# How do Firms React to Minimum Wage Changes?

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**Abstract**

This paper provides the first systematic study of how minimum wage policies in China affected firm employment over the 2001–06 period. Using a novel administrative dataset of minimum wage regulations across more than 2,800 counties matched with firm and household data, we find that minimum wage hikes have significantly *negative* effects on employment. We investigate the heterogeneous effect of the minimum wage on firm employment in terms of firm, industry, spatial characteristics, and labor market conditions. We show that employment falls more in response to minimum wage hikes in lower-wage firms with lower profit margins. The same is true for firms in labor-intensive industries and in labor markets with high mobility. Furthermore, a major reform in the minimum wage policy was conducted by the central government around 2004. We find that the response of firm employment growth to minimum wage hikes has become larger compared with the pre-reform period. Similar results hold for the numerous specifications and robustness checks with the attrition, implementation, and placebo tests.

*JEL* classifications: J24; J31; 014, F10, F14

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## 1 Introduction

The impact of minimum wages on employment is the subject of challenging debates among economists and policy makers. While traditional research tells us that an increase in the minimum wage reduces employment (Brown, 1999), substantial subsequent literature arrives at little consensus on its impact. Recent theoretical development introduces the possibility of a relationship between the minimum wage and firm employment in the context of bargaining and search models (Burdett and Mortensen, 1998; Acemoglu, 2001; Flinn, 2006), (dynamic) monopsony, and efficiency wage models (Lang and Kahn, 1998; Manning, 1995; Bhaskar, Manning, and To, 2002). The "New Minimum Wage Research" based on firm-level evidence also shows that employment responses are negligible or even positive (see: Katz and Krueger, 1992; Card and Krueger, 1994; and also the studies cited in Neumark and Wascher, 2008).

Our paper contributes to these ongoing debates by providing more reliable estimates of the employment elasticity with respect to minimum wage hikes. As China accounts for nearly 25 percent of the global labor force,[1] the rising cost of labor in China is a topic discussed worldwide. During the period 1992–2007, the average real wage in urban China increased by 202 percent (Ge and Yang, 2014).[2] Among labor market policy tools, the minimum wage policy in China has been considered to be a major force driving increases in wages and putting pressure on firms. As employment hinges on business performance, the minimum wage can raise the income of poorly paid workers, but in the process it causes some of them to lose their jobs. In this paper, we provide evidence of the effect of the minimum wage on employment dynamics by using a novel administrative dataset of minimum wages across more than 2,800 counties in China. At the county level, our paper benefits from the significant variation in minimum wages, in contrast to most policy studies at the provincial level or the prefectural level. Furthermore, the county minimum wage is more closely related to the market conditions of local economies and it is thus more closely related to individual behavior.

To the best of our knowledge, this is the first study to show the heterogeneous effect of minimum wages on employment using a comprehensive dataset that tracks firms and households across China. China's Annual Survey of Industrial Firms provides a representative sample of firm data in the manufacturing sector. For example, in 2004 this survey covered more than 90 percent of China's manufacturing output and 70 percent of its manufacturing employment (Brandt, Van Biesebroeck, and Zhang, 2012). Considering its share in the national economy and employment, the manufacturing sector is of great significance in China's labor market, and therefore the major concerns about the rising labor cost in China have been related to this sector. The overall wage rate of China's manufacturing sector is also relatively low when compared to the average city wage, which makes this sector a pertinent target for policy debates on the minimum wage. The firm data enable us to explore how heterogeneous firms show different responses to minimum wage changes. As the composition of firms, in terms of ownership, size, and other characteristics, changes over time, the evidence of firm heterogeneity in their responses

[1] This share is calculated from the data source of World DataBank: http://databank.worldbank.org.

[2] In the period from 1998–2010, the average growth rate of real wages was 13.8 percent, exceeding the real GDP growth rate as well as the growth of labor productivity (Li, Li, Wu, and Xiong, 2012).

to minimum wage hikes can help us understand the employment dynamics in China.

We also provide evidence of the effectiveness of China's minimum wage policies. Previous studies have frequently documented the imperfect compliance with minimum wage laws. For instance, Ashenfelter and Smith (1979) find an overall compliance rate of only 65 percent, as well as significant geographic heterogeneity, across the various states in the United States. Based on empirical evidence from developing countries, Basu, Chau, and Kanbur (2010) argue that a legislated wage floor and the intensity of enforcement are two indispensable arms of a minimum wage policy. Correspondingly, we obtain evidence of minimum wage compliance from the firm data and the data of Urban Household Survey. In addition, we study a minimum wage policy reform that raised the non-compliance penalty starting in 2004 to test whether and how this new policy changed the impact of the minimum wage on employment.

This paper aims to fill the gap in the literature by dealing with unobservable bias associated with minimum wage policy and employment. The endogenous nature of government policies poses a challenge in measuring the impact of the minimum wage. Freeman (2010) argues that governments could set minimum wages while considering the risk that they can cause more harm than good. In this regard, governments must maintain a balance in order not to draw opposition from local employers. This stresses the necessity of exploring and controlling for observable factors of the minimum wage in the employment estimation, and of exploiting the sensitivity of additional control variables (Angrist and Krueger, 1999). Following the influential study of Sobel (1999), our results show that among various indicators of the local economy, the adjustment of minimum wages in China shares common trends with local living costs, the growth of GDP, and fixed asset investment (a proxy for future growth potential). After being detrended, few variables are still related to the minimum wage growth, except government idiosyncrasies represented by government official characteristics. However, even with the careful selection of appropriate controls, as Angrist and Pischke (2010) suggest, there is still a risk that bias will remain. Following Altonji, Elder, and Taber (2005) and the method recently developed by Oster (2013), we also conduct a careful test of the possible range of unbiased estimates from the selection on observables and unobservables.

We adopt an approach by matching county minimum wages with a hand-collected dataset of China's neighbor county pairs. The use of geographic proximity pioneered by Card and Krueger (1994) in minimum wage research is particularly helpful for studies of firms due to their relatively low mobility. To examine the treatment effect of the minimum wage policy, neighboring counties serve better as candidate control groups. Compared to neighboring provinces or prefectures, the difference in market conditions between treatment and control regions is substantially smaller, especially for labor supply factors, such as labor mobility in China's *Hukou* (household registration) system, which are crucial to our research.

Our first finding is that the employment elasticity with respect to the minimum wage is generally negative. The homogeneous elasticity on an annual basis, estimated from the sample with neighbor-pair fixed effect controls, is $-0.11$, statistically significantly from zero. This impact of the minimum wage is of economic significance considering that our sample includes almost all manufacturing firms and because the underlying labor force is vast.

We also find that firms exhibit significant heterogeneity in their employment responses to minimum wage changes in terms of their characteristics like wages, ownership, and profit margins. In particular, if a firm doubles its wage payments, its employment elasticity with respect to minimum wage hikes reduces by 0.077, both being economically and statistically significant. Firms in different industries also exhibit heterogeneous employment elasticities with respect to the minimum wage. We find that firms in more labor-intensive industries tend to have more negative elasticities. We investigate heterogeneity in terms of labor market conditions. Two proxies for the degree of local market competitiveness between employers and workers are used: a concentration measure of low-wage firm employment and an index of labor mobility. We do not find a significant difference in the estimates due to labor market concentration. By contrast, if workers are more mobile and more inclined to migrate, minimum wage hikes have a larger negative impact on firm employment growth.

To verify the channel that minimum wage hikes have an impact on firm employment, we estimate the effect of the minimum wage on firm wages and we find that it is significantly above zero throughout the whole period. Our analysis of the spillover effect across counties shows that if counties coordinate, in the sense that neighboring counties adjust their minimum wages with the same growth rate for each county, the employment elasticity is reduced by 44 percent. This suggests that labor flow across regions should play an important role in minimum wage policy adjustment, and it justifies the hierarchical and cooperative style of minimum wage policies in China.

