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Global interactions and the ‘twin’ gender gaps in  
employment and wages: evidence from Vietnam

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European University Institute

**Robert Schuman Centre for Advanced Studies**

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## **Abstract**

In this paper we investigate the role of firms with global ties – foreign firms and exporters – in shaping the ‘twin’ gender gaps in employment opportunities and wages in Vietnam for both skilled and unskilled workers. Our analysis shows that foreign firms contribute by boosting employment opportunities in the formal sector for unskilled female workers. Although foreign firms, and in particular exporters, pay lower average wages to unskilled workers – both male and female – we find evidence that they significantly contribute in narrowing the gender wage gap. The presence of foreign firms has, meanwhile, only limited effects on gender gaps in employment for skilled workers. Finally, we show that the negative gaps in wages are entirely due to differences in productivities between female and male workers. Not only do we reject the hypothesis of discrimination, but we find evidence of sizable wage subsidies (for unskilled female workers)

## **Keywords**

Gender inequality; gender discrimination; FDI; Globalization; Vietnam



## 1. Introduction

Closing the gender gap in economic opportunities remains a priority for policymakers in poor and middle-income countries. Globally the average gap in labour-force participation between male and female was, in 2015, 26.6 percent, while the wage gap for the same period was around 16 percent (UNHLP 2016). Poor countries in Southern Asia and Sub-Saharan Africa have the worst levels of gender inequality. From an economic perspective, gender inequality has a negative impact on economic growth. Aguirre et al. (2012) estimated a potential increase in GDP *per capita* by 34 percent in Egypt, 27 percent in India and 5 percent in China in a hypothetical alternative world in which the male and female employment rate was equal. Moreover, the limited access of females to employment opportunities, especially skilled jobs, represents a colossal waste of human resources and talent that would be essential for countries in the early stages of development (Hsieh et al. 2013).

Globalisation, by increasing economic interactions, affects gender inequality in the labour market. In this paper we investigate how and to what extent the participation in the global production network affects gender imbalances in employment opportunities. We are interested in understanding the role that ‘global’ firms – multinational enterprises (MNEs) and exporters – might have in offering opportunities to close the ‘twin’ gaps in employment rates and in wages.

Recent contributions have investigated how MNEs affect gender inequalities in the labour market. Chen et al. (2013) find that foreign firms in China, in particular those dedicated to export, are more likely to hire women, but the gender wage gap is significantly larger compared to domestic ones. These authors do not find evidence of discrimination as the lower wages offered to female workers reflect gender productivity differentials. In Japan, meanwhile, Kodama et al. (2018) find that foreign affiliates employ a higher share of female workers at all skill levels as compared to domestic firms, and also that these firms create more woman-friendly conditions in the workplace.

This paper is focused on Vietnam, a country which has experienced a large and sustained inflow of FDI since the opening up of its economy in 1986 (Doi Moi period). Vietnam has also experienced growing involvement in Global Value Chains (GVCs), though mostly in peripheral<sup>1</sup> and low-skill intensive tasks. Our analysis exploits a rich firm-level dataset developed by UNIDO (2012), the Vietnam Industry Investor Survey (henceforth VIIS 2010). This data set contains detailed information on a representative sample of foreign and domestic firms. The present study contributes to the existing literature in several ways. Firstly, it documents the different propensity of foreign firms and exporters to generate employment opportunities for female workers at various levels of skills. Secondly, it contributes to the debate on the relation between global interactions and gender inequality in developing countries.

We build on recent contributions by Chen et al. (2013) and Dong and Zhang (2009) but we are able to go further and to investigate the role of global firms in affecting gender inequalities by skill level (skilled and unskilled workers). We find evidence that global firms – foreign firms and exporters – are more likely to hire female employees in low-skill positions. Our results suggest that participation in global production and trade networks contributes to boosting the number of employment opportunities in the formal sector for low-skill women in labour-intensive and export-oriented manufacturing (Braunstein 2006; UNCTAD 2014). When considering gender wage gaps, our results highlight a heterogeneous effect for global firms on skilled and unskilled female workers. For *skilled workers*, we find a wage premium associated with foreign firms which does not depend on the share of skilled female in the labour force. This result implies that MNEs do not substantially alter the existing gender wage gap for skilled workers (our estimates show that skilled female workers earn between 60-67% of

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<sup>1</sup> By ‘peripheral’ position in a Global Value Chain we mean specialization in tasks of the production process that are distant from final consumption and concentrated in production phases which add limited value added to the final goods.

the salary earned by skilled male workers). We also show that lower wages among skilled female workers can be satisfactorily explained by productivity differences rather than by pure discrimination.

Although MNEs (and exporters) pay lower average wages for *low-skilled workers* – both male and female compared to domestic firms – our result suggests that this negative premium turns positive for high shares of female in the workforce. In other words, when controlling for other firms' characteristics foreign firms pay significantly higher wages to female worker, thus, reducing the gender wage gap. Global firms, in particular MNEs, can play an important role in generating sizable employment opportunities for unskilled female workers and, at the same time, can help in reducing the gender-wage gap. Most importantly, these processes are usually accompanied by a structural transformation as these jobs are siphoned out of the informal, low-productivity sector.

The paper is organised as follows. In *Section 2* we provide a brief and selective discussion of the existing literature on global interactions and gender inequality in the labour market. In *Section 3* we analyse the different propensity to hire female workers between foreign firms, exporters and other firms. In *Section 4* we focus on the gender wage gap by skill level. We carry out two separate empirical exercises. Firstly, we investigate how the differences in average wages between MNEs and domestic firms are affected by the share of female workers. Secondly, using a novel methodology we test whether the observed gender wage gaps for the different groups of firms are due to discrimination against female employees or to lower productivity. Some concluding remarks are reported in *Section 5*.

## **2. Global interactions and the gender gap in employment and wages: a selective review**

The literature has identified several channels through which global economic interactions affect gender inequality in the labour market. FDI and trade liberalization generate additional employment opportunities for female workers, closing the labour participation gap between men and women. Efficiency-seeking FDI and export-oriented industries tend to employ a large number of female workers, to save on labour costs (Braunstein 2006, Nordas 2004, Ozler 2000, Joeckes 1999). In addition to cost advantages according to Elson and Pearson (1981) foreign investors and labour-intensive exporters perceive female workers as being a better choice as they are less prone to worker unrest, more reliable, and more easily trained than men. However, adverse effects on female employment might, also, be experienced as firms that are highly engaged in global production networks are more likely to be at the technological frontier and to use new production technologies (for instance through production line automation): these are likely to decrease the usage of manual tasks (often performed by female workers in labour-intensive industries). Kuchera and Tejani (2014) find that employers prefer man for more technologically-sophisticated jobs. Though this issue is controversial (Weinberg 2000), a gender-biased technological shift in favour of male workers is more likely to happen in developing countries due to initial high gender gaps in education and training (WEF 2017).

If a sizable gender wage gap and wage discrimination against female predominates in the labour market expanding female employment only produces marginal effects on social and economic well-being. There is a wide consensus in the literature that foreign firms pay higher wages to their employees as compared to domestic firms (Aitken et al. 1996, Lipsey 2004). The higher wages paid by foreign firms spill over to domestic firms and produce a positive effect on the economy at large (Elliott and Zhou 2015). The main channel is through the increase in labour demand.

