Minimum Wage, Market Imperfection, and Production Efficiency: Panel Event Study in Vietnam*

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Abstract

Industries in developing countries involve a host of small businesses which compete with foreign or state-owned firms. This paper examines how an unexpected spike of minimum wages disproportionately affected productivity of domestic and foreign firms under the mixed market structure using Vietnam's enterprise census. While foreign firms were shielded from the policy shock, production of domestic firms has become smaller and informal. A panel event study estimation finds that small domestic firms constrained by the minimum wage regulation significantly reduced employment (-14%), profit margins (-1 percentage point) and TFP (-2%) over three years. Unproductive capital-labor adjustments contributed to the productivity loss. Moreover, a triple-difference regression indicates that small firms faced significantly large negative minimum wage effect when foreign or state-owned firms held strong price setting power in the same market.

Keywords: Minimum wage, imperfect competition, firm productivity, panel data

JEL Classification: L11, O14, J42, J38

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1 Introduction

Vietnam has liberalized local market under *Doi Moi* since 1986, followed by an entry of foreign firms upon joining the World Trade Organization (WTO) in 2007. Despite the market development, the lifecycle growth of domestic enterprises remains weak, resulting in the lowest productivity level among ASEAN countries (Mason and Shetty, 2019).

In developing countries, right-skewed firm size distribution often reflects firm's formal-informal decision to avoid costly regulations, factor misallocations (Hsieh and Klenow, 2009; Ha, Kiyota, and Yamanouchi, 2016), or high market attrition (McKenzie and Paffhausen, 2019). Less is known how labor regulations affect the lifecycle growth of small firms.

This paper examines how an unexpected spike of minimum wage disproportionately affected the productivity of small firms that compete with a few big firms in the market. The coverage of minimum wage has been gradually expanded to domestic enterprises since it became statutory in 1995. The major regulatory revision was made in October 2011, as required by the WTO accession rule, when the difference in minimum wages between domestic and foreign firms was abolished. At the same time, real minimum wage spiked up by 7-20%, followed by continuous upward wage adjustments (Nguyen et al, 2017).

In this context, how did the 2011 minimum wage reform affect firm productivity? How did firms adjust production to it, and did the policy effect differ due to market competition? First, the paper presents a mixed market model with product and labor market imperfections (Pan and Hanazono, 2018) to describe an asymmetry in the equilibrium responses to the reform between domestic and foreign direct investment (FDI) firms. The model predictions are examined using panel data from the Vietnamese Enterprise Census and Surveys (VES). The data cover five years before and after the 2011 reform, providing an ideal setting to evaluate its impact on firm growth. A panel event-study method is used to estimate the dynamic effect of this policy reform on employment, profits and total factor productivity (TFP). In-depth field interviews were also conducted in five provinces to motivate the empirical hypothesis.

This paper contributes to the literature in two ways. First, the paper provides an evi-

dence of the minimum wage effect on firm productivity, which is still scarce. To understand the productivity effect, it assesses how firm's pricing and capital-labor decision adjusted to higher minimum wage following Harasztosi and Lindner (2019). The employment effect of minimum wage has been debated for long with mixed findings (Neumark, 2018; Neumark and Corella, 2019), while recent papers have looked at the policy impact on firm profits (Draca, Machin, and Van Reenen, 2011; Bell and Machin, 2018; Alvarez and Fuentes, 2018). Firms may adjust to higher unit labor cost by raising output prices (Aaronson, 2001), saving labor, or investing on machines (Hau et al., 2018). The relative importance of each adjustment depends on the bindingness of minimum wage regulation, labor supply elasticity, mark-ups, and the elasticity of factor substitution. The total impact of minimum wage on productivity is ambiguous.

The second contribution is to highlight the importance of imperfect market competition in determining minimum wage effect on firm productivity (Aaronson and French, 2007). Specifically, it tests whether high market concentration of FDI and state-owned enterprises (SOEs) in local market altered the severity of minimum wage shock for domestic firms. FDI firms operate with mark-ups and a rise in their market power may lower domestic firms' competitiveness in product and labor markets. Estimating how domestic and FDI firms were disproportionately affected by the reform due to local market condition will shed a new light on the interplay between minimum wage and competition policies.

The empirical analysis finds that the minimum wage hike had an immediate disemployment effect which cumulated to -14% over three years. Domestic firms, especially small ones, faced significant losses in profit margins (-1 percentage point (p.p.)) and TFP (-2%) in three years. Small domestic firms were credit constrained and failed to increase capital investments. While large firms significantly reduced employment, small firms are found to deal with higher labor cost by increasing the share of informal workers. The analysis finds limited response in non-price strategy, including product variety, to the minimum wage hike. Due to limited margin of adjustments, the capital-labor ratio of small firms became sub-optimal and led to a drop in TFP.

Finally, the triple-difference model uses the share of FDI firms or SOEs as market con-

dition category to examine the difference in the treatment effect between places with high versus low market competition. The result shows that small domestic firms faced significantly larger reduction in profits and TFP due to the minimum wage hike under imperfect product market competition. This pattern is consistent with the in-depth interview results, showing that an imperfect market competition augments negative minimum wage effect on firm performance.

The paper is organized as follows. Sections 2 and 3 provides background and summarizes the field interview results. Section 4 summarizes theoretical predictions to guide the empirical analysis. Section 5 discusses the data, followed by panel regression results in sections 6 and 7. Section 8 estimates the triple difference model. Section 9 concludes.

2 Background

2.1 Increase in Labor Cost

Since 2010, the growth rate of minimum wage (MW) has exceeded the speed of labor productivity growth in Vietnam, which doubled the MW-to-labor productivity ratio from 25% in 2007 to 50% in 2015 (Figure 1). Meanwhile, the ratio in other neighboring countries have remained stable or slightly decreased. The Kaitz ratio (the ratio of MW to the mean or the median wages – the measure of the extent to which the minimum wage "bites" the market wage) is around 55-65%, much higher than the regional average in East Asia (38%), Latin America (46%), Eastern Europe (30%) and sub-Saharan Africa (37%) (Bhorat, Kanbur, and Stanwix, 2017). The 2011 minimum wage reform has driven up unit labor costs, which raised a serious concern over its adverse impact on firm survival, especially for small firms whose labor cost is particularly high.[1]

[1]The share of labor cost accounts for more than 40% of sales for small firms with less than 5 employees, while the share is much smaller for large firms.

2.2 Minimum Wage and Social Security System

Vietnam is one of a few countries in the world that differentiates the minimum wage level by districts and firm type.[2] Under the current system, about 700 districts (second-tier administrative unit) in 63 provinces (first-tier unit) are categorized into four groups (Group I – IV) depending on their economic and social conditions. Group I consists of the most developed industrial districts while Group IV includes the least developed, agricultural, and mountainous districts. The minimum wage gap between the highest and lowest groups could be more than 40%.

Around March every year, local government (the Provincial People Committees) proposes a change in the minimum group to be consistent with local labor market and industrial development. At the same time, the Technical Board proposes different reform scenarios in line with inflation and income dynamics, and resident's "basic living needs". The National Wage Council, comprising of the representatives from the Ministry of Labor, the employee and the employer groups (five representatives each, fifteen in total), considers the adjustment package and submits the final proposal to the government in September. Based on the final proposal, the government decides whether or not to (i) raise the minimum level of each group and (ii) reclassify a district into higher group category. The Cabinet makes final decision in the fourth quarter every year.

The government also sets the contribution rate to social security at a noticeably high level. Currently, the employer and the employee contribute 17% and 8% of the gross monthly wages to the social security program, much higher than other Asian countries. In addition, other mandated benefits (i.e. health insurance, unemployment insurance) and labor union fee raise the total cost up to almost one-third of the worker's wage.

2.3 The 2011 Minimum Wage Reform

Under the WTO accession rule, the government rapidly lifted the minimum wage for domestic firms to catch up with the level applied to foreign firms. In October 2011, while

[2] There are only a few countries (e.g., United State, Japan, China, Indonesia, Thailand, Russia, and Brazil) that differentiate statutory minimum wage level by regions.

maintaining the district-level differences, the minimum wage was unified between domestic and foreign firms. The reform resulted in a sharp increase in real minimum wage for domestic firms by around 51% per district on average, whereas foreign firms faced only moderate or no real change (only proportional to inflation) (Figure 2).

Moreover, the minimum wage negotiation process had not been officially shared with public via media before 2013 when formal wage negotiation procedure started. Because of this, most small domestic firms were not fully aware of the 2011 minimum wage reform, creating significant uncertainty and unanticipated shock to domestic firms.

[insert Figures 1-2]

3 In-depth field interviews

In-depth interviews about enterprise managers' *perception* on the 2011 minimum wage reform and market competition were conducted from the end-February to the early-March 2019 in five provinces: Ha Noi, Bac Ninh, Ho Chi Minh city (HCMC), Binh Duong, and Ba Ria-Vung Tau. The interview focused on formal firms, sampled from the list of registered firms at the Ministry of Industry and Investment, while the first day was dedicated to interviews in the informal sector. We interviewed 22 enterprises in industries with high share of minimum wage workers.

Each interview lasted about one hour. We collected firm's basic information (e.g., employment size, year of business registration, main product lines, land access) and details on labor contract including workers' wage by position and their social security coverage. Managers were also asked open-ended questions about their perceptions on minimum wage hikes that have been implemented since 2011, their business adjustment strategies to higher labor cost, and regulatory burdens from tax inspection and monitoring by local regulators. Descriptive statistics and questionnaire used during the interviews are reported in the appendix 1. The key qualitative findings are summarized below.

3.1 Main findings

Based on managers' responses, labor regulations and competition in recruiting skilled workers appear to be major constraints for business expansion for small and medium-sized firms.

None of the interviewed domestic firms anticipated the spike of minimum wage in a scale as implemented in 2011. Only large foreign firms were well informed about details of the 2011 reform. Domestic firms' inattention to minimum wage policy at that time reflects the fact that most small firms were *de facto* unregulated by the minimum wage law. After the initial hike, the government continued to undertake annual minimum wage adjustments. Even in recent years, most interviewed firms were still uncertain about the magnitude of annual wage adjustments until the Prime Minister announces the final proposal in the fourth quarter every year.

On business adjustments to the reform, both domestic and FDI firms answered that they tried to improve production efficiency or diversify product lines (see appendix table A1.2). In contrast, virtually none of them managed to adjust output prices. Domestic firms were constrained by high product market competition that limited the scope of price adjustment. Foreign firms could substitute labor by machine, whereas only few domestic firms could do so due to limited credit.

Regarding market condition, domestic firms were severely constrained by the shortage of skilled labors and unfair market competition with FDI firms and SOEs. For example, private domestic institutions faced difficulty in attracting skilled workers and raising capital as public institutions were favorably treated. In domestic firms' perspective, imperfect market competition is the main barrier for them to grow and survive after the 2011 reform.

4 The Model

With this background in mind, this section describes a basic framework and key predictions on why we expect that the effect of minimum wage reform on firm productivity varies due to product and labor market imperfections. The reform raises unit labor costs and affects labor supply, while firms' profit margins will shrink. In reality, the policy impact would be

non-uniform in a mixed market model where large and small firms co-exist.

4.1 Basic framework

The stylized framework in the appendix 2 considers a monopsony labor market where workers self-select to employers that posted highest wage offer (Manning, 2011, Card et al, 2018). Firms post a pair of formal and informal wages that achieves cost minimization. The labor supply elasticity increases when minimum wage binds more on firms. In a monopsony labor market, a large firm that has wage-setting power marks down wages below productivity, whereas small firms face an upward sloping labor supply curve. The equilibrium wage is determined as a weighted average of minimum wage and worker's productivity. The wage-setting power and inelastic labor supply under monopsony distorts the equilibrium wages from worker's productivity.

Large and small firms are assumed to compete in quantities (play Cournot), taking the input cost given, in the product market. Product prices, outputs, and profits are defined in Nash equilibrium. Large monopolistic firms set output prices with mark-ups depending on the degree of product market imperfection. Firm's revenue total factor productivity (TFPR) A (in log) can be decomposed into price and efficiency components:

$$\ln A_{jd} = \underbrace{\ln p_{jd}}_{\text{price}} + \underbrace{\ln y_{jd} - f(l_{jd}^{F}, l_{jd}^{IF}, k_{jd})}_{\text{efficiency}} \tag{1}$$

where y_{jd} is firm's nominal revenues, l_{jd}^{F} and l_{jd}^{IF} are formal and informal labor inputs,[3] and k_{jd} is capital for firm j in district d.[4] The MW reform affects firm productivity by changing product prices p_{jd} or efficiency by optimizing capital-labor mix or diversifying products.

[3]Formal workers are defined as those who work under a formal labor contract with social insurance benefits.

[4]Levinsohn and Petrin method is used to estimate the TFP as residuals in the production function.

4.2 Predictions

Minimum wage hike increases firm's marginal cost which affects the equilibrium price and output. In the context of Vietnam, the magnitude of wage shock would be large for domestic firms while wage pass-through would be close to zero for FDI firms due to sufficiently high pre-reform wage. The comparative statics using the equilibrium condition provide two predictions on minimum wage policy effect for the empirical test.

Prediction 1. pricing response: In equilibrium, price pass-through of minimum wage hike depends on its impact on marginal costs and mark-ups (the latter component is relevant only for large firms ($j = L$)):

$$\frac{\partial \ln p^*_{jd}}{\partial \underline{w_d}} = \underbrace{\frac{\partial \ln c_j(w^{F*}_{jd}, w^{IF*}_{jd}, r)}{\partial \underline{w_d}}}_{\text{the impact on marginal costs}} + \underbrace{\left[\frac{\partial \ln(\frac{1}{1-\mu})}{\partial \underline{w_d}}\right] 1[j = L]}_{\text{the impact on mark-ups}}$$

where $\underline{w_d}$ is minimum wage, w^{F*}_{jd} and w^{IF*}_{jd} are the equilibrium wages for formal and informal workers, and r is rental cost. In equilibrium, the optimal output price of small domestic firms should rise in proportion to a rapid increase in marginal costs due to binding minimum wage regulation and elastic labor supply. In contrast, large foreign firms may charge higher mark-ups μ above the marginal cost if the market power rises. After the minimum wage hike, large firms may increase mark-ups when own price elasticity of demand is low. Although firm-level prices are absent in my data, firm's pricing decision can be inferred by price-cost margin (PCM).[5]

Prediction 2. asymmetric output response by firm size: In the mixed market model, the equilibrium output response to minimum wage hike depends on the relative

[5] $PCM = \frac{p - c(\cdot)}{p} \approx 1 - \frac{\text{variable costs}}{\text{sales}}$.

increase in marginal costs for large and small firms ($j = S$):

$$\begin{aligned}
\frac{\partial \ln y^*_{Ld}}{\partial \underline{w_d}} &\propto \Theta_1 \left[\Theta_2 \frac{\partial \ln c_S(\cdot)}{\partial \underline{w_d}} - \frac{\partial \ln c_L(\cdot)}{\partial \underline{w_d}} \right] \\
\frac{\partial \ln y^*_{Sd}}{\partial \underline{w_d}} &\propto \Theta_1 \left[\Theta_2 \frac{\partial \ln c_L(\cdot)}{\partial \underline{w_d}} - \frac{\partial \ln c_S(\cdot)}{\partial \underline{w_d}} \right]
\end{aligned}$$

where $c_j(\cdot) = c_j(w^{F*}_{jd}, w^{IF*}_{jd}, r)$. Θ_1 and Θ_2 are the combination of parameters on own and cross-price elasticities of demand (see eq. (A2.7) in appendix 2). This equation implies that the equilibrium output response of large firms ($\ln y_L$) after the reform would be positive. This is because an increase in marginal costs of small domestic firms is positive ($\frac{\partial \ln c_S(\cdot)}{\partial \underline{w_d}} > 0$) while minimum wage does not bind FDI firms ($\frac{\partial \ln c_L(\cdot)}{\partial \underline{w_d}} \approx 0$). Conversely, the equilibrium output response of small firms would be negative.