Among the minimum wage research, our analysis has relevance to the recent debate on the estimation design that uses regional controls and policy discontinuities to control for "spatial heterogeneity". The studies that support this design include that by Allegretto, Dube, and Reich (2011) which considers time-specific fixed effects of census divisions and state-specific linear trends, and those by Dube, Lester, and Reich (2010, 2015) and Allegretto, Dube, Reich, and Zipperer (2013) which study employment stocks and flows with controls for time-specific fixed effects of neighbor county pairs crossing a state border. The studies that rebut this design include those by Neumark, Salas, and Wascher (2014a,b) who argue that synthetic controls for treatment counties may not comprise proximate regions. China's minimum wages vary across counties and are adjusted at the high frequency of one or two years. Our research subject is a large set of countrywide manufacturing firms, rather than a single treatment region. Therefore, our regression-based empirical strategy takes into account the matching based upon the explanatory variables for each county. The introduction of the time-specific fixed effect of neighbor pairs is effectively aimed at controlling for unobservable factors that lead to the endogeneity of minimum wages.

Several recent studies examining the effects of the minimum wage policy in China focus on individual employment from the data obtained from household surveys, but they mostly ignore the endogenous nature of minimum wage setting. Wang and Gunderson (2011) show that the minimum wage has negative employment effects in regions with slower growth, and even greater negative effects for non-state enterprises. Fang and Lin (2013) find that minimum wage increases have resulted in employment reduction for females, young adults, and less-skilled

workers. We instead introduce a county-level dataset of detailed monthly minimum wages across all 31 provinces in China matched with representative firm-level data.[3] Moreover, we take the endogeneity of minimum wage policy, firm characteristics, and macro conditions seriously by implementing a battery of empirical tests and specifications. Importantly, besides the average effects discussed in the literature, we also emphasize the heterogeneous effects across firms, and the potential explanation linked with local market competition and the institutional features of China.

The remainder of our paper is structured as follows. We discuss China's minimum wage policy in the next section. In Section 3, we present the sources of the data, and some descriptive statistics for the dynamics of minimum wages and the wages in the manufacturing sector. We demonstrate our empirical framework for minimum wage factors and firm employment estimation in Section 4. In Section 5, we show the results concerning the homogeneous and heterogeneous effects of minimum wage hikes. In Section 6, we conduct various robustness checks. Section 7 concludes.

## 2 Institutional Background: Minimum Wages in China

In early 1984, during the early phase of its economic reform, China approved the International Labor Organization's (ILO) *Minimum Wage-Fixing Machinery Convention* (1928). In July 1994 the Labor Law stated a requirement to implement a system of guaranteed minimum wages. According to Article 48 of the Labor Law, firms were specifically required to comply with local minimum wage policies. Provincial governments were authorized to set their own minimum wage standards. The levels of minimum wages were not universally the same within a province, in that cities and counties could negotiate their local minimum wages with the higher authorities (Casale and Zhu, 2013). As a common style of China's polices, the minimum wage policy is implemented mainly by local government and the higher authorities may take heed of the enforcement. Before 2003, the adjustment of minimum wages was less frequent than in subsequent years. In 1998, during the Asian financial crisis, only one-fifth of all counties adjusted their minimum wages.

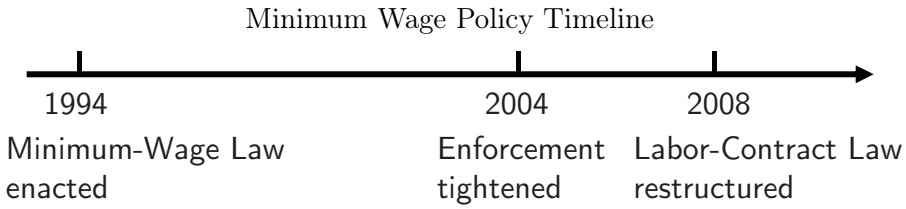
As China had advanced in its market reforms when it joined the WTO in 2001, the framework of minimum wage policies had become outdated and it therefore was in need of change. In March 2004, the MHS[4] issued a new policy that established a more comprehensive coverage of minimum wage standards and increased the non-compliance penalties. This new phase of minimum wage reform in 2004 made the process of minimum wage adjustment more formal and more regular. In particular, this reform emphasized the following major changes: (1) an explicit extension of coverage to town-village enterprises and self-employed businesses; (2) a new standard for hourly minimum wages; (3) an increase in the penalty for violators from 20–100% to 100–500% of the

[3]After our work was first circulated and presented (Huang, Loungani, and Wang, 2013, 2014a,b), Poncet, Mayneris, and Zhang (2014) and Xing and Xu (2014) followed our panel estimation approach but used city-level minimum wage information. However, their IV approach incorrectly treats the minimum wage as a predetermined variable and the contemporaneous city wage as an exogenous variable. Because they ignore the endogeneity of firm characteristics and the serial correlation of the disturbance in their estimation, their estimators are susceptible to inconsistent results.

[4]The Ministry of Labor was renamed the Ministry of Labor and Social Security in 1998, and the Ministry of Human Resources and Social Security in 2008, which we refer to as the MHS.

wage owed; and (4) more frequent minimum-wage adjustment (at least once every two years). The new policy states that local departments of labor exercise supervision within the scope of each hierarchical administration. Although little is explicit about the intensity of enforcement, like how and how often local departments of labor should actively inspect the compliance with the minimum wage policy, Su and Wang (2014) state that after the new policy was implemented, supervision at the local level has been intensified and that the enforcement has been more effective.

Local governments may have enacted the new policy with delays from several months to more than a year. Therefore, the new policy was not completely implemented in the whole country initially in 2004. Seven provinces did not adjust minimum wages in 2004, and, based on our records, four of them (Henan, Hunan, Shaanxi, and Tibet) enacted provincial policies in the following years. Nonetheless, the central government pushed hard for this reform. In April 2005, the MHS issued a decree that urged those who did not raise minimum wages by the end of 2004 to conform to the rule. Furthermore, the MHS emphasized again that it is a top priority to protect the legal rights of workers by implementing the new minimum wage policy. By the end of 2005, with only the exception of Tibet, all provinces had adjusted their minimum wage levels at least once since 2004. Following the transition year of 2004, 2005 was really the year when the post-reform era started.




When the global financial crisis hit China in 2008, the MHS provided policy guidelines that allowed for a delay in minimum wage adjustment. Meanwhile, the new Labor Contract Law enacted in 2008 established the importance of minimum wage policies, and thereafter the minimum wage became one of the key components of China's labor market policies. The above timeline depicts the evolution of China's minimum wage policies over time.

## 3 Data and Descriptions

Our empirical estimation focuses on the effect of minimum wages on firm employment. We match a dataset of China's manufacturing firms with local minimum wages at the county level, as well as with other regional data on economic conditions. A detailed description of how we construct our sample can be found in the Online Appendix. Here, we briefly introduce our data sources and the criteria of sample construction.

### 3.1 Minimum Wages

Our minimum wage data are provided by the MHS and the China Academy of Labor and Social Security. The data span ranges from 1992 to 2012, covering our sample of manufacturing firms. This dataset contains detailed information on all the adjustments of minimum wages at the

county level.[5] To match minimum wages with the annual firm data, we calculate the monthly aggregated minimum wage for every year, based on the dates of minimum wage adjustment, which we refer to as the annual minimum wage.

To the best of our knowledge, this is one of the first papers to study this dataset. Other than minimum wages, empirical research on China's policies rarely finds a target for which a complete panel at the county level can be acquired. A Chinese county (*xian*) is a division administered by a prefectural city (*shi*), which is in turn administered by a province (*sheng*).[6] Counties, prefectural cities, and provinces represent the top three levels of China's administrative divisions. The size of a typical county in China is one-tenth of the size of a prefectural city.[7] Using more disaggregated policy data not only enlarges the variation of minimum wages in the estimation, but it also improves identification by allowing county-wise comparisons.