FDI inflows and trade liberalisation may affect the relative demand of male/female and skilled/unskilled workers differently, and, therefore, induce changes in relative wages by gender. Foreign investments in labour-intensive sectors in developing countries, abundant in female low-skill workers, may increase female wages and reduce the gender wage gap in low-skill occupations. The effect on wages will be higher as long as male labour is not a perfect substitute for female labour. For

instance, in light manufacturing industries (textile, garments) or assembly, women are preferred over men, as they are more productive and better able to perform repetitive manual tasks (Elson and Pearson 1981). The extent to which demand affects the wage gap also depends on labour-market characteristics (e.g. socio-economic factors affecting the supply of labour) and other country-specific conditions. Fussell (2000) argues that in Mexico, foreign firms are attractive for workers, in a country with high population growth and a large informal sector, and not necessarily because of higher wages.

Another concern is that globalisation may weaken the bargaining power of female workers who find themselves segregated in labour-intensive and export-oriented industries (Seguino 2000, Braunstein and Brenner 2007). The increased mobility of firms may increase the precariousness of female jobs and may limit their ability to bargain for higher wages (Seguino 2005). Moreover, as women have also household and childcare responsibilities, firms engaged in competitive environments (e.g. exporting firms) tend to see them as being less committed to work and consequently pay lower wages for women than for men in the same job (Boler et al. 2015).

Gender inequality in the labour market may be caused by employers' prejudices against female workers; "taste-based discrimination". Globalization arguably reduces gender discrimination in at least two ways. First, as suggested by Becker (1957), rising competition in the labour market may discourage employers from discriminating against workers on anything other than their productivity: as these firms may be pushed out of business. Chen et al. (2013), for China, using a firm-level analysis, explicitly test the competition channel by examining the impact of the regional foreign presence and the regional export orientation on the gender wage gap. They show that the foreign presence and that the presence of export industries reduce the gender wage gap by intensifying competition within the local labour markets.

Black and Brainerd (2004) for the US, test the hypothesis that competition from trade reduces gender-based discrimination more in those industries that are less exposed to such competition. They find that, after an increase in international trade over the period 1976-1993, the residual gender wage gap narrowed more rapidly in concentrated industries compared to industries facing more competition. In much the same way, Artecona et al. (2002) compared the wage differential before and after a period of trade liberalization (1987-1993) in Mexico and find that competition benefited women by decreasing wage discrimination. Besides closing the gender wage gap, increasing competition following trade liberalization produce a quantitatively large effect on female employment as well (Ederington et al. 2009).

Secondly, globalization serves as a catalyst for cultural change in the labour market. This is relevant in developing countries characterized by high gender disparities and where FDI flows from (developed) countries with more gender friendly norms. Tang and Zhang (2016) find that foreign affiliates located in China controlled by MNEs whose countries' culture is more favourable to women tend to hire more female workers and to generate cultural spillover at destination. They find evidence that domestic firms respond to increased FDI by employing more female workers. Focusing on Japan, Kodama et al. (2018) discovered that not only foreign affiliates employ a higher share of female workers at all skill levels as compared to domestic firms, but that these firms also create more woman-friendly conditions in the workplace.

There exist few empirical studies analysing the nexus between globalisation and gender inequality in Vietnam. The paper by Fukase (2014) investigates the impact of foreign ownership on wages for different types of workers in Vietnam (in terms of educational attainment and gender) using the Vietnam Household Living Standards Surveys (VHLSSs) for the years 2002 and 2004. Her analysis applies a modified Mincerian equation to account for the individual's human-capital characteristics that influence wages but neglects the firm-level characteristics that do affect average wages as well. Low educated women in Vietnam experience, according to her findings, a larger wage premium while working in foreign firms as compared to male counterparts and relative to the informal sector.

### 3. Foreign firms, global-market orientation and jobs opportunities for female workers

#### *Data and methodology*

We employ the VIIS (2010) dataset which contains detailed information on a cross-section of domestic and foreign firms – respectively 472 and 763 – located in nine Vietnamese provinces that attracted the bulk of FDI inflows in the country. Given the importance of State Owned Enterprises (SOEs) in Vietnam we consider, among domestic firms, these firms as a separate category (237 observations). The sampling of firms was based on the Business Register maintained by the General Statistics Office (GSO) of Vietnam. The stratified sampling, build upon four main dimensions of the firm: industry, size, capitalization, and province of operations. This stratification guarantees the representativeness of the population of firms in terms of ownership (domestic enterprises, foreign enterprises and state-owned enterprises). Given the specialized questions contained in the questionnaire, the data was collected through face-to-face interviews with top-level managers and the firm's specialized staff (see UNIDO and MPIV 2012 for more information). The VIIS data set includes detailed information on firms' internationalisation strategies, as well as a rich set of information on a wide array of firm characteristics, financial data, and investment performance indicators (more than 700 variables). Firms mainly operate in the manufacturing sectors (95%), followed by the construction sector (3.5%) and the public utilities sector (1.5%)<sup>2</sup>. For each firm the data set contains the number of female workers and the number of full-time employees<sup>3</sup> belonging to the following three categories; (i) production workers; (ii) clerks and administrative staff; (iii) technicians and supervisory staff; and (iv) managers. *Table 1* shows the descriptive statistics of the data for the categories of domestic firms, foreign firms, SOEs and exporters.

Female workers comprise 54% of the foreign firms' workforce and 51% of the exporters workforce, whereas this share is significantly lower in domestic firms (39%) and SOEs (35%). The share of low-skill female workers as a part of the total low-skill workforce is significantly higher in foreign firms (54%), while exporters employ the highest share of highly-skilled female workers (53.6%). The average wage of low-skill workers is significantly lower in foreign firms. All typologies of firms pay comparable wages to highly-skilled workers, except SOEs which pay, on average, 17% lower wages to this typology of workers. There also exist some relevant differences in firm's characteristics. Foreign firms are larger and are much more capital and technological intensive compared to domestic firms. More than half of the foreign firms operate in export processing zones and their production is mainly exported.

Approximately 60% of the firms belong to the following four sectors: 1. coke and refined petroleum, chemicals, plastics and rubber & non-metallic mineral products; 2. textiles, garments & leather; 3. electro-mechanical machinery & equipment; and 4. basic metals & fabricated metal products. *Figure 1* shows the distribution of female employment across sectors by typology of firms. Labour-intensive sectors such as "Textiles, garments & leather" and "Electro-mechanical machinery & equipment" employ the highest share of female workers. Foreign firms operating in these sectors show a higher employment of female as compared to domestic firms. Firms operating in the public utilities sector show the lowest usage of female workers whereas this is the only sector in which SOEs employ a highest share of female workers as compared to foreign firms. The picture does not change much, when we consider the distribution of the share of female low-skill employment across sectors by typology of firms (*Figure 2*). In this distribution, even in the public utilities sector, SOEs seem to employ less female workers compared to foreign firms.

