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The Minimum Wage, Exports, and Firm Performance: Evidence from Indonesia

Bin Ni
(Faculty of Business Administration, Toyo University)
Kyosuke Kurita
(School of Economics, Kwansei Gakuin University)

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SCHOOL OF ECONOMICS

KWANSEI GAKUIN UNIVERSITY

1-155 Uegahara Ichiban-cho
Nishinomiya 662-8501, Japan

The Minimum Wage, Exports, and Firm Performance: Evidence from Indonesia

Bin Ni*[1], Kyosuke Kurita[2]

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Abstract

This paper examines the interrelationship between changes in the provincial minimum wage, firms' export behavior, and firms' performance in Indonesia. In this regard, we apply two-stage least squares regression analysis to detailed firm-level data of manufacturing enterprises between 2002 and 2014. We find that an increase in the minimum wage is associated with decreases in a firm's employment rate, its probability of exporting, and its overall performance in terms of productivity and markup. We also use the 2012 minimum wage reform in Indonesia to conduct a combined propensity score matching and difference-in-difference analysis to mitigate the potential endogeneity of minimum wage regulation. Our findings are generally robust to alternative estimation methods. Moreover, the findings suggest that Indonesian exports and the country's comparative advantage in international markets are not negligibly affected by higher labor costs through minimum wage growth.

Key words: minimum wage, firm performance, Indonesia, difference-in-difference.

JEL classification: F14, F16, L25, J88.

* Corresponding author.
[1] Faculty of Business Administration, Toyo University. 5-28-20 Hakusan, Bunkyo-ku, Tokyo 112-8606 Japan. Tel: +81-3-3945-7166. Email: jiadaniel@hotmail.com.
[2] School of Economics, Kwansei Gakuin University. Email: kyosuke@mte.biglobe.ne.jp.

1. Introduction

Because of political instability and poor economic management by President Soeharto during 1945–1965, Indonesia's domestic production and economic development has stagnated. In 1970, one-third of the population lived under the world poverty line (World Bank Indicator). Faced with such deprived conditions, the government decided to introduce the first "Five-year Development Plan," known as Repelita 1, which took effect in 1969. It also made a number of crucial economic reforms during the 1970s and 1980s, including the relaxation of regulations on international trade, foreign investment, capital balances, and banking. In the early 1970s, the government also introduced minimum wage legislation, which was designed to increase citizens' social welfare and reduce income inequality. Nonetheless, how effective is this legislation in practice? Empirical verification is surprisingly rare. In the literature, Del Carpio et al. (2012) find that minimum wage regulation negatively affected firms' employment rates, thereby providing evidence of the direct impact of governmental intervention. However, during the process of implementing a minimum wage policy, firms' performance may also be affected. For example, a rise in the minimum wage causes an increase in the cost of labor, which in turn causes a firm to adjust its resource allocation to other inputs. This situation may have an indirect impact on the firm's productivity. A similar argument can be made regarding the impacts on a firm's markup, sales, and other aspects. Thus, a thorough evaluation of the impact of the minimum wage regulation in Indonesia is necessary to form a better understanding of whether the government's goal has been reached as expected.

The current study applies Indonesian census data for manufacturing, gathered by the National Statistical Office (BPS) and covering 2002–2014, to disentangle the interrelationship between provincial minimum wage regulation, firms' exporting status, and firms' overall performance. After applying various methods of verification, we find that an increase in the minimum wage leads to decreases in a firm's employment rate, its probability of exporting, its productivity, and its markup. Further, to mitigate the possible estimation bias that arises because of the endogenous nature of the minimum wage policy, we use the 2012 minimum wage reform to conduct a difference-in-difference (DID) analysis. In particular, we match firms that have experienced larger minimum wage increases with those that have experienced lower increases. Our results are robust: the impact of minimum wage regulation is generally negative.

The contributions of this study are threefold. First, to the best of our knowledge, few microeconometric studies have attempted to evaluate minimum wage regulation in

Indonesia; thus, we aim to enrich such studies. Second, our study helps to fill the gap in empirical analysis that explores the relationship between minimum wage regulation and firms' markups (productivity). Last, we apply a unique identification strategy by using the 2012 minimum wage reform in Indonesia and estimating the pure impact of this governmental policy in a more rigorous manner. The rest of the paper is organized as follows. Section 2 provides a brief introduction of Indonesia's economic background and its minimum wage policy. Section 3 summarizes the relevant literature. Section 4 introduces the data and methodology, and section 5 presents the results. Section 6 describes the additional robustness checks, while section 7 offers our conclusions.

2. Indonesia's economic background and minimum wage regulation

The general situation in Indonesia

Indonesia is the world's fourth largest country with a population of 258 million at the end of 2015. Further, according to the World Development Indicators of the World Bank, it is the largest economy in Southeast Asia and ranks as the 16th largest in terms of nominal gross domestic product (GDP) as of 2016 (World Development Indicators). Despite its relatively stable and ongoing economic growth[1] compared with other Southeast Asian countries in recent years, Indonesia is still classified as a low ranking middle-income country, with a nominal GDP per capita of US$3300 in 2016 (World Development Indicators).

However, the workforce in Indonesia is becoming increasingly educated, although the literacy level is still low compared with the levels in neighboring countries. In 2016, the average net secondary school enrollment rate in Indonesia was 66%, while the rates in Thailand were 82% for females and 75% for males (World Bank 2017). In the manufacturing sector, the majority of workers have, at most, senior high school degrees (Indonesian Industrial Survey). The large proportion of low-skilled workers has led to a low-income level on average, as shown in Figure 1 (currently USD 1 = IDR 13,442). This finding is consistent with the wage skill premium, as indicated by Amiti and Cameron (2012).[2]

The development of minimum wage regulation

In order to improve the welfare of Indonesian workers so that they have an adequate

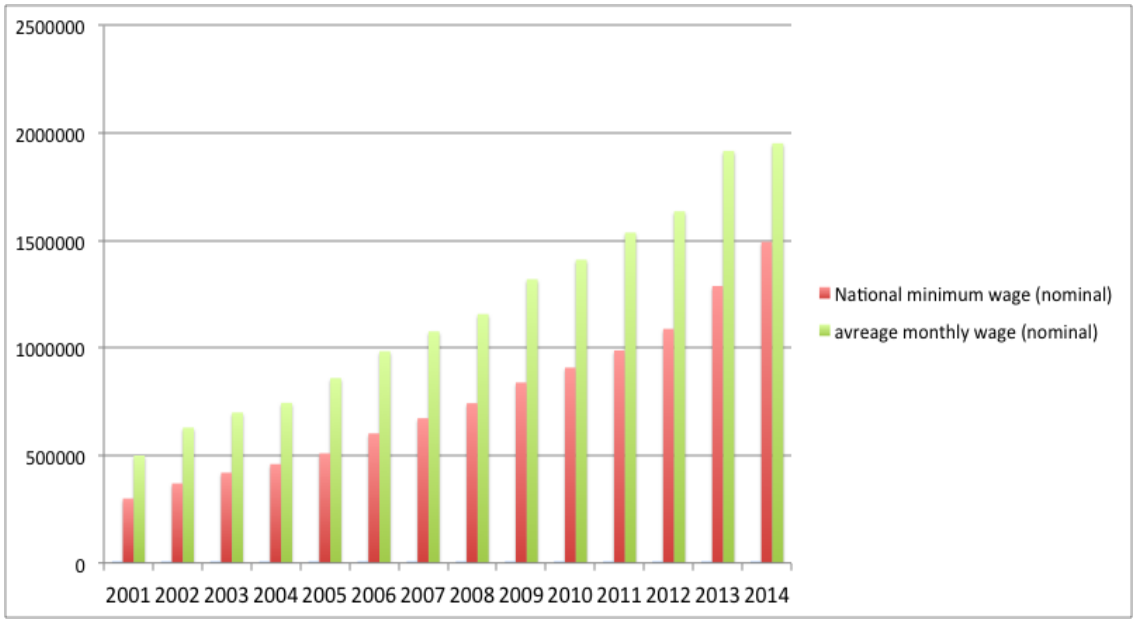
[1] According to the annual GDP growth indicator of the World Bank, the growth rate has remained above 5% for more than a decade since 2004 (except for 2009).

