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# The higher costs of doing business in China: Minimum wages and firms' export behavior☆

Li Gan [a], Manuel A. Hernandez [b], Shuang Ma [c,*]

[a] Southwestern University of Finance and Economics, China and Texas A&M University, USA
[b] International Food Policy Research Institute, USA
[c] Southwestern University of Finance and Economics, China

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ABSTRACT

This paper examines the relationship between changes in the minimum wage and firms' export behavior in China using detailed firm-level data of medium and large manufacturing enterprises between 1998 and 2007. We find that a 10% increase in the minimum wage is associated with a 0.9 percentage-points decrease in the probability of exporting goods and a 0.9% decline in export sales, conditional on exporting. These findings are generally robust to alternative estimation methods and data sources. We further observe a larger decline among firms with lower average wages and a lower capital–labor ratio. The results suggest that Chinese exports and comparative advantage in international markets are not negligibly affected by higher local labor costs and regulations measured through raises in minimum wage standards.



## 1. Introduction

Over the past years, Chinese labor costs have significantly increased and there is an ongoing discussion on how these higher costs are affecting the exports of Chinese enterprises.[1] As shown in Fig. 1, average urban wages in China increased by about 195% from 2002 to 2010 or by 261% after adjusting for the exchange rate.[2] Yet, China's exports to the US, its major (country) trade partner, also increased during the last decade. The exports from China to the US raised by 136% from 2002 to 2007; after a decline in 2008–2009 due to the financial crisis, exports went up again in 2010 to levels similar to 2007.[3] This apparent positive correlation between wages and exports at the aggregate level seems, however, inconsistent with the well documented comparative labor advantage of China in international markets (see, e.g., Lin et al., 2003). It motivates a more detailed analysis using micro data, which permits to better account for changes in other factors that may affect the relationship between labor costs and export behavior such as firms' characteristics and performance.

We use in this paper an extensive firm-level dataset of medium and large manufacturing enterprises in China to formally examine the sensitivity of firms' exports to increasing labor costs and regulations measured through changes in minimum wage standards over time and across regions. The period of analysis is 1998 through 2007. We exploit the significant variation in local minimum wages across different cities in China over the past years to analyze the relationship between firms' export behavior and labor costs. The focus on the manufacturing sector

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* Corresponding author at: 55 Guanghuacun St, Chengdu, Sichuan Province, China, 610074. Tel.: +86 28 8735 2095.
*E-mail addresses:* gan@econ.tamu.edu (L. Gan), m.a.hernandez@cgiar.org (M.A. Hernandez), shuangma@swufe.edu.cn (S. Ma).

[1] An article in the New York Times (2010) indicated that with rising wages in China, export prices would follow with a consequent decrease in Chinese exports; yet, an article in the New York Times (2014) argued that even as wage rises, China exports would continue growing as Chinese manufacturers have had become more productive.

[2] See Ge and Yang (2014) for a detailed analysis of changes in China's wages over the past years. The authors find that most of the wage growth in China between 1992 and 2007 is attributable to a higher pay for basic labor, rising returns to human capital and increases in the state-sector wage premium. Li et al. (2012) also note that China's wages have increased faster than productivity since the late 90s.

[3] It is frequently argued that one of the reasons of the increasing Chinese exports to the US (and the large trade imbalance between these two countries) is the under-valuation of the Yuan relative to the US dollar. Yet, the Yuan has been appreciating against the US dollar since 2005, after the Chinese government allowed its (limited) floatation, but China keeps maintaining an increasing trade surplus with the US and the rest of the world. The rising Chinese import competition and its negative effects on local US labor markets has also received significant attention in the past years (see Autor et al., 2013).

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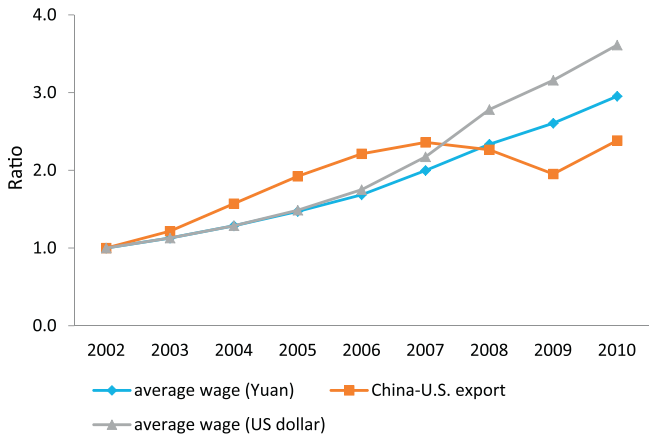


**Fig. 1.** Change in Chinese labor costs and China–US exports, 2002–2010.
Source: National Bureau of Statistics, several years.

is of special interest given its importance on the Chinese economy and exports, and the recurrent debates regarding the pressure exerted by the minimum wage policy on this sector (Huang et al., 2014). Our detailed dataset permits us to control in the analysis for firm-level variables, macroeconomic conditions, time effects and unobserved firm heterogeneity. Similarly, we account for prior changes in different local economic and labor indicators to control for this potential source of variation of minimum wages, which is observed in advance by firms.

The estimation results indicate a statistically significant correlation between changes in the minimum wage and the export behavior of firms. A 10% increase in minimum wages is associated with a 0.9 percentage-points decrease in the probability of exporting goods and a 0.9% decline in export sales, conditional on exporting. These results are generally robust to alternative estimation methods and data sources. In particular, we find a similar negative relation between minimum wages and the decision to export when implementing a difference-in-difference (DID) approach that exploits major differentiated variations in minimum wages from 2006 to 2007 between adjacent areas in China. We also find similar results when using customs-level transaction data from 2004 to 2006. We further observe that firms with lower average wages and a lower capital-labor ratio exhibit a larger decline in their exports after a raise in the minimum wage.

Our paper ties into several literatures. The analysis is related to the extensive theoretical work on minimum wages and trade, which started more than four decades ago. Most of these studies assume firm homogeneity and show that the effect of minimum wages on exports will depend on a combination of factors, including the economic scale, industry and trade structure, and the ease of factor mobility in a country (e.g., Bhagwati and Ramaswami, 1963; Brecher, 1974a, 1974b, 1980; Srinivasan and Bhagwati, 1975; Magee, 1976; Neary, 1985; Flug and Galor, 1986). Brecher (1974a, 1974b), for instance considers a model with two goods, two input factors, wage distortions and constant returns-to-scale production technologies. The author shows that a rise in the minimum wage in labor-intensive countries leads to a decrease in the price of capital, which increases (decreases) the exports of capital-intensive (labor-intensive) products. Neary (1985) finds similar results when extending the analysis to a setting with more input factors than goods, while Brecher (1980) shows that both capital- and labor-intensive exports will increase if the country specializes incompletely. Flug and Galor (1986) account for human capital accumulation in a model with two goods and skilled and unskilled labor. They find that for a large country exporting unskilled labor-intensive goods, an increase in minimum wages for unskilled labor may eventually reverse the trade structure of the country.

More recently, Egger et al. (2012) is one of the few studies that formally incorporate minimum wages in a trade model with heterogeneous firms. In particular, the authors formulate a model with a single factor (labor), heterogeneity in firm productivity, multiple tradable intermediate goods and a final good. They find that a rise in the minimum wage in a country will force inefficient intermediate good suppliers to exit the market, leading to a decline in exports. Their analysis, however, excludes self-selection into exports of both intermediate and final goods and assumes that all intermediate goods producers are exporters.

The study is also related to the general literature on trade and firm heterogeneity, which more closely resembles the well documented intra-industry differences between exporters and non-exporters in terms of, for example, size, productivity and wages.[4] In his seminal paper, Melitz (2003) shows that when entry into export markets is costly, exposure to trade will offer new profit opportunities only to the more productive firms and will also induce prospective firms, which respond to higher potential returns, to enter the market. The higher labor demand by the more productive firms and new entrants will increase wages and eventually force least productive firms to exit. Bernard et al. (2007) extends Melitz's framework by incorporating factor intensity (abundance) differences across sectors (countries) and finds that exposure to costly trade leads to a larger increase in the labor demand by exporters in the comparative advantage industry.[5] Hence, considering that changes in minimum wages also reflect changes in local labor conditions, we would expect then a negative correlation between minimum wages and firms' exports, especially in industries where China exhibits a relative comparative advantage.

Our study also contributes to the empirical literature assessing the effects of higher labor costs in China. Based on these studies, it is not clear that higher minimum wages affect Chinese manufacturers and exporters. Li (2006) argues that labor costs are still proportionally low in China so raises in minimum wages will have a modest effect on firms' export behavior. The author further indicates that China's comparative advantage in international markets is not necessarily only driven by low labor costs while foreign investors in China are not only attracted by cheap labor. Huang and Ren (2008), Chao and Liming (2007), and Yang and Zhang (2007) sustain that China's comparative advantage relies on labor costs per unit of output rather than on absolute labor costs; hence, as long as productivity growth is higher than the growth of wages, the competitiveness of Chinese exports will not be much affected. On this matter, Zheng (2004) points out that the comparative advantage of China's labor costs has been offset by low productivity; thus, exports may be more affected by a low firm productivity than by raises in wages. In contrast to these studies, our analysis is based on a detailed firm-level dataset of manufacturing enterprises in China. These data allows us to examine the association between firms' exports and minimum wages while controlling for unobserved firm heterogeneity and other firm and market controls.