### Geographic and Time Variation

Figure I shows the geographic variation of China's minimum wages over the period 2001–06. Each county on the map is grouped into four quartiles measured at the national level according to their monthly minimum wages. Darker color represents higher quartile of minimum wages. The spatial distribution is clearly not stable throughout this period. For instance, the major origin of counties at the top level of minimum wages changed from the Pearl River Delta to the Yangtze River Delta during this period. In addition, regions populated with ethnic minorities, for example, Tibet and Xinjiang, have relatively higher minimum wage standards than regions with similar levels of economic development.

Figure II shows the geographic variation of annual growth rates of county minimum wages over the period. Similarly, counties are grouped into four quartiles according to their growth rates relative to the national level. It is noticeable that some provinces uniformly raised local minimum wages in a year at a high rate, such as Sichuan in 2003 and Gansu in 2004, because, as we will discuss, minimum wage adjustment is led mainly by the provincial government. We also find that there is no local government that always kept minimum wages growing at a high rate. Minimum wages can be adjusted at a frequency longer than one year, so it is reasonable

[5] Minimum wages are specified in the forms of monthly wages, part-time hourly wages, and full-time hourly wages. Hiring in the manufacturing sector usually involves relatively long and stable employment contracts compared with the service sector. We choose to use full-time minimum wages in our estimation due to the relevance of monthly wages to the manufacturing sector. The other reason is that most counties merely set full-time hourly minimum wages based on monthly minimum wages divided by a factor of around 167.36 ($20.92 \times 8$), presumably the typical number of working hours in a month (on average 20.92 working days a month and eight working hours a day). The hourly minimum wage for full-time workers is thus practically the same measures as the monthly minimum wage.

[6] As of 2007, there were 2,867 counties, 333 cities, and 31 provinces in mainland China. (See http://www.stats.gov.cn/tjsj/tjbz/xzqhdm/200802/t20080215_38311.html.)

[7] County areas vary in China. For counties where more than a few manufacturing firms are located, a typical county has an area between 20 and 2000 square kilometers. For reference, the area of Hong Kong is 1,104 square kilometers. Therefore, adjacent counties are more ideal comparison groups than adjacent cities if we want to control for time-varying unobservables. The data show that 22 percent of cities have uniform levels of minimum wages for their counties and sub-districts, like Beijing; however, the other 78 percent have within-variation in minimum wages. Figure III shows the spatial distribution of cities according to variations in their county minimum wages. Minimum wages are invariant within a city if the city's minimum wages are same as those among its counties, and *vice versa*. We find that those cities with uniform minimum wages are concentrated in several provinces, especially two western provinces with low population density, namely, Tibet and Qinghai, and two northeastern provinces, namely, Heilongjiang and Jilin.

to see that the spatial distribution of minimum wage growth changes over time.

Figure IV shows the trend of median monthly minimum wages and median employee wages for all counties nationwide over the period 1995–2011. Both wages rose rapidly during this period, one which witnessed China's fast growth. When we examine the ratio between these two wages, it appears that the ratio was actually declining in most years during this period. Evidently, the ratio fell from 0.37 in 2000 to 0.25 in 2010. This may not simply indicate that citizen welfare has been less taken care of. Since official statistics of employee wages are measured by average wages, instead of individual wages at a certain quantile to represent the low-wage workers who are most likely to be affected by the minimum wage, enlarging wage inequalities can also be a reason for this pattern. Figure V shows the trends of both nominal and real minimum wages.

#### Adjustment Frequency and Adjustment Range

Figure VI shows the variation of adjustment frequencies for county minimum wages. The proportion of counties that adjusted minimum wages in each year varied from 40 percent to 80 percent before 2006. Most counties adjusted minimum wages on an annual basis after 2006, except in 2009 when the global financial crisis made an impact in China. Minimum wage hikes also exhibited noticeable variations. Some counties changed their minimum wage levels after a considerably long pause. In general, a large part of minimum wage hikes were lower than 20 percent, although some much higher hikes occasionally occured.

### 3.2 Firm Data

Our firm data are mainly from the Annual Survey of Industrial Firms (ASIF), also known as the Chinese Industrial Enterprise Database (CIED). According to this survey, "large-scale" industrial firms file detailed reports every year to their local Bureau of Statistics. The National Bureau of Statistics (NBS) then aggregates the data to produce key statistics for industrial output, such as those in the China Statistical Yearbook. Our main sample spans the period 2001–06 and it contains exactly the same number of observations used by NBS during these years.[8]

The ASIF data contain each firm's end-of-year balance sheet as well as information on input and output[9]. The data also show a firm's average number of employees over a year and its annual wage bills. Although we cannot identify the number of firm employees being paid below the level of the minimum wage, we are able to calculate each firm's average wage per employee, which can arguably be used as an indicator of a firm's exposure to minimum wage shocks.

The 2004 economic census is merged into the ASIF data, since the ASIF data undersampled

[8]In general, compared with the first economic census in 2004, this 2004 survey includes 20 percent of industrial firms, but covers 91 percent of China's industrial output and 71 percent of China's industrial employment. As reported by the 2004 economic census, total employment in China's manufacturing sector amounts to 93.4 million. The 2008 survey is not included in our sample. For reference, compared with the second economic census in 2008, the 2008 survey includes 22 percent of industrial firms, but covers 88 percent of China's industrial sales and 72 percent of its industrial employment.

[9]Each observation represents a firm, a legal person (entity) which independently enjoys civil rights and assumes civil obligations in accordance with China's law. Subsidiary firms which are legal persons file reports separately to their local Bureaus. A firm may have multiple plants which are not legal persons. The data show that more than 95 percent of the manufacturing firms in the sample are single-plant firms.

small firms in 2004 relative to other years.[10] After the construction of a panel sample for the firms in the manufacturing sector, we have in total 2,124,563 observations in the unbalanced panel in the main sample. The attrition rate in the sample varies from 8.2 percent to 20.3 percent.. Since the rate of re-entry[11] is around 10 percent over time, it is likely that a significant number of firms left the sample not because they went out of business but because of sampling omissions. To evaluate the 2004 reform of the minimum wage policy, the period 2001–2006 which we analyze spans both the pre-reform era and the post-reform era. We exclude the data after 2006 from our main sample due to the anticipation and implementation effect that could arise from the Labor Contract Law enacted in 2008.

Our main reason for choosing the manufacturing sector, instead of the service sector,[12] for the study of minimum wages is that this sector is of great significance in China's labor market. Due to local government policies, the service sector has usually discriminated against migrant workers more than has the manufacturing sector. Also, the overall wage rate of China's manufacturing sector is relatively low. Our sample shows that the wage rate of China's manufacturing sector was always below city average wages over the sample period.[13] Ge and Yang (2014) also show that the average real wage of the manufacturing sector is 2 percent below that of the whole sample in 2007 using countywide data from the Urban Household Survey. Finally, the choice of the manufacturing sector is also consistent with the vast literature studying the ASIF data; this means that our results can be easily compared.

### 3.3 Household Data and the Non-Compliance Rate

To show how binding the minimum wage policy is, we calculate two measures of minimum wage exposures. Figure VII reports the average non-compliance rate for the minimum wage policy based on a representative sample of employee wages from the Urban Household Survey. The non-compliance rate is calculated by the share of the employees with wages lower than their county minimum wages. Our data cover 18 provinces during the period 2002–06. Employers and employees from small businesses that are not legal entities are excluded. The sample also excludes those who worked for less than 140 hours or more than 200 hours in the month (December) when they are surveyed. We find that the non-compliance rate is in the range of between 6 percent to 8 percent, and the trend is also mostly flat during the reform period. The wage-to-minimum-wage ratio is below 1 for a non-compliance incident. When the trend of non-compliance rates is

[10] In this paper, firm ownership is categorized as state, collective, private, or foreign if it is explicitly defined in the dataset, otherwise it is attributed to the stockholder using the share of paid-in capital. We also follow the standard definition of a foreign firm in China, which requires no more than 25 percent of stock shares to be controlled by foreigners. In principle, firms in the survey before 2007 should include all the firms in the mining, manufacturing, and utility sectors, with annual sales more than five million Yuan. We refer to firms with annual sales above five million Yuan as "large firms", and other firms as "small firms". As a consequence, the sampling of the ASIF data is by design biased towards large firms. With regard to small firms, the reality is that the data still contain some small, non-state firms, and for small firms, the sampling bias is towards state firms. For more details, please see the Online Appendix.