[2] They showed that workers with low skills in Indonesia are usually paid less than their counterparts with high skills. Moreover, wages increase with educational level.

living standard, the government decided to enhance minimum wage regulation. The introduction of regulation can be traced back to as early as 1956, followed by a national wage council, established in 1969, and minimum wage legislation in the early 1970s. However, the minimum wage did not play a decisive role in bringing extra benefits to citizens in the early years because regulation was not enforced. It was not until 1989, when the government implemented new legislation, that Indonesian society began to pay attention. The legislation stated that minimum wages should be based on minimum physical needs, the local cost of living, and labor market conditions (Rama 2001). In 2000, according to the Indonesian Jobs Report (2010), the Minister of Manpower issued a decision (no. 226/2000) that gave governors, mayors, and the heads of districts the power to set minimum wage levels. In other words, minimum wage setting was decentralized from the national to provincial level and was based on recommendations from local and provincial wage councils. Following this, the provincial governors would announce the final rates.

Figure 1 shows the average monthly minimum wage and actual wage in nominal terms for 2001–2014. Since 2001, both indices steadily increase and experience only a short stagnation at the beginning of the international crisis in 2007/2008; however, this stagnation is barely visible in the figure.

Figure 1 Average monthly minimum wage and salaried wage (in IDR)

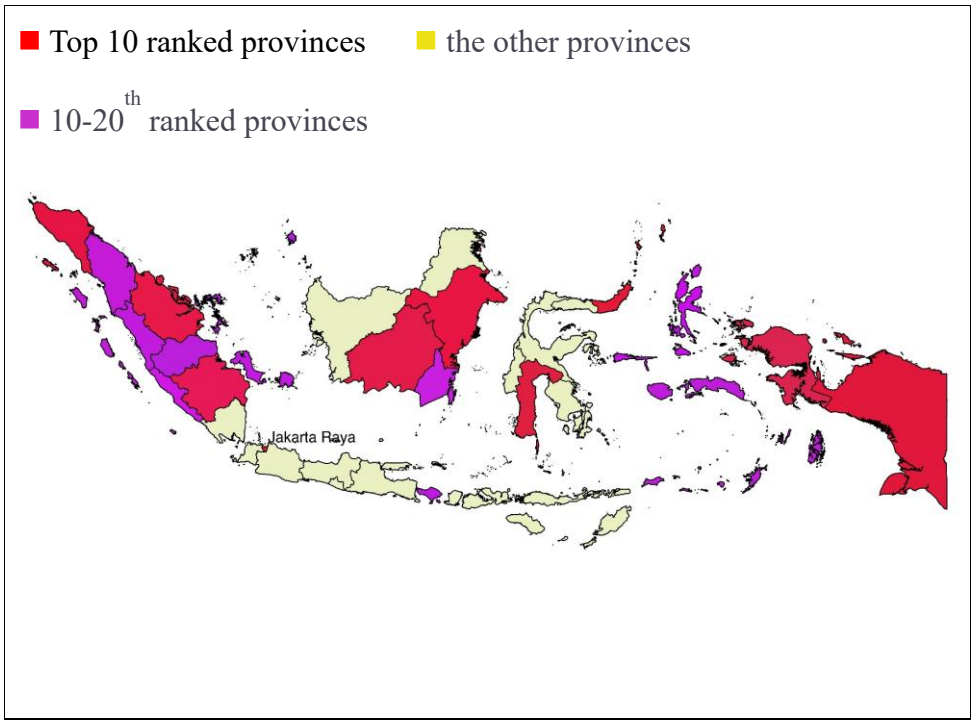


Source: Badan Pusat Statistik (BPS), Jakarta.

On November 22, 2012, another minimum wage reform occurred. Joko "Jokowi"

Widodo, Jakarta's new governor, announced a significant 44% increase in the nominal minimum wage for the capital city(Manning 2012). This increase was later endorsed by the government. The new rate reached IDR 2.22 million per month (approximately US$230) the following year. Meanwhile, the industrial districts in the surrounding provinces such as the Greater Bandung and Surabaya regions, Medan, and Batam responded and promised to raise their own minimum wages by similar or even greater percentages. However, not all the neighboring provinces of Jakarta raised their minimum wages substantially. As can be seen from Figure 2, the distribution of minimum wage growth is dispersed. Strong resistance from employer groups was considered the main obstacle to implementing the reform. Nevertheless, the extremely large increase in the regulated nominal minimum wage during 2012–13 provides an opportunity to undertake a quasi-experimental test to investigate the way in which firms' behavior changed before and after the increase. The methodology section describes how we conducted such a test.

Figure 2 Minimum wage reform in 2012 (growth percentages from 2012 to 2013)



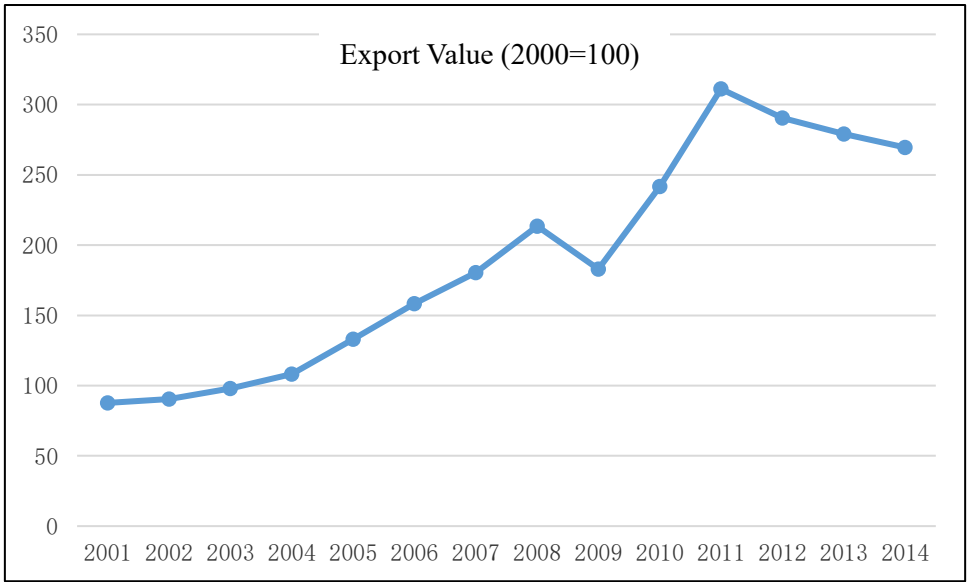
Source: Minimum wage data from BPS, Indonesia