Overall, this paper is to our knowledge the first study that uses micro-level data to deepen our understanding of the relationship between minimum wages and Chinese manufacturing exports, particularly in a context where the direction of the relationship is not fully clear. We combine firm-level data with hand-collected minimum wage standards for a wide set of cities across the country over a period of eleven years. The study is particularly relevant considering the

[4] Empirical studies documenting these differences include Bernard and Jensen (1997, 1999), Tybout (2003), Wagner (2007) and Roberts et al. (2012).

[5] Other trade models that discuss production and export behavior under firm heterogeneity include Bernard et al. (2003), Yeaple (2005), Sutton (2007) and Melitz and Ottaviano (2008). Similar to Melitz (2003) and Bernard et al. (2007), Bernard et al. (2003) and Melitz and Ottaviano (2008) allow for heterogeneity in firm productivity, which is randomly determined; in Yeaple (2005), firm heterogeneity results from firms endogenously selecting different production technologies; Sutton (2007), in turn, allows for firm heterogeneity along the cost and demand (product quality) dimension.

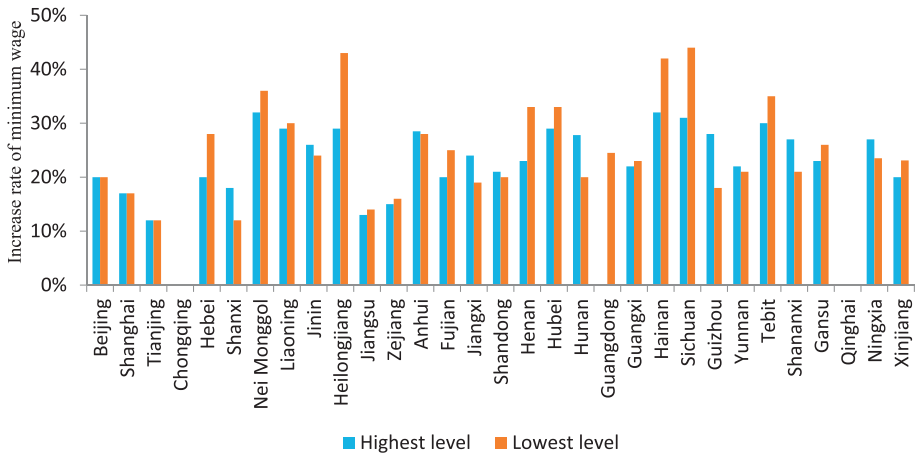


**Fig. 2.** Adjustment of minimum wage in various provinces and municipalities in 2010.
Source: Local government websites, statistical bulletins and labor and civil reports.

ongoing pressures in China to keep raising wages and the continuous and more often adjustments of the minimum wage standards by the Chinese government.[6] In 2010, for example, most of the provinces and municipalities in the country substantially rose their minimum wages. As shown in Fig. 2, the highest and lowest minimum wage levels in 29 (out of 31) of the regions rose between 10% and 35%; on average, the lowest level of the minimum wage increased by 25% and the highest by 24%. According to the 2011–2015 Employment Plan of the Ministry of Labor, minimum wages will keep increasing at an annual growth rate of at least 13% until 2015.

Putting our results in perspective, the estimated effects of changes in the minimum wage on both the extensive margin (decision to export) and the intensive margin (amount of exports) are not small compared, for example, to the estimated sensitivity of Chinese exports to changes in the exchange rate (see, e.g., Aziz and Li, 2007; Thorbecke and Smith, 2010; Li et al., 2014). In particular, Li et al. (2014) who also use detailed firm-level data for 2000–2007 find that a 10% Yuan appreciation decreases the probability of exporting in 2.1 percentage points while the value exported decreases between 2.5% and 5.1% for the average exporter. Considering that China's total exports were around 2210 billion US dollars in 2013, the estimated 0.9% decline in exports after a 10% increase in the minimum wage is equivalent to about 20 billion US dollars, a non-trivial value for government officials and exporters to consider.

The remainder of the paper is organized as follows. Section 2 provides additional details about the minimum wage system in China. Section 3 describes the data and the empirical model used to examine the effect of the minimum wage on firms' export behavior. Section 4 presents and discusses the estimation results. Section 5 performs robustness checks. Section 6 concludes.

## 2. The minimum wage system in China

The Chinese government started in 1994 to implement a minimum wage policy in various cities across the country, which was further intensified in 2004 with additional regulations passed by the Ministry of Labor and Social Security. By the end of 2004, the minimum wage system was already extended to the whole country such that China's thirty one provinces, autonomous regions and municipalities directly under the Central government were implementing a monthly minimum wage. Minimum wage adjustments have also become more frequent with the policy reform of 2004 that requires local governments to renew their minimum wage standards at least once every two years.[7]

The government uses two methods to determine the monthly minimum wage in an area: the proportion method and the Engel Coefficient method.[8] The proportion method is based on the minimum income necessary to cover the standard living costs of an individual living in poor conditions; the Engel Coefficient method is based on the minimum food expenditure divided by the Engel coefficient, which results in a minimum living cost. Both methods also account for the number of people supported by each employer in an area. In practice, the government makes further adjustments to the minimum wage, taking into account the pension and medical insurance premiums paid by workers, housing funds, average wage levels, social benefits, unemployment rate and the economic development of the area.[9]

It is important then to take into account that minimum wage adjustments not only may alter local labor conditions but can also respond to changes in these conditions. More specifically, variations in minimum wages can reflect changes in local market conditions, which are observed in advance by firms who make their decisions based on this information. We control below for prior changes in different economic and labor indicators at the city level to account for this potential source of variation of minimum wages, but certainly minimum wages can also reflect changes in other factors as discussed below.

Another relevant feature of the minimum wage adjustment process for our analysis is that the adjustments are made at the provincial level and not at the local level. Hence, it is less likely that firms in a county will lobby to delay or significantly influence minimum wage adjustments, although we cannot entirely disregard this possibility. In particular, cities in each province are divided into several groups according to their economic development; within each group, cities generally have the same minimum wage and follow the same adjustments.[10] For example,

[6] The "Foxconn suicides" of 2010, where fourteen employees committed suicide between January and November of that year, is a clear example of the recurrent social conflicts in China regarding low wages and poor labor conditions. This incident drew media attention all over China and internationally as Foxconn is a major manufacturer for Apple, Dell, Hewlett Packard, among others, and reinforced the debate regarding wages and employment practices in China. After these events, Foxconn raised salaries by up to 66% (http://www.reuters.com/article/2010/10/01/us-foxconn-idUSTRE6902GD20101001). Other major manufactures have also significantly increased their salaries in the past years.

[7] See Fang and Lin (2013) for a detailed summary of the evolution of the minimum wage policy in China.

[8] The minimum wage system in China also includes an hourly minimum wage, which applies to part-time workers, while the monthly minimum wage applies to full-time workers. The hourly minimum wage is determined based on the monthly minimum wage.

[9] The Chinese government has also been using the minimum wage as an instrument to reduce income gaps across regions.

[10] Minimum wages may differ within a group. For instance, if a city is substantially less developed than the rest of the cities in the group, the city is allowed to adopt the minimum wage of the next less-developed group. Still, when a city is assigned to a minimum wage group, it typically stays in that group.

cities in Hebei Province, located in the north of China, are divided into four minimum-wage groups and wages were adjusted four times between 1998 and 2007 in this province; cities in Fujian Province, located in the southeast, are divided into six groups and wages were adjusted eight times during the same time period. Minimum wage groups can also change over time. Guangdong Province, located in the southeast, had eight groups before 2003 and reduced the number of groups to five in 2005.[11]

Overall, minimum wages have increased substantially in China since the late 90s. In 1998, minimum wages were below 430 Yuan (52 US dollars) while in 2007 average minimum wages in most provinces ranged between 500 and 750 Yuan (66–99 US dollars). We also observe important differences across regions and between groups in the same province. In 2007, the nationwide standard deviation of the minimum wage was 99 Yuan (13 US dollars); the highest minimum wage was in Shenzhen at 850 Yuan (112 US dollars) per month and the lowest was in Xinjiang at 360 Yuan (48 US dollars) per month—only 42% of the minimum wage in Shenzhen. Within the same province, minimum wages in Fujian, for example, ranged between 480 and 690 Yuan (63–91 US dollars) in 2006, while in Guangdong they varied between 500 and 810 Yuan (66–106 US dollars).

## 3. Empirical approach

### 3.1. Data

The main data source of this study is firm-level data from the annual survey of manufacturing firms collected by the central government through the Industry Statistical Reporting System. This reporting system is set up by the National Bureau of Statistics of China to gather information from state and non-state owned enterprises with annual sales above five million Yuan. According to Brandt et al. (2012), in 2004 these enterprises accounted for more than 90% of the total manufacturing output in China and over 71% of the industrial employment. The annual information, collected by provincial-level statistical agencies and relevant departments under the State Council, is complemented with periodic (annual) information directly submitted by the enterprises.[12] Similar to Brandt et al. (2012) and Li et al. (2014) who also use this dataset, we focus on the period 1998 through 2007.