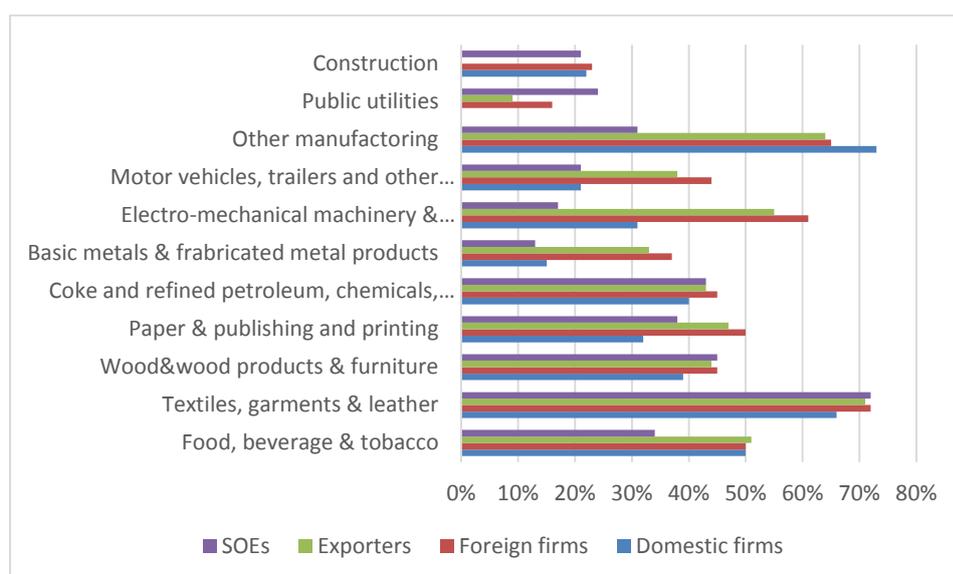
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<sup>2</sup> We estimate our models considering all the sectors. Results do not change significantly when including in the estimations only firms operating in the manufacturing sectors. The later results are available upon request.

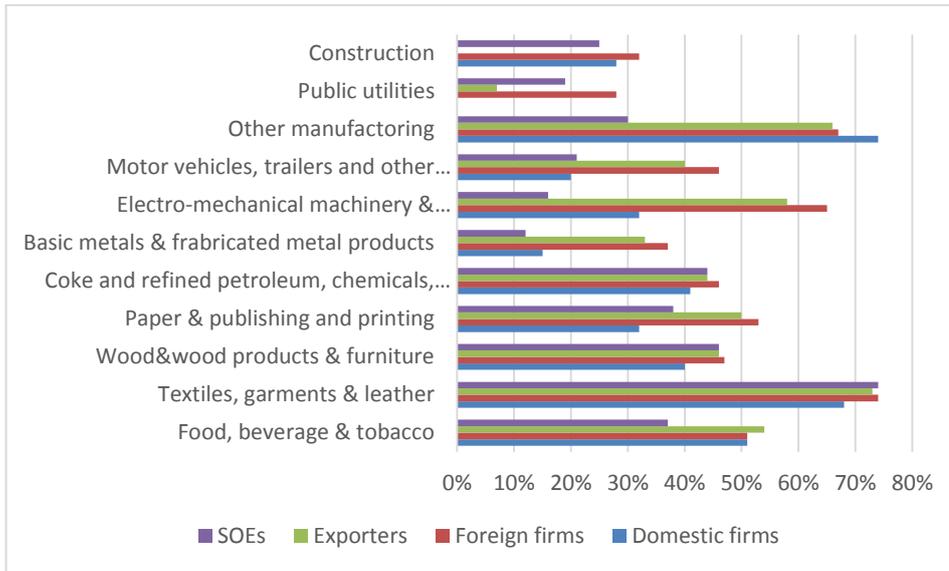
<sup>3</sup> In this paper we focus on full-time workers as the use of part-time workers is relatively limited for the firms included in VIIS data.

TABLE 1. Summary statistics								
	<u>Domestic firms</u>		<u>Foreign firms</u>		<u>SOEs</u>		<u>Exporters</u>	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
<b><u>Dependent variables</u></b>								
Total female share (%)	39.2	25	53.7	26	34.7	23	51	26
Female low-skill/total low-skill (%)	38	29	54.5	29.3	33	27	34	24
Female high-skill/total high-skill (%)	29	21	34	24.8	29.5	20	53.6	27.5
Average monthly wage low-skill (US\$)	262	708	141	100	225	416	183	424
Average monthly wage high-skill (US\$)	419	758	420	433	347	183	422	505
<b><u>Other variables</u></b>								
Average number of workers	377	558	700	1421	617	876	687	1311
Skilled workers/total workers (%)	14	11	12.4	11.2	19.7	13	12.5	10
Size (total output; log)	15.2	1.6	15.6	2.2	16	1.6	15.6	2.05
ICT value/total workers (.000 US\$)	0,14	0.48	10.2	165	0.49	2.3	7,79	144
Capital/ total workers (.000 US\$)	11.3	16.9	642	1340	20	51.2	490	1170
Firm's age (years)	15	12.8	9.9	4.7	24.8	15	12.5	9.5
Industrial Zone (%)	4.2	20	55	50	4.3	20	4	49
Export share (%)	30	40	65	40	17	30	63.4	39.5
Global market orientation (%)	37	48	73	44.5	27	44.7	73.7	44
<b>Observations</b>	<b>331</b>		<b>730</b>		<b>183</b>		<b>955</b>	
Source: UNIDO & MPIV (2012)								

FIGURE 1. Female employment rate across sectors and typology of firms



**FIGURE 2. Employment rate of low-skill women across sectors and typology of firms**



In the first step of our analysis we look at the different propensities to hire female workers between foreign and domestic firms. We employ the following empirical specification:

$$\text{LogFemaleShare}_i = \beta_0 + \beta_1 \text{Ownership}_i + \beta_3 \text{Export} + \beta_3 X_i + \phi_{is} + \phi_{ip} + \varepsilon_i \quad (1)$$

Our main dependent variable is the *logarithm of the share of female full-time workers* over the total number of full time workers in firm  $i$ ,  $\text{LogFemaleShare}_i$ . In addition, we consider the gender composition of the workforce by skill level – i.e. low and highly-skilled positions. We define high skilled workers as those belonging to the categories of technicians, supervisory staff and managers. Production workers and clerks are considered as low-skill workers. We use a OLS method with robust MM estimator (Verardi and Croux 2009) to estimate our coefficients of interest. *Table 1* displays some summary statistics of the dependent and independent variables employed in the estimates.

Our main explanatory variables are included in the vector  $\text{Ownership}_i$ , which contains a set of self-exclusive dummies capturing the ownership structure of the firm. It includes the dummy  $\text{MNE}_i$ , equal to one if the firm is foreign-owned and the state does not own any shares, and 0 otherwise; the dummy  $\text{Domestic}_i$ , equal to one if the firm is domestically-owned and the state does not own any shares, and 0 otherwise (reference category); the dummy  $\text{SOE}_i$ , equal to 1 if the state owns any share of the firm, and 0 otherwise. We considered the SOE typology based on previous studies which show that state-owned firms follow different recruitment rules and norms and are also less likely to discriminate based on gender (Chen et al. 2013, Dong and Zhang 2009). We are also particularly interested in the degree of internationalization of firms through trade as recent contributions have found a positive relationship between exports and the feminization of the workforce in developing and transition economies (Ozler, 2000; Chen et al. 2013). To this end we employ two alternative covariates in order to account for the higher propensity of export-oriented firms to hire female employees: i) *global market orientation*, which is a dummy variable equal to 1 when the firms' final consumers are mostly located in foreign markets; ii) *export shares*, defined as export value over total turnover. Given the importance of direct and indirect-exports through participation in global supply chains (GVCs), we also add a dummy variable (*Industrial Zone*) equal to 1 when the firm operates in the Industrial/Export processing zone. Following the example of other Asian countries (prominently China), industrial zones have been an important policy tool used by the Vietnamese government to attract foreign investors and to link

domestic suppliers to GVCs. To the best of our knowledge, few studies have investigated the gender dimension of labour demand generated by firms located in industrial zones (see Glick and Roubaud 2006).

