal effect of export on the gender wage gap. Moreover, with one of our specifications we are also able to quantify and compare the elasticities of the gender wage gap to firms' export sales and domestic sales.

3.1 The Baseline Estimation Strategy

In this section, we analyse the effects of firms' export activity on the gender wage gap in the German labor market by looking at the within employer-employee matches dynamics. In doing so we depart from most empirical works that study this relation at the industry and firm level.[9] In practice, we adopt a similar approach to Bøler, Javorcik and Ulltveit-Moe (2018), and estimate the following wage equation:

$$\ln w_{ijst} = \beta_1 Exp_{jt} + \beta_2 fem_i * Exp_{jt} + \mathbf{C}'_{it}\pi_1 + \mathbf{F}'_{jt}\pi_2 + \eta_{st} + \eta_{ij} + \varepsilon_{ijst} \tag{1}$$

where w_{ijst} is the gross daily wage of worker i, employed by firm j in sector s and year t. The variable fem_i is a dummy variable indicating whether individual i is female, and Exp_{jt} indicates the export activity of firm j at time t (alternatively, the export share or the log of export value). Equation (1) controls for a vector of worker's characteristics $\mathbf{C}'_{it}$, including experience, its square, and occupation, and for a vector of firm's characteristics $\mathbf{F}'_{jt}$ including (log of) firm size and geographic location.[10]

Further, we control for 2-digit sector×year fixed effects, η_{st}, to account for systematic variation in wages across sectors in any given year. This makes sure that we compare wages within each industry and time, so that the estimate of the coefficient of interest that measures the effect of export on the gender wage gap, β_2, is not driven by selection into industry. This could matter in case exporting firms were more (or less) concentrated in "male-intensive" industries.

Match fixed effects are denoted by η_{ij}, and allow us to exploit a finer source of variation given by the change in the firms' export activity, holding constant the within-firm workforce gender composition. In this specification, the estimated coefficient β_2 captures the effect of time variation in firms' export activity on the relative wage of a specific female-male couple

[9] See for example Ozler (2000), Black and Brainerd (2004), Ederington, Minier and Troske (2009) and Juhn, Ujhelyi and Villegas-Sanchez (2014) among others.

[10] When removing match fixed effects, in Appendix B3, we also control for worker's gender, nationality and education, which do not exhibit time variation.

of workers employed in the firm. By holding the firms' workforce composition constant, the estimation of the effect of export on gender wage gap is less likely to be biased by endogenous mobility and assortative matching issues, which would arise if the firm selects higher ability workers as it intensifies export (Helpman, Itskhoki and Redding, 2010). The within-match identification also reduces possible bias due to reverse causality. It is in fact less likely that the main driver of firms' export is the ability of any individual worker.

Notice that in this specification we cannot quantify the total gender wage gap, since the variable fem_i is collinear with the fixed effect η_{ij} and therefore the parameter associated to it cannot be estimated. However, the results from estimating (1) with firm instead of match fixed effects, reported in Table A5 of Appendix B3, allow us to quantify the firm-level gender wage gap at about 20 per cent.

One issue with the model above is that it does not take into account the possibility of firm-specific productivity shocks that may affect both export decisions and the demand for male and female workers. Thus, in the next specifications we attempt to control for this possible source of bias in two ways. First, by including the (log of) total firms' sales and its interaction with the female dummy as additional proxy for firm heterogeneity in productivity. Second, by controlling for firm-year fixed effects, η_{jt}, to absorb elements of unobserved heterogeneity that may drive selection of firms into exporting. These two extended models are specified in the following equations:[11]

$$\begin{aligned}\ln w_{ijst} \quad = \quad & \gamma_1 Exp_{jt} + \gamma_2 fem_i * Exp_{jt} + \mathbf{C}'_{it}\mu_1 + \mathbf{F}'_{jt}\mu_2 + \\ & \nu_1 \ln S_{jt} + \nu_2 fem_i * \ln S_{jt} + \eta_{st} + \eta_{ij} + \varepsilon_{ijst}\end{aligned} \qquad (2)$$

$$\ln w_{ijst} = \delta_1 fem_i * Exp_{jt} + \mathbf{C}'_{it}\rho_1 + \mathbf{F}'_{jt}\rho_2 + \eta_{jt} + \eta_{ij} + \varepsilon_{ijst} \qquad (3)$$

where the variable S_{jt} indicates total sales of firm j at time t.

The drawback of specification (3) is that it only allows us to estimate the effect on the gender wage gap, but not on the overall wages of male and female workers, since both time-invariant individual characteristics (such as female dummy) and time variant firm characteristics (such as export) are subsumed by the new fixed effect.

In order to account for correlation across workers within firm over time, we cluster standard errors by firm in all specifications.

[11] Since we cannot observe firms that change sector of activity within the year, the firm-year fixed effects, η_{jt}, substitute the sector-year fixed effects, η_{st} in model (3).

3.1.1 Results of the Baseline Estimation

The estimation results are reported in Table 2. Specifically, in column (1) we report the estimated coefficients for specification (1), while in column (2), (3) and (4) we report the results for the model extended to include controls for firms' sales only, its interaction with the female dummy, and firm-year fixed effects, respectively.

Given that our baseline specifications exploit variation of export and wages within-firm and within-match, we proxy firms' export activity with its export share rather than a dummy for export status, which exhibits too little time variation to allow for identification.[12]

The estimation of the baseline equation (1) shows that, when the gender composition of the workforce is held constant, an increase in firms' export share does not have a significant impact on workers' wages. A one percentage point increase in export share is associated to an increase of 0.003% in wages of male employees (coefficient β_1) and to a 0.002% increase in the relative wage of female employees (coefficient β_2), but these coefficients are not statistically significant.[13] Controlling for firms' sales as a proxy for firms' productivity further reduces the magnitude of these coefficients (columns (2) and (3)). An increase in firms' sales, however, seems to have a small but positive effect on the wages of male workers, specifically equal to a 0.009% rise in their salary following a 1% expansion, while it still shows no effect on the relative wages of female employees. Finally, the results from the estimation of equation (3) confirm the absence of a significant effect of export on the gender wage gap.

In all specifications, the results of the estimation of the rest of the control variables are in line with the literature. The linear and quadratic terms of labor market experience have a significant effect on wages, which is increasing at decreasing rates. white-collar workers earn on average 2.7% higher wages relative to their blue collar colleagues, and larger firms exhibit a wage premium of roughly 2.3%.

In conclusion, our regressions reveal that firms' export activity does not have a significant impact on workers' wages, once we control for the gender composition of the workforce. In the next section we explore the possibility that this lack of significant results may mask heterogeneity in the effects of export activity on the gender wage gap depending on workers' occupation as white or blue collars.[14]

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[12] Precisely, the independent variable is share of export on firm's total sales and lies in a [0, 1] interval.

[13] Given that the model is log-linear, the coefficients β_1 (and β_2) represent a semi-elasticity. Given that a unit change in export share represents a 100% change, we divide the estimated coefficient by 100 to obtain a more meaningful interpretation.

[14] We prefer the occupation classification to the education classification of the workforce because, as we could see in Table 1, in the German system there is no clear distinction between high and low skilled workers. Most of the workers have vocational training (64%) and this allows them to work in both white and blue collar occupations.

Table 2: GWG and Export, All Workers

	(1)	(2)	(3)	(4)
Export share	0.003	-0.001	0.000	
	(0.004)	(0.005)	(0.005)	
Female * export share	0.002	0.001	0.000	0.005
	(0.005)	(0.006)	(0.006)	(0.005)
Log (total sales)		0.009***	0.009***	
		(0.002)	(0.002)	
Female * log (total sales)			-0.002	0.000
			(0.002)	(0.001)
Log (firm size)	0.030***	0.023***	0.023***	
	(0.004)	(0.004)	(0.004)	
Experience/10	0.251***	0.245***	0.247***	0.365***
	(0.02)	(0.02)	(0.021)	(0.023)
Experience sq./100	-0.044***	-0.044***	-0.044***	-0.045***
	(0.001)	(0.001)	(0.001)	(0.001)
White Collar	0.027***	0.028***	0.028***	0.027***
	(0.002)	(0.002)	(0.002)	(0.002)
Observations	9,464,792	8,202,310	8,202,310	8,201,361
N firms	9,766	8,641	8,641	8,437
R-sq.	0.947	0.947	0.946	0.951
Federal State FE	Yes	Yes	Yes	Yes
Sector-Year FE	Yes	Yes	Yes	No
Match FE	Yes	Yes	Yes	Yes
Firm-Year FE	No	No	No	Yes

Notes: The dependent variable is the log of daily wage of full-time employees subject to social security in Euros (at 2000 prices). Firm size represents the average number of full time employees in the firm during the year. Total sales refers to turnover in Euros (at 2000 prices). Experience refers to the number of years of labor market experience. Industries are defined at the 2-digit level. The coefficients are estimated with OLS on the sample of matched employees and establishments from the LIAB dataset. Standard errors in parenthesis are clustered at firm level. *, ** and *** denote significance at the 10, 5 and 1% level respectively.

3.2 Heterogeneous Effects by Occupation

In this section, we explore whether firms' export affects the relative wage of female blue-collar workers differently from that of female white-collars. We address this heterogeneity in two ways. First, we focus on the within-match specification and estimate equations (1), (2) and (3) described in Section 3.1 separately on the sample of white collar and blue-collar workers.

Then, we build a model that enables us to directly draw conclusions on the differential impact of firms' export on the two occupational groups of workers, both qualitatively and quantitatively, and to test whether it is statistically significant. Our proposed strategy is to extend the within-match specification explained in equation (1) by adding a triple interaction term between a dummy variable that defines white-collar workers denoted as wc_i, the export variable and a dummy variable for female workers. The model is the following:

$$\begin{aligned} \ln w_{ijst} &= \epsilon_1 Exp_{jt} + \epsilon_2 fem_i * Exp_{jt} + \epsilon_3 wc_i * Exp_{jt} + \epsilon_4 fem_i * wc_i * Exp_{jt} + \\ & \mathbf{C}'_{it}\tau_1 + \mathbf{F}'_{jt}\tau_2 + \eta_{st} + \eta_{ij} + \varepsilon_{ijst} \end{aligned} \quad (4)$$

As in Section 3.1, the main source of identification is given by changes in wages of workers that remain within the same firm as it varies its export share throughout time. This enables us to obtain an estimate of the effect of export on the gender wage gap across different occupation groups which is not biased by workers' selection into export-oriented firms.