The dataset contains information on economic and financial characteristics of each surveyed firm. In particular, we can recover information on the enterprise output, value of exports, output volume of major products, value of assets, liabilities, value of inventories, operating profit, total wages, number of employees, and firm ownership. We exclude from the study businesses that do not adopt the enterprise accounting system or are not categorized as enterprises, such as public institutions and community groups.

The firm-level data is complemented with the minimum wage standards enacted by the municipal governments between 1998 and 2007. Since there is no uniform data source, we obtain this information by browsing local government websites and statistical bulletins and by searching local labor and civil reports directly on the internet. We collect minimum wages for 274 cities across most of the province-level administrative divisions in China.

We also gather economic and labor indicators at the city level from the China Economic Data Website.[13] The indicators include per capita gross domestic product (GDP), population, average annual wages and employment. We then merge the micro data of enterprises with the minimum wage and macroeconomic data by city and year. Our final working sample is an unbalanced panel of 1,261,590 observations corresponding to more than 350 thousand enterprises across 525 four-digit Chinese Industrial Classification (CIC) manufacturing industries.

It is worth noting that besides entries and exits, the panel seems to present sampling omissions. In particular, the attrition rate in our sample varies between 9% and 26% across years but the rate of re-entry is around 8% over time, which suggests that several firms that exit the sample do not necessarily closed but are omitted from the sample in certain years.[14] In addition, some of the variables used in the analysis (specially the financial variables) present missing entries. The results reported below, however, are generally not sensitive to these firm entries, exits, potential omissions and missing values.[15]

Table 1 reports summary statistics of the key variables used in the analysis. The average monthly minimum wage in the cities is 381 Yuan, ranging from 140 Yuan in Ya'an city (Sichuan Province) in 1999 to 850 Yuan in Nanjing (Jiangsu Province) in 2007. Exporting enterprises account for roughly 29% of the total sample with an average value of exports of 48 million Yuan.[16] Firms' assets are roughly three times greater than their liabilities, inventories account for 18% of the output value, and the annual operating profit is close to 2% of the total output. Domestic enterprises represent 79% of the firms in the sample. We also observe a relatively high dispersion in most financial indicators, which is indicative of large differences across firms and over time. The cities included range from Chaoyang city (Liaoning Province) with a per capita GDP of 1226 Yuan in 2002 and Shenzhen city (Guangdong Province) with a per capita GDP of 152,099 Yuan in 2001.

Fig. 3 provides some insights about the relationship between firm wages and local minimum wages. In particular, the figure shows the distribution of the ratio of average enterprise wages to minimum wages in the cities where firms are located for selected years. Two patterns are worth noting. First, average wages are not necessarily higher than minimum wages across all firms. Average wages may be lower than legal minimum wages because firms also offer payment in kind such as amenities and non-monetary welfare provisions, which are usually not recorded as wages in the survey, and wages may also include payments to temporary, non-contracted workers.[17] Similarly, the enforcement and compliance of minimum wage policies is not always perfect.

The second pattern worth noting is that, although minimum wages have increased across time, they have become more binding in recent years. The proportion of enterprises with average wages below the local minimum wage is considerably lower in 2005 and 2007 (5–7%)

[11] This province raised minimum wages three times between 1996 and 2005 and four times between 2006 and 2011.

[12] While several indicators are self-reported by private and state-owned enterprises, incorrect reporting is considered unlawful. There are also strict double-checking procedures in the data collection that contributes to the accuracy and reliability of the dataset (Cai and Liu, 2009).

[13] http://db.cei.gov.cn/page/Login.aspx

[14] The rate of re-entry is based on the proportion of firms re-entering the sample over the total number of firms entering the sample each year. The average rate of re-entry increases to 15% if we consider, instead, the proportion of firms that leave and re-enter the sample over the total number of firms that leave the sample each year.

[15] The results only including 1) firms observed across all periods, 2) firms that never exit the sample (i.e. firms observed across all periods plus firms that enter the sample and are observed across all subsequent periods), and 3) firms that do not re-enter the sample are qualitatively similar to the full sample results. We also find similar results when including dummy variables for missing values and replacing the missing entries with the average firm values, although this procedure does not fully resolve the missing data issue.

[16] The major manufacturing activities of exporting firms include woven and garment manufacturing (1810), comprehensive utilization of waste resources industry (4210), and metal product repair industry (4310). Among non-exporting firms, the major activities include power supply industry (4420), rail transportation and equipment manufacturing (3720) and petroleum exploitation industry (0710).

[17] Hsieh and Klenow (2009) note that the reported labor payments in the annual surveys of manufacturing firms in China generally omit substantial fringe benefits and Social Security contributions.

**Table 1**
Summary statistics and description of key variables.

| Variable | Unit | Description | Mean | Standard deviation | Minimum | Maximum |
|---|---|---|---|---|---|---|
| Minimum wage | Yuan | Local minimum wage | 381 | 125 | 140 | 850 |
| If firm exports | % | Equal to 1 if firm exports; 0 otherwise | 29.0 | 45.3 | 0 | 1 |
| Export value | 1000 yuan | Value of firm exports | 48,097 | 108,044 | 1 | 786,886 |
| Asset value | 1000 yuan | Value of firm assets | 66,265 | 173,234 | 1050 | 1,313,667 |
| Number of employees | Person | Number of firm employees | 267 | 444 | 11 | 3017 |
| Balance ratio | % | Total assets/total liabilities | 295 | 459 | 64 | 3502 |
| Inventory ratio | % | Inventory/output value | 18.4 | 30.9 | 0 | 207 |
| Profit per output | | Operating profit/output value | 0.018 | 0.118 | −0.670 | 0.323 |
| Average wages | Yuan | Average firm wages | 1116 | 853 | 99 | 5481 |
| Capital–labor ratio | 1000 yuan per employee | Total assets/number of workers | 264 | 375 | 11 | 2464 |
| If domestic firm | % | Equal to 1 if all firm funds originated from China (excluding Hong Kong, Macao and Taiwan), such as state-owned, collective, joint-stock cooperative, private-owned and private partnership; 0 otherwise | 78.7 | 40,9 | 0 | 1 |
| If state-owned holding | % | Equal to 1 if absolute state holding or relative state holding; 0 otherwise | 14.8 | 35.5 | 0 | 1 |
| Per capita city GDP | Yuan | Per capita gross domestic product of city | 20,097 | 16,005 | 1226 | 152,099 |
| City population | 10,000 | Total city population | 120 | 140 | 13 | 1526 |
| Average wage in city | Yuan | Average annual wages in city | 14,501 | 7421 | 1969 | 141,387 |
| # observations | | | | | | 1,261,590 |

as compared to 1999 and 2001 (13–15%).[18] Two possible explanations for this pattern are that local regulations have become more severe in recent years such that more firms are required to meet the minimum wage requirements, particularly after the policy enforcement tightening in 2004, and that the labor productivity is increasing and companies are raising the salaries of their workers at a higher rate than the raise in minimum wages. We further discuss the impact of the minimum wage on firm wages in Section 4.[19]

A preliminary comparison, in turn, of changes in minimum wages with export growth at the provincial level do not show a significant correlation between them. Using Guangdong Province as an example, we observe in Fig. A.1 in the Appendix that the minimum wage increased by 300% between 1995 and 2011 (from 320 to 1298 Yuan). During the same time period, the annual growth of total net exports in the province fluctuated substantially. Between 1996 and 2002, the growth rate of net exports decreased from 145% to 4.5% while the average minimum wage remained at 450 Yuan per month. The minimum wage in the province then continuously increased until 2011 while the growth rate of net exports first increased until 2006 and then progressively slowed down.

### 3.2. Model

We now turn to describe the empirical model used to examine the effect of the minimum wage on export behavior at the firm level. Consider the following model,

$$DEXP_{ihjt} = \gamma_0 + \gamma_1 \ln(mwage_{jt}) + \gamma_2 X_{ihjt} + +\gamma_3 Z_{jt} + c_i + \kappa_t + u_{ihjt} \quad (1)$$

$$\ln(EXP_{ihjt}) = \beta_0 + \beta_1 \ln(mwage_{jt}) + \beta_2 X_{ihjt} + \beta_3 Z_{jt} + c_i + \kappa_t + u_{ihjt} \quad (2)$$

where Eq. (1) is the selection equation of whether the enterprise exports or not and Eq. (2) models the value of the enterprise exports. $DEXP_{ihjt}$ is a dummy variable indicating whether enterprise $i$ of industry $h$ located in city $j$ exports part of its production at year $t$; $EXP_{ihjt}$ is the value of firm exports; $mwage_{jt}$ is the local minimum wage; $X_{ihjt}$ is a vector of firm-level characteristics, including different financial indicators and ownership status; and $Z_{jt}$ is a vector of city-level characteristics. We specify the error term to have a firm and time effect and a white noise error $u_{ihjt}$. The parameters of interest are $\gamma_1$ and $\beta_1$, which measure the effect of the minimum wage on the decision to export (extensive margin) and the amount of exports (intensive margin).[20]

Some econometric issues arise in the estimation of Eqs. (1) and (2). In particular, the time-invariant firm-specific effect $c_i$ accounts for any differences across firms, which could drive export behavior and is not well captured by the vector of controls. To the extent that this unobserved heterogeneity might be correlated with some of the explanatory variables, we exploit the panel nature of our data and estimate Eqs. (1) and (2) with firm fixed effects. In the case of Eq. (1), we estimate a Linear Probability Model (LPM) and also fit a Logit model for comparison purposes, considering that a fixed-effects logistic regression only exploits within-firm variation in the decision to export.