Prediction 2 implies that minimum wage reform is expected to create a distributional impact in the mixed market. The profit of monopolistically competitive small firms may turn into negative after the reform, prompting production adjustments or market exit. In contrast, the profit of large firms increases when large firm's market power rises in the product market.

5 Data

The VES is a large-scale survey conducted annually by the General Statistic Office of Vietnam (GSO). It contains data on firm's wage, employment, sales, production cost (material cost, financial and administrative cost, taxes), capital stock and investment, and the depreciation.

Regarding the sampling method, the survey first covers all SOEs, stock companies with more than 50% of shares held by the government, and FDI firms. Second, the VES covers all remaining registered firms with more than a certain number of employees as the threshold. The firm size threshold varies over time and depends on the province where each firm locates. The GSO interviews all firms in small provinces where the number of registered firms is less than 1,000. Details on the sampling criteria are provided in the appendix 3.

The empirical analysis uses the balanced panel data of about 107,000 registered firms (both listed and non-listed) in the manufacturing and service sectors.

5.1 Summary statistics

Table 1a reports the summary statistics from the 2011 VES. Manufacturing and service firms comprise 20% and 80% of the total sample. About 4% is FDI firms and the remainder is domestic firms. At the median, a firm employed less than 10 workers, survived 4 years, the profit margin (profits per sales) was 0.5%, and the valued-added (VA) ratio was only 0.2.[6] Profit margins, VA ratio, and TFP vary significantly across districts and industries. The average age of firm managers is 43 years old, 25% of them are female, and 61% completed high-level (undergraduate, graduate, or post-graduate) education. The share of formal workers is 28% on average.

Figure 3 shows the distributions of log employment and TFP separately for domestic and FDI firms over two census years in 2011 and 2016. As it shows, domestic firms operate in much smaller scale than FDI firm. The firm size gap has widened over time. The distribution of TFP is left-skewed and demonstrates wide dispersion in productivity. Productivity growth over five years has been sluggish and slightly negative for domestic firms.

On average, the fraction of firms paying wages below statutory minimum wage (MW) level was 10% (which rises to 19% when alternative MW bind measure is used) in 2011 (Panel C, Table 1a).[7] As reported in the table 1b, the bindingness of MW regulation significantly varies across regions. The MW bindingness was higher in low-wage cities and the lowest in high-wage cities such as Hanoi and HCMC.

Figure 4 shows domestic firm's average wage distribution in 2010 and 2016 relative to the minimum wage of the following year (in dash lines). While most of FDI firms paid higher wage than the minimum, domestic firms at the bottom of wage distribution did not comply with minimum wage regulation. For the MW Group I, we also observe bunching of firms paying just above the minimum threshold in 2010. As statutory minimum wage

[6] VA is computed as the sum of business profit, wage bills, depreciation, and taxes and dues.
[7] MW bind measures are defined later in eqs. (4) and (5).

continued to rise, a proportion of domestic firms paying below the minimum threshold significantly increased in 2016. This implies that minimum wage revision has continued to "bite" small firms at the bottom of the wage distribution over years, especially in the service sector. This motivates me to estimate the dynamic treatment effect of minimum wage in section 7.

[insert Tables 1a and 1b, and Figures 3-4]

5.2 Market competition

Table 1b shows large interregional variation in market size and concentration. The average market shares of FDI firms and SOEs in sales were 5.7% and 4.9% respectively (Table 1a, Panel D). In some districts, FDI firms dominate the product market, for example around industrial clusters near big markets in Ha Noi and Binh Duong provinces. Total number of firms is particularly large in Hanoi and HCMC where firms are exposed to severe market competition. The Herfindahl-Hirschman index (HHI) in labor market is higher in the mountainous rural areas near the northern border with Laos and China. In rural areas, the market is dominated by small number of firms, typically SOEs.

Panel D of table 1a also reports the level of land ownership (a fraction of owners of the land-use right certificates (LURC)) and an uncertainty related to the implementation of labor regulations. Both data come from the Vietnam Chamber of Commerce and Industry (VCCI)'s annual surveys of market competitiveness index (PCI).[8] The 2010 and 2011 PCI data are merged with the VES data at the province-industry level using the 2-digit 2007 Vietnamese Standard Industrial Classification (VSIC). The ownership of the LURC is still low in many regions and the average ownership rate is only 45%. The LURC is controlled by local governments. Land expropriations and frequent disputes were real concerns for firms. Firms tend to face significant uncertainty on the implementation of labor regulations in some districts where the regulatory uncertainty index approaches one.

[8] See Bai, Jayachandran et al (2017) for details on the PCI data.

6 Empirical analysis

The hypothesis of interest is the heterogeneous effect of the 2011 minimum wage hike on firm productivity between small domestic and large FDI firms. As the baseline, the difference-in-difference (DID) model estimates the average MW treatment effect on log employment, real wage, profit margins, and TFP.

$$y_{jsdt} = \alpha_d + \phi_s + \beta_1 Bind_{jsd} + \beta_2 POST + \beta_3 Bind_{jsd} \times POST + \gamma X_{jsdt} + \varepsilon_{jsdt} \quad (2)$$

where y_{jsdt} is each outcome for firm j in industry s, district d at time t. α_d and ϕ_s are district and industry fixed effects. X_{jsdt} is control variables including firm characteristics (firm age, manager's age, gender, education level, and nationality) and labor market HHI. $Bind_{jsd}$ is a binary treatment variable which is one if firm j's pre-reform real average wage in 2010 ($w_{0,jsd}$) was lower than the new real minimum wage in 2011 ($\underline{w_{sd}}$), and zero otherwise as similarly defined by Draca et al (2011), Neumark et al (2006), and Yamada (2016).[9]

$$Bind_{jsd} = 1[w_{0,jsd} < \underline{w_{sd}}] \quad (3)$$

where $POST$ estimates the average changes in outcome variables for the base group (firms that were not treated by the 2011 MW reform). To trim outliers, firm input and output variables are winsorized to take values between 1st and 99th percentile in each year. Standard errors are clustered at the district-industry level.

The overlap sample of firms that operated business from 2010, a year before the MW hike, to 2012 is used to estimate the immediate policy effect. As the impact of minimum wage on firm production may take time to materialize, I also estimate the evolution of treatment effects β_3 over five years using the overlap sample from 2010 to 2016.

[9] Nominal wage is converted to real values using provincial CPIs as the deflator.

6.1 Baseline results: Difference-in-Difference (DID) estimation

The short-term policy effect is shown in Table 2. Prior to the 2011 reform, $\widehat{\beta_1}$ in column 1 shows that the employment size of treated (MW bind) firms was 16% smaller and paying 30% lower real wages than untreated firms, while the TFP level of treated firms was higher by 1.6%.

After the reform, base group (MW non-bind firms, captured by $\widehat{\beta_2}$) faced an increase in real wages (by 22.7%), which was associated with an increase in profit margins (13 p.p.) and TFP (6.2%). The interaction term $\widehat{\beta_3}$ estimates additional changes relative to the base group for the treated firms. Results confirm that higher marginal costs due to the MW hike led to drops in employment (-3.1%), profit margins (-3.2 p.p.), and TFP (-1.2%) for treated firms.

Estimates for control variables report intuitive results. Large firms hiring many workers were more profitable but less productive. Older firms were larger in size and slightly more efficient. The estimate of the labor HHI is positive for log employment, showing that firms in monopsony labor market operated in a larger scale.

While minimum wage group category remained the same in most districts, the category was upgraded in 27 districts. About 55% of them were the upgrade from the Group II to I, while the rest was the upgrade from the Group III to II or IV to III. In those districts, the minimum wage reform took place in two steps: the category was upgrade first in June 2011 and the minimum wage level was raised later in October 2011. As the reform was phased in two steps, firms that operated in those 27 districts could have been better informed and responded more rationally to the MW hike. For this reason, column 2 dropped firms located in the 27 districts from the sample to check the robustness. The point estimates on $\widehat{\beta_2}$ and $\widehat{\beta_3}$ remain broadly unchanged.

[insert Table 2]

Another concern is that the MW bind variable as defined in eq. (3) misses within-firm heterogeneity in wages among workers with different job responsibilities. Although the VES data cannot be matched to worker-level data, the 2009 VES survey provides within-firm

variations in wage and employment by job positions. According to the 2009 VES data, the proportions of workers as managers, professional (skilled) workers, manual (unskilled) workers, or administrative staffs were 15%, 16%, 63%, and 6%. Most workers were hired as manual labors whose average wage was about a half of managers' wage. As another robustness check, panel B of table 2 reports the DID estimates using two alternative MW treatment variables:

(a) *Alternative MW bind variable*: a dummy variable which is one if the average wage of at least one type of worker position z (manager, skilled or unskilled workers, or administrative staffs) is below $\underline{w_{sd}}$.

$$Bind(alt)_{jsd} = 1[\exists z,\ w_{0,z,jsd} < \underline{w_{sd}}] \tag{4}$$

(b) *Wage gap*: a continuous variable which measures the distance of firm's pre-reform average wage below new statutory minimum wage (in percent) as similarly defined by Dinkelman and Ranchod (2012).

$$Real\ Wage\ Gap_{jsd} = \ln(\underline{w_{sd}}) - \ln(w_{0,jsd}) \tag{5}$$

The results show that the main results in panel A remain robust, which mitigates a concern on the measurement error of the MW bind variable.

6.2 Firms' margins of adjustments

Profit margins and TFP of the MW treated firms declined more than untreated firms. This may reflect the difference in firm's adjustments in pricing of goods or capital-labor mix.

In theory, firms may absorb the increase in labor costs either by expanding or shrinking production frontier. With capital investments (productivity enhancement effect *a la* Riley and Bondibene (2017)) or hiring more workers (Bhaskar, Manning, and To, 2002), revenues may increase if output demand elasticity is high to meet the enhanced production. If output

demand is inelastic, firms may instead use informal workers or simply cut employments to save labor costs.

To examine firm's input adjustments to the reform, table 3 estimates firm's adjustments in prices, capital investments on machine and equipment, and formal to informal labor substitution. Column 2 provides a robustness check after dropping 27 districts where the policy change was implemented in two steps.

In both columns, the treatment effect on PCM is negative. The negative effect is significantly large at 7.5-10 p.p. when alternative treatment variables are used in panel B. The reduction in PCM reflects a combination of higher marginal costs and limited price pass-through.[10] In contrast, $\widehat{\beta_2}$ is positive, which indicates that untreated firm's PCM significantly increased.

Results on machine and equipment investment show negative treatment effect at the extensive margins. The MW bind firms reduced machine investments by 9 p.p. (significant at 1% level), while untreated firms increased machine investments. As a result, the capital-labor ratio significantly increased for untreated firms while treated firms became labor intensive. Results on the share of formal workers shows that untreated group increased formal labor share by 6 p.p., whereas the policy effect for treated firms is negative at around 2-4 p.p.

Among control variables, the positive coefficient of the LURC ownership on machine and equipment investment supports credit constraint story, suggesting that the ownership of land-use right helped an access to credit for scaling-up investments. Higher labor market concentration is associated with a significant increase in PCM, which implies that larger market power was possessed by a few large firms.

[insert Table 3]

[10] In a separate analysis, the degree of price shifting of minimum wage hike to output prices is estimated, which reports small price elasticities to the wage hike. The details of this analysis available upon request.

6.3 Test of product diversification

The relative reduction in PCM, machine investments, and formal labor share for treated firms imply that the MW reform has lowered firm productivity. However, the model in section 4 simply assumes that firms produce a single good. As clarified by the interview, firms could possibly take additional strategies to improve production efficiency. For example, they may diversify product lines or upgrade the quality of products when their profits are falling (Amiti and Konings, 2007). Indeed, the field interviews found that 47% of domestic firms tried to diversify products to deal with higher labor cost after the reform (see the appendix table A1.2).

Table 4 examines if product diversification or quality upgrading can be confirmed with the VES data. Product differentiation is measured in three ways. The first measure is a simple count on the number of production lines (defined by the VSIC 2-digit industry code) including the main product and the top five sub-products. In the data, about 90% of firms have only one production line and only big firms produce multiple products. As a result, the average number of production line is 1.1. Second, following Imbs and Wacziarg (2003) and Cadot, Carrere, and Strauss-Kahn (2011), product diversification is proxied by the Theil's entropy index T.

$$T_j = \frac{1}{5}\sum_{k=1}^{5} \frac{x_{jk}}{\mu_j} \ln\left(\frac{x_{jk}}{\mu_j}\right) \qquad \text{where } \mu_j = \frac{1}{5}\sum_{k=1}^{5} x_{jk}$$

where x_{jk} is the employment in product line k. The third measure accounts for the difference in skill content of product lines. The 2011 Vietnam labor force survey provides worker's occupation and their education level. Based on workers' average education by product lines (classified at the VSIC 2-digit), the weighted average of skill content is computed. The weight is defined as the share of workers hired in each product line out of total employment.

Results in table 4 show the MW bind firms had lower product diversity before 2011 reform. Against the findings from the field interview, the negative coefficient of $\widehat{\beta_2}$ implies that firms rather specialized in their main product and cut subsidiary productions after

the MW hike. For untreated firms, the positive $\widehat{\beta_2}$ on the average skill content indicates a general increase in average skill use of production. However, $\widehat{\beta_3}$ is insignificant for all three measures, showing limited MW policy effect on product diversification. Column 2 confirms robustness of the results.

Among other covariates, product lines and the Theil index were significantly higher for large and old firms, while their average skill content decreased as firms age. This suggests that larger old firms had multiple product lines but provided less skill intensive products or services. Firms run by female managers tend to specialize in main products, but with higher average skill content compared with male-run business. Managers with high education are more willing to diversify products. In labor market with high HHI, firms had a stronger incentive to diversify products.

In sum, the margins of *productive adjustments* were limited. Limited price adjustment, lack of mechanization, and informalization of employment are consistent with the reduction in TFP due to the minimum wage reform.[11]

[insert Table 4]

6.4 Heterogeneous treatment effects

As firm's response will not be uniform, I investigate further on what types of firms were more exposed to the wage shock. As the theory predicts, the MW reform will have an asymmetric effect on outputs and pricing behavior. Price and wage pass-throughs depend on output demand and labor supply elasticities. Holding price fixed, firms adjust employment and capital to maintain profits. Cost minimization in the appendix 2 predicts that firms with high labor intensity substitute formal workers with informal workers or mechanize production to save labor costs.