As before, the specification described in equation (4) does not allow us to estimate the total gender wage gap because the marginal effects on time-invariant variables, like female and white collar dummies and their interaction, are subsumed by the match fixed effects.[15] Nevertheless, it gives us relevant information on the differential effects of export on the gender wage gap for the two groups of workers.[16]

The most informative coefficients for our study are ϵ_2 and $(\epsilon_2 + \epsilon_4)$, which give us information on the (complementary of the) gender wage gap among blue collars and white collars, respectively. Additionally, relevant information is given by the coefficient on the export variable, ϵ_1, which is the export wage premium for blue-collar male workers, and the sum of ϵ_1 and ϵ_2, that give us the (absolute) export wage premium for blue-collar female workers. Similarly, the export wage premium for white-collar male workers is given by the sum of ϵ_1 and ϵ_3, while the sum of the four coefficients, $\epsilon_1 + \epsilon_2 + \epsilon_3 + \epsilon_4$, informs us about the export wage premium for white-collar female workers.

[15] We drop observations of workers who switch occupation throughout time to have a clearer identification of the effect of export on gender wage for white and blue collars. The percentage of occupation switches in the sample used for the estimation is 3%.

[16] The coefficients reported in Table A6, however return a gap of 19.1 and 19.9 percent, respectively for blue and white collar femal employees, respectively.

In the same spirit of what we do in Section 3.1, in order to make sure that these estimates are not affected by other firms' characteristics that may simultaneously affect both export decisions and wages, we also estimate specification (4) including additional observable and unobservable controls for firm productivity, specifically firms' sales and firm-year fixed effects. In the latter we are only able to estimate the coefficient on the triple interaction term, $fem * wc * Exp$, since the rest of the coefficients are collinear with the fixed effects. Thus, we can only draw conclusions on the differential impact of trade on the gender wage gap on white-collar workers relative to blue-collars.

As before, we use the export share of total sales to measure firms' export activity. This implies that the estimated coefficients can be interpreted as semi-elasticities of the gender wage gap to variation in the firms' export share, holding constant the firms' workforce composition, and firms' total sales and firms' unobservable characteristics in the extensions of equation (4). Additionally, we estimate equations (1), (2) and (3) separately on the sample of white-collar and blue-collar workers and specification (4) replacing the export share variable with (the log of) sales from export, controlling for (the log of) domestic sales. We do this to have a clear and direct estimate of the elasticity of wages and gender wage gap to export and domestic sales across occupations. Since this only allows us to look at these relations for the sub-sample of exporting firms (with positive share of export), for comparability we also estimate the effect of export share on the gender wage gap on this restricted sample of firms.

3.2.1 Export and the Gender Wage Gap by Occupation: Results

The results of the estimation of equations (1), (2) and (3) on the different groups of blue collars and white collars are reported in panel a and b, respectively, of Table 3.

The first specification in column (1) reveals that one percentage point increase in the firms' export share positively affects the gender wage gap among blue-collar workers by 0.016%, and it does not have a significant effect on the wages of blue-collar male workers. The coefficient on the interaction term $fem * Exp$ remains negative and significant at the 1% and 5% level even when controlling for (log of) firms' sales and for firm-year fixed effects, respectively, in columns (2) and (3).

Interestingly, the results are the opposite for the group of white-collar workers in panel b. White-collar female workers see an increase in wages of 0.012% compared to their male colleagues, as their employers rise their export share by one percentage point. As in the case for blue-collar workers, these results are robust to the inclusion of additional controls for firm productivity and of firm-year fixed effects. There is a slightly negative effect of export on the wages of white-collar male workers, which is however only significant when controlling for firms' sales in column (2).

Furthermore, an increase in (total) firms' sales has a negative effect for female workers

Table 3: GWG and Export by Occupation

					Elasticities
	(1)	(2)	(3)	(4)	(5)
Panel a - Blue Collar					
Export share	0.005	0.003			
	(0.005)	(0.007)			
Female * export share	-0.016**	-0.021***	-0.012**	-0.017**	-0.003***
	(0.007)	(0.008)	(0.006)	(0.007)	(0.001)
Log (total sales)		0.010***			
		(0.002)			
Female *Log (total sales)		-0.004*	-0.002	-0.002	0.002**
		(0.002)	(0.002)	(0.002)	(0.001)
Observations	6,634,660	5,779,526	5,777,366	4,539,653	4,528,717
N firms	8,664	7,123	6,536	3,150	3,135
R-sq.	0.936	0.935	0.943	0.939	0.939
Panel b - White Collar					
Export share	-0.002	-0.006*			
	(0.003)	(0.003)			
Female * export share	0.012***	0.014***	0.012**	0.015**	0.005***
	(0.004)	(0.005)	(0.005)	(0.006)	(0.001)
Log (total sales)		0.004***			
		(0.001)			
Female *Log (total sales)		0.004**	0.004**	0.008***	0.000
		(0.002)	(0.002)	(0.002)	(0.002)
Observations	2,797,249	2,394,257	2,390,039	1,658,067	1,651,922
N firms	7,956	7,118	6,119	2,958	2,935
R-sq.	0.95	0.95	0.96	0.95	0.95
Federal State FE	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes
Match-FE	Yes	Yes	Yes	Yes	Yes
Firm-Year FE	No	No	Yes	Yes	Yes
Sample	All Firms	All Firms	All Firms	Always Exporters	Always Exporters

Notes: The dependent variable is log daily wages in real values. All specifications includes the additional controls reported in Table 2. In column (5), export is measured as the log of sales from export. When using this variable, observations with zero export are dropped from the sample. The data source is the LIAB dataset for years 1993-2007. The coefficients are estimated on the subsamples of blue collar (panel a) and white collar (panel b) workers. Employees switching between occupations are excluded from the sample. Standard errors in parenthesis are clustered at firm level. *, ** and *** denote significance at the 10, 5 and 1% level respectively.

in blue-collar occupations which is only significant in specification (2) when firm-year fixed effects are not considered (column (2)), while it seems to benefit both female and male workers in white-collar occupations.

As anticipated, approximating the export intensity of firms by the firms' export share does not give us a direct measure of the elasticity of export on wages and gender wage gap, but more importantly, the estimated coefficients are not immediately comparable with the effects of an expansion in firms' sales in domestic markets. For this reason, we use an alternative measure of firms' export intensity - (the log of) the total sales form export - to be able to compare it with the effect of an increase in (the log) of domestic sales. Since, this only allows us to focus on the sample of exporting firms, we also report the results focusing on this type of firms only. In this case, the effect becomes slightly stronger, indicating that one percentage point increase in the firms' export share positively affects the gender wage gap among blue-collar workers by 0.017% and reduces it among white collars by 0.015%, as shown in column (4) of both panels. In quantitative terms, all else equal, a 30% increase in the export share of the firm – corresponding to a shifts from the median to the top quartile of the distribution – causes an annual 39 Euro reduction in the average wage gap in real terms (down from 8600 Euros). Conversely, blue-collar women lose relative to men as an effect of a rise in their employer's exports, with the gender wage gap widening by about 21 Euros (up from 4100) under the above scenario. The elasticity estimation shows that a 10% increase in firms' export sales increases gender wage gap by 0.03% among blue collars, and decreases gender wage gap by 0.05% among white collars, as from column (5) in both panels. On the other hand, the effect of domestic sale is positive among blue collars, in the sense that it reduces the gender wage gap, and non significant among white collars.

The estimation results of the models that include a triple interaction term between the female dummy, the export variable and the white collar dummy, described in specification (4) are reported in Table 4. They largely confirm the evidence from the baseline estimation on the different groups of white and blue-collar workers described above.

First, in column (1) we report the results of the estimation of equation (4) using the variable export share as proxy for the firms' export activity. The coefficient on the triple interaction term, $\hat{\epsilon}_4$, reveals the presence of a strongly significant differentiated impact of export on gender wage gap for white-collar relative to blue-collar workers. Specifically, a one percentage point rise in export share induces a divergence in the gender wage gap between white- and blue-collar workers by 0.027%. This seems to be due to both a rise of the gender wage differential for blue-collar workers and a reduction for white-collar workers. The coefficient that informs about the female wage premium for blue collars ($\hat{\epsilon}_2$) is in fact negative and statistically significant at the 5% level, indicating that a one percentage point increase in the firms' export share increases the gender wage gap among blue-collar workers by 0.015%.

Table 4: GWG and Export - Differential Effect on Blue Collar and White Collar

					Elasticities
	(1)	(2)	(3)	(4)	(5)
Export	-0.001	-0.005			
	(0.005)	(0.007)			
Female * export	-0.015**	-0.019**	-0.012**	-0.016**	-0.003
	(0.007)	(0.008)	(0.006)	(0.008)	(0.002)
White collar * export	0.012*	0.016*	0.013*	0.024***	0.002
	(0.006)	(0.008)	(0.007)	(0.009)	(0.002)
Female * white collar * export	0.027***	0.034***	0.028***	0.034***	0.008***
	(0.008)	(0.01)	(0.008)	(0.01)	(0.002)
Log (sales)		0.011***			
		(0.002)			
Female * log (sales)		-0.004	-0.002	-0.003	0.001
		(0.003)	(0.002)	(0.002)	(0.002)
White collar * log (sales)		-0.007***	-0.005**	-0.007**	-0.007***
		(0.002)	(0.002)	(0.003)	(0.002)
Female * white collar * log (sales)		0.008**	0.006**	0.011***	-0.002
		(0.003)	(0.003)	(0.004)	(0.002)
Observations	9,129,144	7,899,714	7,898,714	6,008,566	5,981,525
R-sq.	0.948	0.947	0.952	0.950	0.948
Federal State FE	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes
Match-FE	Yes	Yes	Yes	Yes	Yes
Firm-Year FE	No	No	Yes	Yes	Yes
Sample	All Firms	All Firms	All Firms	Always Exporters	Always Exporters

Notes: The dependent variable is log daily wages in real values. All specifications includes the additional controls reported in Table 2. In column (5) we use the logarithm of sales from export to approximate firms' export activity and domestic sales instead of total sales. The data source is the LIAB dataset for years 1993-2007. Standard errors in parenthesis are clustered at firm level. *, ** and *** denote significance at the 10, 5 and 1% level respectively.