The export trend in Indonesia

Indonesia's high rate of economic growth has been driven by its export-oriented policy. However, the situation is changing. As can be seen in Figure 3, Indonesian exports increase in value until 2011 (except for a fall during the 2008–2009 economic crisis). The

value of exports then falls. There are many reasons that can cause such a change. To some extent, it has been triggered by a reduction in Indonesia's economic growth.[3] Other factors such as protectionist policies toward international trade, the weakening of the Indonesian Rupiah against other currencies, the reduction of exports because of China's cooling economy, and declining global commodity prices can also play critical roles. Nevertheless, few studies have attempted to investigate the export mechanism from the firms' perspective. Given that the decision about the 2012 minimum wage reform in Indonesia was made at the end of 2011 and the total export value started to fall during the same period, we cannot help but ask: Does firms' decision-making about exports have anything to do with minimum wage regulation, after we control for all the macro determinants of exporting? This question provides our motivation to investigate further.

Figure 3 Export value index for Indonesia



Source: World Bank Indicator.

3. Literature review

The current study is associated with several aspects of scholarly literature. The first is the relationship between minimum wage regulation and employment. Theoretically, if existing wages are set much below the workers' marginal product of labor (MPL), as in the case of a monopolistic firm, a moderate increase in minimum wages can benefit workers without leading to job losses because the firm still profits by hiring workers

[3] According to the World Bank, the economic growth rate in Indonesia fell to 4.7% in 2015.

(Rebitzer and Taylor 1995). However, in the case of a competitive labor market, a minimum wage increase leads to less employment.

Another aspect of literature related to the current study is the theoretical work that considers minimum wages and international trade. Earlier studies can be traced back to Brecher (1974a, 1974b), who uses a model with two goods, two input factors, wage distortion, and constant return-to-scale technologies. The author shows that a rise in the minimum wage in labor-intensive countries leads to an increase in input, which decreases the export of products. Neary (1985) finds similar results after including more input factors.

The analysis of minimum wage regulation also extends to another series of theoretical verifications that emphasize the relationship between firm heterogeneity and trade (Melitz 2003, Bernard et al. 2007). Melitz (2003) shows that when entry into export markets is costly, only firms with greater productivity choose to serve the export market, while the most productive firms choose foreign direct investment (FDI). The increasing demand for labor among incumbents and new entrants with greater productivity drives up the average wage, thereby forcing less productive firms to exit the market. Bernard et al. (2007) build on Melitz's framework but incorporate another factor: the difference in the intensity of inputs across sectors. Their findings show that exporters in an industry with a comparative advantage may refrain from exporting when exposed to costly trading expenses. Thus, a firm’s productivity, the demand for labor associated with minimum wage changes, and decision-making about exports are interrelated; however, the correlation is inconclusive, thereby leaving an empirical problem that must be solved.

In terms of empirical studies, quite a few investigate the impact of minimum wage regulation. Nguyen (2010) explores this impact on employment in Vietnam, while Neumark and Wascher (2008) study the US. Others, such as Maloney and Nunez (2004) regarding Columbia, Ginding and Terrell (2007) regarding Costa Rica, and Ma et al. (2012) and Huang et al. (2014) regarding China, all find a negative correlation between minimum wage regulation and employment. A recent study by Gan et al. (2016) analyzes the effect of the minimum wage on Chinese firms’ exports and presents a further negative conclusion.

Numerous studies also focus on Indonesia. Alatas and Cameron (2008) use household labor market panel data to investigate the relationship between minimum wages and employment, while Rama (2001) applies 1993 labor force survey data. Both studies reach the conclusion that the impact of the minimum wage varies depending on a firm's size; moreover, the influence is negative for small firms. Del Carpio et al.'s (2012) study is the closest to our own in terms of the data source. They find that the impact of minimum

wages on employment is negative among small-scale firms. Javorcik and Poelhekke (2014) show how FDI promotes a firm's performance, while Takii and Ramstetter (2005) find that FDI can also increase a firm's labor productivity. Nevertheless, no empirical studies have tried to explore the interrelationship between minimum wage regulation, a firm's exporting decisions, and the firm's performance. Thus, the current study aims to fill this gap by comprehensively evaluating Indonesian governmental policy from various perspectives.

4. Data and estimation strategy

Data set

This study's main data set was taken from the Survei Manufaktur, the Indonesian Census of Manufacturing, conducted by the BPS, covering 2002–2014. The census surveys all registered manufacturing firms with more than 20 employees and captures a wide set of plant-level characteristics, which we used to study the nature of plant-level heterogeneity. The characteristics include output, capital stock (fixed capital), the number of employees, the value of intermediate material (both domestic and imported), sales volume, the total wage bill (for production and non-production workers), ownership, and participation in international trade. We removed observations with negative sales, output, and all types of input to avoid misreporting the information. The final number of observations after cleaning is 259,283, of which approximately 8.8% belong to foreign-owned firms.

The BPS also provided data on the industry-level wholesale price index (WPI), which we used to deflate the variables measured in value terms; namely, output, capital, sales, total wages, and raw material. With regard to industry codes, the Indonesian government changed the coding system in 2010. Because our data set covers the period both before and after 2010, we required concordant information to ensure the consistency of the measurement. Thus, we used a two-digit industry code to create a concordance table. This table had 27 industries in total. The WPIs were matched to their corresponding industries, with a base year of 2000.

Provincial minimum wage information was also sourced from the BPS. There are 33 provinces in our data set. The minimum wage data were matched to the plant-level data using the codes and years of these provinces. Observations were missing for some years; however, we used information from the prior and following years for interpolation.[4]

[4] When a missing observation belongs to the last year of our sample period, we used the average growth rate in prior years for interpolation.

Methodology

Our analysis uses firm panel data to estimate four outcome variables of interest: *total employment*, *whether or not a firm engages in export activities*, *a firm's markup*, and *total factor productivity*. In order to model decision-making about drafting the minimum wage more effectively and determine the minimum wage's sole impact on firms' behavior, we use two-stage least squares (2SLS) regression analysis as our baseline estimation strategy, as shown in the following equations:

$$Ln(mwage_{jt-1}) = \beta_j Z_{jt-2} + u_{jt-1} \quad (1)$$

$$Y_{ijt} = \alpha_{it} + \beta_{mwage} Ln(mwage_{jt-1})^* + \beta_i X_{it-1} + g_t \quad (2)$$

In the first stage, we regress the log minimum wage in province *j* at time *t-1* on a vector, *Z*, of provincial characteristics in time *t-2* that may influence the economic environment of that particular province, such as GDP per capita, the unemployment rate, the Gini coefficient, the labor participation rate, and minimum living expenses (all in their respective logarithmic forms). These factors are considered to indirectly lead to different minimum wage levels that have been determined by governmental officials in each province.