Frictions in credit market or adjustment costs in capital-labor input will also narrow the margin of adjustments. For the restaurant industry in the U.S., the Putty-Clay model

[11] As another productivity channel, my companion paper tests whether the MW increase affected worker's labor incentive as Shapiro-Stiglitz efficiency wage model predicts. The regression discontinuity analysis found no significant difference in labor intensity at minimum wage gap cut-off, which rules out possible labor supply adjustments to the MW policy at the intensive margin. The result is available upon request.

(Aaronson, French, Sorkin, and To, 2018) predicts that the MW hike causes little employment changes in the short-run for incumbent firms as their input mix is fixed like "clay". In contrast, new firms' technology is flexible like "putty".

6.4.1 Heterogeneity by industry

Minimum wage will be more binding for smaller firms and non-tradable service industry (like restaurants and retail shops) as they tend to employ more minimum wage workers. However, past studies for the U.S. and Hungary found larger disemployment effect of minimum wage for tradable sector than non-tradable sector (Cengiz, Dube, Lindner and Zipperer, 2019). The source of this heterogeneity stems from the elasticity of consumer demand in the product market.

Panel A of table 5 explores the MW impact heterogeneity on employment, profits, and TFP by industry. Results are shown separately for domestic and FDI firms over time. As discussed in section 2, FDI firms had been formally regulated by minimum wage law since the mid-1990s while domestic firms were *de facto* unregulated. In this regard, domestic firms were heavily treated by the 2011 reform while FDI firms were less exposed. Thus, the policy impact on FDI firms can serve as a placebo test.

In Panel A of table 5, results in column 1 show that $\widehat{\beta_3}$ is always negative on employment, profit margins, and TFP for domestic firms. In 2012, firms in the service sector faced significant immediate reduction in employment (-3.2%), profit margins (-3.3 p.p.) and TFP (-1%). The negative effect on TFP was slightly larger at -2% in the manufacturing industry. The negative effect on employment increased from 2012 to 2016, which indicates that the wage shock created permanent disemployment effect. In contrast, the policy impact on FDI firms (column 2) is always insignificant, showing that FDI firms were shielded from the MW policy shock.

Panel B of table 5 shows the impact heterogeneity on adjustment margins by industry. In the short-term, the reform led to reduction in machine investments by -10 p.p. for both industries (significant at 1% level). The formal labor share decreased by -5.8 p.p. for manufacturing firms and -2 p.p. for service firms in 2012. The placebo test confirms no

significant effect for FDI firms.

[insert Table 5]

6.4.2 Heterogeneity by firm size

Figure 5 shows the DID estimate $\widehat{\beta_3}$ when eq. (3) is estimated for sub-samples of domestic firms grouped by employment size: "small" (less than 100 employees) and "large" (greater than 100 employees). The estimate for FDI firms is also presented.

In Panel A of figure 5, disemployment effect was the largest and continued to bite over five years for large domestic firms. In contrast, FDI firms continued to have positive employment effect (although the confidence interval is wide due to small sample size). This suggests some reallocation of workers from domestic to FDI firms after the reform.[12] Similarly, Panel B shows positive MW effect on TFP for FDI firms whereas zero effect for domestic firms.

Panels C and D show the impact heterogeneity on PCM and machine investment. The policy effect on PCM remains zero for domestic firms, while PCM increased by about 0.8 p.p. for FDI firms in the initial year. On machine investments, the effect is positive for large domestic firms, whereas small domestic firms significantly cut back machine investments for the first two years after the reform. The temporary drop in machine investments by small firms likely reflects credit constraint. Finally, the reform prompted opposite labor adjustments between small and large firms (Panel E). Small domestic firms significantly reduced formal labor share to save social security payments, whereas FDI firms formalized their labor contract and expanded production.

[insert Figure 5]

[12] Dustmann, Lindner et al (2020) found an evidence that the introduction of minimum wage in Germany induced workers to move from low paying firms to better firms. The reallocation of workers will have an aggregate implication on productivity by changing the composition of workers. This paper cannot directly address such reallocation effect at individual firm level due to data gap.

7 Panel event-study analysis

In section 6, the treatment status was defined at one time point in 2011. However, as minimum wage continued to be raised, firms could be treated at later time. Since treatment timing varies by firms, a fully dynamic model is used to estimate the year-by-year impact of minimum wage hike. This relates to staggered adoption design (Athey and Imbens, 2018) which defines "relative time" – the number of periods relative to the year of treatment (Borusyak and Jaravel, 2017; Sun and Abraham, 2020; Dobkin, Finkelstein et al. 2018; Tewari, 2014).

Following the literature, firm j is treated (treatment group, $G_j = 1$) when the previous year's average wage is lower than MW in some year τ_j (≥ 2011) and stay treated after that. The relative time from the event: $K_{jt} = t - \tau_j$ defines treatment period. About 30% of domestic firms that are never affected by the reform (control group, $G_j = 0$) is also included. Specifically, I estimate the fixed effect (FE) regression with the relative period indicators:

$$y_{jsdt} = \alpha_j + \phi_s + \delta_t + \sum_{k=-1}^{5} \beta_k 1[K_{jsdt} = k] \cdot G_{jsd} + \gamma X_{jsdt} + v_d t + \varepsilon_{jsdt} \tag{6}$$

where an indicator variable $1[K_{jsdt} = k]$ for $k < 0$ captures pre-trend and β_k for $k \geq 0$ estimate dynamic effects k period relative to the event. The contemporaneous effect β_0 is omitted as the reference category.

The MW bind measure may have endogeneity problem if unproductive firms were more likely to underpay wages below minimum wage level. In this case, previous DID estimates will be downward biased. The FE regression addresses this concern by looking at the treatment effect for the same firm over years as firm-level FE α_j purges unobserved firm-level heterogeneity. ϕ_s, and δ_t additionally control for industry and year FEs.

The DID estimator assumes that the dynamics of outcome is parallel between treatment and control groups in the absence of the MW reform. This assumption may be implausible if selection for treatment is correlated with output dynamics (Meer and West, 2016). Ap-

pendix 4 tests this assumption, which indicates some differential pre-trend in profits and TFP. Including the pre-trend term in eq. (6) will correct for this. Using longer panel data, province-specific linear time trends $v_d t$ is also added to account for a linear pre-trend in each province.

7.1 Results

Figure 6 reports the point estimates of β_k where $-1 \leq k \leq 5$. The figure compares the dynamic treatment effects for the manufacturing and service sector separately.

Panel A of figure 6 shows that minimum wage hikes had large negative effect on log employment (significant at 1% level). The point estimate is larger than the two-period DID estimate of -3% (in table 2). The disemployment effect of minimum wage cumulates over years, so larger elasticity with the panel data sample is plausible. The disemployment effect is estimated at -11.7% in one year. The negative policy effect cumulated to -14% in three years and reached -21% in five years. Both sectors faced negative shocks on employments, but manufacturing industry lost employment more than service industry.

Panels B and C confirm significant loss in profit margins and TFP. The dynamic model shows a drop in profit margins by -1 p.p. in a year which cumulated to -3.6 p.p. in five years. Similarly, TFP dropped by -1.6% in a year which cumulated to -4% in five years. The reduction in profits and TFP was particularly severe in service industry. The TFP of service firms significantly dropped by -5.3% in five years. The result confirms large and cumulative efficiency loss in TFP due to the minimum wage hike.

[insert Figure 6]

8 Triple difference estimation: the heterogeneous treatment effect by market competition

In theory, competition induces firms to produce high-quality goods or services with reasonable prices. On the other hand, competitive pressures created by FDI firms or SOEs

could be detrimental for small domestic firms in developing countries. Intense competition often creates negative cannibalization effect for local businesses in sales or recruiting skilled workers, or forces firms to set prices too low.

In Vietnam, the qualitative interview suggests that the market environment does not seem to support small firm growth. The negative minimum wage effect on firm profits and productivity would have been augmented by the imperfect labor and product market competition (see predictions 1 and 2). The severity of the 2011 MW reform was an unexpected event for small firms, and whether the magnitude of this unexpected shock differed by market structure will be well identified by comparing the MW treatment effect across local markets.[13]

I use the triple difference (DDD) model and estimate the difference of the double-difference (DD) estimates. The DDD model purges differential time-trend in firm outcomes, thus improves the identification of the MW policy effect. The triple interaction term between $Bind_{jsd}$, $POST_t$, and the treatment market category dummy TC_{sd} estimates the heterogeneous treatment effect by the degree of market competition.

$$\begin{aligned} y_{jsdt} &= \alpha_d + \phi_s + \beta_1 Bind_{jsd} + \beta_2 POST + \beta_3 TC_{sd} + \beta_4 Bind_{jsd} \times POST + \beta_5 Bind_{jsd} \times TC_{sd} \\ &\quad + \beta_6 POST \times TC_{sd} + \beta_7 Bind_{jsd} \times POST \times TC_{sd} + \gamma X_{jsdt} + \varepsilon_{jsdt} \end{aligned} \tag{7}$$

Table 6 presents the difference in profit margins (column 1) and TFP (column 2) between treatment and control groups before and after the 2011 MW reform. The estimates are shown separately by industry and firm size. The DDD estimate β_7 is the difference in two double-differences, i.e., how the presence of FDI firms or SOEs changed the policy effect. Only domestic firms are included for the estimation.

To define treatment category, each enterprise's targeted market area must be clarified. As the relevant market area of individual firms is unknown, I assume that firms compete within the same province and industry.[14] The degree of market competition for each

[13] Basker (2007) examined the impact of market entry of larger firms (like Wal-Mart in the U.S.) on local market. The identification is challenging as the market entry is firms' endogenous choice.

[14] As the market size is particularly large in Ha Noi and HCMC (see Table 1b), the relevant market is

district-industry pair TC_{sd} is defined by the sales share of FDI firms or SOEs. Their market shares are computed at the province-industry level using the pre-reform census data in 2010. TC_{sd} is one for firms that run business in the market with FDI or SOE firms' sales share above the provincial average (High FDI/SOE share) and zero otherwise.[15]

8.1 Results

Panel A of table 6 shows the DDD results when the share of FDI firms is used as the treatment market category. Before the MW reform, profit margins are higher in markets with high FDI share than low FDI share in both sectors (column 1). This may reflect positive spillovers from FDI firms in expanding local markets. However, after the reform, the average profit margins significantly dropped in the market with high FDI share, which results in negative DD estimate. The DDD estimate is significantly negative at -12.2 p.p. for small manufacturing firms and -14.4 p.p. for small service firms. In column 2, DD and DDD estimates demonstrate a similar pattern as column 1. Small domestic firms faced significant deterioration in TFP due to the MW hike in the market with high FDI share by 5.9% for manufacturing firms and 7.6% for service firms. This result reflects that domestic firms faced competitive disadvantage in competing with FDI firms.

Panel B replaces the treatment category with the share of SOE firms. Like results in Panel A, firms that operate in the market with high SOE share exhibit higher profit margins and TFP before the 2011 reform. After the MW reform, profit margins and TFP significantly dropped for small firms in the service industry. Small firms were adversely affected as SOE firms have stronger market power as well as political connections to the government.

[insert Table 6]

defined in smaller cells at district level for firms located in these two provinces.

[15] I also checked the alternative definition of TC_{sd} that is benchmarked against the industry average, but main results remain robust. The result is available upon request.

9 Conclusion

This paper examined the effect of the 2011 minimum wage reform in Vietnam on employment, profits, and productivity using the ten-year panel data. Vietnam is one of a few countries in the world with district-industry variations in the minimum wage policy, offering an interesting natural experiment to evaluate the effectiveness of the policy reform.

The panel event study provided three key findings. First, minimum wage hike created immediate and large medium-term disemployment effects, that cumulated to -14% over three years. As implied by the mixed market model, domestic firms, especially small ones, faced significant losses in profits and TFP. In contrast, FDI firms were virtually not affected. Second, various margins of adjustments to the reform, including the responses in output prices, employment, and machine investment, were examined. The MW untreated firms generally tried to mechanize production to reduce labor costs, but small domestic firms could not increase machine investments due to credit constraints. Disemployment effect was larger for large firms, while small firms started to employ more informal workers after the policy reform. For the MW treated firms, lack of machine investment and an increase in informal workers made the capital-labor mix sub-optimal, contributing to the reduction in TFP. Finally, the triple-difference model found that small domestic firms faced significantly larger deterioration in profits and TFP due to the policy shock when their local market was dominated by large FDI firms or SOEs.

In a policy perspective, my result shows that labor regulations could be a significant barrier for small firm growth in developing countries. Moreover, the negative effect of minimum wage on productivity could be augmented by market imperfections. When large firms have a strong market power, the change in minimum wage regulation can create price and wage distortions, leading to factor misallocations and the reduction in TFP. In this regard, policy makers should carefully examine the interaction between minimum wage and competition policy for designing an effective development strategy.

As a final note, this paper uses the balanced panel of surviving firms, thus firm's entry and exit dynamics after minimum wage hike is not directly addressed. On one hand, this

simplification allows me to better identify the productivity effect of minimum wage through product and factor market adjustments. However, my preliminary analysis indicates a drop in net market entry rate with higher firm attrition after the 2011 reform. Incorporating the endogenous market selection effect using unbalanced panel data is left for future research.

References

Aaronson, D., 2001. Price pass-through and the minimum wage. *Review of Economics and Statistics*, 83(1), pp.158-169.

Aaronson, D. and French, E., 2007. Product market evidence on the employment effects of the minimum wage. *Journal of Labor Economics*, 25(1), pp.167-200.

Aaronson, D., French, E., Sorkin, I. and To, T., 2018. Industry dynamics and the minimum wage: a putty-clay approach. *International Economic Review*, 59(1), pp.51-84.

Alvarez, R. and Fuentez, R. 2018. Minimum wage and productivity: Evidence from Chilean manufacturing plants. *Economic Development and Cultural Change*, 67(1), pp. 193-224.

Amiti, M. and Konings, J., 2007. Trade liberalization, intermediate inputs, and productivity: Evidence from Indonesia. *American Economic Review*, 97(5), pp.1611-1638.

Athey, S. and Imbens, G.W., 2018. Design-based analysis in difference-in-differences settings with staggered adoption, *NBER working paper*, No. w24963.

Bai, J., Jayachandran, S., Malesky, E.J. and Olken, B.A., 2017. Firm growth and corruption: Empirical evidence from Vietnam. *Economic Journal*, 129(618), pp.651-677.

Basker, E., 2007. The Causes and Consequences of Wal-Mart's Growth. *Journal of Economic Perspectives*, 21(3), pp.177-198.

Bell, B. and Machin, S., 2018. Minimum wages and firm value. *Journal of Labor Economics*, 36(1), pp.159-195.

Bhaskar, V., Manning, A. and To, T., 2002. Oligopsony and monopsonistic competition in labor markets. *Journal of Economic Perspectives*, 16(2), pp.155-174.

Bhorat, H., Kanbur, R. and Stanwix, B., 2017. Minimum wages in Sub-Saharan Africa: a primer. *World Bank Research Observer*, 32(1), pp.21-74.