Additionally, the estimation results show that this effect can be attributed mostly to a drop in wages of blue-collar female workers, given that wages on theirs male colleagues are not affected by export (the coefficient $\hat{\epsilon}_1$ is close to 0 and not significant). Conversely, a one percentage point rise in firms' export share seem to significantly reduce the gender wage gap for white-collar workers by 0.012%.[17] In this case, we can say that both white-collar men and women benefit from trade, but the positive effect on women is stronger than for men. In particular white-collar women wages increase by 0.023% following a unit increase in the export share, while wages of white-collar men only by 0.011%.[18]

These results are further confirmed if we modify equation (4) to control for observable firms' characteristics in column (2), firm-year fixed effects in column (3) and when the sample is shrunk to only consider firms that have exported throughout the entire sample, in column (4). The effect of export on gender wage gap is significantly different for white and blue collars, being positive and statistically significant for the former group and negative and statistically significant for the latter. Additionally, an increase in total sales seem to have no significant effect of the gender wage gap for blue-collar workers, and a slightly negative effect on the gender wage gap for white-collar workers (see column (2) and (3)).[19]

The results for the estimation of the specification that uses the alternative measure of firms' export intensity - (the log of) the total sales form export- and (the log) of domestic sales are reported in column (5) of Table 4. They confirm that, even when we net out the unobserved heterogeneity at the match and firm-time level, what really matters for the gender wage gap is firms' export activity rather than domestic sales. Specifically, we obtain that an increase in firms' sales abroad reduces gender wage gap for white-collar workers, while a rise in domestic sales seem to be irrelevant for it. A 10% increase in export sales contributes to close the gender wage gap among white collar employees by roughly 0.05%, while no significant effects are found for blue-collar workers.[20] The coefficient that informs us about it, $\hat{\epsilon}_2$, is in fact non statistically significant. Furthermore, a rise in firms' domestic sales has no significant effect on the gender wage gap neither for blue collar or white-collar female workers but, interestingly, it reduces the skill premium for white-collar male workers.

[17] The total effect of export on gender wage gap for white collars is given by the sum of coefficients $\hat{\epsilon}_2 =$ 0.027 and $\hat{\epsilon}_4 =$ -0.015. They are both statistically significant at 5% and 1% level respectively.

[18] The effect of export on white collar women wages is computed from the convolution of parameters $\hat{\epsilon}_1 + \hat{\epsilon}_2 + \hat{\epsilon}_3 + \hat{\epsilon}_4 =$ 0.0273 + 0.0117 - 0.0145 - 0.0006. The effect on male white collar wages is given by $\hat{\epsilon}_1 + \hat{\epsilon}_3 =$ 0.012 - 0.001.

[19] Similarly to interpretation of the coefficients for the export variable, the effect of total sales on gender wage gap of white collar female workers is given by the sum of the coefficient of the triple interaction ($Fem_i * wc_i * \ln S_{jt} =$ 0.008 and the double interaction $Fem_i * \ln S_{jt} =$ -0.004 (see column (2), results are similar when firm-year fixed effects are taken into account (column (3))).

[20] The total effect on gender wage gap on white collar employees is given by $\hat{\epsilon}_2 + \hat{\epsilon}_4 =$ 0.008 - 0.003.

3.3 Export and the Gender Wage Gap by Occupation: Robustness

The results in Tables 3 and 4 document a new stylized fact about the different effects of firms' export activity on the gender wage gap for blue and white-collar workers. Before exploring the mechanism behind this evidence, we perform some robustness checks to address possible concerns about identification and sample selection. First, to account for the possibility that the gender wage gap, export and other indicators of firm's performance follow a trend, which may be confounded in the estimates for our coefficients of interest, we add to the specification in column (2) of Table 3 a time trend interacted, alternatively, with the initial value of firm-level gender wage gap (specific to blue-collar workers in panel a and to white-collar workers in panel b), export share, sales, employment and female share of employment (specific to each occupation). The results reported in Table 5 are in line with those in Table 3, suggesting that the effects of export on the gender wage gap is not driven by coincing trends.

Next, to address the dynamics in the effects of export on the gender wage gap, we reestimate the specifications in Table 4 using one-year lags of the main explanatory variables. The results, reported in columns 1-3 of Table 6, show the effects of lagged export is consistent with the estimates in Table 4, although the coefficients for blue-collar workers is now less precisely estimated.

Another concern may be that recent hires may be affected differently relative to more tenured employees, and that the prevalence of either type of workers among blue vs white-collar workers may then generate the results reported in Tables 3 and 4. To address this possibility, we replicate the estimates of Table 4 on the sample including only workers with more than three years of tenure and report the coefficients in columns 4-6 of Table 6.

In the Appendix, we estimate additional specifications to account for wage censoring and to gauge the importance of adopting our idenfication strategy, based on within firm-worker variation, rather than only exploiting within-sector and within-firm variation.

In light of the evidence shown in this section, we can conclude that firms' export activity benefits white-collar female workers and harms their blue collar colleagues, both in absolute terms and relative to their male coworkers. This seems a strong stylized fact for our observational sample which poses interesting challenges for its interpretation. In the next section we take on these challenges by investigating some of the possible mechanisms that may drive these empirical results.

4 Export and the Gender Wage Gap: Exploring the Mechanisms

So far, we have investigated the effects of firms' export activity on workers' wages. For the purpose of our identification strategy, we have mostly focused on changes in wages of workers staying within the firm as it intensifies its exports. We have found no significant effect on the

Table 5: GWG and Export by Occupation - Controlling for Trends

	(1)	(2)	(3)	(4)	(5)
			panel a - Blue Collar		
Export share	0.002	0.004	0.002	0.003	0.003
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Female * export share	-0.021***	-0.021***	-0.021***	-0.021***	-0.022***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Log (total sales)	0.010***	0.010***	0.010***	0.010***	0.010***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Female *Log (total sales)	-0.004	-0.003*	-0.003*	-0.004*	-0.004*
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
Observations	5,604,275	5,779,526	5,779,526	5,779,526	5,779,526
R-sq.	0.934	0.934	0.934	0.934	0.934
			panel b - White Collar		
Export share	-0.006**	-0.005	-0.005	-0.005	-0.005*
	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)
Female * export share	0.014***	0.014***	0.014***	0.014***	0.014***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Log (total sales)	0.004***	0.004***	0.004***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Female *Log (total sales)	0.005**	0.005**	0.005**	0.005**	0.005**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Observations	2,258,733	2,394,257	2,394,257	2,394,257	2,394,257
R-sq.	0.947	0.950	0.950	0.950	0.95
Federal State FE	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes
Match-FE	Yes	Yes	Yes	Yes	Yes
Firm-Year FE	No	No	No	No	No
Trend*initial value of	GWG	Export	log(total sales)	log(firm size)	Female Empl. Share

Notes: The dependent variable is log daily wages in real values. All specifications includes the additional controls reported in Table 2. Each column additionally controls for a time effect interacted with the initial firm-level value of the variable indicated in the last row. In particular, GWG is the average gender wage gap computed among blue collar workers in panel a and white collar workers in panel b; Export is the export share in total sales; and Female Employment share is computed among blue collar workers in panel a and white collar workers in panel b. The data source is the LIAB dataset for years 1993-2007. The coefficients are estimated on the subsamples of blue collar (panel a) and white collar (panel b) workers. Employees switching between occupations are excluded from the sample. Standard errors in parenthesis are clustered at firm level. *, ** and *** denote significance at the 10, 5 and 1% level respectively.

Table 6: Robustness Checks - Lags and Tenured Workers

	Lagged Controls			Workers with 3+ Year Tenure		
			Elasticity			Elasticity
	(1)	(2)	(3)	(4)	(5)	(6)
Exp	-0.012			-0.005		
	(0.008)			(0.007)		
Female * Exp	-0.007	-0.010	-0.002	-0.018**	-0.010	-0.002
	(0.009)	(0.008)	(0.002)	(0.008)	(0.007)	(0.002)
White collar * Exp	0.019**	0.016**	0.003	0.012	0.010	0.000
	(0.009)	(0.008)	(0.002)	(0.009)	(0.008)	(0.002)
Female* White collar * Exp	0.025**	0.025***	0.008***	0.035***	0.029***	0.009***
	(0.01)	(0.009)	(0.002)	(0.01)	(0.009)	(0.002)
Sales	0.007**			0.012***		
	(0.003)			(0.002)		
Female * Sales	-0.005*	-0.003	0.000	-0.005*	-0.002	0.001
	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
White collar * Sales	-0.003	-0.002	-0.005**	-0.009***	-0.007**	-0.008***
	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Female* White collar * Sales	0.009**	0.006**	-0.003*	0.011***	0.009***	-0.001
	(0.004)	(0.003)	(0.002)	(0.003)	(0.003)	(0.002)
Observations	5,201,718	5,200,926	3,993,666	6,728,587	6,726,955	5,194,615
R-sq.	0.95	0.95	0.95	0.95	0.95	0.95
Federal State FE	Yes	No	No	Yes	No	No
Industry-Year FE	Yes	No	No	Yes	No	No
Match-FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Year FE	No	Yes	Yes	No	Yes	Yes

Notes: The dependent variable is log daily wages in real values. All specifications includes the additional controls reported in Table 2. In columns (3) and (6) we use the logarithm of sales from export to approximate firms' export activity and domestic sales instead of total sales. In columns (1)-(3), all control variables are lagged by one year. In columns (4)-(6), the sample includes only full-time workers with a tenure of 3 years or more in the firm. The data source is the LIAB dataset for years 1993-2007. Standard errors in parenthesis are clustered at firm level. *, ** and *** denote significance at the 10, 5 and 1% level respectively.

gender wage gap in general, which masks a strong and positive effect on white-collar female workers' wages and a negative one on blue-collar female workers. Moreover, we have shown an increse in domestic sales to have a significantly weaker effect than an expansion in export In this section we try to understand the channels that may be driving these results.

In particular, we address the following hypothesis, based on gender-specific comparative advantage. If export requires a more intensive use of "male" skills in production (e.g., because it changes the production line in a way that calls for more "brawn"), and of "female" skills in non-production tasks (e.g., because it takes more ability in interpersonal relations to deal with foreign customers), an expansion in foreign activities will increase (decrease) the demand for women in white-collar (blue-collar) occupations, thereby raising (reducing) both relative female employment and wages. We assess this mechanism following three steps.