In the estimation of Eq. (2) we further need to take into account the potential sample selection arising from only including in the regression those firms actually exporting products. Following Heckman (1979), in a cross-section setting we could add the inverse Mills ratio resulting from the estimation of Eq. (1), to control for the likely selection bias in the estimation of Eq. (2). However, addressing the simultaneous presence of sample selection and unobserved heterogeneity in a panel data setting imposes additional complexities.

[18] Using the Chinese Annual Urban Household Survey from 2004 to 2009, Fang and Lin (2013) find that 5.6% of workers have a total monthly wage below the minimum wage. Ye et al. (2015) use matched firm-employee data for six provinces in 2009 and find that 3.4% of employees have a monthly wage below the minimum wage after accounting for wage bonuses.

[19] Another pattern not reported is that the percentage of firms with wages below the minimum wage is higher among non-exporting than exporting firms, but these differences have decreased over time. In 1998–1999, the proportion of firms with average wages below the minimum wage among non-exporting firms is 1.8 times higher than among exporting firms while in 2006–2007 is 1.3–1.4 times higher. If these apparent compliance differences bias our estimation results, we would expect a lower (negative) effect of minimum wages on firms' export behavior in recent years. Yet, as discussed below, we observe a weaker effect of minimum wages on the value of exports in recent years, but we find the opposite on the decision to export, although these variations could also be explained by other factors.

[20] We also tested for lagged effects (up to two lags) of minimum wages on export behavior as it may take time for firms to make adjustments when labor costs increase. The lagged terms, however, are not statistically significant at conventional levels in both the decision and amount of exports. The models with lags further provide a poorer fit in terms of the Schwarz Bayesian Information criterion (SBIC) than the models without lags considered in Eqs. (1) and (2).

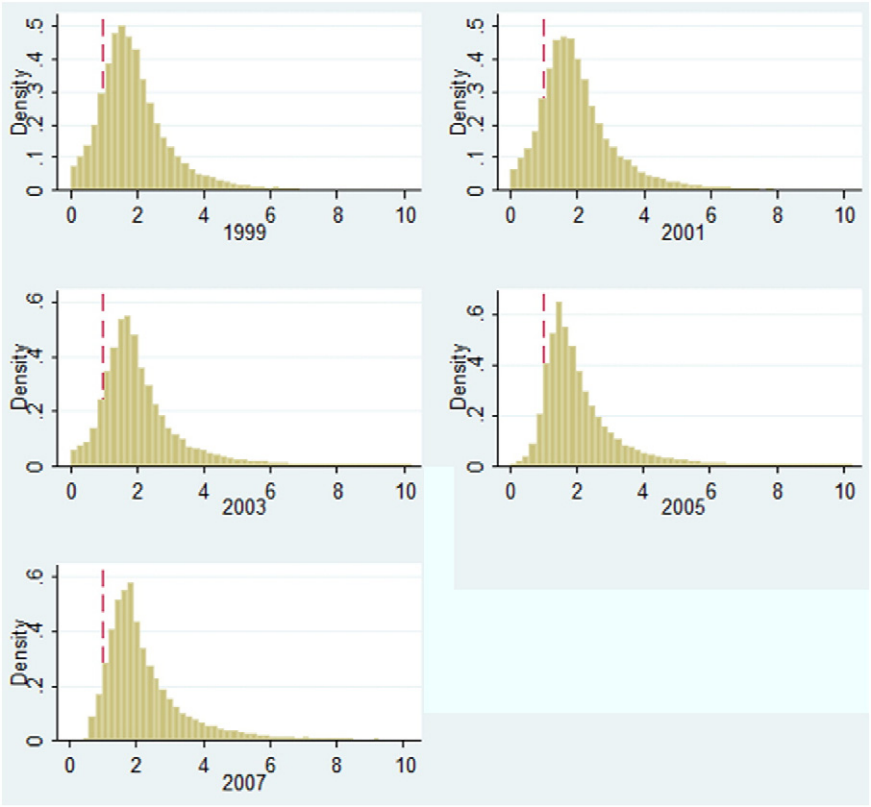


**Fig. 3.** Distribution of the ratio of the average firm wage to local minimum wage for selected years.
Source: Local government websites, statistical bulletins and labor and civil reports; Industry Statistical Reporting System.

Kyriazidou (1997) provides a solution for short-length panels. He proposes a two-step estimation procedure which "differences out" both the sample selection effect and the unobservable firm effect. Coefficients $\hat{\gamma}$ of the selection Eq. (1) are consistently estimated in the first step. In the second stage, Eq. (2) is estimated in first differences and by weighted least squares using $\sqrt{\hat{\psi}_i}$ as weights, where

$$\hat{\psi}_i = \frac{1}{h} K\left(\frac{\Delta R_i \hat{\gamma}}{h}\right), \tag{3}$$

$\Delta R_i$ is the difference across two periods of the control variables included in Eq. (1), $K(\cdot)$ is a kernel density and $h$ is the corresponding bandwidth. Hence, the fixed effect in Eq. (2) is eliminated by taking time differences on the observed selected variables, while the first-step estimates serve to construct weights. The magnitude of these weights depends on the magnitude of the sample selection bias; observations with a larger selectivity bias, i.e. a larger $|\Delta R_i \hat{\gamma}|$, are given a smaller weight. We also estimate Eq. (2) following this two-step procedure for comparability purposes with our full sample model, which only considers exporting firms. We implement the method for selected pair of years given that this procedure is designed for short-length panels.

As noted above, minimum wage adjustments can also reflect changes in local market conditions, which are observed in advance by firms and their export decisions may be influenced by these varying conditions. Similar to Huang et al. (2014), we further include in Eqs. (1) and (2) lagged city-level variables that account for a city's growth, living costs and labor market conditions. In particular, we add lagged per capita GDP growth, population growth, average annual wages and employment growth.[21] The inclusion of these additional regressors permit to control for this potential source of variation of minimum wages, although we cannot rule out other factors driving changes in minimum wages and lastly affecting local exports. For instance, unobserved changes in labor productivity or improved access to foreign markets by some exporters in a region may affect both minimum wages and subsequent export behavior in the region. More specifically, in a context with heterogeneous firm productivity and segmentation of labor markets, a significant increase in the productivity of large exporters or their expansion to new markets may end up exerting a positive effect on local minimum wages, ultimately raising the labor costs of weaker firms and reducing their likelihood of exporting, which is compatible with the results presented below.[22]

Finally, we acknowledge the potential endogeneity of some of the firm-level control variables $X_{ihjt}$ on export behavior, especially asset value, number of employees, debt and inventory ratio and product profitability as access to external markets in a particular year may also have a contemporaneous effect on these variables. Given the lack of standard instruments, we use lags of these financial indicators.

[21] Table A.1 in the Appendix shows the regression results of local minimum wages on the lagged city-level variables, controlling also for city and time fixed effects. We observe that an increase in a city's per capita GDP is positively associated with a higher minimum wage in the following period; variations in the other variables, however, do not appear to influence minimum wages in a city. We also note a high within R-square and a low between R-square, which suggests i) a high correlation between local economic conditions and minimum wages across time, and ii) certain flexibility from local governments in adjusting minimum wages to local conditions.

[22] We thank the Editor for pointing this issue.

## 4. Estimation results

This section presents the main estimation results. We first briefly examine the effect of changes in local minimum wages on employment costs. We then analyze the impact of the minimum wage on firms' export behavior modeled in Eqs. (1) and (2).We deflate all monetary variables in the regression analysis using the province CPI.[23]

Table A.2 reports the estimation results of regressing average firm wages on the local minimum wage and all firm and city controls described above. The table presents the results of the fixed-effects model, which formally accounts for the unobserved firm heterogeneity. The reported standard errors are robust and clustered at the city level. We find a positive and statistically significant correlation between the local minimum wage and average firm wages. After controlling for firm characteristics, macroeconomic conditions and time effects, an increase in the local minimum wage by 10% results in a 0.25% rise in average wages.