Additional firm-level covariates are included in vector  $X_i$ . In particular, we control for the degree of automation in production and technology which affects, at the firm level, the demand for physically-demanding tasks (Juhn et al. 2014). To this end, we use the variables *Capital intensity* (logarithm of fixed assets on total assets), *ICT intensity* (ICT assets per employee lagged one year) and *Skill intensity* (number of skilled employee on total employees) (Chen et al 2013). We also include the *age* (log of the years since its establishment) and the *size* of each firm (log of the output value).

Finally, we include *sector fixed effects*,  $\phi_{is}$ , as well as *province fixed effects*,  $\phi_{in}$ , to control for unobserved additional factors that might affect firms' incentive to hire women in different industries and across the different provinces.

### Empirical results

The results of our regressions are reported in *Table 2*. In models 1 and 2— where our dependent variable is the female share of total employment – we find a positive and highly significant coefficient of the dummy *MNE*, suggesting that foreign firms employ a higher share of female workers as compared to domestic firms (the magnitude of the effect is between +4.3-5.8% depending on the specification). Our results suggest – in accordance with the study of Chen et al. (2013) on China – that foreign firms in Vietnam generate sizable employment opportunities for female workers in the formal sector even after controlling for a large set of the firms' characteristics.

A higher export orientation – measured either with the dummy global market orientation or in terms of export share – is positively associated with the share of women in total employment. To investigate if foreign and SOE exporters differ from domestic exporters, we insert in our model the interaction between *MNE*, *SOE* and *export share*. We find robust indication that the higher usage of low-skill female employees by foreign firms is moderated by the export intensity. A possible explanation for this result could be the relative lower productivity of low-skill women as compared to low-skill men (see the analysis reported in *Table 4*, *Model 6* below). Foreign firms with a high export intensity are very likely to be part of highly competitive GVCs which face higher pressures for higher standards of product and process quality. Our result can be due to the fact that these firms face a relatively higher opportunity cost in employing low-skilled-low-productivity female workers. We observe an interesting positive association between firms' location in Industrial Zones and female employment shares. The feminization of the labour force is weaker in capital intensive firms (Tejani and Milberg 2010). This result suggests that the complementarity (or substitutability) between factors of production – capital and labour – is heterogeneous by gender. Investments in production automation have a negative impact on the need for manual and repetitive tasks that female workers generally perform in labour-intensive firms.

Along these lines, we observe that more *skill-intensive firms* have a lower share of female workers. This might be explained either by a lower demand of highly-skilled female workers or by a lower average of educational attainments/skill level of the female component of the Vietnamese labour force.<sup>4</sup> Larger firms employ lower shares of female employees, while the age of the firm is not significantly associated with the share of female workers.

In model 3(4) of *Table 2*, we employ as dependent variables the shares of *skilled (unskilled) female* out of total skilled (unskilled) employees. The higher propensity of foreign firms to hire female

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<sup>4</sup> Among developing countries, Vietnam presents a relatively balanced educational system. Literacy rates and enrolment in primary and secondary education are only slightly lower for women with a female-to-male ratio of approximately 0.95-0.96. A larger gap characterizes participation in tertiary education (female-to-male ratio of 0.73). WEF (2014)

workers compared to domestic ones is entirely explained by the greater employment of unskilled female workers. No gender differences are found in the employment of skilled workers (see model 3). It is worth considering that the export intensity of firms is positively associated with the use of both skilled and unskilled female workers, though the magnitude of the effect is larger for unskilled women. As export-oriented firms are highly sensitive to wages and more exposed to international competition, a higher share of female workers might be the direct result of the gender wage gap (Ozler, 2000; Seguino, 2005).

**TABLE 2. Female employment, foreign firms and SOEs versus domestic firms**

VARIABLES	Model (1)	Model (2)	Model (3)	Model (4)
	Log (Total female/total workers)		Log (Skilled female/ Total skilled)	Log (Unskilled female/ Total Unskilled)
MNE	0.084***(0.024)	0.0584***(0.012)	0.032(0.021)	0.091***(0.026)
SOE	-0.0023(0.0203)	-0.016(0.015)	-0.002(0.013)	-0.010(0.025)
Export share	0.0018***(0.0002)		0.0009***(0.0002)	0.0019***(0.0003)
MNE* Export share	-0.0007**(0.0003)		-0.0002(0.0003)	-0.0008***(0.0003)
SOE* Export share	-0.0001(0.0005)		-1.53e-05(0.0005)	0.0001(0.0005)
Global market orientation		0.103***(0.012)		
Industrial Zone	0.033***(0.010)	0.0256**(0.010)	0.029(0.018)	0.0368***(0.011)
Capital intensity (Log)	-0.0065**(0.003)	-0.0077***(0.002)	-0.022***(0.005)	-0.0053*(0.003)
ICT intensity (Log)	-0.001(0.002)	-0.0013(0.002)	0.0037(0.002)	-0.002(0.002)
Skill intensity	-0.169***(0.056)	-0.210***(0.042)	0.179***(0.060)	-0.133*(0.076)
Output (Log)	-0.0046*(0.002)	-0.0038(0.002)	0.004(0.004)	-0.005**(0.002)
Age (Log)	0.003(0.009)	-0.0107(0.008)	0.0054(0.0102)	9.64e-05(0.010)
Sector fixed effects	YES	YES	YES	YES
Province fixed effects	YES	YES	YES	YES
Constant	0.483***(0.062)	0.539***(0.053)	0.340***(0.078)	0.502***(0.063)
Observations	1,244	1,440	1,240	1,243

Estimations using MM OLS method. Dependent variable: Log share of female employees on of total workforce in the firm and female share by skill. Reference category is domestic firms. Standard errors in parentheses.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

We find evidence that skill-intensity is positively associated with the share of skilled female workers, but negatively associated with unskilled ones. As the overall demand of skilled workers increases, firms tend to hire a larger share of skilled female workers, most likely because of the lower price associated with this component of the labour force (see *Section 3*). Finally, firms located in Industrial Zones show a higher propensity to hire unskilled female workers; the positive association between this variable and skilled female share is not statistically significant.

#### 4. Global interactions and the gender wage gap: boon or bane?

Do MNEs in Vietnam pay lower salaries to women compared to domestic firms controlling for firm-level characteristics and for the skill level of employees? The answer to this important question is reported in *Table 3* which contains respectively the estimates of firm level average wage equations for the total workforce (model 1) and by skill levels (models 2 and 3).

We employ the following empirical specification of average wages using OLS with robust MM estimator:

$$Wage_i = \beta_0 + \beta_1 Ownership_i + \beta_2 Z_i + \phi_{is} + \phi_{ip} + \varepsilon_i \quad (2)$$

where our dependent variables,  $Wage_i$ , are specified as average wages at the firm level for the total workforce (logarithm of total wage bill of the firm divided by the total number of full time employees) or, separately, for respectively skilled and unskilled workers (See Table A1 in the appendix for definitions). The vector of covariates,  $Z_i$ , includes a set of firm-level characteristics. More specifically we control for capital and skill intensities as we expect both variable to be associated with higher average wages. We include firm export shares as we expect that exporting firms in Vietnam base their competitive advantage on labour-intensive tasks and low wages. We include a dummy which is equal to 1 if the firm is located in an Industrial or Export Processing Zone and a control for the years since operation started in a given firm. Finally,  $\phi_s, \phi_p$  are, respectively, sectoral and provincial fixed effects.