First, we check whether employment responds to changes in export consistently with the proposed mechanism: an increase in relative labor demand may be reflected both in higher relative wages and employment. Unfortunately, given that we do not observe the number of hours worked in the LIAB dataset, we can only focus on the extensive margin of employment, leaving the effect on the intensive margin to be the object of investigation in future research.

Next, we focus on workers that stay within the firm as it exports more and assess whether female white collars are in higher request as the firm's export activity increases. Being unable to quantify this in terms of hours worked, we turn to study the effect of export on the (relative) probability of promotions especially of female white-collar workers.

Finally, we investigate further whether women performing specific tasks are more valuable and more paid as the firm exports more. We do so by splitting the samples of blue- and white-collar workers in groups of occupations classified according to the intensity of tasks performed on the job. Specifically, we consider five occupational sub-categories: manual routine, manual non-routine, cognitive routine, analytic non-routine, and interactive non-routine. On this sub-samples we estimate the same regressions presented in Section 3.1.

4.1 Export and Firms' Employment

In this section we explore how firms' employment structure changes with export activity. Specifically, since we observe a rise (drop) in wages of white-collar (blue-collar) female workers relative to their male colleagues in the same occupation, we want to assess whether this effect is accompanied by an increase (decrease) in the firm's relative employment of this group of workers. Since in the wage analysis we only focused of full-time workers, we do the same here and only consider as employed the workers that are employed full time.

In particular, we estimate the following linear model at the firm-year level:

$$Y_{jst} = \gamma_1 \ln Exp_{jt} + \mathbf{F}'_{jt}\beta_1 + \eta_j + \eta_{st} + \varepsilon_{jst} \tag{5}$$

Table 7: Firm's Employment and Export

	Share of white collar	Share female white collar		Share female blue collar	
	(1)	(2)	(3)	(4)	(5)
Log (export)	-0.001	0.003***	0.002**	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Log (domestic sales)	0.000	0.002	0.003	0.002**	0.003***
	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
Female share (t-1)			0.232***		0.148***
			(0.009)		(0.005)
Observations	11,163	10,885	10,885	10,777	10,774
N firms	2,469	2,397	2,397	2,365	2,364
R-sq	0.968	0.896	0.902	0.963	0.966
Federal State FE	Yes	Yes	Yes	Yes	Yes
Sector- Year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variables are indicated in column headers. The share of white collar workers in column (1) is computed as the ratio between full-time white collar workers and all full time workers. The share of female white collar workers in column (2)-(3) is computed as the ratio between full-time female white collar workers and white collar workers. The share of female blue collar workers in column (4)-(5) is computed as the ratio between full-time female blue collar workers and blue collar workers. The data source is the LIAB dataset for years 1993-2007, collapsed at the firm level. Heteroscedasticity-robust standard errors are reported in parenthesis. *, ** and *** denote significance at the 10, 5 and 1% level respectively.

where the dependent variable Y_{jst} represents, respectively, (i) the total share of white-collar workers, (ii) the total share of women among white collars and, lastly, (iii) the total share of women among blue collars.

One caveat of this specification is that it does not allows to distinguish between newcomers and stayers. Thus, to fully understand if and on which component of the workforce the firm is implementing the changes, we also estimate equation (5) for the number of newly hired workers and their female share by occupation. In particular, new hires are defined as workers that are employed in firm j at time t but were not employed in firm j at time $t-1$, $t-2$ and $t-3$. To complete the picture, we also estimate the same specification for workers' separations and their female share by occupation.

We use the (log of) export as proxy for firm's export activity and we always control for

Table 8: Firm's Hiring and Export

	Share of white collar	Share female white collar		Share female blue collar	
	(1)	(2)	(3)	(4)	(5)
Log (export)	0.001	0.007*	0.007*	0.004	0.004
	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
Log (domestic sales)	0.000	0.000	0.001	0.002	0.002
	(0.007)	(0.006)	(0.006)	(0.005)	(0.005)
Female share (t-1)			-0.068**		-0.022
			(0.029)		(0.023)
Observations	10,709	10,709	10,701	10,709	10,701
N firms	2,322	2,322	2,320	2,322	2,320
R-sq	0.469	0.352	0.351	0.443	0.443
Federal State FE	Yes	Yes	Yes	Yes	Yes
Sector- Year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variables are indicated in column headers. Newly hired workers are defined as workers employed in firm j at time t but not in t-1, t- 2, t- 3. The share of newly hired white collar workers in column (1) is computed as the ratio between newly hired full-time white collar workers and all newly hired full time workers. The share of female white collar workers in column (2)-(3) is computed as the ratio between newly hired full-time female white collar workers and newly hired white collar workers. The share of female blue collar workers in column (4)-(5) is computed as the ratio between newly hired full-time female blue collar workers and newly hired full-time blue collar workers. The sample includes all firms that exhibit non-zero variation in white collars during the observed sample period.. For those firms that did not experience some type of hiring, the dependent variables are set to zero accordingly. The data source is the LIAB dataset for years 1993-2007, collapsed at the firm level. Heteroscedasticity-robust standard errors are reported in parenthesis. *, ** and *** denote significance at the 10, 5 and 1% level respectively.

the the (log of) domestic sales as proxy for firm's productivity.[21] As a robustness check, we also estimate the same relationship using the (log of) export and domestic sales at time $t-1$, since it is plausible that demand adjustments as a response to changes in export may take one period to implement.

Unfortunately, in this specification we can only control for firms' time invariant unobserved heterogeneity, since including firm-year fixed effects would not allow us to estimate the impact of export on the changes in the shares of workers within the firm. We are aware that this prevents us from drawing conclusions on the causal effect of sales from export on changes in

[21] We find similar results even when we use the share of export on total sales as a measure of firms' export activity.

Table 9: Firm's Separations and Export

	Share of white collar	Share female white collar		Share female blue collar	
	(1)	(2)	(3)	(4)	(5)
Log (export)	0.001	0.004	0.003	-0.004	-0.004
	(0.005)	(0.005)	(0.005)	(0.003)	(0.003)
Log (domestic sales)	0.010	0.013	0.013	0.004	0.005
	(0.007)	(0.008)	(0.008)	(0.005)	(0.005)
Female share (t-1)			0.065*		0.125***
			(0.035)		(0.022)
Observations	14,702	14,702	14,683	14,702	14,683
R-sq	0.492	0.385	0.384	0.542	0.543
Federal State FE	Yes	Yes	Yes	Yes	Yes
Sector- Year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variables are indicated in column headers. Separations are defined as workers who were employed full time in firm *j* at time *t-1* but not at time *t*. The share of white collar workers in column (1) is computed as the ratio between white collar workers that experience separation and all separators. The share of female white collar workers in column (2)-(3) is computed as the ratio between female white collar workers that experience separation and all white collar separators. The share of female blue collar workers in column (4)-(5) is computed as the ratio between female blue collar workers that experience separation and full-time blue collar workers separators. The sample includes all firms. For those firms that did not experience some types of separations, the dependent variables are set to zero accordingly. The data source is the LIAB dataset for years 1993-2007, collapsed at the firm level. Heteroscedasticity-robust standard errors are reported in parenthesis. *, ** and *** denote significance at the 10, 5 and 1% level respectively.

firms' labor demand. However, we believe that studying correlations between firms' export activity and workforce composition can be informative for our analysis.

The results of the model's estimations exploiting within-firm variation are reported in Table 7. In column (1) we show firm's export and domestic sales to be non-significantly correlated with the share of white-collar workers. Column (2), however, suggests that as the firm exports more, it employs more female white collars relative to male. This result holds if we keep the share of female workers from the previous period constant. This variable is used as a control for firm-specific factors, like hiring preferences, and it strongly predicts gender workforce composition among white collars, as shown in column (3). Finally, when we turn to the share of female blue collars in columns (4) and (5), we find no significant correlation with firms' export and a weak positive association with domestic sales, which disappears as we control for the share of female workers in the firm.

Results from the estimation of equation (5) for newly hired workers are reported in Table 8. In line with the results for employment, column (1) confirms that variation in firm's exports is not accompanied by a significant change in the share of white-collar workers amog new hires. The share of female workers in newly hired white collars, however, increases with export, as shown in columns (2) and (3). As in Table 7, no significant correlations are estimated for the female share in newly hired blue-collar workers. Finally, Table 9, reporting the estimates for workers' separation, shows no correlation between export and this margin of the change in employment patterns.

In conclusion, more export activity within the firm is associated to a higher share of female white-collar workers and no significant changes in the share of female blue-collar workers. In particular, the change in gender composition among white collars is driven by the hiring margin. A further change in employment in response to increased export activity may occur along the intensive margin of hours worked by current employees. If female white-collar (blue-collar) employees were asked to work longer (shorter) hours, this would help explain the evidence in Section 3.2. Unfortunately, we cannot assess whether this channel is relevant, since our data do not have information on hours per worker.

4.2 Export and Promotions

After showing export to be associated to an increase in the relative demand for women in white collar occupations, we now investigate whether white (blue) collar female workers employed within the firm become relatively more (less) valuable as the firm sells more abroad. We do so by turning to the effects of export on the relative probability of promotion of female workers for white and blue-collar workers. We use the same identification strategy of Section 3.2 and focus on workers that stay within the firm as it expands its export activity. In this way we control for possible sources of bias due to match-specific unobserved heterogeneity. Unobserved match heterogeneity could bias the results because if the firm employs better workers as it exports more it can also be inclined to promote them more.

To define the probability of promotion we follow Bronson and Thoursie (2017) and record a promotion as a given discrete percentage change in an individual's wage compared to the rest of the co-workers in the same broad occupation category (white collar versus blue collar). In practice, we first compute the average yearly wage growth rate of the two groups of white and blue-collar workers in the same firm and year. Then, we consider a worker to be promoted if he or she experiences a change in wages that is 10% higher compared to the rest of the workers within his or her occupation category.[22]

[22] As a robustness check, we also slightly modify the definition of promotion by only considering a worker to be promoted if he or she experiences a change in wages that is 15% higher compared to the rest of the

Promotions are very few in the dataset: among people that stay within the firm for at least two periods, we only observe on average 5.63% of promotions.[23] This result is in line with the literature, for example for Swedish data Bronson and Thoursie (2017) find that promotions only occur two or three times maximum in a worker's life.