Borusyak, K. and X. Jaravel, 2017. Revisiting event study designs. Working Paper. Harvard University.

Cadot, O., Carrere, C. and Strauss-Kahn, V., 2011. Export diversification: what's behind the hump?. *Review of Economics and Statistics*, 93(2), pp.590-605.

Card, D., Cardoso, A.R., Heining, J. and Kline, P., 2018. Firms and labor market inequality: Evidence and some theory. *Journal of Labor Economics*, 36(S1), pp.S13-S70.

Cengiz, D., Dube, A., Lindner, A. and Zipperer, B., 2019. The effect of minimum wages on low-wage jobs: Evidence from the United States using a bunching estimator (No. w25434). National Bureau of Economic Research.

Dinkelman, Taryn and Vimal Ranchhod. 2012. Evidence on the Impact of Minimum Wage Laws in an Informal Sector: Domestic Workers in South Africa. *Journal of Development Economics*, vol. 99(1), pp. 27-45.

Dobkin, C., Finkelstein, A., Kluender, R. and Notowidigdo, M.J., 2018. The economic consequences of hospital admissions. *American Economic Review*, 108(2), pp.308-52.

Draca, M., Machin, S. and Van Reenen, J., 2011. Minimum wages and firm profitability. *American Economic Journal: Applied Economics*, 3(1), pp.129-51.

Dustmann, C., Lindner, A., Schonberg, U., Umkehrer, M. and vom Berge, P., 2020. Reallocation effects of the minimum wage: Evidence from Germany. mimeo, University College London.

Ha, D.T.T., Kiyota, K. and Yamanouchi, K., 2016. Misallocation and productivity: The case of Vietnamese manufacturing. *Asian Development Review*, 33(2), pp.94-118.

Harasztosi, P. and Lindner, A. 2019. Who pays for the minimum wage? *American Economic Review*, 109(8), pp. 2693-2727.

Hau, H., Huang, Y. and Wang, G., 2018. Firm response to competitive shocks: Evidence from China's minimum wage policy. Swiss Finance Institute Research Paper, (16-47).

Hsieh, C.T. and Klenow, P.J., 2009. Misallocation and manufacturing TFP in China and India. *Quarterly Journal of Economics,* 124(4), pp.1403-1448.

Imbs, J. and Wacziarg, R., 2003. Stages of diversification. *American Economic Review*, 93(1), pp.63-86.

Manning, A. 2011. Imperfect competition in the labor market. In *Handbook of Labor Economics*, vol. 4, pp. 973-1041.

Mason, A.D. and Shetty, S., 2019. A Resurgent East Asia: Navigating a Changing World. The World Bank.

McKenzie, D. and Paffhausen, A.L., 2019. Small firm death in developing countries. *Review of Economics and Statistics*, vol. 101(4), pp. 645-657.

Meer, J. and West, J., 2016. Effects of the minimum wage on employment dynamics. *Journal of Human Resources*, 51(2), pp.500-522.

Neumark, D., 2018. Employment effects of minimum wages. *IZA World of Labor*.

Neumark, D. and Corella, L. F, 2019. Do minimum wages reduce employment in developing countries? A survey and exploration of conflicting evidence. *NBER Working Paper #26462*.

Neumark, D., Cunningham, W. and Siga, L., 2006. The effects of the minimum wage in Brazil on the distribution of family incomes: 1996–2001. *Journal of Development Economics*, 80(1), pp.136-159.

Nguyen, D. T., K. Ohno, F. Yamauchi, T. D. Nguyen, T. T. Trinh Pham, and T. T. Nguyen. 2017. Labor productivity and wage growth in Viet Nam: trends and policy implications. Ha Noi.

Pan, L. and Hanazono, M., 2018. Is a Big Entrant a Threat to Incumbents? The Role of Demand Substitutability in Competition among the Big and the Small. *Journal of Industrial Economics*, 66(1), pp.30-65.

Riley, R. and Bondibene, C.R., 2017. Raising the standard: minimum wages and firm productivity. *Labour Economics*, 44, pp.27-50.

Sun, L. and S. Abraham, 2020. Estimating dynamic treatment effects in event studies with heterogeneous treatment effects. Working Paper. Harvard University.

Tewari, I., 2014. The distributive impacts of financial development: Evidence from mortgage markets during us bank branch deregulation. *American Economic Journal: Applied Economics*, 6(4), pp.175-96.

Yamada, K., 2016. Tracing the impact of large minimum wage changes on household welfare in Indonesia. *European Economic Review*, 87, pp.287-303.

Table 1a. Summary Statistics

	Obervations	Mean	Standard dev.	Minimum	Median	Maximum
(A) Firm characteristics						
Employment	106,914	50.7	408.9	1	9	84,660
Small firm (employment<10)	106,914	0.602	0.489	0	1	1
Middle-sized firm (10<employment<100)	106,914	0.324	0.468	0	0	1
Large firm (100<employment)	106,914	0.070	0.256	0	0	1
Firm age	106,437	4.8	4.5	0	4	66
Manager age	106,914	42.9	9.7	18	42	88
Manager female	106,914	0.249	0.432	0	0	1
Manager with high education	106,914	0.608	0.488	0	1	1
Manager's nationality is local	106,914	0.965	0.185	0	1	1
(B) Firm performance						
Profit margins	101,401	-0.143	0.991	-20.120	0.005	0.319
Value added ratio	101,858	0.338	0.590	-3.800	0.198	8.541
TFP	74,243	0.186	1.433	-10.215	0.391	2.406
Pr(real machine and equipment inv.)	106,914	0.025	0.155	0	0	1
Price-cost margins (PCM)	99,929	0.708	1.450	0	0	27
Number of production lines	106,914	1.115	0	1	1	5
(C) Minimum wage (MW) and labor						
MW bind 1/	105,135	0.102	0.303	0	0	1
MW bind (alt)	80,343	0.192	0.394	0	0	1
MW wage gap	105,135	-0.636	0.538	-2.690	-0.674	1.941
Labor share of formal workers	106,914	0.277	0.387	0	0	1
(D) Local market environment						
Number of competitors	106,597	375	653	1	87	3,232
FDI market share	106,597	0.057	0.154	0	0.000	1
SOE market share	106,597	0.049	0.108	0	0.001	1
HHI index (labor concentration)	106,597	0.085	0.146	0.001	0.031	1
Percent of LURC owners	101,406	0.451	0.262	0	0.417	1
Labor regulatory uncertainty index	101,242	0.464	0.218	0	0.469	1

Note:
1/ "MW bind" is a discrete minimum wage treatment indicator that is one if firm's pre-reform average wage is lower than new statutory minimum wage level (in real term), and zero otherwise.

Table 1b. Regional Market Structure

Region	MW bind	Total number of firms	Market share in sales 1/		Number of competitors 2/	Labor HHI 2/
			FDIs	SOEs		
Red River Delta	9.2%	32,972	7.5%	5.1%	61.6	0.29
of which						
Bac Ninh	16.3%	1,126	10.1%	2.8%	14.4	0.34
Ha Noi	6.2%	23,429	5.2%	5.6%	148.7	0.19
North Eastern	16.4%	3,822	4.2%	5.8%	16.5	0.43
North Western	14.5%	1,900	1.2%	9.0%	9.0	0.42
Central Highlands	10.3%	2,339	1.9%	5.3%	15.8	0.37
North Central	12.2%	6,908	0.8%	6.1%	17.5	0.34
Coastal Central	14.9%	7,840	3.4%	6.2%	24.2	0.36
South Eastern	7.8%	42,539	12.6%	5.7%	112.4	0.24
of which						
Ba Ria-Vung Tau	12.2%	436	11.3%	7.3%	38.3	0.25
Binh Duong	10.3%	3,969	23.8%	5.8%	36.2	0.27
Ho Chí Minh city (HCMC)	7.3%	34,957	7.5%	5.4%	196.7	0.13
Mekong River Delta	16.1%	8,594	1.9%	4.2%	14.9	0.37

Note:
1/ Each indicator is computed at the district-industry (VSIC 2 digit) level. The provincial average of each indicator is shown in this table.

Table 2. Difference-in-Difference Estimates for Firm Growth: from 2010 to 2012 (short-term effect)

	(1) Total sample				(2) Drop 27 districts with MW reform in two steps			
	Log employment	Log real wage	Profit margins	TFP	Log employment	Log real wage	Profit margins	TFP
Panel A. Treatment = MW bind								
β1 (Bind)	-0.158***	-0.297***	0.000	0.016***	-0.159***	-0.299***	0.002	0.017***
	[0.011]	[0.007]	[0.010]	[0.003]	[0.011]	[0.007]	[0.011]	[0.003]
β2 (Post)	-0.042***	0.227***	0.131***	0.062***	-0.040***	0.226***	0.139***	0.063***
	[0.005]	[0.002]	[0.003]	[0.001]	[0.005]	[0.003]	[0.004]	[0.001]
β3 (MW bind x Post)	**-0.031****	**0.042*****	**-0.032*****	**-0.012*****	**-0.030****	**0.048*****	**-0.034*****	**-0.013*****
	[0.015]	[0.008]	[0.010]	[0.004]	[0.015]	[0.009]	[0.011]	[0.004]
Control variables								
Log employment	…	0.075***	0.055***	-0.047***	…	0.078***	0.059***	-0.047***
	…	[0.001]	[0.002]	[0.001]	…	[0.001]	[0.002]	[0.001]
Firm age	0.070***	0.004***	0.003***	0.001***	0.069***	0.004***	0.003***	0.001***
	[0.001]	[0.000]	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]
Manager age	0.007***	-0.000***	0.000*	0.000***	0.007***	-0.000**	0.000*	0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Manager female	-0.074***	-0.013***	-0.002	-0.003**	-0.080***	-0.015***	-0.002	-0.003**
	[0.005]	[0.003]	[0.004]	[0.001]	[0.005]	[0.003]	[0.004]	[0.001]
Manager with high education	0.384***	0.081***	-0.035***	-0.003***	0.371***	0.075***	-0.037***	-0.004***
	[0.005]	[0.003]	[0.003]	[0.001]	[0.005]	[0.003]	[0.003]	[0.001]
Manager's nationality is local	-1.118***	-0.201***	0.099***	0.013***	-1.126***	-0.179***	0.107***	0.026***
	[0.019]	[0.008]	[0.010]	[0.004]	[0.024]	[0.010]	[0.016]	[0.006]
Labor HHI	0.341***	-0.034***	0.003	0.048***	0.389***	-0.030***	-0.006	0.051***
	[0.022]	[0.011]	[0.014]	[0.005]	[0.023]	[0.011]	[0.015]	[0.005]
Observations	209,000	202,000	198,000	164,000	189,000	183,000	179,000	148,000
Adjusted R squared	0.373	0.244	0.030	0.110	0.343	0.246	0.030	0.106
District and industry FE	Y	Y	Y	Y	Y	Y	Y	Y
Panel B: DID estimates (β3) using alternative treatment variable								
MW bind (alt) x Post	-0.024*	-0.009	-0.061***	-0.017***	-0.025*	-0.011	-0.063***	-0.018***
	[0.013]	[0.007]	[0.006]	[0.003]	[0.014]	[0.007]	[0.006]	[0.003]
Observations	160,000	155,000	153,000	129,000	144,000	139,000	138,000	117,000
Real wage gap x Post	-0.028***	0.017***	-0.070***	-0.016***	-0.026***	0.017***	-0.072***	-0.017***
	[0.009]	[0.005]	[0.006]	[0.002]	[0.009]	[0.005]	[0.007]	[0.002]
Observations	209,000	202,000	198,000	164,000	189,000	183,000	179,000	148,000

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

Note: Panel B conducts a robustness check using alternative treatment variables which control for same sets of covariates and fixed effects. Standard errors, which are clustered at the district-industry level, are reported in the bracket.

Table 3. Difference-in-Difference Estimates for Margins of Adjustments: from 2010 to 2012 (short-term effect)

	(1) Total sample			(2) Drop 27 districts with MW reform in two steps		
	Price-cost margins (PCM)	Pr(machine & equipment investment)	Labor share of formal workers	Price-cost margins (PCM)	Pr(machine & equipment investment)	Labor share of formal workers
Panel A. Treatment = MW bind						
β1 (Bind)	0.116***	0.024***	-0.027***	0.121***	0.027***	-0.027***
	[0.016]	[0.002]	[0.004]	[0.017]	[0.002]	[0.004]
β2 (Post)	0.446***	0.181***	0.060***	0.451***	0.185***	0.061***
	[0.015]	[0.001]	[0.001]	[0.016]	[0.001]	[0.001]
β3 (Bind X Post)	**-0.046**	**-0.094*****	**-0.025*****	**-0.035**	**-0.097*****	**-0.022*****
	[0.043]	[0.004]	[0.005]	[0.047]	[0.004]	[0.005]
Control variables						
Log employment	-0.283***	-0.015***	0.082***	-0.288***	-0.015***	0.081***
	[0.009]	[0.001]	[0.001]	[0.009]	[0.001]	[0.001]
Firm age	-0.003*	-0.001***	0.009***	-0.003*	-0.001***	0.009***
	[0.002]	[0.000]	[0.000]	[0.002]	[0.000]	[0.000]
Manager age	0.002***	0.000	0.001***	0.002***	0.000	0.001***
	[0.001]	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]
Manager female	-0.015	-0.001	0.001	-0.016	-0.002	0.000
	[0.016]	[0.002]	[0.002]	[0.018]	[0.002]	[0.002]
Manager with high education	0.113***	0.005***	0.082***	0.124***	0.005***	0.080***
	[0.016]	[0.002]	[0.002]	[0.017]	[0.002]	[0.002]
Manager's nationality is local	-0.122***	0.035***	-0.246***	-0.018	0.039***	-0.216***
	[0.030]	[0.004]	[0.004]	[0.042]	[0.005]	[0.005]
Labor HHI	0.288***	0.001	0.044***	0.339***	-0.003	0.053***
	[0.064]	[0.006]	[0.007]	[0.065]	[0.006]	[0.007]
Percent of LURC owners	0.129***	0.080***	-0.014***	0.172***	0.089***	-0.012***
	[0.036]	[0.003]	[0.004]	[0.038]	[0.004]	[0.004]
Labor regulatory uncertainty index	-0.183***	0.004	-0.040***	-0.216***	0.007**	-0.038***
	[0.035]	[0.003]	[0.004]	[0.038]	[0.003]	[0.004]
Observations	183,000	197,000	197,000	167,000	178,000	178,000
Adjusted R squared	0.046	0.140	0.297	0.046	0.143	0.275
District and industry FEs	Y	Y	Y	Y	Y	Y
Panel B: DID estimates (β3) using alternative treatment variable						
MW bind (alt) x Post	-0.075**	-0.092***	-0.041***	-0.087**	-0.095***	-0.040***
	[0.032]	[0.003]	[0.004]	[0.035]	[0.004]	[0.004]
Observations	141,000	150,000	150,000	128,000	135,000	135,000
Real wage gap x Post	-0.099***	-0.047***	-0.013***	-0.104***	-0.048***	-0.013***
	[0.027]	[0.002]	[0.003]	[0.028]	[0.002]	[0.003]
Observations	183,000	197,000	197,000	167,000	178,000	197,000

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

Note: Panel B conducts a robustness check using alternative treatment variables which control for same sets of covariates and fixed effects. Standard errors, which are clustered at the district-industry level, are reported in the bracket.