Hence, a raise in the minimum wage seems to exert a positive influence on labor costs, which may in turn affect firms' export decisions. The effect, though, is smaller than other studies that have recently examined in more detail the impact of minimum wages on China's wages and employment (e.g., Ma et al., 2012; Huang et al., 2014; Ye et al., 2015).[24] In principle, minimum wages are supposed to directly affect wages of low-income workers and indirectly affect wages of high-income workers, thereby shifting the whole wage distribution. This can be explained both in a basic and general equilibrium search framework with information frictions and homogeneous or heterogeneous firms (see, e.g., Van den Berg and Ridder, 1998; Burdett and Mortensen, 1998). Van den Berg (2003) further shows that even when firms' wages are greater than the minimum wage imposed, changes in the minimum wage will still shift upwards market wages.

We now turn to explicitly examine the impact of changes in the minimum wage on the export behavior of firms. Table 2 reports the estimation results of the firm export decision model defined in Eq. (1). The first three columns correspond to the results of the Linear Probability Model with firm fixed effects and including different covariates. We find a negative correlation between local minimum wages and the likelihood of exporting. In column (1), which accounts for time effects, a 10% increase in the minimum wage is correlated with a 0.9 percentage-points drop in the probability of exporting. In column (2), which adds time-varying firm-level covariates like enterprise scale, operating conditions and holdings status, the probability of exporting also drops by 0.9 percentage-points as well as in column (3), which adds macroeconomic variables at the city level. In terms of elasticities, this is equivalent to an export-minimum wage elasticity of −0.31 considering that the sample-average probability of exporting is 29%.

Column (4) reports the marginal effects of the fixed-effects Logit model. This model exploits within-firm variation in the decision to export across time, reason why we use a much smaller estimation sample. We also observe that a rise in the minimum wage is associated with a decrease in the likelihood to export. In this case a 10% increase in the local minimum wage results in a 1.5 percentage-points decrease in the probability of exporting, and the corresponding export-minimum wage elasticity is equal to −0.52. Since both the linear probability model and the Logit model indicate a statistically significant negative correlation between minimum wages and the likelihood of exporting, but the working samples vary considerably, we rely on the former method for the subsequent estimations performed in the study on the decision to export.

**Table 2**
Decision to export regressions.

| Coefficient | Linear probability model | | | Logit model |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | Dependent variable: if firm exports | | | |
| Log of minimum wage | −0.0876*** | −0.0871*** | −0.0887*** | −0.1481** |
| | [0.0033] | [0.0033] | [0.0033] | [0.0535] |
| Lag log assets | | 0.0135*** | 0.0132*** | 0.0248** |
| | | [0.0008] | [0.0008] | [0.0093] |
| Lag log employees | | 0.0202*** | 0.0205*** | 0.0355** |
| | | [0.0008] | [0.0008] | [0.0133] |
| Lag balance ratio | | −0.0001 | −0.0001 | −0.0000 |
| | | [0.0001] | [0.0001] | [0.0002] |
| Lag inventory ratio | | −0.0145*** | −0.0141*** | −0.0274** |
| | | [0.0016] | [0.0016] | [0.0117] |
| Lag profit per output | | 0.0127*** | 0.0124*** | 0.0264** |
| | | [0.0032] | [0.0032] | [0.0116] |
| If domestic firm | | −0.0305*** | −0.0305*** | −0.0415** |
| | | [0.0044] | [0.0044] | [0.0158] |
| If state-owned holding | | 0.0015 | 0.0014 | 0.0045 |
| | | [0.0022] | [0.0022] | [0.0043] |
| Log of city GDP | | | 0.0177*** | 0.0282** |
| | | | [0.0022] | [0.0123] |
| Log of city population | | | 0.0044** | 0.0032 |
| | | | [0.0019] | [0.0036] |
| Log of city average annual wages | | | −0.0256*** | −0.0565** |
| | | | [0.0025] | [0.0186] |
| Constant | 0.5500*** | 0.4374*** | 0.3988*** | |
| | [0.0102] | [0.0130] | [0.0284] | |
| Minimum-wage controls | Yes | Yes | Yes | Yes |
| Firm fixed effects | Yes | Yes | Yes | Yes |
| Time fixed effects | Yes | Yes | Yes | Yes |
| # observations | 1,261,590 | 1,261,590 | 1,261,590 | 211,130 |
| Log likelihood | −385,186 | −386,971 | −387,626 | −76,121 |

Note: Robust standard errors reported in brackets, clustered at the city level. Marginal effects reported in column (4).
*** Denotes statistical significance at a 1% level.
** Denotes statistical significance at a 5% level.

The estimated coefficients of the controls variables generally have the expected signs. For example, firms with more assets and employees are more likely to be exporting. The probability of exporting is significantly higher among firms with foreign participation, which reflects that foreign investment in manufacturing in China is mainly attracted for trading purposes. Exporting firms are more likely to operate in areas with low average wages, but the amount of firms' exports in these areas is lower than in areas with high wages as pointed below. While not reported, there is a significant increase in the number of firms exporting beginning in 2001, when China entered the World Trade Organization (WTO).[25]

Table 3 presents the estimation results of the value of firm exports model defined in Eq. (2). Columns (1) through (3) correspond to the fixed-effects model, considering all firms exporting in the sample but without correcting for the potential selection bias. The difference between the columns are the covariates included in the regressions. Conditional on exporting, we find a negative correlation between local minimum wages and the amount of firm exports. In column (1), which accounts for time effects, a 10% increase in the minimum wage decreases the amount exported by a firm in 0.6%. When adding firm-level controls in column (2) and city-level controls in column (3), a 10% rise in minimum wages is associated with a 0.6% and 0.9% drop in the amount of exports respectively.

[23] The CPI used is based on the provincial-level basket values (price levels) originally reported in Brandt and Holtz (2006) and updated in the companion website of the study, http://ihome.ust.hk/~socholz/SpatialDeflators.html (Accessed November 15, 2014).

[24] Ma et al. (2012) find a 0.38% increase in wages after a 10% increase in minimum wages, while Huang et al. (2014) find a 3.3–3.5% increase; Ye et al. (2015) shows an 8.7% rise in basic wages but this positive correlation disappears when further considering basic wages plus bonuses and supplements.

[25] As noted by Ge and Yang (2014), China's accession to the WTO in 2001 resulted in a considerable expansion of the external demand for Chinese goods in the following years.

**Table 3**
Value of export regressions.

| Coefficient | Linear model | | | Kyriazidou (1997) two-step method 2003–2004 |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | Dependent variable: log of value of exports | | | |
| Log of minimum wage | −0.0599** | −0.0578** | −0.0880*** | −0.1712*** |
| | [0.0265] | [0.0251] | [0.0252] | [0.0567] |
| Lag log assets | | 0.2906*** | 0.2881*** | 0.0968*** |
| | | [0.0056] | [0.0056] | [0.0186] |
| Lag log employees | | 0.1987*** | 0.2018*** | 0.1154*** |
| | | [0.0056] | [0.0057] | [0.0217] |
| Lag balance ratio | | −0.0037*** | −0.0038*** | −0.0009 |
| | | [0.0005] | [0.0005] | [0.0015] |
| Lag inventory ratio | | −0.3630*** | −0.3594*** | 0.1846*** |
| | | [0.0138] | [0.0138] | [0.0325] |
| Lag profit per output | | 0.3945*** | 0.3955*** | 0.0506 |
| | | [0.0299] | [0.0299] | [0.0732] |
| If domestic firm | | −0.0451** | −0.0427** | 0.0243 |
| | | [0.0202] | [0.0202] | [0.0746] |
| If state-owned holding | | −0.0248 | −0.0231 | −0.0767** |
| | | [0.0211] | [0.0211] | [0.0391] |
| Log of city GDP | | | 0.1088*** | 0.5225*** |
| | | | [0.0124] | [0.0951] |
| Log of city population | | | 0.0210** | −0.0692 |
| | | | [0.0093] | [0.0812] |
| Log of city average annual wages | | | 0.0325** | 0.2343* |
| | | | [0.0143] | [0.1198] |
| Constant | 6.5808*** | 3.6721*** | 2.2546*** | 0.5119 |
| | [0.0806] | [0.0878] | [0.1974] | [1.2108] |
| Minimum-wage controls | Yes | Yes | Yes | Yes |
| Firm fixed effects | Yes | Yes | Yes | Yes |
| Time fixed effects | Yes | Yes | Yes | Yes |
| # observations | 366,003 | 366,003 | 366,003 | 52,010 |
| Log likelihood | −339,945 | −330,578 | −330,433 | −33,570 |

Note: Robust standard errors reported in brackets, clustered at the city level.
*** Denotes statistical significance at a 1% level.
** Denotes statistical significance at a 5% level.
* Denotes statistical significance at a 10% level.

When accounting for the potential selection bias of only considering exporting firms, we also observe a decrease in the amount of exports after a raise in the local minimum wage. To save space, column (4) reports the estimation results using Kyriazidou (1997) two-stage approach for the sample period 2003–2004 as the results are generally similar when considering alternative sample periods.[26] We find that an increase in the minimum wage by 10% is correlated with a 1.7% decline in the amount of exports.