In the second stage, as in equation (2), we estimate the minimum wage's impact on the four aforementioned outcome variables, using the fitted value of the dependent variable obtained in the first stage. Y_{ijt} is the outcome for firm *i* located in province *j* at time *t*. The control variables include a vector of firm characteristics, X_{it-1}, at time *t-1*, such as the capital–labor ratio; the sales volume; the inventory–sales ratio; the total amount of labor (except when estimating total employment); the year dummy, g_t; and firm fixed effects. ε_{ijt} is the error term. Because the minimum wage is determined for each province, we also cluster the standard error at the provincial level.

Total factor productivity and markup calculation

Firm-level markup is defined as the ratio of price to marginal cost. However, since firms rarely report products' prices, we follow the recent work of De Loecker and Warzynski (2012) to establish the firm-level markup. Thus, the production function of firm *i* at time *t* is as follows:

$$Q_{it} = F_{it}(L_{it}, K_{it}, M_{it}, \omega_{it}) \quad (3)$$

where *L*, *K*, and *M* are the physical input of labor, capital, and intermediate materials respectively. ω denotes firm-specific productivity, which we also establish to estimate

a firm's total factor productivity (TFP).

The estimation of firm-level markup hinges on the optimal choice of input without any adjustment cost and estimation of the output elasticity of any input. As indicated by De Loecker and Warzynski (2012), since the choices regarding labor and capital are usually not exogenously determined, we focus on the optimization of intermediate materials. Thus, the optimal choice of input is equal to the optimization problem. In this regard, we write the Lagrangian function as:

$$L(L_{it}, K_{it}, M_{it}, \lambda_{it}) = w_{it}L_{it} + r_{it}K_{it} + p_{it}^{m}M_{it} + \lambda_{it}[\overline{Q_{it}} - F_{it}(L_{it}, K_{it}, M_{it}, \omega_{it})] \quad (4)$$

where $\overline{Q_{it}}$ is the minimum amount of output that firm *i* at time *t* needs to produce in order to survive. The first-order condition for intermediate materials then gives the following:

$$\frac{\partial L}{\partial M_{it}} = p_{it}^{m} - \lambda_{it}\frac{\partial F_{it}}{\partial M_{it}} = 0 \quad (5)$$

Using algebra, we can rearrange equation (5) to derive markup μ_{it} as the ratio of price to marginal cost. Thus:

$$\mu_{it} = \theta_{it}^{m}(\alpha_{it}^{m})^{-1} \quad (6)$$

where $\theta_{it}^{m} = \frac{\partial F_{it}}{\partial M_{it}}\frac{M_{it}}{Q_{it}}$ is the output elasticity of intermediate materials. Dividing this by the ratio of the value of intermediate materials and expected output (α_{it}^{m}) yields the markup. The calculation of θ_{it}^{m} needs a detailed estimation of the production function. Following Ackerberg et al. (2006), we adopt the control function approach. Specifically, we use a translog specification of the production function as follows:

$$q_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_{ll} l_{it}^2 + \beta_{kk} k_{it}^2 + \beta_{mm} m_{it}^2 + \beta_{lk} l_{it} k_{it} + \beta_{km} k_{it} m_{it} + \beta_{lm} l_{it} m_{it} + \beta_{lkm} l_{it} k_{it} m_{it} + \omega_{it} + \varepsilon_{it} \quad (7)$$

After the coefficient vector, $\bar{\beta}$, is estimated, we can calculate the output elasticity of materials $\widehat{\theta_{it}^{m}}$ as the sum of the coefficients of all material-related terms in equation (7),[5] thus deriving firm-level markup.

A few points are worth extra attention. In order to estimate equation (7), we need to acquire the three inputs, *L*, *K*, *M*, in terms of physical quantity. With regard to *L*, since the information on employment is available, we can measure labor input directly. However, *K* and *M* are only reported in value terms. We deflated these two variables using the WPI

[5] With regard to equation (7), we can use different specifications. Alternatively, we can assume that $q_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \omega_{it} + \varepsilon_{it}$ or $q_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \omega_{it} + \varepsilon_{it}$. The markup calculated for each case is then represented as markup_2 and markup_3.

for each industry. Despite this practice, the estimation results can still suffer from bias due to the omitted firm-specific input prices (De Loecker and Goldberg 2014). In order to correct this bias, we follow De Loecker and Goldberg (2014) and model the omitted firm-specific input prices as a reduced-form function of output prices, exporter status, and all interaction terms between the three inputs and export status. In this way, we construct a more flexible control function.

However, the TFP, ω_{it}, of firm i at time t can also be inverted using the production function (see equation (3)). We follow the method proposed by De Loecker and Warzynski (2012) who extend Ackerberg et al.'s (2006) study. The TFP estimation proceeds as follows. First, for each two-digit International Standard Industrial Classification (ISIC), we estimate a translog production function of capital and labor (including lags and interactions), allowing for different coefficients by exporter, year, and industry. Using *exporting status* as the state variable, we allow for differences in optimal input demand and do not need to make the perfect competition assumption for each sector. The estimation yields a measure of the fitted value of output ϕ and an error term, ε, for each plant–year–industry combination. Accordingly, unobservable productivity can be determined as $\omega = \varphi - \beta l - \beta k - \beta l^2 - \beta k^2 - \beta lk$. In the second step, we nonparametrically regress TFP on its lag to determine innovations to TFP, which should not be correlated with current capital or labor input. Since labor input at time t is correlated with current TFP innovations, all labor-related terms need to be instrumented with lagged labor terms (i.e., l by l_lag and l by l^2_lag). These moment conditions are combined together to estimate the translog production function using the generalized method of moments (GMM) approach.

Apart from the above, in our section regarding robustness checks we also use the Olley and Pakes (1996) and Levinsohn and Petrin (2003) methods of TFP calculation to confirm our findings.

The endogeneity issue

Even though we try to control for the decision-making of minimum wage implementation by including provincial characteristics, there is still the possibility that unobservable provincial factors (which are correlated with the minimum wage) can also affect firms' exporting behavior and performance. For example, export-oriented provinces are more likely to provide export-promoting policies so that firms located in these provinces have a greater incentive to increase their exports. Meanwhile, complying with minimum wage regulation means that firms' profits are squeezed, which in turn reduces the firms' capabilities to export (firms that are more profitable are more likely to

export). Since we do not take account of the export-promoting policies adopted by each province, ignoring such a factor leads to a downward estimation of the minimum wage's impact on firms' exporting decisions. The same mechanism also applies to other variables of interest. In order to mitigate the estimation bias caused by this kind of endogeneity, we discuss three methods to improve our estimations.

1) The combination of propensity score matching (PSM) and difference-in-difference (DID) estimation

We first use a quasi-experimental practice to single out the pure influence of the minimum wage. The 2012 minimum wage reform, as mentioned in section 2, provides us with a perfect setting to conduct a DID estimation; namely, to compare the change in exporting status (or performance) of firms that are more likely to be affected by the reform (the treatment group) before and after 2012 with firms that are relatively less sensitive to the reform (the control group) during the same period (for a similar strategy, see Lu and Yu 2015, Gan et al. 2016). The specification of the DID estimation takes the following form:

$$\Delta Y_{ijt} = \alpha_{it} + \beta_1 Post2012_t + \beta_2 Ln(\text{mwage})_{jt} + \beta_3 Post2012_t \cdot Treat\_dummy_{it} + \beta_i X_{it-1} + \beta_j Z_{jt-1} + g_t + \varepsilon_{ijt} \quad (8)$$

where ΔY_{ijt} is the performance change from before the minimum wage reform to after the reform for firm *i* located in industry *j* at time *t*. $Post2012_t$ indicates the post-reform period, which takes a value of 1 if it is after 2012 and 0 otherwise. $Treat\_dummy_{it}$ is a binary indicator to show whether or not firm *i* is categorized as a treated firm under different circumstances. The coefficient of the interaction term, β_3, thus becomes our main interest.