In *Figure 1* we also report the MNE wage premia conditional on the female share of the labour force which are helpful for appreciating the role of MNEs in affecting the gender wage gap in Vietnam for skilled and for unskilled workers.

When considering the total workforce (*model 1*), we find strong evidence of a gender wage gap as average wages are declining in the share of female workers. Foreign firms and SOEs pay higher average wages, but the positive MNE wage premium of these two categories of firms vis-à-vis non-SOEs domestic firms are not affected by the share of female workers in the labour force. This finding suggests that when considering the 'pooled workforce' (skilled and unskilled) the presence of MNEs does not seem to alter the negative wage gap experienced by female workers.

But this aggregate picture masks important heterogeneity between skilled and unskilled female workers. Our estimates reported in *model 2*, where the dependent variable is the average wage of skilled workers, highlight a rather large positive MNE wage premium vis-à-vis non-SOEs domestic firms for skilled worker which is slightly decreasing, though not significantly, with the share of female workers (*panel a* in *Figure 3*)<sup>5</sup>. We find, instead, strong evidence of an MNE wage discount for unskilled workers, as well as a large gender wage gap (*model 3* in *Table 3*). Though MNEs tend to pay, on average, lower wages to unskilled workers our results suggest that they contribute in reducing the gender wage gap for this class of workers and actually the wage discount turns into a significant wage premium in firms with a high share of female workers (approximately above 75%). (*panel b* in *Figure 3*)<sup>6</sup>. We do not find evidence of a gender wage gap of MNEs compared with SOEs for skilled workers<sup>7</sup>. On the contrary we find evidence that the negative wage premium between these two categories of firms is decreasing with the share of female low-skilled workers. (*panel d* in *Figure 3*)

Overall, our analysis suggests that foreign firms might have an important role in mitigating the existing gender gap in employment as these firms provide more job opportunities to female low-skilled workers, as well as a relatively lower wage gap.

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<sup>5</sup> Figure 3 is based on Table 3 estimations. In Figure 3 the dotted lines correspond to the 5% significance level. The marginal effect is statistically significant when the dotted lines are both above or below the 0-level line.

<sup>6</sup> The higher wages paid by foreign firms compared to domestic ones may be due to the positive selection of workers with higher abilities by the former. Due to data constraints, this analysis cannot explicitly control for worker's abilities as done in papers using matched employer-employee datasets and that are generally unavailable for developing economies (see for example Andrews et al. 2009). We believe that this limitation is less problematic when the category of unskilled workers is considered, as it is unlikely that foreign firms apply a negative selection for unskilled workers.

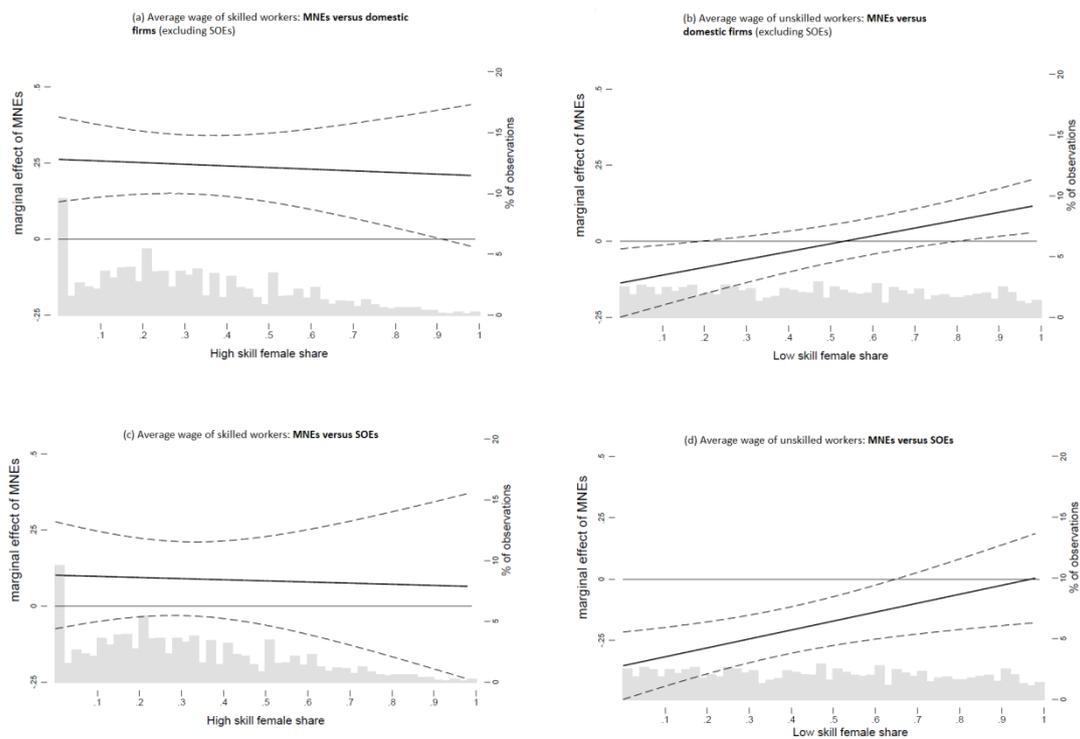
<sup>7</sup> For the comparison MNEs versus SOEs, we present only the graphs with the marginal effects. The tables with estimations are available upon request.

**TABLE 3. Do foreign firms in Vietnam pay lower salaries to women compared to domestic firms?**

VARIABLES	Average total wage	Model (2) Average wage high skill	Model (3) Average wage low skill
MNE	0.121* (0.071)	0.262*** (0.071)	-0.137** (0.057)
SOE	0.235*** (0.082)	0.161** (0.074)	0.216*** (0.082)
Female share	-0.313*** (0.110)		
MNE*Female share	0.037 (0.120)		
SOE*Female share	-0.104 (0.176)		
HS female share		-0.164 (0.112)	
MNE*HS Female share		-0.054 (0.163)	
SOE*HS Female share		-0.016 (0.206)	
LS female share			-0.371*** (0.076)
MNE*LS Female share			0.258*** (0.082)
SOE* LS female share			-0.107 (0.141)
Capital intensity (Log)	0.0262 (0.016)	0.0292** (0.011)	-0.00142 (0.006)
Export share	-0.0011** (0.0004)	-0.0005 (0.0004)	-0.000639** (0.0002)
Skill intensity	0.851*** (0.284)	-0.204 (0.148)	0.111 (0.124)
Age (Log)	-0.005 (0.024)	-0.0158 (0.026)	-0.0013 (0.017)
Output (Log)	0.0486*** (0.009)	0.0384*** (0.013)	0.0098** (0.004)
Industrial Zone	0.0047 (0.031)	-0.0638 (0.050)	0.003 (0.019)
Sector fixed effects	YES	YES	YES
Province fixed effects	YES	YES	YES
Constant	6.850*** (0.192)	4.956*** (0.230)	5.026*** (0.111)
Observations	1,214	1,195	1,196