Regarding the control variables, most of the signs of the estimated coefficients are again as expected. Enterprises with more assets and employees exhibit greater exports. Domestic firms show a lower amount of exports, as opposed to foreign firms, although the differences are not statistically significant across all specifications. Similarly, enterprises operating in areas with high wages and large populations seem to exhibit a higher amount of exports. Although not reported, the amount of exports were also smaller between 2000 and 2003 (relative to 1998), likely due to the Asian financial crisis in the late 90s, and they started to recover in 2004.

## 5. Robustness

The estimation results indicate a non-trivial effect of changes in the local minimum wage on firms' export behavior. We now perform alternative estimations to further assess the validity of our results. First, we exploit significant differentiated variations in minimum wages between two adjacent areas in China and implement a difference-in-difference (DID) estimation. Second, we examine potential heterogeneous impacts across enterprises with different wage levels and capital-labor ratios. Third, we analyze varying effects across time. Fourth, we use customs-level transaction data as an alternative data source for firms' exports.

### 5.1. Difference-in-difference (DID) estimation

This section draws on the important variation in minimum wages in most of the cities in Fujian Province as opposed to the cities in the neighboring Guangdong Province between 2006 and 2007. As shown in Table A.3, local minimum wages among most of cities in Fujian Province increased by more than 8% from 2006 to 2007. In contrast, the minimum wage did not change in all of the cities in Guangdong Province but Shenzhen where minimum wages increased by 5%.

We take advantage of these differentiated variations across adjacent areas to implement a DID approach using the following model specification,

$$DEXP_{ihjt} = \theta_0 + \theta_1 D07_t + \theta_2 Fujian_{jt} + \theta_3 D07_t * Fujian_{jt} + \theta_4 X_{ihjt} + \theta_5 Z_{jt} + c_h + u_{ihjt} \quad (4)$$

$$\ln(EXP_{ihjt}) = \eta_0 + \eta_1 D07_t + \eta_2 Fujian_{jt} + \eta_3 D07_t * Fujian_{jt} + \eta_4 X_{ihjt} + \eta_5 Z_{jt} + c_h + u_{ihjt} \quad (5)$$

where $D07_t$ is a time dummy variable equal to one for the year 2007; *Fujian* is a dummy variable for Fujian Province, i.e. the "treatment" variable; and the other covariates are defined as in Eqs. (1) and (2). The coefficients $\theta_3$ and $\eta_3$, which capture changes in export behavior among enterprises in Fujian Province relative to enterprises in Guangdong Province between 2006 and 2007, serve in this case as a proxy of the impact of variations in local minimum wages on firms' decision to export and amount of exports.

The comparability of the "treatment" and "control" groups is critical when implementing a DID estimation. Both Fujian and Guangdong provinces are southeast coastal provinces located next to each other and their manufacturing industry is export oriented, although their level of development is different. We particularly focus on comparing the behavior of firms located in the city of Zhangzhou in Fujian Province versus the neighboring cities of Chaozhou, Shantou and Jieyang in Guangdong Province (see Fig. A.2). The minimum wage in Zhangzhou increased by 18% between 2006 and 2007 while it did not change in Chaozhou, Shantou and Jieyang. As shown in Table A.4, which reports several economic indicators of the selected cities in 2006, the "treatment" and "comparison" groups are generally comparable in terms of economic development and trade.

Table 4 reports the regression results of this exercise. The first column corresponds to the export decision regression and the other two columns to the amount of exports regression. The rise in the minimum wage in Zhangzhou is associated with a 6.8 percentage-points decrease in the likelihood of exporting relative to Chaozhou, Shantou and Jieyang. Considering a sample-average probability of exporting in these cities of 44.1% and that minimum wages in Zhangzhou increased by 18%, this is equivalent to an export-minimum wage elasticity of −0.86, which is also higher than the elasticity obtained in the base results. In the case of variations in the amount of exports, however, we do not observe a statistically significant difference between firms in the two areas.[27]

[26] The estimated effect of minimum wages on the value of exports is negative and statistically significant at the 95% confidence level across different sample periods but the magnitude varies. Further details are available upon request.

[27] We do find a significant drop in the value of exports among enterprises in Fujian relative to Guangdong equivalent to 6.7% (elasticity of −0.36) when implementing the biased-corrected matching estimator proposed by Abadie and Imbens (2002). Enterprises in the "treatment" and "control" group are matched based on a set of covariates such as asset value, debt and inventory ratio, profitability and ownership status. We considered the full sample of enterprises in Fujian and Guangdong provinces in order to obtain a convenient support for the matching. A similar result is obtained when doing propensity score matching.

**Table 4**
Difference-in-difference estimation of export behavior: Zhangzhou (Fujian Province) versus Chaozhou, Shantou and Jieyang (Guangdong Province).

| Coefficient | DID regression | | Kyriazidou (1997) two-step method |
|---|---|---|---|
| | (1) | (2) | (3) |
| | Dependent variable: if firm exports | Dependent variable: log of value of exports | Dependent variable: log of value of exports |
| D07 | −0.1355*** | 0.3216*** | 0.3608*** |
| | [0.0207] | [0.0689] | [0.0727] |
| Area = Zhangzhou | −0.9048*** | 1.4745*** | 1.8910*** |
| | [0.1352] | [0.4694] | [0.4811] |
| D07 * area | −0.0677*** | 0.1064 | 0.1381 |
| | [0.0225] | [0.0931] | [0.0989] |
| Constant | −9.8806*** | 23.1371*** | 26.1943*** |
| | [1.0587] | [3.7757] | [3.8233] |
| Firm-level variables | Yes | Yes | Yes |
| City-level variables | Yes | Yes | Yes |
| Minimum-wage controls | Yes | Yes | Yes |
| Industry fixed effects | Yes | Yes | Yes |
| # observations | 6832 | 3011 | 3011 |
| Log likelihood | −3606 | −4,290 | −4,287 |

Note: Robust standard errors reported in brackets, clustered at the city level.
*** Denotes statistical significance at a 1% level.

**Table 5**
Export behavior regressions by quintiles of average firm wages.

| Coefficient | Linear model | |
|---|---|---|
| | (1) | (2) |
| | Dependent variable: if firm exports | Dependent variable: log of value of exports |
| Log of minimum wage | −0.1207*** | −0.4981*** |
| | [0.0058] | [0.0431] |
| Log of minimum wage * quintile 2 | 0.0090 | 0.1268*** |
| | [0.0068] | [0.0479] |
| Log of minimum wage * quintile 3 | 0.0325*** | 0.2684*** |
| | [0.0066] | [0.0464] |
| Log of minimum wage * quintile 4 | 0.0385*** | 0.4434*** |
| | [0.0066] | [0.0462] |
| Log of minimum wage * quintile 5 | 0.0626*** | 0.7834*** |
| | [0.0066] | [0.0468] |
| Constant | 0.3730*** | 2.6441*** |
| | [0.0319] | [0.1964] |
| Quintile dummies | Yes | Yes |
| Firm-level variables | Yes | Yes |
| City-level variables | Yes | Yes |
| Minimum-wage controls | Yes | Yes |
| Firm fixed effects | Yes | Yes |
| Time fixed effects | Yes | Yes |
| # observations | 1,261,590 | 366,003 |
| Log likelihood | −387,822 | −329,710 |

Note: Robust standard errors reported in brackets, clustered at the city level.
*** Denotes statistical significance at a 1% level.

Hence, when performing an alternative DID estimation based on adjacent and rather similar areas, we still observe an effect of local minimum wages on firms' export behavior, particularly on the extensive margin or decision to export. Certainly, the results rely on the strict comparability of the "treatment" and "control" groups in both observable and unobservable characteristics, which is difficult to attain in a non-experimental setting.

### 5.2. Heterogeneous impact

Changes in the minimum wage may also have a differentiated impact on different firms. Ma et al. (2012), for example, provide supportive evidence regarding the heterogeneous impact of local minimum wages on average wages of different enterprises and a stronger effect among firms with average wages close to the minimum wage. Hence, the impact of minimum wages on export behavior may also differ across different types of firms.

Consider the following model specification,

$$DEXP_{ihjt} = \alpha_0 + \alpha_1 \ln(mwage_{jt}) + \alpha_2 D_{ihjt} + \alpha_3 \ln(mwage_{jt}) * D_{ihjt} + \alpha_4 X_{ihjt} + \alpha_5 Z_{jt} + c_i + \kappa_t + u_{ihjt} \quad (6)$$

$$\ln(EXP_{ihjt}) = \varphi_0 + \varphi_1 \ln(mwage_{jt}) + \varphi_2 D_{ihjt} + \varphi_3 \ln(mwage_{jt}) * D_{ihjt} + \varphi_4 X_{ihjt} + \varphi_5 Z_{jt} + c_i + \kappa_t + u_{ihjt} \quad (7)$$

where $D_{ihjt}$ is the grouping variable(s) to distinguish among different types of firms. The parameters of interest are $\alpha_3$ and $\varphi_3$, which capture potential differences in the effect of changes in local minimum wages on different firm groups. We allow for heterogeneous effects based on the firm's wage level and capital to labor ratio.