[11] The rate of re-entry is calculated by the ratio of re-entrants to total entrants for every year.

[12] For example, restaurants are chosen as the typical industry in major studies by Katz and Krueger (1992).

[13] The wage rate of China's manufacturing sector is calculated by the median of firm average wages over the county. City average wages are denoted by the median of city average wages over those of the county. At the national level, the ratio between them was 65 percent in 2004, and it remained stable over the period of 2001–07. We can also examine the gap between them at the city level. In 2004, the wages of manufacturing firms were below city average wages in 96 percent of cities.

compared with the fractions of the group with the wage-to-minimum-wage ratio falling within the range of $[1, 1.5]$, we find that these two trends after 2002 are similar, which shows that the reform which started in 2004 did not change minimum wage non-compliance. By using the ASIF firm data, Figure VIII shows that there are a non-negligible number of firms paying average employee wages lower than the minimum wage. The proportion of these firms was above 7 percent in 2002 and below 2 percent in 2004 and 2006. This does not necessarily mean that these firms are non-compliant with the legislation, because the measure of firm wages is based on the average wage, better interpreted as minimum wage exposure. We find that the data of firm wage bills in the ASIF data have greater measurement errors than firm employment because employee wages are easily confused with the corresponding accounting subjects with similar names. Other than this, one well-known issue of the ASIF data is that the information of employee earnings omits substantial fringe benefits and the social security contributions paid by employers (Hsieh and Klenow, 2009; Song, Storesletten, and Zilibotti, 2011). Therefore, employee earnings are systematically under-reported if they are compared with other market wage measures such as the minimum wage, and the statistics of non-compliance based on firms' employee wages should be regarded with caution.

### 3.4 Firm Wage Dynamics

Because the growth of China's minimum wages has been behind the growth of average wages, how does it compare to the growth of firm wages in the manufacturing industry? Figure IX gives the answer with descriptive statistics. It shows the annual density distributions of firm wages relative to local minimum wages during the period 2001–06. As we can clearly see, a turning point happened in 2004 for these annual distributions. After 2004, firm relative wages became higher. The thinner left tails after 2004 are pronounced, which indicates that the proportion of low-wage firms relative to local minimum wages became smaller.

### 3.5 Macroeconomic and Political Factors

Economic variables at the city and provincial level[14] are collected to control for the factors of minimum wage policies and the market factors affecting firm employment. The major source of city variables is the China Statistical Yearbook Database from CNKI.[15] Our city database contains a panel of 337 cities[16] over the period 1990–2012, with interpolation for some missing values in early years. This annual dataset can therefore completely match the sample of manufacturing firms.[17] For political considerations at the city level, we supplement the characteristics of city chiefs, which include their ages and tenure years, to our data.

[14] Other than minimum wages, we do not have complete panel data of economic variables at the county level. Some variables, such as the consumer price index, can be observed only at the provincial level.

[15] China National Knowledge Infrastructure, www.cnki.net

[16] These 337 cities include four municipalities controlled by the central government as well as the 333 prefectural cities. Directly controlled municipalities are administered at the highest level, and are much larger in terms of their economic size, but their area size is similar to that of prefectural cities.

[17] Occasionally cities and counties were divided up and/or combined into other regions. This divisional restructuring occurred more frequently in the 1990s and much less after 2003. We collect the corresponding information, and adjust the city and county code for all the affected firms. Because the adjustments to minimum wages should take into account all regional conditions, no county should have experienced a hike in minimum wages due to the change of its administrative division. This fact is confirmed in the data.

### 3.6 Geography and Neighbor Counties

Our analysis uses a dataset of neighbor county pairs in 2007. Two counties are defined as neighbors if (1) they share same land, rivers, or coastal waters border and (2) the distance between their centroids is no more than 100 kilometers. The median number of county neighbors in the dataset is six. Neighbor counties can still differ in many economic conditions, but because of their geographic adjacency, we are more inclined to assume neighbor counties may experience several similar growth factors, including unobservable shocks in the labor market.

#### Difference in Minimum Wage Hikes between Neighboring Counties

China's minimum wage hikes differ across regions, which can be found both across provinces and within provinces. Figure X shows that for most years, about half of the neighboring counties had different minimum wage hikes. Although most of these hike differences existed between neighboring counties across the province border, there were still roughly 20 percent of neighboring county pairs within province that experienced hike differences in minimum wages.

## 4 Identification and Empirical Framework

To identify exogenous shocks of the minimum wage, firstly, we need to control for economic factors of the minimum wage. Since the late 1990s, the adjustment of local minimum wages has been a regular policy decision led by the provincial government, and it also involves considerations and negotiations of the city and county governments. The data show that the ratio of the minimum wage to the local average wage is in the range of $[0.2, 0.5]$ throughout this time. Thus, the rise of the minimum wage is often a concerted movement with other factors, rather than an exogenous shock which we need to study. In general, when choosing a new minimum wage, government officials face a trade-off. On the one hand, the government has an incentive to freeze or slow down the adjustment in the minimum wage in order to avert labor cost hikes and a private investment squeeze, which will otherwise ultimately lead to employment reductions. On the other hand, concerns about social stability and citizen welfare motivate the government to improve labor market policies. This implies that we must account for both welfare and growth imperatives in the setting of local minimum wages. We will first estimate the relationship between county minimum wages and their accounting factors in section 4.1.

Secondly, we aim to improve the quality of the identification by using dynamic panel estimations; this is because past firm employment contains most information about a firm's employment specificity. Furthermore, if labor adjustment is sluggish at the annual level, contemporaneous hiring shocks affect future employment, which renders the assumption of strict exogeneity commonly used in panel estimation invalid. If we choose the weaker assumption of sequential exogeneity that regressors are uncorrelated with future shocks, we can apply the method of difference GMM[18] to acquire consistent estimates with efficiency. By including a lagged dependent variable as one explanatory variable, the estimated elasticity can also be interpreted as the re-

[18]Main literature includes Arellano and Bond (1991), Arellano and Bover (1995), Blundell and Bond (1998), and Windmeijer (2005). We use the routine developed by Roodman (2009) to implement the estimation.

sponse of employment growth, which is emphasized by recent studies (Meer and West, 2013). To answer the question of how to select the appropriate controls and how stable our estimation is due to different control specifications, we employ Oster (2013)'s recent findings on unobservable selection to test the sensitivity of our controls in a regression with pooled OLS.

Thirdly, we emphasize explicitly common trends within a certain geographic area. The panel estimation still cannot capture unobservable time trends that are correlated with both the dependent variable and independent variables, including the minimum wage. The coordinated adjustment of minimum wages at the province level indicates that the consideration of time-varying factors within a province is of great importance. One the one hand, the size of a typical province in China is somewhat large, to the extent that only a limited amount of trends can be captured. On the other hand, to study within-city variations is not feasible because most of our macroeconomic controls are at city level. Instead, we develop an estimation framework that examines the variations within a region of neighboring county pair, which is restricted to be inside a province, but not necessarily inside a city. Consequently, the area size of a neighboring county pair is small enough for us to assume that its labor market is largely integrated and that its neighboring counties share many common trends. Meanwhile, sufficient variation of minimum wage changes can still be identified because neighboring counties can be located in the same city, and they can also straddle the city border. Card and Krueger (1994) pioneered this use of geographic proximity in minimum wage analysis. Correspondingly, a common strategy on studying US minimum wage policy is to control for state-by-year fixed effects. Our approach of including the fixed effect of neighboring counties is similar to that of Dube, Lester, and Reich (2010), who study US border counties.