Table 4. Product differentiation: Two-period Difference-in-Difference Estimates (2010-2012)

	(1) Total sample			(2) Drop 27 districts with MW reform in two steps		
	Number of product line	Theil index (z-score)	Average skill content (z-score)	Number of product line	Theil index (z-score)	Average skill content (z-score)
Panel A. Treatment = MW bind						
β1 (Bind)	-0.017***	-0.029***	0.082***	-0.019***	-0.026**	0.084***
	[0.005]	[0.011]	[0.015]	[0.005]	[0.010]	[0.015]
β2 (Post)	-0.029***	-0.013***	0.022***	-0.036***	-0.005	0.019***
	[0.002]	[0.004]	[0.006]	[0.002]	[0.004]	[0.007]
β3 (Bind X Post)	**0.004**	**0.007**	**-0.023**	**0.003**	**0.005**	**-0.030**
	[0.006]	[0.014]	[0.020]	[0.006]	[0.014]	[0.021]
Control variables						
Log employment	0.095***	0.237***	-0.073***	0.087***	0.237***	-0.076***
	[0.002]	[0.004]	[0.003]	[0.001]	[0.004]	[0.004]
Firm age	0.006***	0.015***	-0.014***	0.007***	0.015***	-0.012***
	[0.000]	[0.001]	[0.001]	[0.000]	[0.001]	[0.001]
Manager age	0.000	-0.001**	-0.001***	0.000	-0.001***	-0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Manager female	-0.011***	-0.019***	0.020***	-0.012***	-0.013***	0.025***
	[0.002]	[0.004]	[0.007]	[0.002]	[0.004]	[0.007]
Manager with high education	0.015***	0.036***	-0.002	0.017***	0.029***	-0.001
	[0.002]	[0.005]	[0.007]	[0.002]	[0.005]	[0.007]
Manager's nationality is local	0.043***	0.078**	-0.052	0.027***	0.053	-0.035
	[0.010]	[0.032]	[0.051]	[0.010]	[0.033]	[0.054]
Labor HHI	0.051***	0.067***	-0.098***	0.055***	0.064**	-0.094***
	[0.011]	[0.025]	[0.030]	[0.011]	[0.025]	[0.031]
Percent of LURC owners	0.032***	0.054***	-0.031*	0.031***	0.057***	-0.032*
	[0.006]	[0.014]	[0.017]	[0.006]	[0.014]	[0.018]
Labor regulatory uncertainty index	-0.002	-0.035**	-0.043***	0.003	-0.028**	-0.049***
	[0.006]	[0.014]	[0.016]	[0.006]	[0.013]	[0.017]
Observations	175,000	191,000	110,000	175,000	175,000	101,000
Adjusted R squared	0.155	0.133	0.030	0.151	0.147	0.030
District and industry FEs	Y	Y	Y	Y	Y	Y
Panel B: DID estimates (β3) using alternative treatment variable						
β3 (Bind (alt)X Post)	0.003	0.012	0.001	0.002	0.017	-0.004
	[0.006]	[0.014]	[0.018]	[0.006]	[0.014]	[0.019]
Observations	133,000	145,000	78,682	133000	133,000	71,972
Real wage gap x Post	-0.002	-0.01	-0.001	-0.003	-0.008	-0.004
	[0.004]	[0.009]	[0.011]	[0.003]	[0.009]	[0.012]
Observations	175,000	191,000	110,000	175,000	175,000	101,000

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

Note: Panel B conducts a robustness check using alternative treatment variables which control for same sets of covariates and fixed effects. Standard errors, which are clustered at the district-industry level, are reported in the bracket.

Table 5. Heterogeneous MW Effect by Firm Type and Industry:

from 2010 to 2012 (short-term) or 2016 (long-term)

	(1) Domestic firms				(2) FDI firms			
	Manufacturing		Service		Manufacturing		Service	
	2012	2016	2012	2016	2012	2016	2012	2016
A. DD estimates on firm growth								
Log employment	-0.026	-0.072**	-0.032**	-0.057***	0.067	0.057	0.118	0.263
	[0.033]	[0.035]	[0.016]	[0.016]	[0.147]	[0.154]	[0.173]	[0.210]
Observations	36,583	36,248	165,000	165,000	5,783	5,782	1,599	1,655
Profit margins	-0.016	-0.015	-0.033***	-0.018	-0.014	-0.008	0.064	0.103
	[0.016]	[0.019]	[0.012]	[0.013]	[0.043]	[0.058]	[0.297]	[0.306]
Observations	35,036	34,054	157,000	153,000	4,794	4,667	1,225	1,275
TFP	-0.020***	0.005	-0.009**	-0.001	-0.016	0.041	0.155	0.082
	[0.006]	[0.008]	[0.004]	[0.007]	[0.030]	[0.031]	[0.108]	[0.159]
Observations	30,507	27,828	129,000	111,000	3,387	3,420	909	889
B. DD estimates on adjustment margins								
Pr(machine & equip.inv)	-0.101***	-0.010*	-0.097***	-0.005**	-0.059**	-0.023	0.033*	0.018**
	[0.009]	[0.005]	[0.004]	[0.002]	[0.027]	[0.030]	[0.019]	[0.009]
Observations	33,552	33,213	157,000	158,000	4,586	4,577	1,504	1,555
Share of formal labors	-0.058***	-0.016	-0.019***	-0.023***	0.028	0.024	0.043	0.097
	[0.009]	[0.010]	[0.005]	[0.006]	[0.034]	[0.037]	[0.067]	[0.064]
Observations	33,551	33,209	157,000	158,000	4,586	4,576	1,504	1,555

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

Note: This table collects the DID estimates (β_3) for each regression sample. The regression includes basic firm and firm manager characteristics, labor HHI, and industry and district dummies. Standard errors, which are clustered at the district-industry level, are reported in the bracket.

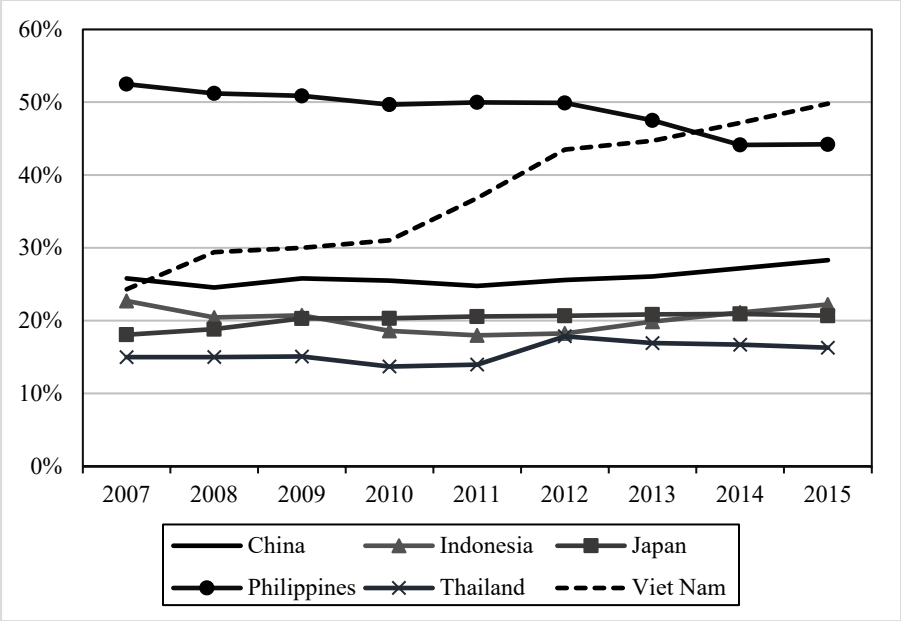
Table 6. Triple Difference: MW Impact Heterogeneity by Market Structure

Short-term effect from 2010 to 2012

	(1) Difference in profit margins $= E(\pi \mid MW\ bind) - E(\pi \mid MW\ nonbind)$				(2) Difference in TFP $= E(TFP \mid MW\ bind) - E(TFP \mid MW\ nonbind)$			
	Manufacturing		Service		Manufacturing		Service	
	Small	Large	Small	Large	Small	Large	Small	Large
Panel A. treatment category = the share of FDI firms								
Before								
High FDI share	0.059	0.008	0.045	0.078	0.058	-0.014	0.051	-0.004
Low FDI share	-0.035	0.016	0.002	-0.020	0.035	-0.028	0.034	-0.034
DD estimate (1)	0.094*	-0.008	0.043	0.098	0.022	0.014	0.017	0.030
	[0.052]	[0.032]	[0.062]	[0.080]	[0.020]	[0.020]	[0.026]	[0.039]
After								
High FDI share	-0.064	-0.034	-0.124	0.003	-0.035	-0.039	-0.040	-0.011
Low FDI share	-0.036	-0.009	-0.023	-0.009	0.002	-0.024	0.019	-0.011
DD estimate (2)	-0.028	-0.025	-0.101***	0.012	-0.037**	-0.015	-0.059***	0.001
	[0.019]	[0.030]	[0.016]	[0.034]	[0.015]	[0.019]	[0.015]	[0.027]
DDD estimate (β_7)	**-0.122****	**-0.017**	**-0.144****	**-0.086**	**-0.059****	**-0.029**	**-0.076*****	**-0.029**
=(2)-(1)	[0.052]	[0.032]	[0.062]	[0.081]	[0.023]	[0.024]	[0.029]	[0.046]
Observations	15,132	4,165	103,957	5,355	12,889	2,954	82,930	4,003
Panel B. treatment category = the share of SOEs								
Before								
High SOE share	0.051	0.009	0.063	-0.024	0.055	-0.016	0.035	-0.022
Low SOE share	-0.017	0.014	-0.015	0.003	0.039	-0.025	0.035	-0.035
DD estimate (1)	0.068	-0.004	0.078**	-0.027	0.017	0.009	0.000	0.013
	[0.051]	[0.043]	[0.037]	[0.034]	[0.023]	[0.021]	[0.018]	[0.037]
After								
High SOE share	-0.060	-0.057	-0.104	-0.011	-0.010	-0.031	-0.011	-0.002
Low SOE share	-0.040	-0.008	-0.014	-0.006	-0.010	-0.029	0.018	-0.018
DD estimate (2)	-0.019	-0.050	-0.090***	-0.005	-0.001	-0.002	-0.029***	0.016
	[0.022]	[0.040]	[0.011]	[0.019]	[0.019]	[0.022]	[0.010]	[0.016]
DDD estimate (β_7)	**-0.088**	**-0.045**	**-0.168*****	**0.022**	**-0.017**	**-0.011**	**-0.030**	**0.003**
=(2)-(1)	[0.054]	[0.047]	[0.038]	[0.038]	[0.028]	[0.028]	[0.020]	[0.038]
Observations	15,132	4,165	103,957	5,355	12,889	2,954	82,930	4,003

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

Note: Regression includes basic firm and firm manager characteristics, and industry and district dummies. The DDD regressions are run for each sample for the period of 2010-12. Standard errors, which are clustered at the district-industry level, are reported in the bracket.



Source: Nguyen et al. (2017)

Note: Philippines and Thailand: monthly minimum wage is computed from hourly minimum wage (8 hours x 23 days), Thailand's minimum wage rate is for Bangkok; Vietnam: minimum wage rate before 2011 is for domestic firms in Group I regions. Labor productivity is calculated as GDP/total labor force.

Figure 1. Minimum Wage-to-Labor Productivity Ratio, 2007-2015

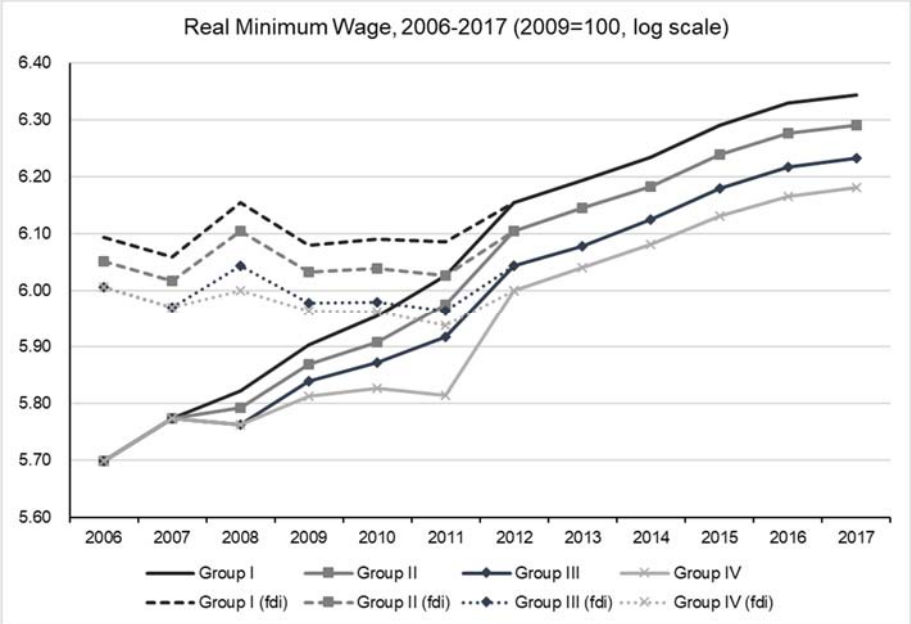


Figure 2. Real Minimum Wage by Group, 2006-17 (2009=100, log scale)