Estimations using MM OLS method. Dependent variable: Logarithm of average wage by skill level. Reference category is domestic firms. Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**FIGURE 3. Estimated MNEs wage premium vis-à-vis domestic firms (panels a and b) and SOEs (panels c and d) by skill-level and female share in the workforce**



It is interesting to note that a higher export share is negatively associated to the average wages of low-skilled workers but does not seem to be related to that of skilled one. This finding seems to confirm the idea that firms' internationalization, such as participation in GVCs, is often associated to increased within-firm wage inequalities as rents are unequally distributed.<sup>8</sup>

### ***Gender wage gap: productivity differences or discrimination? A test***

The existence of a gender wage gap does not necessarily imply that female workers are discriminated against in the labour market. Firms might set lower wages if female workers are less productive compared to male workers, say. In the last step of our analysis we test the hypothesis of gender wage discrimination by skill-level extending previous works by Dong and Zhang (2009) and Chen et al. (2013). Using Chinese firm level data, these previous contributions show that the gender wage gap – which is particularly high for exporters – is largely explained by differences in productivity. The authors jointly estimate wage and production equations derived from a theoretical framework of female discrimination *à la* Becker (1957, 1985). Due to data limitation, their models are estimated under the highly restrictive assumption of identical male-female wage differentials for skilled and unskilled groups of workers. Evidence such as Blau and Kahn (1997), as well as our findings above,

<sup>8</sup> The globalisation of firms has altered the relative demand for workers with different skills and qualifications both in rich and poor countries thus altering their relative returns. Recent evidence shows that the gap between skilled and unskilled wages has increased all over the world. Using data US firms between 1994-2013, Keller and Olney (2017) find evidence of a causal effect for exports on the rise of compensation of workers at the top end of the skill distribution scale (executives). According to the author both market and non-market channels explain these facts; this class of workers has hence benefited from increased rent extraction thanks to the globalisation of their firms.

shows that the pay gap of female to male workers among skill groups is different and variable. We develop an alternative framework that allows us to investigate the hypothesis of wage discrimination and measure its extent separately for skilled and unskilled female workers.

We derive and estimate the following system of equations (see *Appendix* for details):

$$\text{Average wage for skilled workers: } \ln(W_i^S) = \theta_0 + \ln \left[ 1 + \frac{(\varphi^S - 1)F_i^S}{L_i^S} \right] + X_i' \theta + u_i \quad (2)$$

$$\text{Average wage for unskilled workers: } \ln(W_i^{US}) = \gamma_0 + \ln \left[ 1 + \frac{(\varphi^{US} - 1)F_i^{US}}{L_i^{US}} \right] + X_i' \gamma + v_i \quad (3)$$

Firm total production:

$$\ln(Q_i) = \delta_0 + \alpha \ln \left[ 1 + \frac{(\rho^S - 1)F_i^S}{L_i^S} \right] + \mu \ln \left[ 1 + \frac{(\rho^{US} - 1)F_i^{US}}{L_i^{US}} \right] + \beta \ln(K_i) + \alpha \ln(L_i^S) + \mu \ln(L_i^{US}) + X_i' \delta + \varepsilon_i \quad (4)$$

where  $F_i^S, F_i^{US}$  are respectively the share of female skilled and unskilled workers in firm  $i$ ;  $L_i^S, L_i^{US}$  are the total number of skilled and unskilled workers;  $K_i$  is the total value of fixed assets of the firm and  $X_i'$  is a vector of firm-level covariates that influence both wages and production function.

From equations (2) and (3) we obtain the main parameters of interest:  $\varphi^S$  and  $\varphi^{US}$ , measuring, respectively, the wage ratio of skilled females to skilled males and the wage ratio of unskilled females to unskilled males. Ratios below 1 imply that female workers are paid less than male; for instance  $\varphi^S = 0.8$  means that the average wage for female skilled workers is 80% that of male workers.

The productivity ratio of skilled females to skilled males,  $\rho^S$ , and the productivity ratio of unskilled females to unskilled males,  $\rho^{US}$ , are derived from equation (4). Similarly, the value of parameter  $\rho^S$  ( $\rho^{US}$ ) lower than 1, imply that female skilled (unskilled) workers have lower productivity than their male counterparts. The reverse is true when the estimated parameters are higher than 1.

The hypothesis of female discrimination is rejected if we cannot reject the null-hypothesis of equality of these set of parameters;  $\varphi^S = \rho^S$  for skilled workers and  $\varphi^{US} = \rho^{US}$  for unskilled ones. Female wage discrimination is verified when  $\varphi^S < \rho^S$  or  $\varphi^{US} < \rho^{US}$ ; on the contrary values of wage ratios higher than productivity ratios,  $\varphi^S > \rho^S$ ;  $\varphi^{US} > \rho^{US}$  imply that female wages are subsidized.

The vector  $X_i$  above includes the following control variables: *Firm Age*, *MNE*, *Export Share* and *SOE* as specified in the wage equation reported in *Table 3* and the variables (as in Dong and Zhang 2009); *Small firm* (equal to 1 if the firm has more than 240 workers and 0 otherwise) which is a proxy for size; *ICT intensity* (measured as the ICT assets per employee) which is a proxy for the technological intensity of the firm. In addition, *sector* and *province fixed effects* are included in all equations to take into account sectoral and location characteristics that might influence wages and production. Since wages and production may be influenced by the same unobserved factors, we estimate the system of equations by using the non-linear seemingly unrelated regression method which allows for correlations between the error terms of equations.

In *Table 4, Panel A*, we present the results of our estimates for the total average wage ratio of female to male workers (pooling skilled and unskilled workers). *Column 1* shows that the average wages of female is 70% that of the average wages of male workers. This finding is similar to a wage

ratio (70-80%) found by a survey carried out by the Vietnam General Confederation of Labour (VGCL) in 2012 (see ILO 2013)<sup>9</sup> and to the estimates of Chen et al. (2013) for China. The statistical test of equality between wages ( $\phi=1$ ) is rejected at 1%, confirming the existence of a significant gender wage gap. The results also show that the productivity of female workers ( $\rho$ ) is only 44% of the productivity of male workers at a 1% level of confidence. The comparison between the two estimated ratios highlights how the overall female to male wage ratio is, on average, 26% higher than the productivity ratio. As the test of equality between  $\phi$  and  $\rho$  ( $\phi=\rho$ ) is rejected at 1%, with some confidence, we can conclude that female wages are subsidised when taking into account relative productivity.

In *column 2* we look at the sub-sample of foreign firms. For these firms, we find a lower productivity ratio compared to the wage ratio, suggesting female workers gain relatively more than their productivity. However, we cannot reject the null hypothesis of equality between gender wages and productivity gaps ( $\phi=\rho$ ). This result suggests that foreign firms do not subsidize female work compared to male work, as apparently domestic firms do ( $\phi=\rho$  is rejected at 1%; this is not reported in the table). In *columns 3 and 4* we estimate, respectively, the gender wages and productivity ratios for exporters and for firms with a global-market orientation. In both cases we reject the hypothesis of discrimination and we find evidence that exporters pay relatively higher wages to female when considering their relative productivity as wages are 72.6% of those paid to males, but productivity is only 46% of the productivity of the male component of the workforce.