Specifically, in line with Section 3.1, we estimate the following linear probability model:

$$\begin{aligned}\Pr(promotion_{ijst} &= 1|\mathbf{X}) = \zeta_1 Exp_{jt} + \zeta_2 fem_i * Exp_{jt} + \zeta_3 wc_i * Exp_{jt} \\ &\quad + \zeta_4 fem_i * wc_i * Exp_{jt} + \mathbf{C}'_{it}\nu_1 + \mathbf{F}'_{jt}\nu_2 + \eta_{st} + \eta_{ij} + \varepsilon_{ijst}\end{aligned} \tag{6}$$

where, $promotion_{ijst}$ is a dummy taking value 1 if individual i in firm j in sector s receives a salary increase at time t relative to time $t-1$ that is higher than 10% the average increase in salary of their colleagues. Here, we directly use the (log of) sales from export to proxy the export variable and we control for the (log of) domestic sales as a proxy for firm productivity, to obtain a direct measure of the elasticities of promotion to these two variables. We estimate the model also controlling for firm-year fixed effects in order to take into account possible sources of bias that may affect both export decision and probability of promotion. The interpretation of the parameters follows the explanation in Section 3.2. We are particularly interested in the estimation of parameter ζ_4, which informs us about the extent of the gender gap in the probability of being promoted among white collar relative to blue-collar workers.

The estimation results of equation (6) are reported in Table 10. In column (1) we show the baseline results, and in column (2) the outcome of the estimation that includes firm-year fixed effects. The baseline results show a negative and significant effect of export on the probability of promotion of blue-collar male workers (coefficient ζ_1) and a positive and significant effect of export on the probability of promotion of white-collar male workers (coefficient ζ_3). We find that the coefficient for the triple interaction term, ζ_4, is positive but not statistically significant signalling no differential impact of export on the probability of promotion for white-collar female workers relative to their male white collar colleagues. Interestingly, an increase in domestic sales seems to have similar effects of a rise in export, fostering career progressions of white-collar male workers and reducing the promotion probability of blue-collar male workers. It also seems that white-collar female workers see their relative probability of being promoted reduced as the firm increases domestic sales.

However, once we subsume firm's export and domestic sales with firm-year fixed effects, results are different: the estimates in column (2) shows a positive and significant coefficient

workers within his or her occupation category.

[23] The percentage of promotions in the dataset is equal to 2.40% when we use the second definition of promotions, in which we only consider a worker to be promoted if he or she experiences a change in wages that is 15% higher compared to the rest of the workers within his or her occupation category.

Table 10: Promotions and Export

	(1)	(2)	(3)	(4)
Log (export)	-0.005***		-0.0025	
	(0.002)		0.001	
Female * log (export)	0.002	0.000	0.0003	-0.0014
	(0.002)	(0.002)	0.001	0.001
White collar * log (export)	0.003*	0.001	0.0013	0.0002
	(0.002)	(0.002)	0.001	0.001
Female* white collar * log (export)	0.002	0.005*	0.0025	0.0043**
	(0.003)	(0.003)	0.002	0.002
Log (domestic sales)	-0.005***		-0.0026	
	(0.002)		0.001	
Female * log (domestic sales)	0.002	0.001	0.0002	0.0002
	(0.002)	(0.002)	0.001	0.001
White collar * log (domestic sales)	0.004*	0.001	0.0020	0.0006
	(0.002)	(0.002)	0.001	0.001
Female* white collar * log (domestic sales)	-0.007**	-0.005*	-0.0023	-0.0021
	(0.003)	(0.003)	0.002	0.002
Observations	3,952,910	3,952,828	3,952,910	3,952,828
R-sq.	0.274	0.283	0.274	0.281
Federal State FE	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes
Match-FE	Yes	Yes	Yes	Yes
Firm-Year FE	No	Yes	No	Yes
Δlog(w) treshold for Promotion	10%	10%	15%	15%

Notes: The dependent variable is a dummy variable taking value one if the worker was awarded a promotion in the year and zero otherwise. Promotion is defined in columns (1) and (2) as a 10% (or larger) increase in annual wage relative to the previous year; and as a 15% (or larger) increase in columns (3) and (4). The data source is the LIAB dataset for years 1993-2007. The coefficients are estimated with OLS. Standard errors in parenthesis are clustered at firm level. *, ** and *** denote significance at the 10, 5 and 1% level respectively.

for the triple interaction term, ζ_4, equal to 0.005, which indicates that white collar women face a higher probability of being promoted relative to men as the firm intensifies its exports.

Interestingly, the effect of an expansion of domestic sales has opposite sign, indicating that white collar men mostly benefit from this in terms of promotions. No significant effects of both export and domestic sales are found for men and blue-collar workers.

We can, therefore, conclude that the reduction in gender wage gap for white-collar workers is accompanied by a slightly higher probability of promotion for white-collar female workers, as firms intensify their export activity. This may indicate that, as firms export more, their matches with female white-collar workers become increasingly valuable. This seems in line with the existence of a comparative advantage of this group of workers in tasks which the firm values more as it exports more.

4.3 Export, Gender Wage Gap and Occupational Task Content

We have documented a reduction and a rise in the gender wage gap among white and blue-collar workers, respectively, associated with the increase of firms' export intensity. We have also shown that this is accompanied by a positive correlation between firms' export and share of female employees among white-collar workers (with no significant changes in hirings) and by a slight increase in the relative female-male promotion probability among white collars compared to blue collars.

The combination of these empirical facts seems to indicate that white-collar women employed in firms that intensify their export activity perform jobs particularly valuable to this end. In support to this, previous research has documented that international firms value more non-routine, interactive jobs compared to routine ones (Becker, Ekholm and Muendler, 2013). In parallel, a growing body of literature documents that women have a comparative advantage in non-routine tasks requiring interpersonal skills, whose demand has increased in the past decades, contributing to the reduction in the gender wage gap (Spitz-Oener, 2006; Cortes et al., 2018; Black and Spitz-Oener, 2010; Borghans et al., 2014; Olivetti and Petrongolo, 2016).

The availability of detailed data on the content of the activities performed on the job by workers in Germany is a powerful resource to empirically test the validity of this channel. Specifically, we classify occupations according to their "task content", that is the detailed set of activities performed on the job, using the information provided in the "Survey on qualification and working conditions" (BiBB/IAB and BIBB/BAuA- 91/92, 98/99, 2006), and estimate the effect of firms' exports on the gender wage gap for each occupational sub-category. In the econometric analysis, we use the same estimation framework described in Section 3.1 in models (1), (2), (3).

The "Survey on qualification and working conditions" consists of a repeated cross section

Table 11: Occupations by task content

	White collar	Blue collar
Manual Routine	3.02	64.38
Manual Non Routine	5.36	8.15
Cognitive Routine	0	0.16
Analytic Non Routine	21.54	6.07
Interactive Non Routine	70.07	21.24
Total	100	100

Notes: The numbers refer to the share of 3-digit occupations within white collar and blue collar occupations that are classified as intensive in Manual Routine, Manula Non Routine, Cognitive Routine, Analytic Non Routine and Interactive Non Routine tasks. Occupations at 3-digit level are classified by their task intensity as described in Appendix Y using information from the LIAB dataset and the "Survey on qualification and working conditions" (BiBB/IAB and BIBB/BAuA- 91/92, 98/99, 2006).

of a random sample of workers covering 0.1 percent of the German labor force. It contains detailed information on workers' attributes (age, gender, education), earnings and occupation, as well as information on the workplace characteristics. In particular, it provides detailed data on the set of activities performed in each job, that allows us to classify 15 longitudinally consistent tasks, following the methodology given in Becker and Muendler (2014). Based the definition of tasks, we follow Spitz-Oener (2006) and group occupations in five sub-categories based on the activity performed more often on the job. The five sub-categories are: 1) Manual routine, 2) Manual non-routine, 3) Cognitive routine, 4) Analytic non-routine, 5) Interactive non-routine. A detailed description of the definition of tasks and their mapping into occupation categories is provided in Appendix B. After we assign one category for each occupation based on its task content, we link the information to the LIAB dataset using the occupational code KldB2010 with three digit level of detail. This allows us to obtain a unique matched employer-employee dataset with detailed information on the activities performed by workers on the job.

We show the breakdown of occupation categories by task content for white-collar and blue-collar workers in Table 11. In our dataset, 70% of white collar occupations are categorized as interactive non-routine, followed by 21% categorized as analytic non-routine, and less than 10% classified as manual.[24] Among blue collar occupations, 64% are classified as manual routine, 21% as interactive non-routine and 8% as manual non-routine.[25]

[24] Examples of white collar manual routine jobs are: postal deliverers, railway engine drivers, office auxiliary workers and of white collar manual non-routine jobs: nurses, social workers, care workers.

[25] Some relevant examples of blue collar interactive non-routine jobs are: waiters, stewards, domestic and non-domestic servants, watchmen, custodians, cooks.

We perform our estimation on all sub-categories of occupations for white- and blue-collar workers, but we only report the results for the most representative ones for both groups. That is, we report the estimation results for specifications (2) and (3) for manual routine, interactive non-routine and manual non-routine occupations for blue-collar workers in Table 12, and for interactive non-routine and analytic non-routine occupations for white-collar workers in Table 13. More specifically, for each sub-group of occupations, in the first column of the results tables, we report the estimates for the specification including the firms' export share on total sales, the firm's total sales, in addition to federal state, sector-year and firm-worker fixed effects. In the second column, we show the results of the estimation of equation (3), in which we add to the previous specification controls for firm-year fixed effects to absorb shocks at the firm-year level that could bias the results. The third column of each sub-category shows the estimated gender wage gap elasticity to export and domestic sales, computed on the restricted sample of firms that have exported throughout the entire sample period.