As described in section 2, the distribution of minimum wage growth among provinces in Indonesia is quite unbalanced. Contrary to the notion that only the surrounding provinces of Jakarta would increase their minimum wages to a greater extent, some remote provinces witnessed an even greater growth in their minimum wages after the 2012 reform. Given the random distribution of minimum wage increases across the country, we use real provincial minimum wage growth in 2013 and 2014,[6] rather than geographical proximity, as the first criteria to decide on the treatment and control groups. Specifically, if a province experienced a minimum wage growth rate of more than 50%

[6] We use the growth percentages from 2012 to 2013, from 2013 to 2014, the weighted average growth of these two years, and combinations of the foregoing to conduct the analysis. The results remain unchanged.

for 2013 and 2014 combined, we consider it a treated province;[7] otherwise, we consider it a control province. Treated firms are defined as those that are located in the treated provinces, while the rest are those that belong to the control provinces. Accordingly, the identification assumption with the DID estimation specification is that, conditional on a set of covariates, $\{ \alpha_{it}, X_{it-1}, Z_{jt-1} \}$, the regressor of interest $Post2012_t \cdot Treat\_dummy_{it}$ should be uncorrelated with the error term ε_{ijt}:

$$\mathrm{E}\left[\varepsilon_{it} \middle| Post2012_t \cdot Treat_{dummy_{it}}, \alpha_{it}, X_{it-1}, Z_{jt-1}\right] = \mathrm{E}\left[\varepsilon_{it} \middle| \alpha_{it}, X_{it-1}, Z_{jt-1}\right] \quad (9)$$

In simple terms, the exporting status or performance of firms located in the treated provinces would have experienced the same percentage of change as those located in the control provinces had there been no minimum wage reform in 2012.

However, a concern with DID specification is that the treatment and control groups may differ in some aspects that are related to the reform. If so, β_3 in equation (8) captures not only the impact of the reform but also the initial heterogeneity between the two groups. For example, firms may observe the macroeconomic conditions of each province before the 2012 minimum wage reform. They could then make approximate predictions of the provincial levels of the minimum wage in the years to come. Such predictions will lead to changes in the firms' production behavior,[8] causing "selection bias" when we estimate the impact of minimum wage reform on firms' performance. Propensity score matching (PSM) is a widely used non-experimental design to handle this type of selection problem. First introduced by Rosenbaum and Rubin (1983), propensity scores are used to "balance" treatment and control groups on a vector of baseline characteristics; namely, the scores make the groups as similar as possible with respect to these observed characteristics. The propensity score itself is defined as the probability of being in the treatment group as a function of the covariates. The covariates of our study consist of firm and province characteristics. In the first step, we apply a probit model to estimate propensity scores. In the second step, we embed the results into the DID setting to determine the pure influence of 2012 minimum wage reform on firms' behavior.

2) Compliance vs. stickiness

In the data set, we do not observe whether or not a firm complies with minimum wage

[7] This includes nine of 33 provinces in total: Sumatera Selatan, Bengkulu, Kep. Riau, DKI Jakarta, Bali, Kalimantan Barat, Kalimantan Timur, Sulawesi Selatan, and Gorontalo.

[8] One scenario is that after predicting a large increase in a province's minimum wage after 2012, a firm may reduce its hiring of low-skilled workers to avoid an enlarged labor cost.

regulation.[9] It is difficult to record such information because a firm can provide different types of workers with various payrolls. For example, technicians are paid more than their colleagues in the production department. Since firms only report the overall value of their wage bills and the total number of employees, it is more reasonable to use the average wage of a firm as the criteria. We define the category of firms that tend to adjust the average wage to meet the minimum wage criteria in the following year as the treatment group, or the compliant group. We define those firms that do not make such an adjustment as the control group, or the sticky group. Specifically, we compare a firm's average wage with the minimum wage in the prior year and in the current year. If the firm changes its average wage from below the minimum wage to above the minimum wage in the second year, we count it as a treated firm (in the data set, 95.6% of the observations belong to the control group). After controlling for other firm characteristics, we try to verify the differences in performance between firms in the treatment and control groups. In a different manner to the strategy used in the two foregoing methods, the standard of the "treatment" is the status change required for firms to meet minimum wage regulation throughout the estimation period, rather than the likelihood of complying with 2012 reform.

3) Quantile regression

The third practice is to implement quantile regression, which is a commonly used method in the literature (e.g., Gan et al. 2016). As Ma et al. (2012) indicate, local minimum wages have heterogeneous impacts on firms with different average wages; moreover, a stronger effect is observed on firms with average wages that are relatively close to the minimum wage. Hence, the impact of minimum wages on firms' behavior may differ depending on the initial wage level of each firm.

Consequently, firms that always offer low wages in prior periods should experience a much greater shock if they comply with the minimum wage increase after 2012. In contrast, firms that provide employees with higher average wages should be more immune to the shock and less likely to change their economic behavior. Thus, we expect the 2012 minimum wage reform to have a greater effect on firms with relatively lower wages where the minimum wage tends to be binding. We accordingly group firms into quantiles based on their average wage rates (the total wage bill/total employees): 0–25%, 25–50%, 50–75%, and 75%–100%. The estimation specification then becomes the

[9] According to Del Carpio et al. (2012), compliance with minimum wage law is a critical issue in Indonesia. The minimum wage is larger than a firm's average wage only for a small percentage of the whole sample.

following:

$$Y_{ijt} = \alpha_{it} + \beta_1 Post2012_t + \beta_2 Ln(\text{mwage})_{jt} + \beta_{quantile} Ln(\text{mwage})_{jt} \cdot Quantile1{\sim}4_t + \beta_i X_{it-1} + \beta_j Z_{jt-1} + g_t + \varepsilon_{ijt} \quad (10)$$

where *quantile1–4* are all binary indicators that represent the first quantile to the fourth quantile. For example, if the average wage of a firm falls into the category of the first quantile of overall wage distribution, *quantile1* takes a value of 1; otherwise, it takes a value of 0. The same rule applies to the other quantile variables. In this instance, we are interested in the sign of $\beta_{quantile}$, which captures the heterogeneous impact that the minimum wage may have on firms with different average wages.