In *Panel B of Table 4* we turn to the relationship between gender wages and productivity ratios for skilled and unskilled workers considered as distinct production factors. The first element of interest is a wider gender wage gap for skilled female workers; the female-to-male wage ratio for skilled workers is in the range of 60-67% while for unskilled workers the estimated ratios are close to 78%. The gap is particularly significant for foreign firms (*column 6*). For skilled workers we cannot reject the null hypothesis of no discrimination ( $\phi=\rho$ ). On the contrary for unskilled workers we consistently find evidence that the female/male productivity ratios are significantly lower than the wage ratios,  $\phi^{US} > \rho^{US}$ . Our evidence points to wage subsidies for unskilled female workers, in particular from foreign firms.

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<sup>9</sup> See [http://www.ilo.org/hanoi/Informationresources/Publicinformation/Pressreleases/WCMS\\_206104/lang--en/index.htm](http://www.ilo.org/hanoi/Informationresources/Publicinformation/Pressreleases/WCMS_206104/lang--en/index.htm).

**TABLE 4. Joint estimates of wage equations and productivity equations.***(In Panel B, joint estimates of 2 wage equations (by skill) and a productivity equation)*

	Panel A				Panel B			
	(1) Total Firms	(2) Foreign Firms	(3) Only exporters	(4) Global market	(5) Total Firms by skill	(6) Foreign Firms by skill	(7) Only exporters	(8) Global market
<b>Wage ratio (phi)</b>	0.70*** (0.055)	0.76*** (0.06)	0.726*** (0.066)	0.748*** (0.077)				
Test (phi=1)	0.000	0.000	0.000	0.001				
<b>Productivity ratio (rho)</b>	0.44*** (0.124)	0.66*** (0.21)	0.46*** (0.15)	0.577*** (0.193)				
Test (rho=1)	0.000	0.10	0.000	0.028				
Test (phi=rho)	<b>0.044</b>	<b>0.64</b>	<b>0.093</b>	<b>0.38</b>				
<b>Wage ratio skilled</b>					0.671*** (0.052)	0.597*** (0.066)	0.619*** (0.057)	0.657*** (0.068)
Test (phi=1)					0.000	0.000	0.000	0.000
<b>Productivity ratio skilled (rho)</b>					0.45 (0.359)	1.03 (0.80)	0.914 (0.666)	1.15 (0.814)
Test (rho=1)					0.034	0.97	0.79	0.85
Test (phi=rho)					<b>0.127</b>	<b>0.59</b>	<b>0.90</b>	<b>0.54</b>
<b>Wage ratio unskilled</b>					0.778*** (0.044)	0.787*** (0.047)	0.781*** (0.052)	0.779*** (0.059)
Test (phi=1)					0.000	0.000	0.000	0.000
<b>Productivity ratio unskilled (rho)</b>					0.378*** (0.152)	0.28* (0.148)	0.429** (0.193)	0.377** (0.172)
Test (rho=1)					0.000	0.000	0.003	0.003
Test (phi=rho)					<b>0.01</b>	<b>0.001</b>	<b>0.07</b>	<b>0.02</b>
Observations	975	566	726	528	965	560	719	522

Standard errors in parentheses.\*\*\* p<0.01, \*\* p<0.05, \* p<0.1. The P values for the equality of the wage and the productivity ratios are obtained for two-sided alternatives and the remainders are for a one-sided alternative

The evidence from Vietnam provides justifications for the large gap between wage ratio and productivity ratio. First, the demand for unskilled female workers may exceed the relative supply of unskilled female workers, increasing their relative wages (Blau and Kahn 1997). The low additional supply of female workers in Vietnam is very likely given that almost 72% of female are employed in 2010 (World Bank 2010)<sup>10</sup>, and the female propensity to engage in paid labour is restrained by unpaid labour such as housework and childcare. On the demand side, FDI in Vietnam is concentrated in sectors such as light manufacturing and assembly where low-skilled female workers are in great demand and are even preferred to male workers. Moreover, within occupations asking a low level of skills, women usually perform tasks with lower productivity (assembly service), as compared to men and this lower productivity may not be proportionally translated into lower wages.

Our results confirm the importance of analysing gender wage discrimination patterns separately for skilled and unskilled workers. We find robust evidence of a fair determination of wages for skilled female workers, whereas firms generally tend to subsidise the wages of unskilled female workers relative to the wages of unskilled male workers. Foreign firms – the main actors in Vietnam’s growing links to the global production network – are contributing to the levelling of gender imbalances in the labour market: more job opportunities and relatively lower gender wage gaps for unskilled workers.

<sup>10</sup> World Bank Development Indicators for year 2010 (ILO estimate).

#### **4. Conclusions**

Globalisation, through its multiple channels, has important distributional effects in participating countries. In this paper we shed light on the effects of participation in global production and international trade on gender inequalities in employment opportunities. We focus on Vietnam, a developing country which is increasingly integrated in the global economy, not least thanks to the role of foreign firms and GVC participation. We observe that foreign firms offer relatively more employment opportunities to female workers in Vietnam, though the majority of these jobs are in low-skilled occupations. On the contrary, job opportunities for highly-skilled female workers created by foreign firms are limited, a result which is most likely driven by the comparative advantage of Vietnam in labour intensive and relatively low-technology production.

The MNE wage premium for unskilled workers is increasing in the share of female in the firms' labour forces. This evidence suggests that foreign firms are playing an important role in closing the gender gap for unskilled workers. The case of Vietnam lends support to the relative strength of a competition channel in the labour market through which FDI boost wages, in particular, of the highly demanded female labour resources. On the contrary we do not find evidence that global interactions increases gender inequality; a scenario that might be theoretically possible via a gender biased technological change or via the reduction of bargaining power of female workers.

One additional novel element of our paper is the analysis of wage discrimination by skill-level. We show that the lower wages for skilled female workers reflect their relative productivities suggesting that there is no evidence of discrimination. For unskilled workers we find evidence of a gender wage gap that is lower compared to the gender productivity gap. Firms generally tend to subsidise the wages of unskilled female workers relative to the wages of unskilled male workers, in particular foreign firms.

Our results are based on an analysis of foreign and domestic firms operating in the formal manufacturing sector. The positive effect of FDI (and to a lesser extent export activities) on gender inequality is likely to be much larger when considering the structural change that these investments generate and their contribution in moving a large number of female workers from low-paid jobs in the agricultural and informal sectors to better paid jobs in the formal one. Foreign investments in the service sector have been subject to important limits in Vietnam during the recent transformation phase. Some of these impediments have been lifted only recently. Whether the results found in this paper also apply to FDI in the service sector is an interesting question that is left for future research. Intuitively, the role of service FDI in affecting the gender gap in employment opportunities would likely depend on whether such investments are directed toward tradable or non-tradable sectors, the former being more similar to the type of FDI inflows experienced by Vietnam in the last decades.

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## Appendix

TABLE A1. Variables employed in the empirical analysis.