### 4.1 Minimum Wage Accounting

Local governments do not have a specific function hard-coded to calculate the adjustment needed for the next period.[19] We attempt to capture their welfare and growth considerations with local macroeconomic variables and estimate the relationship in a linear model. The first source of minimum wage factors is aggregate measures of local labor income. We use city average wages from statistical yearbooks and county manufacturing wages derived from the ASIF data. The second source relates to the prospects for economic growth in the local area. We choose fixed asset investment to represent this expectation, which is often adopted by local governments as one of the main drivers to boost the economy. If growth concerns play a role, this variable should show a positive relationship with minimum wage adjustment. The third source includes industrial policies that balance economic growth. We include output shares of secondary and tertiary industries to address how government weighs the importance of the manufacturing sector. The fourth source of the factors we control for is labor market conditions, represented by the lagged growth rate of the labor force and the unemployment rate for this. We account

[19] As documented literally in the law, minimum wage adjustment should take into account the following policy variables:

$$MW = f(C, S, A, U, E, a),$$

where $C$ is the average level of consumption, $S$ is social security, $A$ is the local average wage, $U$ is the unemployment rate, $E$ is the general condition of local economy, and $a$ refers to other factors. This requirement can be interpreted as general guidance for local governments.

for employment growth both at the city level for total employment, and at the county level for manufacturing employment.

The estimation covers the period 2001–06, and the sample contains more than 2,400 counties. Minimum wages grow along with local average wages over time, as shown in Figure IV.[20] Furthermore, many of the macroeconomic variables which we use to account for the minimum wage adjustment are pre-determined but not exogenous in the model, in the sense that contemporaneous disturbance is correlated with future explanatory variables. We use difference GMM to estimate a dynamic model of minimum wages. As a result, difference variables are stationary and sufficient instruments can be found internally.

The estimation equation is standard as follows:

$$MW_{ct} = \alpha + \beta_1 MW_{c,t-1} + X_{ct}\beta + \mu_c + \tau_t + \varepsilon_{ct},$$

where $MW_{ct}$ denotes the log of the minimum wage[21] in county $c$ at year $t$. $\mu_c$ is county $c$'s fixed effect, and $\tau_t$ represents year fixed effects. $\varepsilon_{ct}$ is the error term that satisfies the assumption of sequential exogeneity. Minimum wage factors in $X_{ct}$ are all lagged by one year and assumed to be pre-determined. This is equivalent to assuming that the minimum wage does not respond contemporaneously to other macroeconomic shocks. Lagged firm employment from two years to four years is used to form GMM-style instruments.

Table I presents summary statistics for minimum wages and city variables over the period 2001–06. We find that the median of minimum wages was around one-third of the median of city wages per employee. Furthermore, the median of city wages per employee was one-quarter higher than the median of city GDP per capita. The growth of GDP per capita and FDI was high and it peaked in the run-up to the global financial crisis in 2008. The share of the tertiary industry was more or less stable, whereas the share of the secondary industry had been rising since 2001.

Table II shows how minimum wages adjust to policy variables,[22] in which estimates are shown in three columns from different specifications. The sample period is 2001–06. The difference between column 1 and the two other columns is whether or not to control for the province-by-year fixed effects. In column 3 we add two variables of city chief characteristics to capture the effect of political considerations.

One notable finding from the whole table is that the lagged minimum wage shows a strong explanatory power. City average wages, however, are negatively correlated with minimum wages although the correlation is statistically insignificant. After controlling for the province-by-year fixed effects, the relationship between city wages and minimum wages simply disappears. This is also the case for the county manufacturing wage. Growth of county employment, growth of city

[20]The estimation relies mainly on cross-sectional variation. Although unit root tests for individual counties often fail to reject the null hypothesis that the processes of minimum wages and local wages contain a unit root, by including a linear trend, unit root tests for panel datasets as in Harris and Tzavalis (1999) and Levin et al. (2002) strongly reject the null hypothesis.

[21]Local government may have different rules about whether to include fringe benefits in the minimum wage (Fang and Lin, 2013). When we consider within-county difference in the estimation, if this local consideration and the fraction of fringe benefits in employee wages do not change much over time, this issue has little impact on the estimation.

[22]From this point, the minimum wage refers to the annual minimum wage we defined above.

employment, and the unemployment rate, are three variables representing local labor markets, and their effects are mostly insignificant from zero. Similarly, we do not find the effect from the variables of fixed asset investment and output shares of the secondary and the tertiary industry. In short, after first-differencing and controlling for the province-by-year fixed effects, the change in county minimum wages is at most weakly correlated with other macroeconomic variables. Interestingly, the age of city chiefs shows a significantly positive effect on the minimum wage but the effect of their tenure is not significant. This might suggest that when the city chief is close to the age of retirement, not the time of post reassignment, government officials in the department of labor tend to raise the minimum wage faster. The introduction of political considerations captures certain motivations to adjust the minimum wage.

### 4.2 Minimum Wage Shocks

In general, our findings show that after detrending, the minimum wage variation is not closely related to other macroeconomic variables, in the dimension of either time series or the cross-section. Our regressions below, using the minimum wage as an explanatory variable, also include these macroeconomic variables, for which the coefficients are suppressed in the reporting tables. Intuitively, we use unexplained changes in the minimum wage as minimum wage shocks.

One source of minimum wage shocks is the unanticipated replacement of government officials in charge of minimum wage adjustment, which could lead to delays of adjustment and revisions of planned changes. The second possible cause is expectation errors of policy makers, especially for the government more concerned about the alignment of the minimum wage and the local economy in the future. The third cause of adjustment discontinuity is more common. A new schedule of minimum wage adjustment enacted by the provincial government usually includes a list of candidate levels for subordinate departments of labor to choose from. To raise a concrete example, a fast-growing county whose minimum wage was at the bottom tier of the province intends to move up the ladder of the list in order to keep the minimum wage in line with the local economy. However, the county must weigh two optional levels of monthly minimum wages, namely, RMB 500 and RMB 550. Although RMB 500 is thought to be low, the level of RMB 550 that the county ends up with may be too high according to this county's macroeconomic conditions. In this case, relative to other counties that remain in the same tier as in previous years, a minimum wage hike occurs in this county.

A real example from the municipality Chongqing is shown in Figure XI. There are 40 counties in Chongqing. In 2004, county minimum wages in Chongqing grew at a rate of 12, 17, or 18 percent. If we compare the growth rates of minimum wage hikes and the growth rates of GDP per capita, we cannot find a pattern that counties with high growth rates of GDP per capita also adjusted their minimum wages at a high rate. A significant amount of unexplained variations in minimum wage hikes are left for us to identify their impact on firm employment.

### 4.3 Neighbor County Pairs

The strategy of considering neighboring county pairs is analogous to the boundary discontinuity design. The idea is to use adjacent areas to control for common unobserved factors that change

over time in the neighborhood. County areas vary in China. A typical county that contains more than a few manufacturing firms will have an area of between 20 and 2,000 square kilometers. Therefore, commuting or migration across county borders incurs no large costs for workers. As Dube et al. (2010) argue, contiguous regions are more likely to have similar labor markets and employment trends. One problem arising from the application of this approach in China is that neighboring counties that cross provincial borders may not be good controls. The historical background of China's provincial borders is mainly related to economic and social integrity, which also implies cultural, dialectal, and institutional coherence. Labor markets across provincial borders can exhibit significant differences in this sense. Our strategy focuses on within-province county pairs, which can still differ in minimum wage changes, but are sufficiently similar.

Empirically, we include dummy variables of neighboring county pairs in the estimation. Because it is very likely that two neighbors will differ from their own neighboring counties, it is impossible to form closed neighbor groups. Using neighbor pairs allows us to cover all the counties completely. One county may be included in different county pairs. Therefore, we need to make repeated observations for those counties with more than one neighbor. For ease of computing, we retain counties with at least 5 manufacturing firms in the sample. As a result, we have 3,704 pairs left in the sample of a panel over the period 2001–06, while in total there are more than 10,000 county pairs in China. Unlike the typical method used by Holmes (1998), Huang (2008), and Dube et al. (2010), which include only the border segments separating counties with different policy treatment, our sample does not exclude neighboring counties with the same growth rates of minimum wages in order to circumvent the selection problem.