We focus first on firms with different average wages. We expect a higher effect on firms with lower wages where the minimum wage is more likely to be binding. We accordingly group firms into quintiles based on their average wage. Table 5 shows the corresponding results. In column (1), which models firms' export decisions, we generally observe a decrease in the impact of the minimum wage on the likelihood of exporting as we move to higher wage quintiles. A 10% rise in the minimum wage is linked to a 1.21 percentage-points decrease in the probability of exporting among firms in the first and second quintile, while the negative effect is 0.33, 0.39 and 0.63 smaller among firms in the third, fourth and fifth quintile. The corresponding export-minimum wage elasticity is −0.42 for the first two wage quintiles and −0.3, −0.28 and −0.2 for the upper quintiles. In column (2), which models the amount of exports, we observe a decreasing effect of changes in the minimum wage on the value of firm exports by quintile. A 10% increase in the minimum wage decreases the amount exported by a firm in 5% in the lowest wage quintile, 3.7% in the second quintile, 2.3% in the third quintile, 0.5% in the fourth quintile, and the negative effect is reversed in the fifth quintile (2.9% increase). Hence, firms with lower wages are more likely to be affected by changes in the local minimum wage.

We find qualitatively similar results when grouping firms by their capital to labor ratio. As shown in Table 6, the effect of changes in the minimum wage on firms' exports is generally smaller with a higher capital–labor ratio. That is, raises in the minimum wage reduce the exports of labor-intensive manufacturing industries like animal and food and textile industries, and may actually increase the amount of exports of more capital-intensive manufacturing industries like plastics and electronics industries. Among firms with the lowest capital–labor ratio (first quintile), a 10% increase in the local minimum wage is associated with a 1.1 percentage-points decrease in the likelihood of exporting (elasticity of −0.38) and a 3.3% drop in the amount of exports; among firms with the highest capital-labor ratio (fifth quintile), the 10% increase is correlated with a 0.7 percentage-points drop in the probability of exporting (elasticity of −0.24) but a 3% increase in the amount of exports. Overall, rises in the minimum wage seem to have a stronger negative effect on low-wage and labor-intensive firms.

### 5.3. Effects across time

We also examine time-varying effects of local minimum wages on firms' export behavior. We can expect a higher impact of minimum

**Table 6**
Export behavior regressions by quintiles of firms' capital to labor ratio.

| Coefficient | Linear model | |
|---|---|---|
| | (1) | (2) |
| | Dependent variable: if firm exports | Dependent variable: log of value of exports |
| Log of minimum wage | −0.1073*** | −0.3337*** |
| | [0.0055] | [0.0310] |
| Log of minimum wage * quintile 2 | 0.0026 | 0.0262 |
| | [0.0063] | [0.0339] |
| Log of minimum wage * quintile 3 | 0.0118* | 0.2322*** |
| | [0.0063] | [0.0360] |
| Log of minimum wage * quintile 4 | 0.0314*** | 0.3170*** |
| | [0.0062] | [0.0382] |
| Log of minimum wage * quintile 5 | 0.0392*** | 0.6350*** |
| | [0.0064] | [0.0417] |
| Constant | 0.3629*** | 2.4491*** |
| | [0.0319] | [0.1963] |
| Quintile dummies | Yes | Yes |
| Firm-level variables | Yes | Yes |
| City-level variables | Yes | Yes |
| Minimum-wage controls | Yes | Yes |
| Firm fixed effects | Yes | Yes |
| Time fixed effects | Yes | Yes |
| # observations | 1,261,590 | 366,003 |
| Log likelihood | −387,732 | −329,873 |

Note: Robust standard errors reported in brackets, clustered at the city level.
*** Denotes statistical significance at a 1% level.
* Denotes statistical significance at a 10% level.

**Table 7**
Export behavior regressions with time-varying effects.

| Coefficient | Linear model | |
|---|---|---|
| | (1) | (2) |
| | Dependent variable: if firm exports | Dependent variable: log of value of exports |
| Log of minimum wage | −0.0835*** | −0.2423*** |
| | [0.0061] | [0.0538] |
| Log of minimum wage * year = 2000–2001 | 0.0122** | 0.1461*** |
| | [0.0049] | [0.0438] |
| Log of minimum wage * year = 2002–2003 | 0.0251*** | 0.2220*** |
| | [0.0061] | [0.0535] |
| Log of minimum wage * year = 2004–2005 | −0.0016 | 0.1763*** |
| | [0.0065] | [0.0558] |
| Log of minimum wage * year = 2006–2007 | −0.0477*** | 0.1206** |
| | [0.0070] | [0.0576] |
| Constant | 0.3586*** | 2.7034*** |
| | [0.0353] | [0.2381] |
| Firm-level variables | Yes | Yes |
| City-level variables | Yes | Yes |
| Minimum-wage controls | Yes | Yes |
| Firm fixed effects | Yes | Yes |
| Time fixed effects | Yes | Yes |
| # observations | 1,261,590 | 366,003 |
| Log likelihood | −387,908 | −330,653 |

Note: Robust standard errors reported in brackets, clustered at the city level.
*** Denotes statistical significance at a 1% level.
** Denotes statistical significance at a 5% level.

wages with time due to more stringent labor supervision mechanisms and higher non-compliance penalties, especially after the major policy reform of 2004. Alternatively, a higher labor productivity (with higher wages in place) or more capital- and skill-intensive exports may simply weaken the effect of raises in the minimum wage on the export behavior of enterprises. On this matter, Rodrik (2006); Amiti and Freund (2007) and Schott (2008) point out that in the past two decades Chinese exports have become more sophisticated, moving out of apparel and textiles into electronics, telecommunications and machinery.[28]

Table 7 reports the estimation results when allowing for differentiated effects across every two-year periods. Interestingly, the effect of minimum wages on both the extensive and intensive export margin initially decreased until 2002–2003 and then started to recover, reaching in the case of the extensive margin values even higher than in the late 90s. From the first column, a 10% increase in the minimum wage is associated with a 0.8 percentage-points decrease in the likelihood of exporting in 1998–1999 (elasticity of −0.28), which reduces to 0.6 percentage-points in 2002–2003 (elasticity of −0.21) and increases to 1.3 percentage-points in 2006–2007 (elasticity of −0.45). Regarding the amount of exports in the second column, a 10% raise in the minimum wages is associated with a 2.4% decrease in exports in 1998–1999, which reduces to 0.2% in 2002–2003 and increases to 1.2% in 2006–2007.[29]

These varying patterns of the effect of minimum wages on the extensive and intensive export margins over time suggest that there are different factors in place, which are also difficult to disentangle. Besides changes in the enforcement of the law, labor productivity and composition of exports, firms could, for example, better anticipate minimum wage variations after the policy reform of 2004, which required local governments to adjust their minimum wage standards at least once every two years. The inclusion of lagged city-level variables in the regressions account in some way for predictable changes in local minimum wages and, consequently, for possible anticipated behavior, but we cannot fully rule it out.

### 5.4. Alternative dataset

Finally, we use customs transaction data for the period 2004 through 2006.[30] This dataset is more accurate and is subject to less measurement error than the data reported in surveys. Similarly, it comprises transactions from a wide range of enterprises, including firms with annual sales below 5 million Yuan. In addition, it permits to examine whether the rise in local minimum wages is reflected in the price and/or quantity of exported goods, which can help to validate the conclusions made in the study. Still, the dataset only includes basic firm information and we are subject to a potential selection bias of solely observing transactions from exporting firms.

Columns (1) through (3) in Table A.5 report the effect of the minimum wage on the price, volume and value of single commodity exports (based on 4 digits of the Harmonized System (HS) code). The reported estimates are the average regression coefficients corresponding to 100 sampling loops of different commodities. A 10% raise in the minimum wage is associated with a 0.9% increase in the price of the exported good, a 1.1% decline in the volume of exports and an overall 0.4% decline in the value of exports. Hence, as expected, the increasing labor costs driven by the rise in the minimum wage leads to an increase in the price of exported goods, thereby reducing the competitiveness of exporters in international markets and their volume of exports. The results

[28] Yet, Amiti and Freund (2007) indicate that the increase in the skill content of Chinese exports is largely due to the increase in processing trade, which assembles imported intermediate inputs with higher skill content.
[29] When segmenting the sample for the periods 1998–2003 and 2004–2008, i.e. before and after the major policy reform, we also observe a higher (negative) effect of minimum wages on the decision to export in recent years but a lower effect on the value of exports.
[30] The data include between 1 and 2 million monthly records of traded goods.

also confirm the negative correlation between local minimum wages and the value of firms' exports. In column (4), when we stack observations from all sampled commodities, a 10% increase in the minimum wage is roughly correlated with a 1% decrease in the total value of firm exports.

## 6. Conclusions

The important rise of minimum wage standards in China in the past years has received a lot of attention in academic and policy forums and in the international media, and there is an ongoing discussion on how higher labor costs and stricter regulations are affecting Chinese enterprises exports. This paper contributes to this debate by empirically examining the sensitivity of firms' exports to rising labor costs measured through changes in the minimum wage over time and across regions. We use an extensive firm-level dataset of medium and large manufacturing enterprises in China from 1998 to 2007 to analyze the relationship between variations in the minimum wage and firms' export behavior on the extensive and intensive margin.