5. Estimation results

Baseline

In our baseline estimation using the 2SLS method, all four firm indices (the log of total employment, exports, markup, and productivity) are negatively affected by changes in the minimum wage. Table 2 reports the results. We regress provincial minimum wages on each firm index while controlling for firm and province heterogeneity. The reported standard errors are robust and clustered at the provincial level. In columns (3)–(5), we report the results using different markup measurements, as described in section 4. We find a negative and statistically significant correlation between the provinces' minimum wages and all four dependent variables. Specifically, column (1) shows that after controlling for firm characteristics, macroeconomic conditions, and time effects, an increase in the minimum wage by 10% results in a 23.6% reduction in total employment, which is a substantial impact. This effect is consistent with the findings in the literature (Gan et al. 2016, Del Carpio et al. 2012). Such literature points out that since minimum wages are supposed to directly affect the wages of low-income workers and indirectly affect the wages of high-income workers, a firm must adjust its hiring scheme.

(Table 2 here)

Column (2) presents the findings for export status. Here, a negative correlation between the minimum wage and a firm's decision to engage in exporting is confirmed, although the correlation is not statistically significant at the 10% level (it becomes significant at 15%). This result is consistent with the finding in Gan et al. (2016), which indicates that a 10% increase in a provincial minimum wage is correlated with a 2.73% drop in the probability of exporting. Although we choose a linear probability model in the second

stage as our baseline estimation, we find similar results even if we use a logit/probit model as an alternative.

Columns (3)–(6) show the results when we focus on the two major indicators of firm performance: markup and productivity. Despite some variation in terms of scale, the implementation of minimum wage regulation all points in the same direction as far as markup is concerned: a negative and significant correlation is observed. A similar finding can be seen for firms' productivity. A possible interpretation is that because a firm complies with minimum wage regulation in a certain province, its labor cost increases. This increase reduces the price/marginal cost ratio if the firm chooses to maintain the stability of its commodity's price to avoid losing customers. In such a case, the markup would fall, as predicted by the estimation results. Meanwhile, in accordance with the mechanism described in Melitz (2003), if firms that have greater productivity are more likely to engage in exporting activities, the opposite is also true. In other words, if a firm withdraws from the export market, it probably faces a productivity reduction.

PSM–DID estimation

Table 3 shows the results when we apply the criteria of whether or not a region has experienced a larger minimum wage increase in order to divide the sample of firms. As aforementioned, we first use a set of provincial characteristics (*ln_gdp_percapita, ln_minimumliving_expense, unemploymentrate, labor_participation_rate,* and *gini_index*) and firm characteristics (*capital_labor_ratio, ln_sales_volume, inventory_sales_ratio,* and *foreign_dummy*) in 2011 together with a probit model to predict a firm's probability of being in the treatment group.

(Table 3 here)

In the second step, for the dependent variable, we calculate the difference for each firm performance index between 2011 and 2013.[10] We then estimate the average treatment effect on the treated (ATT) for the outcome variables using the propensity score. In all cases, being in a treatment group leads to a decrease in firms' performance, including performance in employment, the probability of exporting, productivity, and markup. In other words, after the implementation of the 2012 reform, if a firm that is located in the provinces experiences a minimum wage increase of more than 50%, its performance index is likely to reduce to a greater extent than that of a firm with similar characteristics that is located in similar provinces but which has experienced a minimum wage increase

[10] We also considered the difference between 2011 and 2014. The qualitative predictions remain the same.

of less than 50%. For example, in terms of employment, a treated firm experiences a reduction in performance of 0.6% more than a control firm. The findings are consistent with those in the baseline estimation; however, we also extend the findings by taking into account "selection bias." In this regard, we find that the negative impact of minimum wage regulation is not as large as we have observed in the baseline regression. This result implies that "selection" behavior has a downward influence on our predictions.

Quantile regression

Table 4 shows the results when quantile regression is applied. We interacted the log of provincial minimum wage with quantile indicators while controlling for major firm and provincial characteristics. All the interaction terms have negatively significant signs in all specifications, except for productivity. However, if we combine the coefficients of the interaction terms with that of *ln_minimum_wage,* we find that minimum wage regulation has a robustly negative impact on all aspects of firms. Another result is that the absolute value of the coefficients for the interaction terms increases with the quantile range. This result contrasts with the findings in Gan et al. (2016), where the opposite is observed. A possible reason is that although the average wage for firms located in the upper quantile is large, the firms' share of low-wage workers is also large. Thus, minimum wage regulation has had a more substantial influence on these firms than on firms with average wages categorized in the lower quantile.

(Table 4 here)

Compliance vs. stickiness

The results using the criteria of compliance with minimum wage regulation are presented in Table 5. These results present a clearer picture of how to evaluate a minimum wage policy. *wage_adjusted_dummy* takes a value of 1 if a firm's average wage was below the minimum wage in the prior year but adjusted its average wage to meet the minimum wage standard in the following year. [11] The interaction term *ln_minimumwage*adjusted_dummy* then captures the difference between the impact that the minimum wage has on the performance of compliant firms and that of non-compliant firms.

(Table 5 here)

[11] The assumption that we make here is that if a firm's average wage is above the level of the provincial minimum wage, the firm is more likely to be one that complies with minimum wage regulation. However, we are aware that in reality, firms with low average wages may also comply with minimum wage regulation.

The results show that *ln_minimumwage*adjusted_dummy* has a negative and significant impact on all the performance indices of a firm. Further, *ln_minimum_wage* has its expected signs. This finding supports our conclusion that from a firm's perspective, compliance with local minimum wage regulation has a negative influence, although compliance may bring benefits from the employees' perspective. Thus, minimum wage regulation proves to be a double-bladed sword; hence, further welfare analysis is needed for a thorough evaluation.

6. Robustness check

Firms' entry and exit

If we are to follow the logic described in Melitz (2003), we assume that when a firm complies with minimum wage regulation, it must increase its competitiveness to survive. In this regard, the survival rate is expected to affect the firm's performance because productive firms are more likely to succeed than their competitors, thereby forcing the latter from the market. Thus, we create an entry and exit dummy to control for a firm's entry into, and exit from, markets. Apart from the first year recorded in our data (2002), if firm *i* does not exist in the prior year but has an observation during the current year *t*, *entry_dummy* at time *t* takes a value of 1. Similarly, if the current year is the last year of firm *i*'s existence (except for 2014), *exit_dummy* at time *t* takes a value of 1. In all specifications, including these two alternative terms, our predictions do not change.[12]

Timing of the 2012 minimum wage reform

As outlined in section 2, the significant jump in the regulated nominal minimum wage during 2012–2013 proved to be an ideal environment in which to conduct a quasi-experimental test because firms were less likely to perceive this change before the announcement. The decision about the 2012 minimum wage reform adopted a top-down approach; thus, individual firms had little influence over the rate of the minimum wage in each province. However, considering the large percentage of state-owned firms in Indonesia, one could still argue that the 2012 reform was predictable, at least by those firms with strong governmental connections (presumably large firms). These firms could adjust their behavior before the minimum wage reform took effect in 2012. Consequently, we first use *firm size*, measured by sales volume, to control for this factor that could potentially contaminate our estimation of minimum wage regulation's pure effect. Second, we include an additional term in the DID regression, $Treat\_dummy_{it} \cdot$*one year before*

[12] We do not report the results here; however, they are available on request.

the 2012 reform$_t$, to check whether firms changed their behavior when expecting the reform. These robustness checks do not change our qualitative findings.