The recent debate between Allegretto et al. (2013) and Neumark et al. (2014a,b) on the research design of controlling for spatial heterogeneity has attracted wide attention. The synthetic control, which they use to evaluate the estimation method, is not well applicable in the analysis of China's minimum wage policy. China's minimum wages vary across counties and they have been adjusted at a frequency of one or two years. Regional and time variations of the minimum wage can be used to identify the minimum wage shocks in a standard framework of linear regressions. Counties that experience high minimum wage growth, while other factors being controlled for, are thus identified as treatment groups and those with low minimum wage growth are control groups. Controlling for the time specific fixed effects of neighbor pairs implies that within-pair variations are used in the regression, but this does not mean that neighbor counties are used as control groups. In fact, the aim of such controls is to address the existence of unobservable factors that lead to the endogeneity of minimum wage adjustment, rather than to specify the control groups. As we include the countrywide sample in the regression, control groups are themselves identified according to their within-pair minimum wage growth and their regional loadings (coefficients) of explanatory variables.

### 4.4 Empirical Model

Based on our panel sample, we apply a dynamic model with unobserved, time-invariant effects at the firm level. One of the main dependent variables is denoted by $L$, the logarithm of a firm's

employment over a year.[23] Following Arellano and Bond (1991), one-period lagged dependent variables are included as explanatory variables. This creates a dynamic bias that needs to be addressed. Hence, we estimate a first-difference model with GMM-style instruments as in the Arellano–Bond model (difference GMM).

We present the theoretical background relating to labor market competition and monopsony, and its implications for the minimum wage in the Main Appendix. The advantage of using firm employment over regional employment is that it is much easier and more precise to account for a firm's employment demand with the aid of firm data. Other than the minimum wage, other proxies of market wages, including market factors relevant to regional labor demand and labor supply are also controlled for in order for the model to better represent a firm's marginal cost of labor. In our theoretical framework, equation (3) leads to a linear function for $L_{it}$:

$$L_{it} = f\left(L_{i,t-1}, A_{it}, \left(\frac{\omega_{it}}{P_{it}}\right), \left(\frac{P_k}{P_{it}}\right), \left(\frac{P_m}{P_{it}}\right), \ldots\right),$$

where $i$ and $t$ denote firm and year respectively, $\omega$ denotes the marginal cost of labor, $P_k$ and $P_M$ are market prices of capital input and intermediate goods. Therefore, the corresponding estimation equation is

$$L_{it} = \alpha + \beta_l L_{i,t-1} + X_{it}\beta_i + X_{ct}\beta_c + \gamma MW_{ct} + \mu_i + \tau_t + \varepsilon_{it}, \tag{1}$$

where all variables are in logs, except the variables in the form of ratios. $L_{it}$ is the dependent variable, firm employment. $X_{it}$ then controls for firm $i$'s characteristics at year $t$, together with regional and industry conditions for firm $i$ denoted by $X_{ct}$. $MW_{ct}$ is the annual minimum wage in county $c$ at year $t$. $\mu_i$ is firm $i$'s fixed effect and $\tau_t$ represents year fixed effects. $\gamma$ measures the elasticity of minimum wages on firm employment, and it is the key parameter we estimate. $\varepsilon_{it}$ is the error term, which we assume satisfies the condition of sequential exogeneity with explanatory variables. Aside from lagged employment, other explanatory variables are mainly in the form of lags, which we expect will not correlate with contemporary disturbance $\varepsilon_{it}$. Because typical firm dynamics imply that current hiring shocks affect future explanatory variables, it is invalid to assume strict exogeneity that $\varepsilon_{it}$ is uncorrelated with explanatory variables at any period. As opposed to the fixed-effect method, first-differencing or other transformations, like "forward deviations" in Arellano and Bover (1995), allow variables in earlier periods to be used as instruments for the endogenous variables after differencing.

Our identification strategy further controls explicitly for common regional trends in the labor market that are likely to affect policy making in minimum wage adjustment. These trends in the labor market relate to economic and institutional factors that set the background to how the government regulates the market and how firms comply with the regulation. One standard method is to control for the province-by-year fixed effect. We also apply the neighbor-pair approach, by including the pair-by-year fixed effect in the model. As an extension of equation

[23] Logarithms of most of the explanatory variables, if they are not ratios, for instance, are also used, so their coefficients should be interpreted as elasticities.

(1), we pool these firms together and estimate the following equation:

$$L_{ipt} = \alpha + \beta_l L_{ip,t-1} + X_{it}\beta_i + X_{ct}\beta_c + \gamma MW_{ct} + \mu_i + \mu_p \times \tau_t + \varepsilon_{it}, \tag{2}$$

where $\mu_p$ denotes the fixed effect of county pairs $p$. $\mu_p = 1$ if firm $i$ is located in one of the counties in the county pair $p$. Intuitively, all the county pairs are stacked up together and $\gamma$ measures the average of treatment effects for these pairs. If there is only one neighbor pair in the sample, it reduces to the typical analysis of difference-in-difference for policy evaluation. Since there are more than three thousand county pairs in our main sample, we first demean each firm's variables, by subtracting the average values of their county pairs in every year from the firm observation. In this way, the term $\mu_p \times \tau_t$ is canceled out in the demeaned equations. Then, we apply difference GMM to estimate the equation. The loss of degree of freedom is adjusted in the calculation of estimated standard errors, which is equal to the number of neighbor pairs multiplied by the number of years in estimation.

The specification of boundary fixed effects is slightly different from Black (1999) and Bayer et al. (2007), who use boundary discontinuity to control for unobserved neighborhood housing quality. Their design includes a full set of boundary fixed effects as explanatory variables, whereas we assign the fixed effect of each boundary segment to one duplicated observation if a county has multiple neighbors.

When we analyze the heterogeneous effect of the minimum wage in terms of firm and industry characteristics, the interaction terms are added with the form of the products between these variables and $MW$.

### Variables Related to Firm Employment

The main dependent variable is firm employment. Explanatory variables are selected as proxies for the variables in our theoretical framework. A comprehensive list of all the variables in the estimation is shown in the Main Appendix. In the following we discuss the main variables, mostly from the side of firm labor demand.

*Firm employment*: $L_i$. This is reported as the average of a firm's end-of-month employees in a year.

*Firm wage*: $W_i$. We compute a firm's total wage bill as the sum of its reported wages, monetary allowances, and unemployment insurance. The average wage per employee is a firm's wage denominated by its annual employment. We define firm relative wages as the ratio of firm wages to local minimum wages.

*Marginal labor cost*: $\omega$. We do not observe the market price of labor input faced by each firm. The price of labor input in this paper is measured jointly by county minimum wages ($MW$) and industry average wages imputed from the firm sample. Lagged city wages and county manufacturing wages are both used as controls and minimum wage factors. We use the log of minimum wages as the key regressor. Some studies on minimum wages use the ratio of the minimum wages to the average wage as the main explanatory variable, multiplied by the fraction of industry employment covered by the minimum wage. At the aggregate level, the

so-called Kaitz index is the coverage-weighted minimum wage relative to the average wage. In our case, on the one hand, most of the firms in China's manufacturing sector are covered by the policy. On the other hand, coverage is not important for an individual firm because labor flow between covered and uncovered labor markets is not relevant to a firm's decision to hire labor.[24]

*Aggregate demand*: $\bar{Y}$. This includes industry output and city GDP per capita. Industry output is an indicator of industry aggregate demand measured by total output at the two-digit industry level.

*Price elasticity*: $\sigma$. This is measured by the Herfindahl index (HHI) for each industry at the four-digit level. $\sigma$ is negatively correlated with HHI, so we expect a positive coefficient for the interaction term of wages and HHI.

*Labor income share*. This is measured by the share of industry labor income in the value of industry gross output. Because only the variation across industry matters for our estimation, if the labor share[25] in the data is biased downwards but the bias does not correlate with industry distribution, we do not need to adjust this measure. We expect a negative coefficient for the interaction term of wages and labor share.