The results for the sub-groups of blue-collar workers in Table 12 show that women employed in manual routine occupations are significantly disadvantaged by the firm's export activity. Specifically, a one percentage point increase in export share is associated with a 0.022% reduction in the relative wage of female employees, statistically significant at the 1% level (column (1)), while the (log) wage of male workers in this category seems not to be significantly affected by export. Adding firm-year fixed effects (column (2)) partly absorbs the effect of export on gender wage gap, thereby reducing the magnitude of the coefficient representing the relation between the two variables, but without affecting the sign nor the statistical significance. In particular, the estimates indicate that a one percentage point increase in export share is associated to a 0.013% reduction in the relative wage of female employees, statistically significant at the 1% level. Finally, the estimated elasticity of female employees relative wage to export sales and domestic sales are, respectively, negative and positive, but not statistically significant (column (3)). The results for the sub-group of blue-collar manual non-routine workers are in line with the ones on the manual routine occupations, showing a negative effect of export on the relative wages of female blue-collar employees, but they are not statistically significant for all the estimated specifications. The only exception is the one reported in column (4), in which we estimate the model controlling for firms' total sales. In particular, it shows a strong and statistically significant negative correlation between export and relative wage of female workers. Firms' exports seem not to have any significant effect on wages of blue-collar workers performing interactive non-routine jobs. However, in contrast with the results for the other occupational sub-categories for blue-collar workers, in this case a rise in domestic sales seems to significantly contribute to the closure of the gender wage gap.

The estimation results reported in Table 13 show no significant relation between firms'

Table 12: GWG and Export by Task Intensity, Blue Collar

	Manual routine			Manual non-routine			Interactive non-routine		
			Elasticity			Elasticity			Elasticity
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Export	0.002			0.008			0.000		
	0.007			0.009			0.006		
Female* export	-0.022**	-0.013*	-0.003	-0.024**	-0.012	0.002	-0.013	-0.008	0.001
	0.009	0.007	0.002	0.01	0.011	0.003	0.009	0.006	0.002
Log (sales)	0.009***			0.000			0.007**		
	0.002			0.003			0.003		
Female * log (sales)	-0.005*	-0.002	0.003	0.006	0.001	0.006	0.010	0.009*	0.006**
	0.003	0.002	0.002	0.005	0.005	(0.006)	0.006	0.005	0.003
Observations	3,619,521	3,616,644	2,752,094	329,727	326,195	205,853	1,020,565	1,015,909	710,474
R2	0.92	0.93	0.93	0.96	0.97	0.95	0.96	0.96	0.95
Federal State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Match FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Year FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes

Notes: The dependent variable is log daily wages in real values. All specifications includes the additional controls reported in Table 2. In columns (3), (6) and (9), we use the logarithm of sales from export to approximate firms' export activity and domestic sales instead of total sales. The estimation samples include only blue collar workers mainly engaged in Manual routine tasks (columns 1-3), Manual non-routine tasks (columns 4-6) and Interactive non-routine tasks (columns 7-9). The data source is the LIAB dataset for years 1993-2007. Standard errors in parenthesis are clustered at firm level. *, ** and *** denote significance at the 10, 5 and 1% level respectively.

export activity and the gender wage gap for white-collar workers employed in analytic non-routine occupations. In fact, the estimates in all model specifications are not statistically significant. On the contrary, white-collar female workers mostly performing interactive tasks, seem to benefit from firms' export activity significantly. More specifically, column (4) of Table 13, in which we report the results of the estimation of the baseline model, shows that a one percentage point increase in export share is associated to a 0.007% increase in the relative wage of female employees, statistically significant at the 5% level. The effect on the (log) wages of male employees is also positive, but smaller in size and not statistically significant, indicating that the reduction in the gender wage gap is mostly attributable to a rise in wages of tenured female employees. Additionally, an increase in firms' total sales has a positive effect both on the relative wage of female employees and on the wages of male employees. Adding firm-year fixed effects (column (5)) does not make the coefficient that captures the relation between export share and the gender wage gap vary significantly in size, but in this case it is no longer statistically significant. Interestingly, the relative female-male wage elasticity to export sales, in column (6), is positive and significant at the 1% level for this group of workers, indicating that a 10% increase in export sales contributes to close the gender wage gap for this group workers by roughly 0.03%, while the gender wage gap seem to not respond to variation in domestic sales.

In light of these results, we can conclude that the total positive effect of an increase in firms' exports on the relative wage of white-collar female workers, discussed in Section

Table 13: GWG and Export by Task Intensity, White Collar

	Analytic non-routine			Interactive non-routine		
			Elasticity			Elasticity
	(1)	(2)	(3)	(4)	(5)	(6)
Export	-0.005			0.000		
	(0.004)			(0.003)		
Female* Export	0.008	0.006	0.000	0.007*	0.006	0.003***
	(0.008)	0.008	(0.002)	(0.004)	(0.004)	(0.001)
Log (sales)	0.002**			0.003***		
	(0.001)			(0.001)		
Female * log (sales)	0.001	-0.001	0.000	0.006***	0.004**	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Observations	569,444	568,494	428,580	1,521,720	1,516,515	960,278
R2	0.96	0.96	0.96	0.96	0.96	0.95
Federal State FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Match FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Year FE	No	Yes	Yes	No	Yes	Yes

Notes: The dependent variable is log daily wages in real values. All specifications includes the additional controls reported in Table 2. In columns (3) and (6), we use the logarithm of sales from export to approximate firms' export activity and domestic sales instead of total sales. The estimation samples include only white collar workers mainly engaged in Analytical non-routine tasks (columns 1-3) and Interactive non-routine tasks (columns 4-6). The data source is the LIAB dataset for years 1993-2007. Standard errors in parenthesis are clustered at firm level. *, ** and *** denote significance at the 10, 5 and 1% level respectively.

3 and reported in Tables 3 and 4, is likely to be driven by increases in wages of female workers employed in occupations in which interactive non-routine tasks are most intensively performed. Additionally, it seems that the widening of the gender wage gap in response to firms' exports expansion among blue-collar workers is mostly driven by manual routine occupations. However, we have seen that the estimated gender wage gap elasticities to export are not significant for blue-collar workers in general and, specifically, for the sub-group of manual routine workers.

These results seem to lend support to the comparative advantage channel in explaining the correlations between firms' export expansion and reduction in gender wage gap for (tenured) white-collar workers. As the firm expands its exports, it values more highly qualified workers performing non routine interpersonal jobs, for which women have a comparative advantage. This induces the firm to increase their wages, as for example to pay them for a production bonus or simply in order to retain them, thereby contributing to the closure of the gender wage gap.

5 Conclusions

International trade has long been considered as one of the main causes of the increase in income inequality, by favouring some workers and penalizing others. At the same time, investigation of the forces driving the gender wage gap - declining in the recent years, but still existent - has attracted the attention of academic economists and policy makers. However, the relationship between these two important trends has received little attention.

We contribute to filling this gap in the literature by investigating the role of firms' export activity on the gender wage gap, using matched employer-employee data on Germany for the 1993-2007 period. The structure of the dataset allows us to observe the changes throughout time in export sales of the single firm and the evolution of wages of all the workers employed by that specific firm. We exploit this feature of the data to estimate what we believe is the causal relationship between exports and the gender wage gap. Specifically, we focus on the same pair of female-male workers employed in the firm and look at the changes in their relative wages as the firm expands its export activity. This specification is likely to reveal the causal effect of export on the gender wage gap because it takes into account the possible sources of bias related to individual and firm characteristics, sorting and reverse causality issues.

Our first baseline estimates display the lack of effect of export on the gender wage gap on average. However, when we split the sample by workers' occupation, we find that an increase in export reduces the gender wage gap among white-collar workers and increases it by a similar amount among blue-collar workers.

When probing deeper into the mechanism behind this result, we find evidence supporting the hypothesis that export reinforces female comparative advantage in tasks considered more important by international firms, such as the non-routine interactive ones. In particular, we show that the results on the closing gender wage gap for white-collar workers are mostly driven by the sub-group of workers that perform more interactive non-routine jobs.

A limitation of our data is the lack of information on the number of hours worked by each employee. Availability of this variable would allow us, in future work, to estimate the effect of export on the intensive margin of the demand for labor at the worker-firm level and hence to further assess our proposed mechanism through gender comparative advantage.

The evidence in this paper provides some important insights. First, it highlights the role of trade as an opportunity for the reduction of the gender wage gap among non-production workers, but also as a threat especially for women in occupations for which they have a comparative disadvantage. Besides underscoring a so far overlooked determinant of gender disparities in earnings, this is relevant for policy makers, since it suggest for instance how to structure re-training programmes in such a way that globalization helps to reduce the wage gender gap for more women. Second, it contributes to the understanding of the sources of comparative advantage in trade models and suggests that the composition of the labor force by gender and occupation may matter for the aggregate performance of countries as exporters. Linking our micro evidence to aggregate outcomes seems therefore an interesting avenue for future research.

Appendix A Task Content of Occupations

The second source of information used in our analysis, in addition to LIAB, is the "Survey on qualification and working conditions" carried out by the German Federal Institute for Vocational Training (BIBB) and the Research Institute of the Federal Employment Service (IAB). The dataset consists of a repeated cross section of a random sample of workers covering 0.1 percent of the German labor force. It was conducted in 1979, 1986, 1992, 1999, 2006 and 2012 and we use it to classify occupations into groups according to their tasks' content. The detailed information on tasks performed in each job allows us to classify 15 longitudinally consistent tasks relating to what the worker does on the job following the methodology given in Becker and Muendler (2014). Once the tasks are correctly defined, each occupation is classified according to the following five categories defined by Spitz-Oener (2006), based on the intensity of activity performed on the job: 1) Manual-routine, 2) Manual non-routine, 3) Cognitive routine, 4) Analytic non-routine, 5) Interactive non-routine. The correspondence between occupation category and task is reported in Table A1.