Variables	Definition	Source
<b>Dependent variable</b>		
<i>LogFemaleShare</i>	Logarithm of the share of full time female workers employed by the firm.	Vietnam Industry Investment
<i>Wage (Log)</i>	Average wage of workers in the firm (logarithm of total wage bill of the firm divided by the total number of full time employee).	Survey (VHS 2010)
<i>WageSkilled (Log)</i>	Average wage of skilled workers in the firm (average monthly wage of managers, technicians and supervisory staff weighted by the portion of each category within the workforce of the firm)	-  -
<i>WageUnskilled (Log)</i>	Average wage of unskilled workers in the firm. (average monthly wage of production workers and clerk/administrative staff weight by the proportion of each category within the workforce of the firm)	-  -
<b>Firm-level variables</b>		
<i>MNE</i>	Dummy equal to 1 if firm has more than 10% foreign ownership and has no state participation, and 0 otherwise.	-  -
<i>Domestic</i>	Dummy equal to 1 if firm is domestically-owned and has no state participation, and 0 otherwise.	
<i>SOE</i>	Dummy equal to 1 if the state owns shares of the firm, and 0 otherwise.	
<i>Export share</i>	Share of exports on total sales	-  -
<i>ICT Intensity</i>	ICT assets per employee (in log \$)	-  -
<i>Capital intensity</i>	Fixed assets per employee (in log \$)	-  -
<i>Skill intensity</i>	Share of skilled on unskilled workers	-  -
<i>Industrial zone</i>	Dummy equal to 1 if the firm is allocated in an industrial zone	-  -
<i>Global market orientation</i>	Dummy equal to 1 if firms declare the final consumers are mostly located in foreign markets.	-  -
<i>Age</i>	Number of years since creation.	-  -
<i>Size</i>	Value of output (in log \$)	-  -
<i>Small firm</i>	Dummy equal to 1 if the firm has more than 240 employees.	-  -
<i>Q (Value added)</i>	Sales (net of goods bought for resale) minus the sum of costs of raw material, inventory of finished products of the previous year and the inventory of raw material of the previous year. The costs are net of inputs bought for resale.	
<i>Province dummies</i>	Ha Noi, Hai Phong, Da Nang, HCMC, BRVT, Bac Ninh, Binh Duong, Dong Nai, Vinh Phuc	-  -
<i>Sector dummies</i>	food, beverage & tobacco; textiles, garments & leather; wood & wood products & furniture; paper & publishing and printing; basic metals & fabricated metal products; electro-mechanical machinery & equipment; motor vehicles, trailers and other transport equipment; other manufacturing; public utilities; construction.	-  -

**Derivation of average wage equations by skill level<sup>11</sup>**

As in Dong and Zhang (2009) we assume that the average wage of skilled workers,  $W^S$ , is a weighted average of the wage of female skilled workers,  $W_f^S$ , and the wage of male skilled ones,  $W_m^S$ .  $F^S$  and  $M^S$  are the female skilled workforce and male skilled workforce, respectively and  $L^S = F^S + M^S$  is the total skilled workforce of the firm.

Using a simple algebraic manipulation we have:

$$W^S = W_m^S \left( \frac{M^S}{L^S} \right) + W_f^S \left( \frac{F^S}{L^S} \right) = W_m^S + \frac{F^S}{L^S} (W_f^S - W_m^S) \quad (1)$$

<sup>11</sup> Firm subscript is omitted for simplicity.

A similar equation can be expressed for the average wage of low skilled workers,  $W^{US}$ , as follows:

$$W^{US} = W_m^{US} \left( \frac{M^{US}}{L^{US}} \right) + W_f^{US} \left( \frac{F^{US}}{L^{US}} \right) = W_m^{US} + \frac{F^{US}}{L^{US}} (W_f^{US} - W_m^{US}) \quad (2)$$

Rearranging equations (1) and (2), substituting the two expressions of the gender wage gaps  $\varphi^S = \frac{W_f^S}{W_m^S}$  and  $\varphi^{US} = \frac{W_f^{US}}{W_m^{US}}$  and expressing both in logarithm terms, we obtain:

$$\ln(W^S) = \ln(W_m^S) + \ln \left[ 1 + \frac{(\varphi^S - 1)F^S}{L^S} \right] \quad (1a)$$

$$\ln(W^{US}) = \ln(W_m^{US}) + \ln \left[ 1 + \frac{(\varphi^{US} - 1)F^{US}}{L^{US}} \right] \quad (2a)$$

As  $W_m^S$  and  $W_m^{US}$  are unobserved, we substitute the terms  $\ln(W_m^S)$  and  $\ln(W_m^{US})$  with a linear stochastic function of wage determinants,  $\theta_0 + \theta X' + \mu\gamma_0 + \gamma X' + v$ , respectively. Then (1a) and (2a) become:

$$\ln(W_m^S) = \theta_0 \ln \left[ 1 + \frac{(\varphi^S - 1)F^S}{L^S} \right] + X' \theta + u \quad (1b)$$

$$\ln(W_m^{US}) = \gamma_0 + \ln \left[ 1 + \frac{(\varphi^{US} - 1)F^{US}}{L^{US}} \right] + X' \gamma + v \quad (2b)$$

Where  $X'$  is the vector of firm characteristics that influence both the average wage of skilled and unskilled workers. These are the final equations we estimate in the paper.

### **Derivation of the productivity equation**

Let consider a Cobb-Douglas production function where capital,  $K$ , is used jointly with two types of labour, skilled  $L^S$  and unskilled  $L^{US}$  as follows:

$$Q = A \left[ (E^S L^S)^\alpha (E^{US} L^{US})^\mu \right] K^\beta \quad (3)$$

Where  $Q$  is the total value of production,  $A$  is the technical coefficient,  $E^S$  and  $E^{US}$  are respectively the average qualities of skilled and unskilled labour, and  $K$  is capital.

The average quality of labour for the skilled  $E^S$  and unskilled  $E^{US}$  is aggregated over men and woman with similar skill levels:

$$E^S = q_m^S \left( \frac{M^S}{L^S} \right) + q_f^S \left( \frac{F^S}{L^S} \right) \quad (4)$$

$$E^{US} = q_m^{US} \left( \frac{M^{US}}{L^{US}} \right) + q_f^{US} \left( \frac{F^{US}}{L^{US}} \right) \quad (5)$$

Where  $q^S$  and  $q^{US}$  are the labour quality indexes of skilled and unskilled, respectively.

After rearranging the equations and defining  $\rho^S = \frac{q_f^S}{q_m^S}$  and  $\rho^{US} = \frac{q_f^{US}}{q_m^{US}}$  as the marginal product of female to male workers, by skill level we can substitute in the production function as follows:

$$Q = A \left\{ \left\{ q_m^S \left[ \rho^S \left( \frac{F^S}{L^S} \right) + \left( \frac{M^S}{L^S} \right) \right] L^S \right\}^\alpha \left\{ q_m^{US} \left[ \rho^{US} \left( \frac{F^{US}}{L^{US}} \right) + \left( \frac{M^{US}}{L^{US}} \right) \right] L^{US} \right\}^\mu \right\} K^\beta \quad (6)$$

After rearranging and taking the logarithm, equation (6) becomes:

$$\ln(Q) = \ln(A) + \beta \ln(K) + \alpha \ln(q_m^S) + \mu \ln(q_m^{US}) + \alpha \ln \left[ 1 + \frac{(\rho^S - 1) F^S}{L^S} \right] + \mu \ln \left[ 1 + \frac{(\rho^{US} - 1) F^{US}}{L^{US}} \right] \quad (7)$$

The empirical production function that we estimate in the paper is obtained by replacing the following unobserved terms  $\ln(A) + \alpha \ln(q_m^S) + \mu \ln(q_m^{US})$  with a stochastic function containing a set of covariates that determine the productivities of the production factors,  $\delta_0 + X' \delta + \varepsilon$ .

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