The estimation results indicate a non-negligible effect of changes in the local minimum wage on the likelihood of exporting. A 10% increase in the minimum wage is correlated with a 0.9 percentage-points decrease in the probability of exporting. This is equivalent to an export-minimum wage elasticity of −0.31 considering a sample-average probability of exporting of 29%. Similarly, we find a negative correlation between local minimum wages and the amount of exports. Conditional on exporting, a 10% rise in the minimum wage is correlated with a 0.9% drop in the amount exported. This negative correlation remains or increases when further controlling for the likelihood of exporting for specific subsample periods.

Additional estimations help to validate these findings. We observe a similar negative relation between minimum wages and the decision to export when using a quasi-experimental approach, which exploits significant variations in local minimum wages from 2006 to 2007 between adjacent cities in Fujian and Guangdong provinces. Similar results are also obtained when using detailed customs-level transaction data from 2004 to 2006. We further find differentiated impacts across firms with varying wage levels and capital-labor ratios and across time. Rises in the minimum wage seem to have a stronger negative effect on low-wage and labor-intensive firms. In terms of variations across time, the effect of minimum wages on both the likelihood and amount of exports decreased until 2002–2003 but have then showed an upward trend.

In sum, the results suggest that Chinese exports and comparative advantage in international markets are affected to some extent by higher labor costs and harsher local labor regulations measured through raises in minimum wage standards. It is important to remark, however, that minimum wages not only may vary local labor conditions but can also reflect changes in these conditions, which drive firms' export behavior. We control for prior variations in different local market indicators, but changes in minimum wages may respond to multiple factors. Even in the absence of minimum wages, the tightening of local labor markets in a context of heterogeneous firm productivity and segmented labor markets, may still induce firms to export less, particularly the less productive ones. Similarly, the degree of the correlation between minimum wages and firm export behavior can be affected by a series of factors, including changes in labor productivity driven by variations in human capital and capital investment, wages already increasing at a higher rate than minimum wages, changes in the supply-chain processes and in the composition of exports, among others. Disentangling these factors, however, is beyond the scope of this study. Note also that labor costs in China still represent a small fraction of the output price, particularly among multinational firms operating in the country. Future research should continue examining the export behavior of Chinese enterprises in the face of rising wages, tighter labor markets and harsher labor regulations.

## Appendix A.


**Fig. A.1.** Monthly minimum wage and annual growth rate of net exports in Guangdong Province.
Source: Local government website and statistical bulletin of Guangdong Province.


**Fig. A.2.** Selected cities in Fujian and Guangdong Provinces.

**Table A.1**
Determinants of city minimum wages.

| Coefficient | Linear model | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| *Dependent variable: log minimum wage* | | | |
| Lag per capita GDP growth | 0.0391*** | 0.0391*** | 0.0389*** |
| | [0.0132] | [0.0131] | [0.0132] |
| Lag population growth | 0.0221 | 0.0221 | 0.0185 |
| | [0.0145] | [0.0146] | [0.0153] |
| Lag log average wage | | 0.0004 | −0.0003 |
| | | [0.0241] | [0.0242] |
| Lag employment growth | | | 0.0109 |
| | | | [0.0100] |
| Constant | 5.5983*** | 5.5946*** | 5.6028*** |
| | [0.0072] | [0.2160] | [0.2169] |
| City fixed effects | Yes | Yes | Yes |
| Time fixed effects | Yes | Yes | Yes |
| # observations | 2150 | 2150 | 2150 |
| Cities | 274 | 274 | 274 |
| Within R-square | 0.8163 | 0.8163 | 0.8164 |
| Between R-square | 0.0075 | 0.0080 | 0.0069 |
| Overall R-square | 0.4995 | 0.4999 | 0.4992 |

Note: Robust standard errors reported in brackets, clustered at the city level. *** denotes statistical significance at a 1% level.

**Table A.2**
Average firm wage regressions.

| Coefficient | Linear model |
|---|---|
| | (1) |
| *Dependent variable: log of average firm wages* | |
| Log of minimum wage | 0.0246*** |
| | [0.0068] |
| Lag log assets | 0.0208*** |
| | [0.0017] |
| Lag log employees | 0.0156*** |
| | [0.0020] |
| Lag balance ratio | −0.0004** |
| | [0.0002] |
| Lag inventory ratio | −0.0772*** |
| | [0.0038] |
| Lag profit per output | 0.1193*** |
| | [0.0078] |
| Domestic firm | −0.0236*** |
| | [0.0069] |
| State-owned holding | −0.0024 |
| | [0.0045] |
| Log of city GDP | 0.0262*** |
| | [0.0045] |
| Log of city population | −0.0212*** |
| | [0.0038] |
| Log of city average annual wages | 0.0522*** |
| | [0.0057] |
| Constant | −4.0829*** |
| | [0.0651] |
| Minimum-wage controls | Yes |
| Firm fixed effects | Yes |
| Time fixed effects | Yes |
| # observations | 1,261,590 |
| Log likelihood | −515,038 |

Note: Robust standard errors reported in brackets, clustered at the city level. ***, ** denote statistical significance at a 1% and 5% level.

**Table A.3**
Minimum wages of cities in Fujian and Guangdong Province, 2006–2007.
Source: Local government websites, statistical bulletins and labor and civil reports of Fujian and Guangdong provinces.

| | Cities | 2006 wage (Yuan) | 2007 wage (Yuan) | Growth rate |
|---|---|---|---|---|
| Fujian Province | Nanping, Longyan, Sanming, Ningde | 480 | 570 | 19% |
| | Xiamen | 650 | 750 | 15% |
| | Quanzhou | 600 | 650 | 8% |
| | Zhangzhou, Putian | 550 | 650 | 18% |
| | Fuzhou | 570 | 650 | 14% |
| Guangdong Province | Dongguan, Zhongshan, Foshan, Zhuhai | 690 | 690 | 0% |
| | Guangzhou | 780 | 780 | 0% |
| | Jiangmen, Shantou, Huizhou | 600 | 600 | 0% |
| | Shenzhen | 810 | 850 | 5% |
| | Zhaoqing, Maoming, Yangjiang, Shaoguan, Zhanjiang, Qingyuan, Chaozhou, Heyuan, Shanwei, Meizhou, Yunfu, Jieyang | 500 | 500 | 0% |

**Table A.4**
Economic indicators of cities in Fujian and Guangdong Province selected as treatment and control groups, 2006.
Source: 2006 economic and statistical releases for each city (National Bureau of Statistics of China). The values for Guangdong Province are the corresponding averages for the three cities considered.

| Variable | Fujian Province | Guangdong Province |
|---|---|---|
| | Zhangzhou | Chaozhou, Shantou & Jieyang |
| GDP (100 million Yuan) | 714.93 | 525.73 |
| Population (10 thousand) | 472.00 | 437.86 |
| GDP per capita (Yuan) | 15,147 | 12,010 |
| Share of primary industry (%) | 0.23 | 0.13 |
| Share of secondary industry (%) | 0.43 | 0.53 |
| Share of tertiary industry (%) | 0.34 | 0.37 |
| Export (100 million U.S. dollars) | 29.80 | 22.44 |
| Share of exports over GDP (%) | 34.76 | 35.60 |
| Import (100 million U.S. dollars) | 12.80 | 9.03 |
| Share of imports over GDP (%) | 14.88 | 14.32 |

**Table A.5**
Export behavior regressions using customs data from 2004 to 2006.

| Coefficient | Linear model | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | Log of price of single export | Log of volume of single export | Log of value of single export | Log of monthly value of exports |
| Average log of minimum wage coefficient | 0.085*** | −0.110*** | −0.038* | −0.095*** |
| Standard deviation of coefficient | 0.016 | 0.026 | 0.024 | |
| Average standard error | [0.0018] | [0.027] | [0.023] | [0.014] |
| Firm-level variables | Yes | Yes | Yes | Yes |
| City-level variables | Yes | Yes | Yes | Yes |
| Minimum-wage controls | Yes | Yes | Yes | Yes |
| Firm fixed effects | Yes | Yes | Yes | Yes |
| Time fixed effects | Yes | Yes | Yes | Yes |
| Product fixed effects | No | No | No | Yes |
| # observations | 2,117,539 | 2,125,452 | 2,130,273 | 2,130,273 |

Note: Robust standard errors reported in brackets, clustered at the city level. ***, * denote statistical significance at a 1% and 10% level. Results of columns (1)–(3) based on 100 sampling loops of single commodities defined using 4 digits of the Harmonized System (HS) code. The firm and city variables used in the regressions include if the enterprise imports, log of value of imports, number of types of exported goods, number of destinations (countries) of exports, frequency of monthly exports, share of exports over total trade, proportion of processing trade over total exports and proportion of feeding processing trade over total exports, log of per capita GDP, log of population, log of average annual wages, lagged per capita GDP growth, lagged population growth, lagged average annual wages and lagged employment growth. The time fixed effects include both year and monthly dummies to account for seasonal effects. The product fixed effects correspond to dummy variables for the commodity type based on the 4-digits HS code.

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