Table A1: Tasks and Occupation Classification

Category	Task
Manual Routine	Manufacture, Produce Goods
	Transport, Store, Dispatch
	Oversee, Control Machinery and Techn. Processes
Manual Non Routine	Repair, Maintain
	Entertain, Accommodate, Prepare Foods
	Nurse, Look After, Cure
Cognitive Routine	Measure, Inspect, Control Quality
Analytical Non Routine	Gather Information, Develop, Research, Construct
	Program a Computer
	Apply Legal Knowledge
Interactive Non Routine	Purchase, Procure, Sell
	Advertise, Promote, Conduct Marketing and PR
	Organize, Plan, Prepare (others' work)
	Consult and Inform
	Train, Teach, Instruct, Educate

We follow Antonczyk, Fitzenberger and Leuschner (2009) and define the steps to classify each occupation by its task intensity as follows. First, we define a certain level of intensity of performance of activities belonging to task category c for individual i (employed in occupation k) at time t, by taking the ratio between the sum of all the activities performed by i that belong to category c and the sum of all activities performed by i across all categories. This represents an indicator of the intensity of activities performed by i in category c, and formally is defined as follows:

Table A2: Tasks and Occupation Classification: Examples

Task Index $_{c,k,t}$	Teacher			Baker		
	1992	**1999**	**2006**	**1992**	**1999**	**2006**
Manual routine	0.02	0.02	0.07	**0.73**	**0.37**	**0.31**
Manual non-routine	0.01	0.22	0.14	0.03	0.16	0.13
Cognitive routine	0.04	0.07	0.08	0.01	0.11	0.12
Analytical non-routine	0.11	0.15	0.24	0.05	0.04	0.13
Interactive non-routine	**0.82**	**0.54**	**0.47**	0.19	0.31	0.30

$$\text{Intensity Index}^c_{ikt} = \frac{\sum_a (\text{task } a \text{ in category } c)_{ikt}}{\sum_a (\text{all tasks } a)_{ikt}}.$$

Then, to obtain a measure of the intensity with which a certain category of tasks is performed within each occupation, we just average the Intensity Index^c across all individuals employed in occupation k. Formally, we obtain the following index:

$$\text{Task Index}_{c,k,t} = \frac{\sum_i \text{Intensity Index}^c_{ikt}}{N_k}.$$

Finally, we consider occupation k to belong to category c if the maximum value of Task Index$_{c,k,t}$ across all categories is attached to category c.

In Table A2 we provide an example of the values of the Task Indices defined above, Task Index$_{c,k,t}$, for two occupations, teacher and baker. We can see that in each year of the survey, teacher belongs to the interactive non-routine category and baker to manual routine. We can also notice that within strongly manual routine occupations, like baker, there is a substantial reduction of intensity of manual routine tasks throughout time, indicating the role of automation (see for example Cortes et al. (2018)).

Appendix B More Robustness Checks

In this Appendix we perform robustness checks to address additional concerns about our specifications and the identification strategy.

B.1 Wage Censoring

Concerns may arise from the censoring of wages. As explained in Section 2, the information on wages provided in the LIAB dataset is censored up to a contribution limit. Specifically, 13% of wages are censored in the whole dataset. This issue mostly affects white-collar workers, among which 33% of observations are censored, while it only affects 4% of observations in the group of blue-collar workers. Additionally, among white collars, the share of censored wages for male and female workers are respectively equal to 46.45% and 8.76%.

Therefore, if exports affected wages of men above the contribution limits, we would not be able to see its true effect, and our results on the closing gender wage gap among white-collar workers may be biased.

The approaches in the literature to deal with this issue are essentially two, one is to drop censored observations (see Baumgarten, Geishecker and Grg, 2013), and the other one is to impute a wage using a Tobit model for censored data (see Schank, Schnabel and Wagner, 2007). For now, we depart from these two approaches and deal with this problem differently.[26]

Specifically, we check whether our estimation of the impact of export on wages for white-collar workers is mostly captured by the censored observations. In practice, we estimate the following linear model on the sub-sample of white-collar workers:

$$\begin{aligned} \ln w_{ijst} = {} & \zeta_1 Exp_{jt} + \zeta_2 fem_i + \zeta_3 (fem_i * Exp_{jt}) + \zeta_4 cens_{i,t-1} + \zeta_5 (fem_i * cens_{i,t-1}) \\ & + \zeta_6 (cens_{i,t-1} * Exp_{jt}) + \zeta_7 (fem_i * Exp_{jt} * cens_{i,t-1}) \qquad \text{(A1)} \\ & + \mathbf{C}'_{it}\chi_1 + \mathbf{F}'_{jt}\chi_2 + \eta_{st} + \eta_{ij} + \varepsilon_{ijst} \end{aligned}$$

where, $cens_{i,t-1}$ is a dummy variable indicating whether the wage observation was censored at time (t - 1).

The model mimics specification (4), and the source of identification follows the main estimation strategy, which exploits variation of wages for workers staying within the same firm as it varies its exports over time. Similarly to what we do in Section 3.2, we estimate equation (A1) first approximating the firm's export activity with the export share and then with the log of export. We also estimate the model including firm-year fixed effects. The results of the estimation are reported in Table A3. In column (1) we show the estimates of the baseline estimation, in column (2) the estimates of the model specification with firm-year fixed effects, in column (3) we report the results only for the sample of exporting firms and in column (4) we report the estimates the relative wage elasticity to export and domestic sales obtained by using the log of export and of domestic sales.

[26] Given that our analysis focuses on the differential effects of trade on white and blue collar workers, and that a high share of wages of white collar workers is censored, we prefer not to drop these observations in order to not lose relevant information and estimation power. Additionally, we do not perform wage imputation because we would have to take into account in the procedure firms' export, given that it represents the focus of the analysis. Schank, Schnabel and Wagner (2007) face a similar problem and impute wages of white collar workers by draws of a random variable using a truncated distribution, by also considering firm level fixed effects in the imputation procedure. They find a slightly higher effect of export on wages when using imputed wages.

Table A3: GWG and Export - White Collar Wage Censoring

	(1)	(2)	(3)	Elasticity (4)
Log(Export)	0.007**			
	(0.003)			
Female * Log(Export)	0.008**	0.007*	0.012*	0.005**
	(0.004)	(0.004)	(0.007)	(0.002)
Censored wage at (t-1)	0.017***	0.013***	0.019***	0.022*
	(0.002)	(0.002)	(0.003)	(0.012)
Female * Censored wage at (t-1)	0.001	0.003	0.008*	0.015
	(0.003)	(0.003)	(0.004)	(0.021)
Log(Export) * Censored wage at (t-1)	-0.023***	-0.018***	-0.028***	-0.005***
	(0.004)	(0.003)	(0.005)	(0.001)
Female * Log(Export) * Censored wage at (t-1)	0.013**	0.011**	0.005	0.002*
	(0.006)	(0.005)	(0.006)	(0.001)
Female * Log(sales)				0.002
				(0.002)
Log(sales) * Censored wage at (t-1)				0.004***
				(0.001)
Female * Log(sales) * Censored wage at (t-1)				-0.002*
				(0.001)
Observations	1,594,300	1,590,341	1,061,936	988,091
R-sq	0.96	0.96	0.95	0.96
Federal State FE	Yes	No	No	No
Industry-Year FE	Yes	No	No	No
Match FE	Yes	Yes	Yes	Yes
Firm-Year FE	No	Yes	Yes	Yes

Notes: The dependent variable is log daily wages in real values. All specifications include the additional controls reported in Table 2. Censored wage is a dummy variable taking value 1 if the worker's wage at time t-1 was censored and zero otherwise. Sales denote domestic sales. The estimations are performed on the subsample of white collar workers. The data source is the LIAB dataset for years 1993-2007. Standard errors in parenthesis are clustered at firm level. *, ** and *** denote significance at the 10, 5 and 1% level respectively.

In all specifications, we find a positive and significant coefficient ζ_3, which implies that export is associated with a reduction of the gender wage gap for workers that are not affected by wage censoring. Additionally, we find a small and positive effect of export on wages for women affected by censoring and an slightly negative effect on men in the same category.[27]

The fact that we find an effect of export on gender wage gap for workers not affected by censoring that is in line with the main results, provide some confidence for the validity of our estimations, at least from a qualitative point of view.

B.2 Manufacturing Only

Exporters in our sample account for 66.5% of firms in manufacturing, and only for 17.6% in services. Our identification strategy, based on within-match variation in wage in response to within-firm changes in export, should not be biased by varying sectoral composition of firms and employment. Nevertheless, in this section we replicate the main estimations in Tables 2 and 3 on the subsample of manufacturing firms only. The results, reported in Table A4 are both qualititatively and quantitatively very close to those in Tables 2 and 3, suggesting that the effects of firm's export on the gender wage gap are the same across manufacturing and services.

B.3 Additional Specifications

In the main body of this paper we have shown that an increase in firms' export activity does not have any significant effect on the gender wage gap in total, but that it is associated to a significant increase in relative wages of female white-collar workers and to a significant decrease in relative wages of female blue-collar workers.

These results are obtained exploiting within-firm variation in export and within worker-firm matches variation in relative wages. We mainly focus on this level of detail because we want to capture the (closest to the) true causal relationship between these two variables. We believe that only looking at changes in the relative wages of a specific male-female pair of workers employed by the same firm as it increases its export activity eliminates important sources of bias related to firm heterogeneity in productivity or hiring process and workers' heterogeneity in innate ability.

However, to the best of our knowledge, most of the existing literature, with the exception of Bøler et al. (2018), uses sector and firm-level data, which only allow to exploit sector and firm level variation to investigate the relationship between export and gender wage gap. For example, Black and Brainerd (2004) and Saure and Zoabi (2014b), using sector level data on

[27] The effect of export on censored wages of female workers is given by the sum of coefficients ζ_1, ζ_3, ζ_6 the and ζ_7; while the effect on censored wages for male workers if given by $\zeta_1 + \zeta_6$.

Table A4: GWG and Export, Manufacturing Firms Only

	All Workers		**Blue Collar**		**White Collar**	
	(1)	(2)	(3)	(4)	(5)	(6)
Export share	-0.002		0.001		-0.009***	
	(0.006)		(0.007)		0.003	
Female * export share	0.001	0.006	-0.021***	-0.018**	0.018***	0.020***
	(0.006)	(0.005)	(0.008)	(0.008)	0.006	0.007
Log (total sales)	0.008***		0.009***		0.003***	
	0.002		(0.002)		0.001	
Female * log (total sales)	-0.001	0.001	-0.004	-0.003	0.006***	0.008***
	(0.002)	(0.002)	(0.003)	(0.002)	0.002	0.003
Observations	6,598,075	6,597,920	4,895,291	4,330,966	1,679,887	1,449,156
N Firms	3,520	3,491	3,475	2,299	3,281	2,182
R-sq.	0.94	0.946	0.927	0.936	0.94	0.94
Federal State FE	Yes	Yes	Yes	Yes	Yes	Yes
Iector-Year FE	Yes	No	Yes	No	Yes	No
Match FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Year FE	No	Yes	No	Yes	No	Yes

Notes: The dependent variable is log daily wages in real values. All specifications includes the additional controls reported in Table 2. The data source is the LIAB dataset for years 1993-2007. The coefficients in colunms (1)-(2) are estimated on the full sample of workers , those in (3)-(4) and (5)-(6) on the subsamples of blue collar and white collar workers, respectively. Employees switching between occupations are excluded from the latter two samples. All samples only include workers matched with firms in manufacturing industries. Standard errors in parenthesis are clustered at firm level. *, ** and *** denote significance at the 10, 5 and 1% level respectively.

the US, find contrasting results on the role of international trade in the gender wage gap. In Black and Brainerd (2004) trade liberalization is interpreted as an increase in competition on the labor market which, under the assumption that firms operate in a non competitive market and adopt a costly discriminatory behaviour against female workers, leads to a reduction in the gender wage gap. On the contrary, Saure and Zoabi (2014b) show that trade liberalization widens the gender wage gap. They motivate their findings by modelling the labor market under the assumption of a strong complementarity between female labor and capital intensive technology. After a trade shock, the capital sector expands, attracting male workers from the labor intensive sector, thereby reducing the capital-labor ratio and increasing the gender wage gap. Additionally, Ozler (2000), exploiting firm level data on Turkey, finds a positive correlation between firm level demand for female workers and export activity. Ederington et al. (2009) further confirms that the demand for female workers increases in firms that operate in industries that experience more relevant tariff reductions in Colombia. Finally, Juhn et al. (2014) show that women in blue-collar occupations in Mexico experience an increase in their relative wages after a cut in tariffs, while white-collar women remain largely unaffected by such policy.