*Productivity*: $A_i$. We use the profit margin as one proxy for firm revenue-based productivity. In addition, ownership is widely recognized to be a relatively exogenous indicator of firm productivity. In our sample, firm owners are categorized as being state, collective, private, or foreign if they are thus explicitly stated in the data, otherwise ownership is attributed to the stakeholder using the share of paid-in capital. The export-to-sales ratio is also included, given the positive relationship between firm exporting choice and productivity indicated by trade theory.

*Firm size measured by revenue*: $S_i$. Aside from lagged employment, lagged annual real sales are used to account for firm size. We expect the variable of firm sales to capture extra information about a firm's production scale.

Table III reports the identified test following Oster (2013). We first compare the coefficients and $R^2$ of the baseline effect by pooled OLS and the controlled effect by using several macro variables. The results show that the coefficients of the controlled effect are smaller than the baseline effect. However, the $R^2$ has improved greatly, from 0.012 to 0.926. In addition, the identified effect is within the range of $[-0.029, -0.021]$ , and therefore rejects the null hypothesis of zero, which indicates that the effect is robust to coefficient stability.

### Neighbor Spillover

To examine labor flow across neighboring borders driven by minimum wages, we include the minimum wage in each firm's neighbor area and estimate its effect. Specifically, the variable of interest $SP_{ct}$ is denoted by

$$SP_{ct} = MW_{ct} - NBMW_{ct},$$

[24]For detailed discussion on whether the minimum wage in the United States arguably is a more appropriate variable than is the Kaitz index, see Card and Krueger (1995, 215). One reason given is that the minimum wage and the average wage are not independent sources of variation.

[25]Underreporting of the labor share in the ASIF data has been well documented. For example, see Hsieh and Klenow (2009).

where $NBMW_t$ is the average minimum wage of county $c$'s neighbors. To further control for the neighbor influence on decision making about local minimum wages, the estimation includes neighbor minimum wages, neighbor manufacturing wages, and the growth of neighbor manufacturing employment, all lagged by one year. In this estimation by controlling for neighbor minimum wages, we can force the neighboring area of each county to raise minimum wages at the same rate, so the coefficient of $MW_{ct}$ measures the counter-factual employment elasticity without spillover of labor flow. If there is positive spillover from the neighbor, in the sense that high neighbor minimum wages lead to labor inflow, we expect the coefficient of $SP_{ct}$ to be positive in regressions on firm employment.

## 5 Main Results

In this section we present our main results concerning the minimum wage effect on firm employment. Our analysis proceeds in two steps. We first estimate the homogeneous effect of minimum wages on firm employment over the period 2001–06. Then, we estimate the heterogeneous effects of minimum wages according to various firm characteristics, in particular, firm wages.

### 5.1 The Homogeneous Effect on Firm Employment

In this section we estimate the elasticity of the minimum wage by using equations (1) and (2). The summary statistics of firm variables are shown in Table I.

#### Minimum Wage Effect

As we have discussed, our main specifications explicitly include the region-by-year fixed effects. We estimate the elasticity of the minimum wage for the period 2001–06.

Table IV shows the effects of minimum wages on firm employment based on different sets of controls. All level variables shown in our tables are in the the logarithmic form. Column 1 does not include the region-by-year fixed effect, while column 2 includes the province-by-year fixed effect. Columns 3 to 5 all include the pair-by-year fixed effect. Aside from the region-by-year fixed effect, column 3 includes the full set of controls, as in columns 1 and 2, while for the purpose of comparison, column 4 removes minimum wage factors and column 5 removes contemporaneous controls of macroeconomic variables. The coefficients of the main firm variables are also shown while the remaining coefficients are not reported.

Without any controls of the regional-by-year fixed effect, column 1 shows that the employment elasticity with respect to the minimum wage is not significant from zero. In other columns with the regional-by-year effects controlled for, these employment elasticities are significantly negative and economically large. Column 2, controlling for the province-by-year effect, shows an employment elasticity to the minimum wage of -0.073, and column 3, controlling for the county-pair effect by year, shows an employment elasticity of -0.110. If there is good news about the development of local labor markets, policy-makers generally tend to raise minimum wages further because their growth concern is alleviated. The news of labor market trends is thus positively correlated with the growth of firm employment and minimum wages. As a result,

the bias caused by missing controls for labor market trends is likely to be upwards. After we control for more local trends, we find that the estimates of minimum wage coefficients become more negative, which is consistent with this prediction. The cost of controlling for regional fixed effects by year is the decline of estimation power. We see that the standard errors in columns 2 and 3 become larger when we attempt to control for trends in smaller regions. Our estimates show that the significance levels for the elasticities are 5 percent respectively when the fixed effects of province and neighbor pairs are included. As additional checks, columns 4 and 5 justify the effort to control for macroeconomic variables affecting firm employment and minimum wages. If they are not included, minimum wage effects become slightly different and their standard errors are smaller compared with column 3. Specifically, the exclusion of the minimum wage factors renders the minimum wage effect to be more negative and the exclusion of macroeconomic variables render the minimum wage effect to be less negative.

The Online Appendix shows the effect of minimum wage on aggregate manufacturing employment. The estimated elasticities are much closer to zero than the average elasticities we estimated from firm employment with region-by-year fixed effects.

**The Effect of Firm Characteristics**

It is interesting to analyze what generally determines the size of a Chinese firm. The coefficients of firm variables are similar across different specifications, except for lagged employment, when no region-by-year effect is controlled for in column 1. The coefficient of lagged firm employment in column 1 is 0.7, larger than coefficients in other columns which are about 0.56. We are more inclined to accept the results by using region-by-year controls because they are more in line with common estimates in the existing literature on the auto-correlation nature of firm employment. The negative coefficient of firm sales suggests that firm employment grows at a lower rate in firms that experienced faster growth in sales revenue. It is common to use sales growth as a proxy of Tobin's $Q$ for individual firms if there is a lack of the information about market capitalization. Our evidence shows that on an annual basis, employment growth becomes slower for firms with previously higher sales growth when past employment growth is controlled for. In terms of export growth, we find that relative export growth in terms of the change in export-to-sales ratios indicates a negative relationship with future employment growth. Our results further show that higher profit margins predict higher future employment growth. Considering the magnitude of its impact on firm employment, the estimate from column 3 indicates that a 0.1 increase in the lagged profit margin offsets about a 10 percent increase in the minimum wage. Regarding ownership over the entire period of 2001–06, we find that private firms tend to show slower employment growth than state firms. However, foreign firms, being the reference group in the regression, have similar trends of employment growth as state firms. One reason for this is that massive privatization during this period was usually followed by firm restructuring and employment reduction. The estimate of this reduction is small, however, being around 3 percent on an annual basis.

### 5.2 The Heterogeneous Effect on Firm Employment

Table V investigates the heterogeneous effect of minimum wages in terms of various characteristics by adding interaction terms of minimum wages with firm variables.

#### Firm Wage

In theory, firm average wages serve as an indicator of the extent to which a firm responds to minimum wage changes. On the one hand, low-wage firms are more likely to hire more low-wage workers and more likely to be demand-constrained; their wages are thus more exposed to minimum wage changes and their employment tends to move in the opposite direction to minimum wages. On the other hand, in response to minimum wage hikes, worker spillover effects still penetrate high-wage firms, but their wages should be affected less. Meanwhile, high-wage firms are more likely to be supply-constrained, and thus they may even increase employment in response to a minimum wage hike.

The coefficients for the interaction $MW_t \times (FW_{t-1} - MW_{t-1})$ measure the heterogeneous effect of minimum wages on firm employment, where $MW_t$ denotes the log of the minimum wage and $FW_{t-1} - MW_{t-1}$ measures the log difference between the lagged firm wage and the local minimum wage. The difference between firm wage and the local minimum wage is an indicator of the firm relative wage. We emphasize two findings. Qualitatively, low-wage firms tend to slow down employment growth more than high-wage firms in response to minimum wage hikes. This monotone relationship holds for all the specifications with or without controlling for the region-by-year fixed effect, and it is more pronounced in column 3 when the neighbor-pair fixed effect is included. Quantitatively, the heterogeneity in terms of firm wages for the minimum wage is large. Figure IX shows that firm relative wage ranges generally from 1 to 4. The decline of one unit in firm relative wage results in a rise of the employment elasticity by 0.11, which is equal to the homogeneous elasticity.