Alternative DID strategy

As a further robustness check, we use foreign/domestic ownership as a criterion to divide the treatment and control groups, while taking account of the shock of the 2012 minimum wage reform. We also conduct PSM for the compliance standard used in section 4. By doing so, we make those firms that comply with minimum wage regulation comparable with those that do not comply in all respects, except for the status of compliance. In this way, the pure impact of minimum wage regulation can be determined. All these checks validate our prior findings.

7. Conclusions

This study uses data of Indonesian manufacturing firms supplied by the BPS. We apply this data to investigate the interrelationship between provincial minimum wage regulation, firms' exporting status, and firms' overall performance. In addition to a 2SLS estimation, we use the Indonesian 2012 minimum wage reform to conduct a DID analysis together with PSM. We find a consistent result that an increase in the minimum wage causes decreases in a firm's employment rate, its probability of exporting, its productivity, and its markup. Robustness checks confirm our findings.

In sum, the results suggest that Indonesian firms' exports, comparative advantage, and performance in international markets are to some extent negatively affected by higher labor costs because of minimum wage regulation. However, several caveats are worth mentioning. First, it is important to note that minimum wages may not only alter local labor conditions but also reflect changes in other factors that may drive firms' export behavior. For example, reductions in the probability of exporting may be driven by changes in the structure of human capital and physical capital investment, and changes in the supply-chain process that affect the composition of exports. Moreover, all the variations in decision-making about exports are associated with firms' heterogeneity (performance). The exploration of these factors is beyond the scope of the current study and can be considered by future research.

Second, since the minimum wage legally applies to all workers/laborers, it is assumed that small- and medium-sized firms are those that are mostly affected because of their relatively lower average wage level. Given that these firms account for a substantial share of the total workers in Indonesia, further analysis of small- and medium-sized firms is

crucial for a more complete evaluation of the labor market effects of minimum wage regulation.

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Table 1 Summary statistics

variable	N	mean	sd	min	max	definition	unit
Firm characteristics							
Y	259277	3.30E+07	2.83E+08	0.2727025	4.13E+10	The value of all goods produced	1000 Rp
L	259277	193.5304	733.0872	20	56139	Total number of workers	person
K	258599	2.49E+08	1.93E+10	0.2645503	6.62E+12	All fixed capital based on current value	1000 Rp
SA	259277	3.50E+07	2.88E+08	1	4.13E+10	Total revenue	1000 Rp
W	259277	2028935	1.49E+07	105.3846	4.35E+09	Total wage for both production and other workers	1000 Rp
M	259277	1.74E+07	1.46E+08	0.3072197	1.89E+10	The value of total raw material	1000 Rp
E	259277	732200.2	1.50E+07	0.2340276	3.93E+09	The quantity of electricity purchased	KwH
INV	259277	1.18E+07	7.75E+08	0.2572678	3.04E+11	The value of the inventory at the end of the year	1000 Rp
ex	175802	0.1836782	0.3872227	0	1	Export status	
KL_ratio	258599	886701	6.21E+07	0.0000178	2.37E+10	Capital/labor ratio	
inventory_ratio	259277	238200.9	4.50E+07	3.88E-11	1.99E+10	Value of inventory/value of all goods produced	
minimum_wage	259140	677.3283	323.3333	237.027	2441.301	Provincial minimum wage	Rp

foreign_dummy	259278	0.0878748	0.2831133	0	1	Dummy variable to show whether a firm has foreign capital	
markup_1	238415	11.05138	25.84633	7.94E-07	496.5185	Firm's markup (method 1)	
markup_2	238415	9.812031	21.76704	1.15E-06	241.8129	Firm's markup (method 1)	
markup_3	238415	18.24	40.46367	2.14E-06	449.5162	Firm's markup (method 1)	
productivity	238415	7.381699	2.854154	-12.94269	15.59557	Firm's total factor productivity	
average_wage	259277	7680.644	28301.56	4.112688	1.20E+07	Total wage/total number of workers	
Province characterisics							
unemployment_rate	259158	8.810833	3.409894	0	18.9	The unemployment rate of the province	
ln_gdpperca	259154	8.968838	0.5372053	7.547502	10.82281	Log of GDP per capita of the province	
ln_minimum_living_expense	202097	13.56286	0.3299477	12.73442	14.64836	Log of the minimum living expenses of the province	
labor_participation_rate	259158	0.6680254	0.0383993	0	0.8099	labor participation rate of the province	
gini_coefficient	222790	0.3530329	0.037477	0.24	0.46	Gini coefficient of the province	

Table 2 Baseline: 2SLS estimation results

VARIABLES	(1) log of total labor	(2) export status	(3) markup_1	(4) markup_2	(5) markup_3	(6) productivity
ln_minimum_wage_lag1	-0.236***	-0.0273	-2.872*	-3.271**	-6.081**	-0.204**
	(0.0369)	(0.0251)	(1.670)	(1.385)	(2.575)	(0.0832)
capital_labor_ratio_lag1	-1.30e-10**	0	8.57e-09	6.04e-09	1.12e-08	-1.08e-10
	(6.17e-11)	(0)	(7.15e-09)	(5.30e-09)	(9.86e-09)	(1.41e-10)
ln_sales_volume_lag1	0.418***	0.00856***	5.716***	4.889***	9.089***	0.885***
	(0.00331)	(0.00172)	(0.393)	(0.332)	(0.616)	(0.0154)
inventory_sales_ratio_lag1	2.71e-09**	-7.79e-10	3.63e-08**	3.32e-08**	6.17e-08**	-1.94e-09
	(1.17e-09)	(8.07e-10)	(1.78e-08)	(1.60e-08)	(2.97e-08)	(2.04e-09)
ln_total_labor_lag1		0.106***	-2.589***	-4.229***	-7.862***	-1.066***
		(0.00278)	(0.282)	(0.228)	(0.424)	(0.0249)
foreign_dummy_lag1	0.212***	0.298***	-1.101*	-1.006**	-1.871**	-0.0616*
	(0.0173)	(0.0110)	(0.593)	(0.506)	(0.940)	(0.0341)
Observations	178,596	120,508	178,596	178,596	178,596	178,596
R-squared	0.575	0.170	0.150	0.122	0.122	0.185

Robust standard errors in parentheses. In the first stage, the second period lag of unemployment_rate, ln_gdp_percapita ln_minimum_living_expense, labor_participation_rate, and gini_index are used to instrument ln_minimum_wage_lag1. Year dummy is included. Standard errors are clustered at provincial level. *** p<0.01, ** p<0.05, * p<0.1

Table 3 PSM in DID estimations: the results for minimum wages in terms of high- and low-growth regions

Variable	Sample	Treated	Controls	Difference
d_ln_total_labor	Unmatched	-0.044027534	-0.01783444	-0.026193094
	ATT	-0.044027534	-0.037785897	-0.006241637
d_export_status	Unmatched	-0.023663453	-0.002564103	-0.021099351
	ATT	-0.023663453	0.69675723	-0.720420684
d_markup_1	Unmatched	-6.76034846	-10.9023419	4.14199347
	ATT	-6.76034846	-5.05403041	-1.70631806
d_markup_2	Unmatched	-7.7392264	-12.0613488	4.32212237
	ATT	-7.7392264	-3.68379817	-4.05542822
d_markup_3	Unmatched	-14.3867721	-22.4213467	8.03457457
	ATT	-14.3867721	-6.84796643	-7.53880566
d_productivity	Unmatched	0.017419401	0.129317865	-0.111898465
	ATT	0.017419401	0.435570388	-0.418150988

We use firm and provincial characteristics in year 2011 to calculate propensity score in the first stage. Single nearest-neighbor matching is applied.