To be able to compare our results to the existing literature, in this section we estimate the relation between export and gender wage gap exploiting only within-sector and within-firm source of variation in the data. Specifically, we estimate on the whole sample and then on the sub-samples of blue and white-collar workers the following linear regression models:

$$\ln w_{ijst} = \beta_0 fem_i + \beta_1 Exp_{jt} + \beta_2 fem_i * Exp_{jt} + \mathbf{C}'_{it}\pi_1 + \mathbf{F}'_{jt}\pi_2 + \varepsilon_{ijst} \quad \text{(A2)}$$

$$\ln w_{ijst} = \beta_0 fem_i + \beta_1 Exp_{jt} + \beta_2 fem_i * Exp_{jt} + \mathbf{C}'_{it}\pi_1 + \mathbf{F}'_{jt}\pi_2 + \eta_{st} + \varepsilon_{ijst} \quad \text{(A3)}$$

$$\ln w_{ijst} = \beta_0 fem_i + \beta_1 Exp_{jt} + \beta_2 fem_i * Exp_{jt} + \mathbf{C}'_{it}\pi_1 + \mathbf{F}'_{jt}\pi_2 + \eta_{st} + \eta_j + \varepsilon_{ijst} \quad \text{(A4)}$$

where, w_{ijst} represents the wage of individual i in firm j in sector s at time t; fem_i is a dummy variable equal to 1 if the worker is a woman and Exp_{jt} represents the share of exports on total sales of firm j at time t. Matrix $\mathbf{C}_{it}$ contains vectors of individual characteristics of individual i at time t, such as education, experience and its square, a dummy variable for white collar and German citizenship. Matrix $\mathbf{F}_{jt}$ contains a vector of firms' characteristics, like the (log of) the number of firms' employees, and fixed effects for the federal state in which the establishment is located. Specification (A3) further includes a set of fixed effects for sector-year denoted as η_{st} and in specification (A4) we add firm fixed effects η_j. The results of the estimation of the three equations for the whole sample are reported in Table A5, respectively in column (1), (2) and (3).

The estimation of specification (A2) shows that women are paid on average 26% less than men, and that firms that export more pay their male employees higher wages and are characterised by a lower gender wage gap. This specification compares the size of the gender wage gaps in firms with different export shares that operate in different sectors of activity. The estimation of the correlation between the gender wage gap and export is then likely to be biased by sector-level heterogeneity. For example, if export-oriented firms are concentrated in sectors that systematically employ more female workers, it will also reflect the difference in the gender composition of the workforce in addition to the true effect of export.

This possible source of bias is taken into account in specification (A3), in which sector-year fixed effects are included. In this case, the estimation of the gender wage gap exploits within sector (and year) variation of firms' export activity. Specifically, it allows us to compare the gender wage gap of different firms with different export shares that operate within the same sector of activity. The results for this specification are reported in column (2) and show that being employed in a firm that has a 1 percentage point higher export share is associated to a 0.028% increase in salary for male workers, and to a 0.093% reduction in the gender wage gap.

Table A5: Export Share and GWG, Other Specifications

	(1)	(2)	(3)
Female	-0.259***	-0.233***	-0.204***
	(0.006)	(0.005)	(0.003)
Export Share	0.097***	0.028***	-0.008*
	(0.012)	(0.009)	(0.005)
Female * Export Share	0.139***	0.093***	0.062***
	(0.014)	(0.013)	(0.01)
Experience/10	0.234***	0.238***	0.218***
	(0.005)	(0.004)	(0.004)
Experience sq./100	-0.041***	-0.045***	-0.041***
	(0.002)	(0.001)	(0.001)
White collar	0.173***	0.180***	0.160***
	(0.004)	(0.004)	(0.003)
German	0.025***	0.019***	0.023***
	(0.003)	(0.002)	(0.001)
Medium skill	0.133***	0.122***	0.106***
	(0.004)	(0.003)	(0.002)
High skill	0.351***	0.324***	0.284***
	(0.007)	(0.006)	(0.005)
Log (firm size)	0.044***	0.036***	-0.001
	(0.002)	(0.002)	(0.004)
Observations	10,613,493	10,613,493	10,613,305
N firms	14,757	14,757	14,569
R-sq	0.479	0.524	0.634
Federal State FE	Yes	Yes	Yes
Industry-Year FE	No	Yes	Yes
Firm-Year FE	No	No	Yes

Notes: The dependent variable is the log of daily wage of full-time employees subject to social security in Euros (at 2000 prices). Firm size represents the average number of full time employees in the firm during the year. Total sales refers to turnover in Euros (at 2000 prices). Experience refers to the number of years of labor market experience. White collar, German, Middle Skill, and High Skill are dummy variables. Middle Skill denotes workers with vocational training, High Skill denotes workers with university degree. Industries are defined at the 2-digit level. The coefficients are estimated with OLS on the sample of matched employees and establishments from the LIAB dataset. Standard errors in parenthesis are clustered at firm level. *, ** and *** denote significance at the 10, 5 and 1% level respectively.

If we compare this result to the one in column (1) we notice that the relative female-male wage response to an increase in export is lower when we control for sector-year fixed effects, confirming the (upward) bias in the coefficient estimated in the first specification.

The results for equation (A4), in which we add firm fixed effects to the baseline specification, are reported in column (3), and confirm the estimation results for equations (A2) and (A3), showing a negative correlation between export and gender wage gap. The coefficient of interest, β_2, in this case is smaller than in specification (A3), indicating an additional source of bias, possibly due to the different gender workforce composition between firms within sectors.

The estimation results for the sub-samples of blue-collar (columns (1)-(2)-(3)) and white-collar (columns (4)-(5)-(6)) workers are reported in Table A6. It is interesting to notice that, in contrast with the results we found in the main text, when exploiting only within-sector and within-firm source of variation in the data, both blue collar and white-collar female workers see their relative wages increase in conjunction with a rise in firms' export.

These results confirm what was found in previous papers (e.g. Juhn et al., 2014), but also, when compared to the results obtained in this work using the main identification strategy that exploits within match source of variation, indicate the key importance of workers' characteristics in driving the results. When these characteristics are taken into account, the correlation between relative female-male workers' wages and export is in fact much smaller and becomes negative in the case of blue-collar workers (see Table 3). This result provides some evidence for the assortative matching theory, which states that firms select higher ability workers as they intensify export and pay them higher wages (Helpman, Itskhoki and Redding, 2010).

Table A6: Export Share and GWG by Occupations, Other Specifications

	Blue Collar			White Collar		
	(1)	(2)	(3)	(4)	(5)	(6)
Female	-0.283***	-0.245***	-0.191***	-0.241***	-0.225***	-0.200***
	(0.009)	(0.007)	(0.004)	(0.006)	(0.005)	(0.004)
Export Share	0.097***	0.035***	-0.002	0.089***	-0.001	-0.012**
	(0.013)	(0.01)	(0.006)	(0.015)	(0.011)	(0.005)
Female * Export Share	0.161***	0.096***	0.043***	0.152***	0.115***	0.055***
	(0.022)	(0.018)	(0.01)	(0.017)	(0.016)	(0.016)
Experience/10	0.214***	0.213***	0.194***	0.283***	0.289***	0.270***
	(0.006)	(0.004)	0.004	(0.006)	(0.005)	(0.005)
Experience sq./100	-0.036***	-0.038***	-0.036***	-0.054***	-0.058***	-0.053***
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
German	0.024***	0.018***	0.024***	0.015**	0.000	-0.002
	(0.003)	(0.002)	(0.002)	0.006	0.004	0.003
Medium skill	0.141***	0.124***	0.103***	0.065***	0.065***	0.071***
	(0.004)	(0.003)	(0.002)	0.008	0.007	0.006
High skill	0.416***	0.395***	0.342***	0.288***	0.263***	0.243***
	(0.008)	(0.007)	(0.006)	0.011	0.009	0.008
Log (firm size)	0.046***	0.036***	0.008	0.039***	0.040***	-0.007**
	(0.003)	(0.002)	(0.005)	0.002	0.002	0.003
Observations	7,398,664	7,398,658	7,398,215	3,214,829	3,214,828	3,214,114
N firms	13,052	13,052	12,609	13,222	13,221	12,507
R-sq	0.42	0.48	0.62	0.47	0.52	0.63
Federal State FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	No	Yes	Yes	No	Yes	Yes
Firm-Year FE	No	No	Yes	No	No	Yes

Notes: The dependent variable is the log of daily wage of full-time employees subject to social security in Euros (at 2000 prices). Firm size represents the average number of full time employees in the firm during the year. Total sales refers to turnover in Euros (at 2000 prices). Experience refers to the number of years of labor market experience. White collar, German, Middle Skill, and High Skill are dummy variables. Middle Skill denotes workers with vocational training, High Skill denotes workers with university degree. Industries are defined at the 2-digit level. The coefficients are estimated with OLS on two subsamples of matched employees and establishments from the LIAB dataset. In columns (1)-(3), only blue collar workers are included; in columns (4)-(6), only white collar workers are included. Standard errors in parenthesis are clustered at firm level. *, ** and *** denote significance at the 10, 5 and 1% level respectively.

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