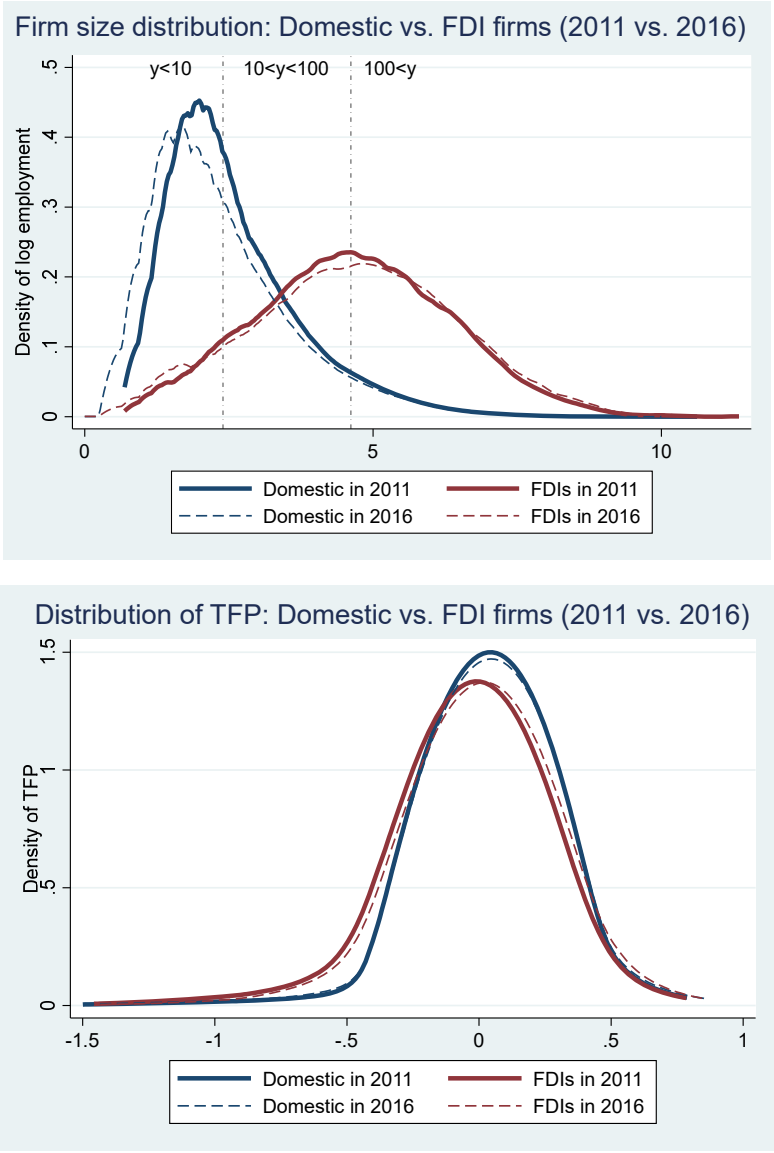
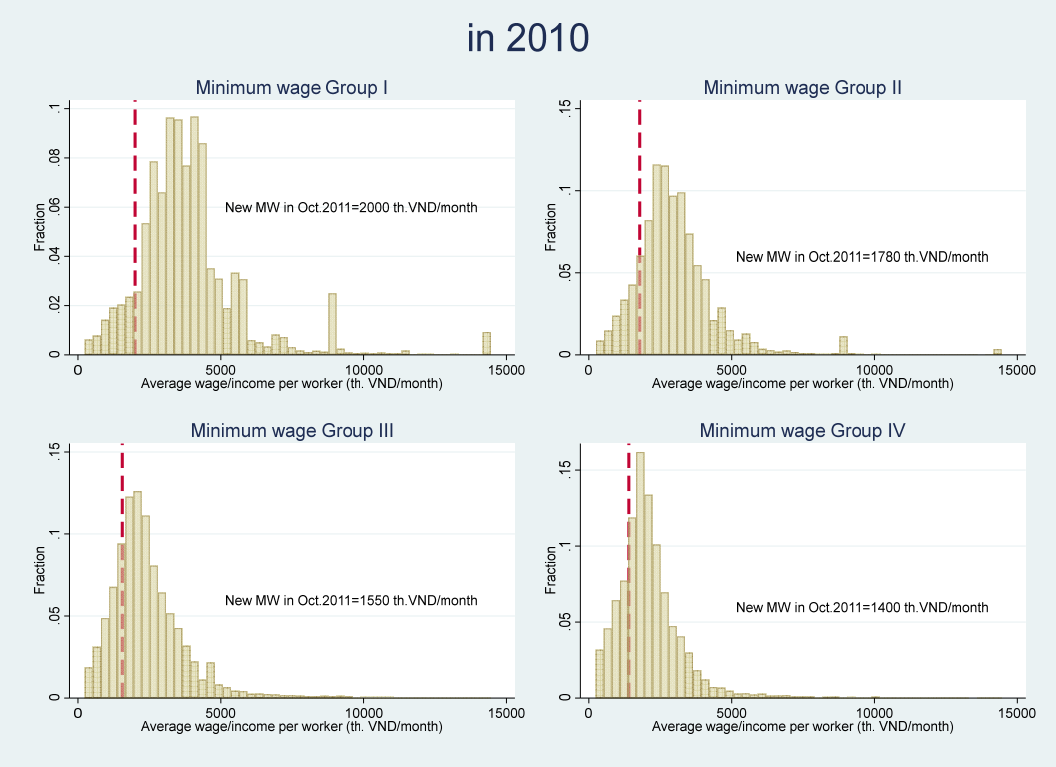
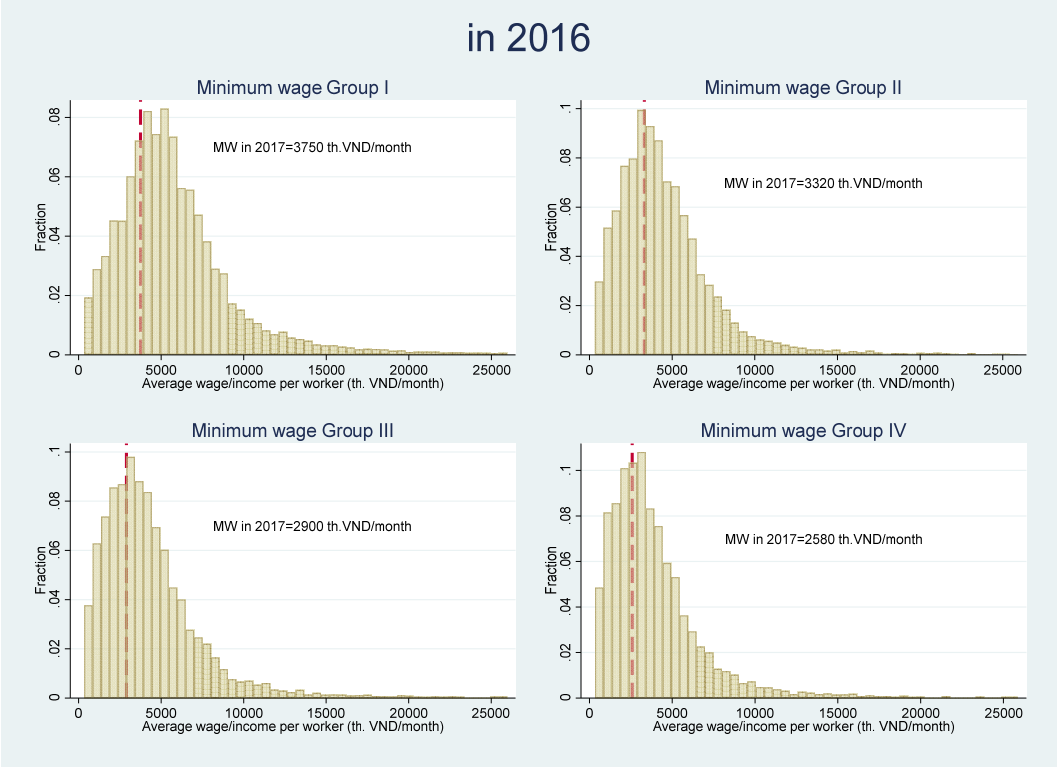


Figure 3. Distributions of Firm Size and TFP:

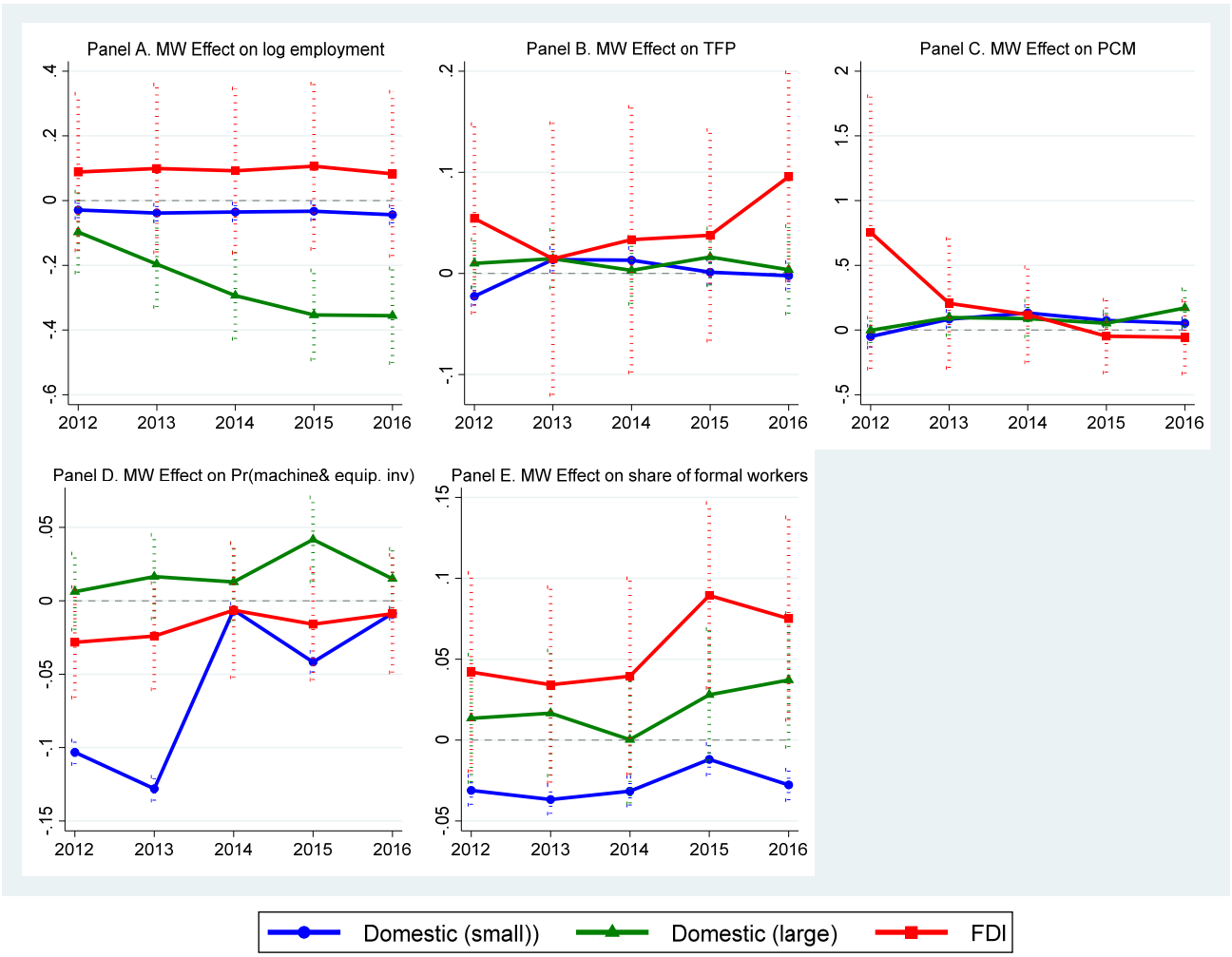
Domestic vs. FDI firms, from 2011 to 2016





Note: Reference line (in dash) shows the minimum wage of each group for the following year.

Figure 4. Domestic Firm's Average Monthly Wage Distribution (relative to the Minimum Wage): Before the reform (in 2010) and after the reform (in 2016)



Note: 95% confidence intervals of the point estimates are shown in dotted lines.

Figure 5. Difference-in-Difference Estimate over the Medium-term

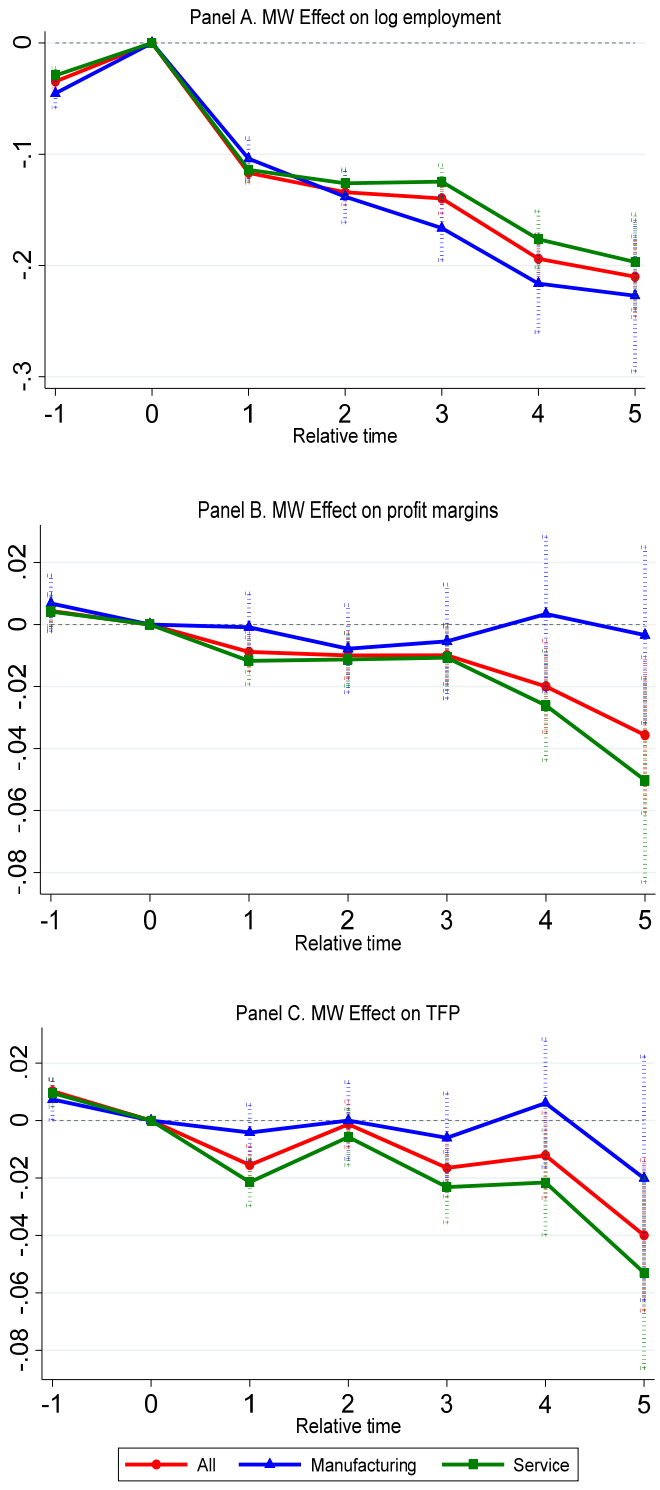


Figure 6. Dynamic MW Treatment Effect on Employment, Profit Margin, and TFP

[Not for publication]
On-line Appendix Materials

Appendix 1: Questionnaire and Summary Statistics from the In-depth Field Interviews

This appendix provides additional description of the questionnaire and results of the in-depth interviews. In collaboration with the Vietnam Institute for Economic and Policy Research (VEPR), the in-depth interview was conducted with fifteen domestic and seven FDI firms, including two informal firms. We also met six government entities (Vietnam Chamber of Commerce and Industry (VCCI) and five provincial governments and ministries). Given that market conditions in north and south Vietnam are different, we sampled enterprises located in both northern (Ha Noi and Bac Ninh) and southern provinces (HCMC, Binh Duong, Ba Ria-Vung Tau) (see the location in figure A1).

Besides firm characteristics, we discussed the following questions to understand firm's perceptions to minimum wage (MW) reform, their adjustment strategies to address rising labor costs, and constraints to operate business.