Table 4 The results using quantile regression (based on average wages)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	log of total labor	export status	markup_1	markup_2	markup_3	productivity
capital_labor_ratio_lag1	0	0	3.69e-09	2.99e-09	5.56e-09	-7.15e-11
	(0)	(0)	(2.95e-09)	(2.24e-09)	(4.16e-09)	(7.25e-11)
ln_sales_volume_lag1	0.118***	0.00376***	2.488***	2.176***	4.045***	0.231***
	(0.0129)	(0.00120)	(0.200)	(0.181)	(0.337)	(0.0192)
inventory_sales_ratio_lag1	1.25e-10	-0	4.88e-08	4.98e-08	9.26e-08	-7.74e-09
	(7.12e-10)	(4.66e-10)	(4.41e-08)	(3.97e-08)	(7.38e-08)	(5.07e-09)
ln_total_labor_lag1		0.0194***	-0.509*	-1.589***	-2.954***	-0.316***
		(0.00273)	(0.293)	(0.297)	(0.552)	(0.0319)
foreign_dummy_lag1	0.0317***	0.00107	0.850	0.343	0.637	-0.0323
	(0.0110)	(0.0103)	(0.635)	(0.469)	(0.872)	(0.0416)
ln_minimum_wage_lag1	-0.0374	-0.517	0.817	0.740	1.376	-0.229
	(0.0404)	(0.329)	(3.105)	(3.342)	(6.212)	(0.158)
ln_minimumwage*quantile1		-0.0285				

		(0.0193)				
ln_minimumwage*quantile2	-0.00299***	-0.0283	-1.438***	-1.450***	-2.696***	0.0612***
	(0.000586)	(0.0193)	(0.319)	(0.348)	(0.648)	(0.00456)
ln_minimumwage*quantile3	-0.00507***	-0.0273	-1.918***	-1.860***	-3.457***	0.110***
	(0.00100)	(0.0193)	(0.360)	(0.393)	(0.731)	(0.00680)
ln_minimumwage*quantile4	-0.00915***	-0.0268	-2.673***	-2.507***	-4.660***	0.155***
	(0.00147)	(0.0193)	(0.417)	(0.451)	(0.838)	(0.0103)
unemploymentrate_lag1	-0.00104	-0.000618	0.0217	0.0166	0.0309	-0.00992
	(0.00342)	(0.00131)	(0.229)	(0.254)	(0.472)	(0.0120)
ln_gdppercapita_lag1	0.143	0.191***	2.934	3.314	6.161	-0.739*
	(0.128)	(0.0507)	(6.599)	(7.129)	(13.25)	(0.421)
ln_minimumliving_expense_lag1	-0.0421	-0.0317***	-1.029	-0.664	-1.234	-0.0160
	(0.0276)	(0.0118)	(1.983)	(2.153)	(4.002)	(0.0899)
laborparticipationrate_lag1	0.0689	-0.0928	-28.97	-27.45	-51.03	-1.168
	(0.206)	(0.113)	(26.47)	(29.47)	(54.77)	(0.801)
gini_index_lag1	-0.138	0.172***	1.692	3.098	5.760	-0.0884
	(0.106)	(0.0605)	(10.41)	(10.91)	(20.28)	(0.503)
Observations	178,621	120,522	178,621	178,621	178,621	178,621
R-squared	0.060	0.006	0.080	0.097	0.097	0.057
Number of psid	31,227	26,155	31,227	31,227	31,227	31,227

Robust standard errors in parentheses. Year dummy is included. Standard errors are clustered at provincial level. Fixed-effects model is applied. *** p<0.01, ** p<0.05, * p<0.1

Table 5 The results for wage-adjusted and non-adjusted firms

VARIABLES	(1) log of total labor	(2) export status	(3) markup_1	(4) markup_2	(5) markup_3	(6) productivity
capital_labor_ratio_lag1	0	0	3.91e-09	3.18e-09	5.91e-09	-8.56e-11
	(0)	(0)	(3.09e-09)	(2.36e-09)	(4.38e-09)	(7.49e-11)
ln_sales_volume_lag1	0.117***	0.00420***	1.789***	1.511***	2.808***	0.270***
	(0.0126)	(0.00115)	(0.182)	(0.167)	(0.310)	(0.0225)
inventory_sales_ratio_lag1	1.32e-10	-0	4.83e-08	4.92e-08	9.15e-08	-7.73e-09
	(7.08e-10)	(4.70e-10)	(4.25e-08)	(3.83e-08)	(7.13e-08)	(4.98e-09)
ln_total_labor_lag1		0.0191***	0.0138	-1.092***	-2.029***	-0.345***
		(0.00272)	(0.293)	(0.306)	(0.568)	(0.0331)
foreign_dummy_lag1	0.0319***	0.000924	0.833	0.322	0.599	-0.0320
	(0.0109)	(0.0103)	(0.646)	(0.477)	(0.887)	(0.0428)
ln_minimum_wage_lag1	-0.0506	-0.0264	-1.773	-1.569	-2.916	-0.0349
	(0.0404)	(0.0194)	(3.161)	(3.374)	(6.272)	(0.168)
wage_adjusted_dummy	0.360**	0.218*	75.49**	82.11**	152.6**	4.575***
	(0.177)	(0.117)	(37.20)	(41.58)	(77.30)	(1.076)
ln_minimumwage*adjusted_dummy	-0.0475*	-0.0331*	-12.89**	-14.01**	-26.05**	-0.658***
	(0.0266)	(0.0178)	(5.497)	(6.150)	(11.43)	(0.159)
unemploymentrate_lag1	-0.00162	-0.000502	-0.100	-0.0954	-0.177	-0.00140
	(0.00349)	(0.00131)	(0.242)	(0.262)	(0.487)	(0.0118)
ln_gdppercapita_lag1	0.155	0.188***	5.105	5.152	9.577	-0.884*
	(0.132)	(0.0508)	(6.911)	(7.361)	(13.68)	(0.455)
ln_minimumliving_expense_lag1	-0.0376	-0.0322***	-0.0483	0.239	0.444	-0.0829
	(0.0279)	(0.0118)	(2.046)	(2.186)	(4.063)	(0.0925)
laborparticipationrate_lag1	0.0961	-0.0940	-25.85	-24.74	-45.98	-1.409*
	(0.208)	(0.114)	(28.06)	(30.91)	(57.45)	(0.800)
gini_index_lag1	-0.148	0.174***	-0.280	1.342	2.494	0.0206
	(0.108)	(0.0607)	(10.93)	(11.43)	(21.24)	(0.511)
Observations	178,621	120,522	178,621	178,621	178,621	178,621
R-squared	0.058	0.006	0.041	0.057	0.057	0.032
Number of psid	31,227	26,155	31,227	31,227	31,227	31,227

Robust standard errors in parentheses. Year dummy is included. Standard errors are clustered at provincial level. Fixed-effects model is applied. *** p<0.01, ** p<0.05, * p<0.1