Table A1.1: Open-ended questions

Constraints for business
• Is land access (the ownership of land -use certificate) main constraint for your business? Has it become easier to own land or land-use certificate? • (For informal firms) do you plan to formally register your business? If so, how do you register? • What is the ideal size of your business? To expand, how do you recruit workers? • How often are you inspected by local regulators on taxation or regulations? • How does current market condition (competition & regulation) affect your business?
The impact of the 2011 minimum wage (MW) reform and adjustment strategies
• In October 2011, did you anticipate the MW reform in such magnitude? • How was your business profitability affected after the MW reform in 2011? • For years after 2011, did you expect that minimum wage would continue to increase above inflation? • Were there more firms entering or exiting from the market? Has the market competition become more severe in your targeted market since 2011? • How did the MW reform affect the number of employees (full-time vs. part-time, by education level & age) and wages/social security of each job position? • Were more workers interested in working for your company after the base salary increased? • How did you adjust your business strategy to the MW hike? Did you raise the price of your product? Did your company mechanize your production? Did you compete by non -pricing strategy (e.g., improve product/service quality, increase product lines)?

Based on each interviewed firms' responses to the above questions, table A1.2 summarizes the proportion of firms that faced main business constraints and took related business strategies to the policy shock. Among domestic firms, lack of skilled workers and unfair market competition were perceived as major business constraints. Most of FDI firms raised

labor regulations and the shortage of skilled workers as main concerns for their business.

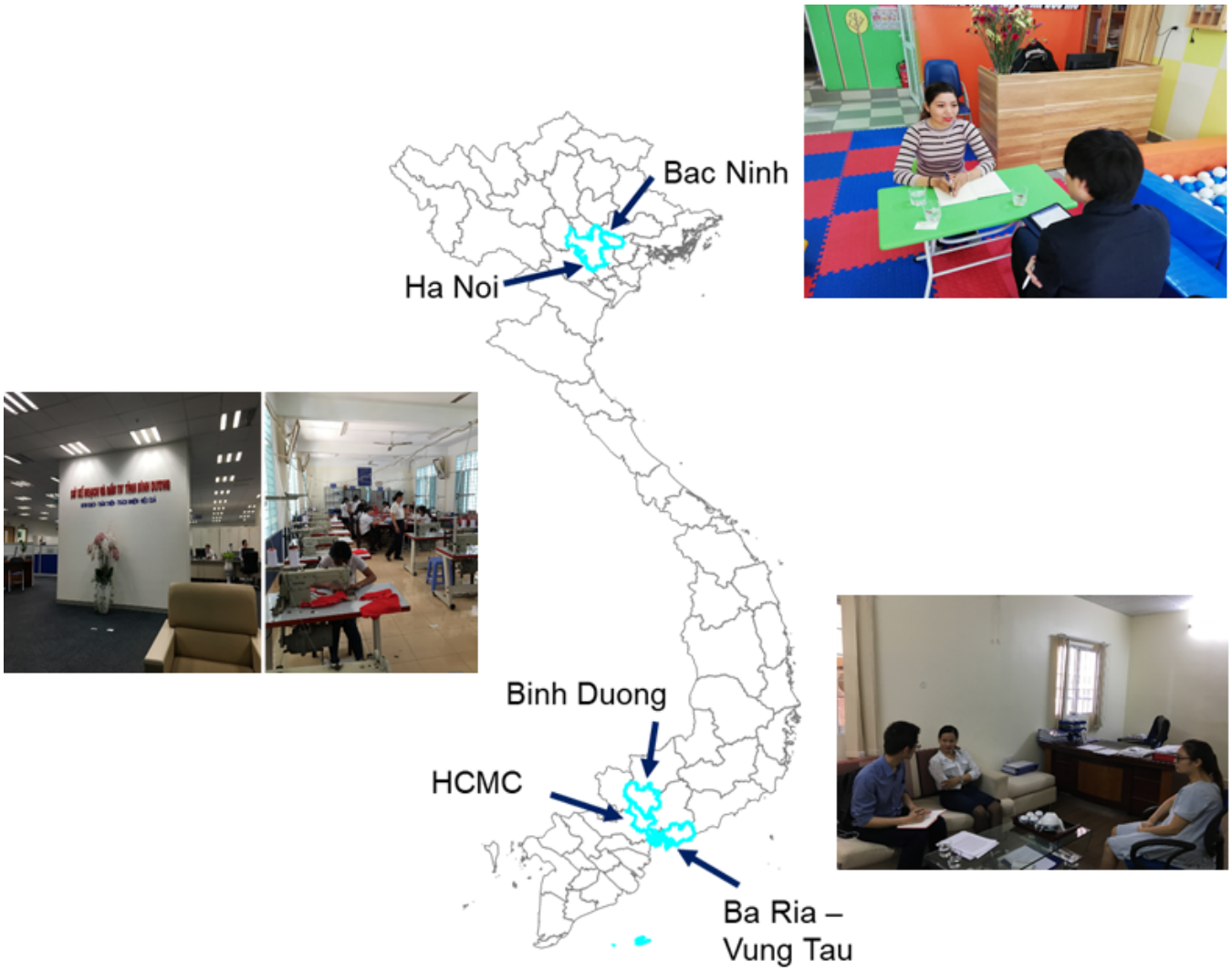
In terms of adjustment strategies to the 2011 reform, domestic firms expressed difficulty in adjusting output prices due to unfair market competition. Only 20% of domestic firms could make machine investments mainly for lack of credits. On the other hand, FDI firms we interviewed could mechanize their production or improve efficiency while output price was fixed with their foreign partners in the U.S., E.U. and Japan under the long-term contract. Small domestic firms financed business by their own capital or borrowing from their family members, while larger firms could access to bank credit. FDI firms also had difficulty in getting financing from local banks, thus often relied on parent company.

Finally, several firms we interviewed raised a concern and proposed the necessity of rationalizing the MW group classification to properly reflect each district's living standard. In the southern Vietnam, large industrial zones exist near HCMC, Binh Duong, Dong Nai, and Ba Ria-Vung Tau provinces where both foreign firms and millions of minimum wage workers co-exist. According to firms located near industrial zones, small firms face difficulty in complying with high MW level as applied to large foreign firms. Districts near industrial parks are categorized in the same MW group as HCMC while living standard in the district is roughly half of that in HCMC. For example, in June 2011, small districts in Ba Ria-Vung Tau province experienced unexpected change in their MW category from Group II to Group I. The sudden increase in minimum wage forced small firms near the industrial parks to pay salaries far above workers' productivity level and/or raise prices of products and services.

Table A1.2. Field Interviews: Summary Statistics

	Domestic firms (N=15)		FDI firms (N=7)	
	Mean	Median	Mean	Median
Firm age	6.8	5.0	12.3	11.5
Firm size (number of employees)	55	15	4,299	600
Land size (in hectares)	1,304	200	52,417	23,250
Constraints for business (1: Yes, 0: No)				
Formal registration process	0.13		0.14	
Shortage of skilled workers	0.40		0.71	
Labor regulation (minimum wage, social security burdens)	0.20		0.86	
Unfair market competition	0.33		0.14	
Land access	0.13		0.43	
General business environment (taxation, regulation)	0.27		0.57	
Adjustments to the MW reform				
Mechanization	0.20		0.71	
Saving labor costs (substitute with informal workers etc)	0.07		0.00	
Diversify product/improve product quality	0.47		0.14	
Raise output price	0.07		0.00	
Improve efficiency (improve management, incentive scheme, IT etc)	0.27		0.43	

Figure A1. Location of Interviews



Appendix 2: Theoretical framework

Labor market imperfection

Let us consider an economy where multiple firms employ workers under formal (F) or informal (IF) contracts. Firms have some power to set wages as in monopsony models. Based on wages (w^F, w^{IF}) posted by firms at the beginning of each period, worker i decides to work for firm j located in district d that maximizes the following utility function:

$$u^g_{ijd} = \beta^g \ln(w^g_{jd} - b^g_{jd}) + \varepsilon^g_{ijd}$$

where b^g_{jd} is the reference wage level for formal ($g = F$) and informal ($g = IF$) workers. The reference wage is the effective minimum wage (MW) $\lambda^g_{jd}\underline{w_d}$, determined by the district-specific MW floor $\underline{w}$ and the bindingness of the MW regulation λ_{jd} which varies between large and small firms. ε^g_{ijd} is the idiosyncratic preference component. The firm-specific labor supply functions are derived as follows:

$$L^g_{ijd} = a^g(w^g_{jd} - \lambda^g_{jd}\underline{w_d})^{\beta^g} \tag{A2.1}$$

where a^g is the constant term common to all firms in the same market. The elasticities of labor supply are:

$$\eta^g_{ijd} = \frac{\beta^g w^g_{jd}}{w^g_{jd} - \lambda^g_{jd}\underline{w_d}} \tag{A2.2}$$

The elasticity of labor to wages gets higher as $\underline{w}$ rises. This implies that workers are more sensitive to an wage offer when higher minimum wages are secured by regulation.

Wage determination

Let us define the production function of firm j in district d as $y_{jd} = A_{jd}f(l^F_{jd}(w^F_{jd}), l^{IF}_{jd}(w^{IF}_{jd}), k_{jd}(r))$. l^F and l^{IF} are firm's demand for formal and informal workers, and k and r are capital and rental cost. A is firm productivity. Combined with eq. (A2.2), expenditure minimization determines the optimal wage level as follows:

$$w^{g*}_{jd} = \frac{\lambda^g_{jd}}{1+\beta^g}\underline{w_d} + \frac{\beta^g}{1+\beta^g}A_{jd}\frac{\partial y_{jd}}{\partial l^g_{jd}}c_{jd} \tag{A2.3}$$

where c_{jd} is the marginal cost of production. The equilibrium wage is the weighted

average of minimum wage and the marginal revenue product of workers. The minimum wage hike translates into higher wages with the pass-through rate λ^g_{jd}. The weight on minimum wage increases when labor supply elasticity to wages decreases (η^g_{jd} & $\beta^g \to 0$), while wages are competitively set at worker's productivity when labor supply is elastic to wage offers.

Cournot competition in the mixed product market

Let us consider a market where large and small firms coexist ($k = L$ and S). Large firms have a price-setting market power while small firms are monopolistically competitive. Assume that there are fixed number N_k of large and small firms. Under a quasi-linear quadratic consumer preference (Pan and Hanazono, 2018; Parenti, 2018), the inverse demand functions are defined as the following multiplicative form:

$$\begin{aligned} p_{L,jd} &= \kappa_{L,jd} y_{L,jd}^{-1/\theta_1} Y_{L,d}^{-1/\theta_2} Y_{S,d}^{-1/\theta_3} \\ p_{S,jd} &= \kappa_{S,jd} y_{S,jd}^{-1/\theta_1} Y_{S,d}^{-1/\theta_2} Y_{L,d}^{-1/\theta_3} \end{aligned}$$

where κ_{jd} captures each firm's average price, θ_1 and θ_2 are the demand elasticities to own price and own market aggreagte ($Y_{k,d} = \sum_{j=1}^{N_k} y_{k,jd}$), and θ_3 captures the cross-substitutability between products of large and small firms. Given the input cost, large firms' profit maximization yields the optimal price $p^*_{L,jd}$ and production $y^*_{L,jd}$.

$$\begin{aligned} p^*_{L,jd} &= \frac{c_L(w^{F*}_{jd}, w^{IF*}_{jd}, r)}{1-\mu} \\ y^*_{L,jd} &= \left[\frac{\kappa_{L,jd} Y_{L,d}^{-1/\theta_2} Y_{S,d}^{-1/\theta_3} (1-\mu)}{c_L(w^{F*}_{jd}, w^{IF*}_{jd}, r)} \right]^{\theta_1} \end{aligned} \tag{A2.4}$$

where mark-ups $\mu = \frac{1}{\theta_1} + \frac{y_{L,jd}}{\theta_2 Y_{L,d}}$. Large firms charge mark-ups above the marginal cost when the firm and own market's monopolistic power is high (lower θ_1 and θ_2, and higher $\frac{y_{L,jd}}{Y_{L,d}}$). Small firms' equilibrium output and price come from zero profit condition.

$$\begin{aligned} p^*_{S,jd} &= c_S(w^{F*}_{jd}, w^{IF*}_{jd}, r) \\ y^*_{S,jd} &= \left[\frac{\kappa_{S,jd} Y_{S,d}^{-1/\theta_2} Y_{L,d}^{-1/\theta_3}}{c_S(w^{F*}_{jd}, w^{IF*}_{jd}, r)} \right]^{\theta_1} \end{aligned} \tag{A2.5}$$

In competitive product market, the output price of small firms is set at the marginal cost of production.

Comparative statics

Let us consider the effect of changing the minimum wage on equilibrium price and output.

The MW impact on equilibrium price is derived from the eqs. (A2.3)-(A2.5):

$$\begin{aligned}\frac{\partial \ln p^*_{jd}}{\partial \underline{w}_d} &= \frac{\partial \ln c_j(w^{F*}_{jd}, w^{IF*}_{jd}, r)}{\partial \underline{w}_d} + \left[\frac{\partial \ln(\frac{1}{1-\mu})}{\partial \underline{w}_d}\right] 1[j=L] \qquad \text{(A2.6)}\\ &= \frac{1}{c_j(w^{F*}_{jd}, w^{IF*}_{jd}, r)} \sum_{g\in\{F,IF\}} \left[\left(\frac{\lambda^g_{jd}}{1+\beta^g}\right) l^g_{jd} + w^{g*}_{jd}\frac{\partial l^g_{jd}}{\partial \underline{w}_d}\right] + \left[\frac{\partial \ln(\frac{1}{1-\mu})}{\partial \underline{w}_d}\right] 1[j=L]\end{aligned}$$

The price pass-through of the MW depends on the change in wage bills (the first component in eq. (A2.6)) that varies by the MW bindingness and the change in firm's labor demand due to the MW hike. For large firms, the equilibrium price response increases if mark-ups rise (caused by lowering price elasticities of demand θ_1 and θ_2) due to the MW hike (the second component). The latter effect will dominate in the market where larger firms have stronger market power.

In a symmetric equilibrium, $Y_{k,d} = N_k y^*_k$. From eqs. (A2.4)-(A2.5), the equilbrium outputs can be expressed with relevant parameters in Nash equilibrium:

$$\begin{aligned}\ln y^*_L &= \Theta_1[\ln \kappa_L - \Theta_2 \ln \kappa_S + \Theta_2 \ln c_S(\cdot) - \ln c_L(\cdot) + \ln(1-\mu) - \ln N_S \frac{\theta_2}{(\theta_1+\theta_2)\theta_3} + \ln N_L(\frac{\Theta_2}{\theta_3} - \frac{1}{\theta_2})]\\ \ln y^*_S &= \Theta_1[\ln \kappa_S - \Theta_2 \ln \kappa_L + \Theta_2 \ln c_L(\cdot) - \ln c_S(\cdot) - \Theta_2 \ln(1-\mu) - \ln N_L \frac{\theta_2}{(\theta_1+\theta_2)\theta_3} + \ln N_S(\frac{\Theta_2}{\theta_3} - \frac{1}{\theta_2})]\end{aligned}$$

where $c_j(\cdot) = c_j(w^{F*}_{jd}, w^{IF*}_{jd}, r)$, $\Theta_1 = \theta_1 / \left[1 + \frac{\theta_1}{\theta_2} - \frac{\theta_2}{(\theta_1+\theta_2)}\left(\frac{\theta_1}{\theta_3}\right)^2\right]$, and $\Theta_2 = \frac{\theta_1\theta_2}{(\theta_1+\theta_2)\theta_3}$.
The MW impact on equilibrium outputs is derived as follows:

$$\begin{aligned}\frac{\partial \ln y^*_{Ld}}{\partial \underline{w}_d} &= \Theta_1\left[\Theta_2\frac{\partial \ln c_S(\cdot)}{\partial \underline{w}_d} - \frac{\partial \ln c_L(\cdot)}{\partial \underline{w}_d} + \frac{\partial \ln(1-\mu)}{\partial \underline{w}_d}\right]\\ \frac{\partial \ln y^*_{Sd}}{\partial \underline{w}_d} &= \Theta_1\left[\Theta_2\frac{\partial \ln c_L(\cdot)}{\partial \underline{w}_d} - \frac{\partial \ln c_S(\cdot)}{\partial \underline{w}_d} - \Theta_2\frac{\partial \ln(1-\mu)}{\partial \underline{w}_d}\right] \qquad \text{(A2.7)}\end{aligned}$$

The equilibrium output response to the MW hike is expected to be asymmetric: positive for large firms while negative for small firms: $\frac{\partial \ln y^*_L}{\partial \underline{w}} > 0$, $\frac{\partial \ln y^*_S}{\partial \underline{w}} < 0$. This is because the MW

impact on small firm's marginal costs is larger than the impact on the marginal cost of large firms as the MW regulation is more binding for small firms. Small firms are more labor-intensive, thus the marginal costs increase more to the MW hike. The magnitude of output response also depends on the change in mark-ups, firms' adjustments in employment, and the elasticity parameters. The output responses to the MW hike will be smaller in case of high cross-product substitutability between large and small firms: $\frac{\partial^2 \ln y^*_{jd}}{\partial \underline{w}_d \partial \theta_3} < 0$.

Factor market adjustments to the minimum wage hike

Next, I derive predictions on how firms optimally choose labor and capital to undo the MW shock. Taking the logarithm of Shephard's lemma ($l^g_{jd} = \frac{\partial \ln c(\cdot)}{\partial w^g_{jd}} y_{jd}$) and the derivative with respect to $\underline{w}$ (we drop the firm and district notations from here to simplify the notation):

$$\frac{\partial \ln l^F}{\partial \underline{w}} = \frac{\partial \ln \frac{\partial c(\cdot)}{\partial w^F}}{\partial \underline{w}} + \frac{\partial \ln y^*}{\partial \underline{w}} = \frac{\frac{\partial c_{w^F}(\cdot)}{\partial \underline{w}}}{c_{w^F}(\cdot)} + \frac{\partial \ln y^*}{\partial \underline{w}} = \frac{\left(\frac{\lambda^F}{1+\beta^F}\right) \frac{\partial c_{w^F}(\cdot)}{\partial w^F}}{c_{w^F}(\cdot)} + \frac{\partial \ln y^*}{\partial \underline{w}} \tag{A2.8}$$

The cost function can be rearranged as: $c(\cdot) = w^F l^F + w^{IF} l^{IF} + rk = w^F c_{w^F} + w^{IF} c_{w^{IF}} + rc_r$. Taking the total derivative with respect to w^F:

$$w^F c_{w^F, w^F} + w^{IF} c_{w^{IF}, w^F} + r c_{r, w^F} = 0 \tag{A2.9}$$

Using the eq. (A2.9):

$$w^F \frac{\frac{\partial c_{w^F}(\cdot)}{\partial w^F}}{c_{w^F}(\cdot)} = w^F \frac{c_{w^F, w^F}}{c_{w^F}} = \frac{-w^{IF} c_{w^{IF}, w^F} - r c_{r, w^F}}{c_{w^F}} = -w^{IF} c_{w^{IF}} \sigma_{F, IF} - r c_r \sigma_{F,k}$$

where $\sigma_{m,n}$ is the Allen partial elasticity between factor m and n. From this, the eq. (A2.8) can be simplified as follows:

$$\frac{\partial \ln l^F}{\partial \underline{w}} = -\left(\frac{\lambda^F}{1+\beta^F}\right) \frac{s_{IF} \sigma_{F,IF} + s_k \sigma_{F,k}}{w^F} + \frac{\partial \ln y^*}{\partial \underline{w}} \tag{A2.10}$$

where s_{IF} and s_k are the share of informal labors and capital in total cost. Eq. (A2.10) implies that firms respond to the MW hike by substituting labors with formal contracts to informal ones or to capital with the elasticity of substitution with $\sigma_{F,IF}$ and $\sigma_{F,k}$ respectively. The incentive to save labor will be large for firms with high share of informal contractual workers where the minimum wage regulation is more binding. The last two

terms in eq. (A2.10) capture the MW impacts on labor adjustments due to the changes in output. As eq. (A2.7) predicts, small firms will have stronger incentive to save formal labors if small firm's output declines while large firm's output increases. If price pass-through to consumers is limited (small $\frac{\partial \ln p}{\partial \underline{w}}$), firm's profit margins and outputs shrink, thus may adjust formal employments more.

$\sigma_{F,IF}$ is expected to be large for small-scale service industry where the nature of labor contracts is informal. $\sigma_{F,k}$ will be large for the capital-intensive manufacturing industry where machines can substitute labors for mass-productions, while small for the labor-intensive industry where capital is rather complementary to labor. The degree of factor substitutability also differs between firms already in the market or new firms entering the market as predicated by putty-clay model (Aaronson, French, Sorkin, and To, 2018).

Similarly, the degree of capital adjustment to the MW hike is expressed as follows:

$$\frac{\partial \ln k}{\partial \underline{w}} = \left(\frac{\lambda^F}{1+\beta^F} \right) s_F \sigma_{F,k} + \frac{\partial \ln y^*}{\partial \underline{w}} \tag{A2.11}$$

In the eq. (A2.11), the first term implies larger capital investment in response to the MW hike, especially for capital-intensive industries with high formal labor costs.

References

Aaronson, D., French, E., Sorkin, I. and To, T., 2018. Industry dynamics and the minimum wage: a putty-clay approach. *International Economic Review*, 59(1), pp.51-84.

Pan, L. and Hanazono, M., 2018. Is a Big Entrant a Threat to Incumbents? The Role of Demand Substitutability in Competition among the Big and the Small. *Journal of Industrial Economics*, 66(1), pp.30-65.

Parenti, M., 2018. Large and small firms in a global market: David vs. Goliath. *Journal of International Economics*, 110, pp.103-118.

Shimomura, K.I. and Thisse, J.F., 2012. Competition among the big and the small. *The Rand Journal of Economics*, 43(2), pp.329-347.

Appendix 3: VES Sampling Criteria

VES 1/	Firm size threshold 2/ (# of employees)	Sampling Rate	Province Exceptions	Industry Exceptions
2008	Ha Noi: **20** HCMC: **30** Other provinces: **10**	All provinces: **15%**	Ha Giang, Cao Bang, Bac Kan, Tuyen Quang, Lao Cai, Dien Bien, Lai Chau, Son La, Yen Bai, Hoa Binh, Lang Son, Ha Nam, Ninh Binh, Quang Tri, Phu Yen, Ninh Thuan, Kon Tum, Gia Lai, Dak Lak, Dak Nong, Binh Phuoc, Hau Giang, Tra Vinh, Bac Lieu.	Agriculture, Forestry, and Fishing Transportation Accommodation & food services activities Financial, banking, and insurance activities
2009	Ha Noi & HCMC: **30** Other provinces: **10**	All provinces: **15%**	Ha Giang, Cao Bang, Bac Kan, Tuyen Quang, Lao Cai, Dien Bien, Lai Chau, Son La, Yen Bai, Hoa Binh, Lang Son, Phu Yen, Ninh Thuan, Kon Tum, Dak Nong, Hau Giang, Tra Vinh, Bac Lieu.	Agriculture, Forestry, and Fishing Transportation Accommodation & food services activities Financial, banking, and insurance activities
2010	Ha Noi & HCMC: **50** Dong Nai, Binh Duong , Hai Phong: **30** Other provinces: **20**	Ha Noi & HCMC: **10%** (less than 20 employees); **20%** (20-49 employees); Others: **20%**	Ha Giang, Cao Bang, Bac Kan, Tuyen Quang, Lao Cai, Dien Bien, Lai Chau, Son La, Yen Bai, Lang Son, Ninh Thuan, Kon Tum, Dak Nong, Hau Giang, Tra Vinh, Bac Lieu.	Agriculture, Forestry, and Fishing Accommodation & food services activities Information and Communication
2012	Ha Noi & HCMC: **50** Dong Nai, Binh Duong , Da Nang, and Hai Phong: **30** Other provinces: **20**	Ha Noi & HCMC: **10%** (less than 20 employees); **20%** (20-49 employees); Others: **20%**	Same as above	Transportation Accommodation & food services activities Information and Communication
2013	Same as above	Same as above	Same as above	Transportation Accommodation & food services activities Information and Communication Waste collection & process
2014	Same as above	Same as above	Same as above	Transportation Accommodation & food services activities Information and Communication
2015	Same as above	Same as above	Same as above	Agriculture, Forestry, and Fishing Transportation Accommodation Insurance

Notes: 1/ VESs in 2011 and 2016 are census, therefore, covers all registered firms. 2/ Applied to private firms and stock companies with less than 50% of shares held by the State.

Appendix 4: Validation Test of the Parallel Trend

The following fixed effect model estimates the the log change in outcomes between year t and 2010 (the reference year right before the MW hike) by the MW treatment status for each year:

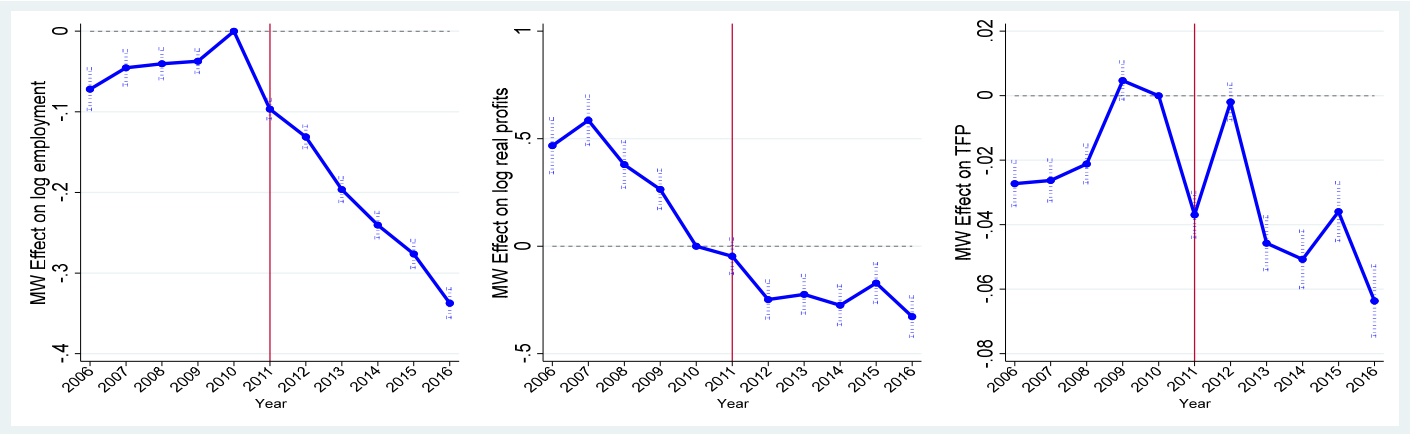
$$\ln y_{jsdt} - \ln y_{jsd,2010} = \alpha_j + \delta_t + \beta_t Bind_{jsd} \times D_t + \varepsilon_{jsdt}$$

where α_j and δ_t are firm and year fixed effects. Figure A.2 presents the plot of the coefficients β_t as well as the 95% confidence intervals, separately for domestic and FDI firms. Panel A shows the declining trends in the MW effect on employment, real profits, and TFP after 2011 for domestic firms. In contrast, Panel B shows upward trends in employment and real profits for FDI firms. This finding shows that domestic firms faced significant negative impact of the 2011 minimum wage hike, while the production of FDI firms was shielded from the policy shock.

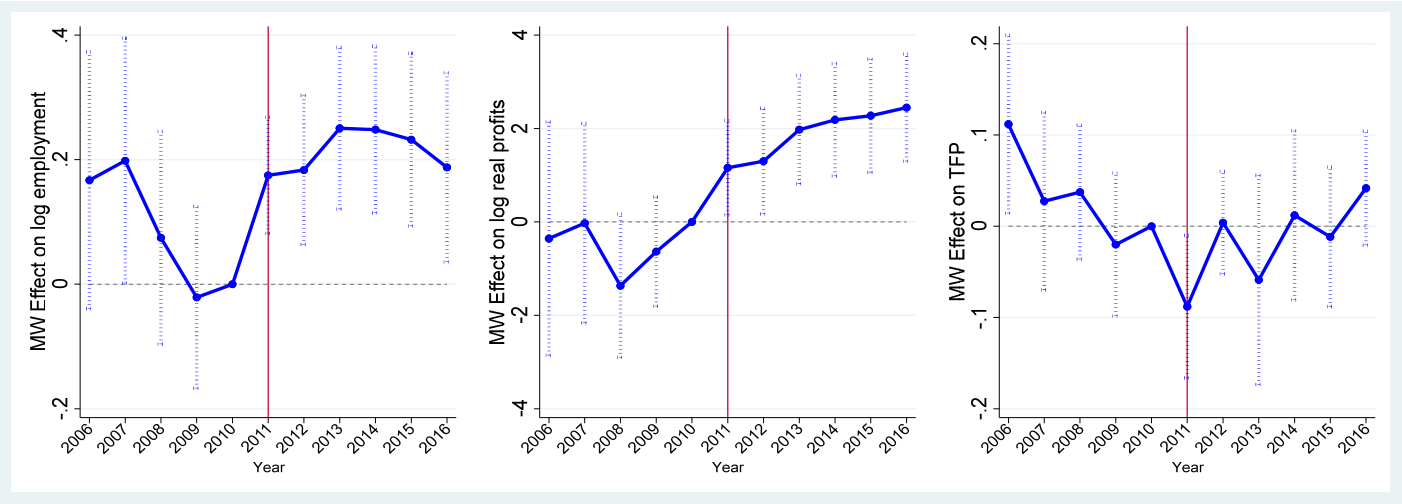
Figure A.2 also provides a test on the parallel trend in employments, profits, and TFP between firms treated and untreated by the 2011 reform. Prior to 2011, the pre-reform trend in employment is close to zero. The negative trend in employment has emerged only after 2011. As for real profits, the declining trend existed from the pre-reform period. The slowdown in firm profits in the pre-reform years likely reflects the downturn in business cycle after the temporary economic booms in 2007 for the WTO accession. The panel event-study method in section 7 of the main text will include the pre-trend term and account for possible violation of the parallel trend assumption.

[insert Figure A.2]

Panel A. Domestic firms



Panel B. FDI firms



Note: The blue line is the point estimate of the MW treatment effect on each outcome variable associated with the 95% confidence intervals.

Figure A.2. Long-term Trend of Employments, Profits, and Productivity