#### Other Firm Characteristics

The results across three specifications of regional controls are qualitatively similar. In the text discussion, we focus on the results in column 3 by controlling for the county-pair-by-year fixed effect.

Most of firm characteristics show significant heterogeneity in employment elasticities with respect to the minimum wage. We find that state firms tend to reduce employment much more than other firms in response to minimum wage hikes. Foreign firms being the reference group, tend to be as responsive as private firms in terms of employment growth. At the same time, firms with lower profit margins tend to have slower employment growth than firms with higher profitability in response to minimum wage hikes.

#### Industry Characteristics

Industry concentration, measured by the HHI and also a proxy of price elasticity, shows a positive coefficient, consistent with theory predictions but not statistically significant. The coefficient

for the labor share interaction is strongly negative, which shows that the minimum wage mainly influences labor-intensive industries. A recent paper by Ji and Wei (2014) studies the passage of China's 2007 Labor Contract Law. They find that the new law generates a positive stock price response of labor-intensive firms. They argue that compliance with labor regulations may actually improve labor productivity. From this point of view, a hike in minimum wages is not bad news for manufacturing firms in the presence of compliance externalities.

**Labor Market Heterogeneity**

In the beginning of subsection 4.4, we argue that there are two complementary explanations of heterogeneous employment elasticities: firm exposure and the elasticity of firm labor-demand schedules. As the heterogeneity is pervasive for various firm characteristics, relying only on the explanation of different firm exposures does not suffice. We need to explore more the positions of firms and workers in the labor market. As long as a firm's labor demand and supply do not perfectly match, the more negative response in later years may imply that firms are more constrained to their labor demand than to their labor supply. From the perspective of the labor market, this transition should be driven by the change in the comparative advantage of job search for firms and workers. If monopsony power declines or labor mobility improves, firm labor supply becomes more elastic, and an increase in the market wage is more likely to reduce firm employment further.

As a supplementary check, this subsection replaces the interaction variables used in section 5.2 to see if the pattern of firm heterogeneity still exists. Specifically, we investigate whether the potential source of heterogeneous effects comes from the degree of local market competition. We examine regional heterogeneity aggregated from firms and apply measures of employer concentration and labor mobility to the model.

For employer concentration, we create a measure denoted by the *employment concentration index* ($ECI$), which is essentially a Herfindahl index in the employer market. For every county $c$ we define the set $F_{c,\tau}$ of manufacturing firms headquartered in county $c$ that have an average wage below the $\tau$ quantile of wage distribution of all manufacturing firms located in that county. For each of the firms $f \in F_{c,\tau}$ let $Emp_{f,t}$ denote the total employment and define the labor share of each firm as

$$\alpha_{f,t} \equiv \frac{Emp_{f,t}}{\sum_{f \in F_{c,\tau}} Emp_{f,t}}.$$

We can then define in country $c$ and among firms within the $\tau$ quantile of least qualified workers as

$$ECI_{t,c,\tau} \equiv \sum_{f \in F_{c,\tau}} (\alpha_{f,t})^2.$$

The employment concentration index measures the degree of local monopsony in the labor market among low-wage firms up to the quantile $\tau$ of the average firm wage. In this paper, we set $\tau$ to 25 percent.

We proxy for labor market mobility with the migrant share from the 2000 population census in each city. The migrants network developed gradually over time improves a worker's success

rate to find a job and settle down easily. A historical migrant share alleviates the concerns of endogeneity. Let $LIMI$ denote a *labor immobility index* ranging from 0 (least immobile) to 1 (most immobile). A high measure of $LIMI$ indicates low labor mobility. Specifically, we assign two dummy variables for each city indicating if $ECI$ and $LIMI$ are higher or lower than the median levels.

Definition of labor market competition

| | $ECI$ Low | $ECI$ High |
|---|---|---|
| $LIMI$ Low | Reference group (most competitive) | Table V Panel C, Row 2 |
| $LIMI$ High | Table V Panel C, Row 1 | (least competitive) |

Panel C in Table V presents our estimation results for the period 2001–06. Row 1 and 2 report the employment elasticities with respect to the minimum wage in regions with high employment high labor immobility and employer concentration. We focus on the results in column 3 in the following discussion.

The (negative) response of firm employment to minimum wage hikes is significantly higher (in the absolute value) in the market with high labor mobility. This result suggests that labor mobility plays an important role in explaining the heterogeneous effects between different wage groups. By contrast, conditional on a given level of labor mobility, a more employer-concentrated market does not exhibit significant difference in employment response to minimum wage hikes. This shows that firm heterogeneity of employment responses to minimum wage shocks has profound implications on the labor market. Labor mobility, as the result shows, is more likely to be a factor that affects a firm's monopsony power.

### 5.3 Neighbor Spillover

Panel A of Table VI shows the result when we consider the impact of neighbor minimum wages. Few studies examine the spillover effect of minimum wages across regions, which means that the mainstream literature views each regional labor market as closed. In a standard model of labor migration, high local wages are more attractive to immigrant workers, so we introduce a new variable measuring the gap of minimum wages between a county and the neighboring area surrounding the county itself. The spillover variable is defined by

$$SP_{ct} = MW_{ct} - NBMW_{ct}.$$

In this estimation, neighbor manufacturing wages and labor growth are controlled for to address any possibility that they influence both local and neighbor minimum wage setting. All of the coefficients for the spillover variable among different control specifications differ insignificantly from zero. The sum of the coefficients for $MW_t$ and $SP_{ct}$ is similar to the average elasticity estimated in Table IV, which shows that the consideration of neighbor wages does not alter the result. The insignificant coefficient shown in the fourth row of column 3 is -0.059, the magnitude of which is about half of the effect of a county's own minimum wage. Quantitatively, although statistically insignificant, this number means that if a neighboring county unexpectedly raises its minimum wage by a certain amount, the effect on labor inflow is equivalent to less than half of the reduction (54 percent) in employment growth with a local minimum wage hike. This sheds light on the policy coordination of China's labor market regulations.

### 5.4 The Policy Reform in 2004

The reform in 2004 is likely to represent a structural change in minimum wage enforcement, and so it will change the effect of minimum wages on firm wages and firm employment, although previous literature indicates ambiguous results in western countries (Freeman, 2010). We interact the minimum wage with period dummy variables to estimate the different employment elasticities to minimum wages for the period before and after the 2004 policy. Specifically, for each county, the dummy is equal to one for years after 2004. In our estimation tables, the dummy is denoted by $(> 2004)$.

In panel A of Figure VII, we show the effect of the minimum wage on firm employment separately for the pre-reform and post-reform periods. The difference between the two elasticities, also seen as the treatment effect of the reform, is also shown together the statistical significance. When no region-by-year fixed effect is controlled for, the level elasticities and the difference between them are all insignificant from zero. However, the difference becomes significantly negative when we control for the region-by-year fixed effect. The elasticity for the post-reform period is -0.17; this is much more negative than the homogeneous elasticity (-0.11) for the whole period. Correspondingly, the treatment effect of the reform turns out to be -0.115. Consistent with the policy report (Su and Wang, 2014),, we here find that the new policy increased the effect of minimum wage hikes and that the increase was economically large.

### 5.5 The Effect of Minimum Wages on Firm Employee Wages

Although minimum wage hikes can in theory impact firm employment in positive or negative directions, they always result in increased employee wages: theory also predicts that minimum wage hikes lead unambiguously to higher average wages in a firm. To verify this, we use a similar model to equation (2) and estimate the effect of minimum wages on firm employee wages. Table VIII provides these estimates. The structure of the explanatory variables is the same as in the employment regressions except for the replacement of the lagged dependent variable and the corresponding instrument. The dependent variable $W_t$ is a firm's average employee wage.

Columns 1 to 3 show the effects of minimum wages on firm employee wages respectively for different specifications of fixed-effect controls. Without the region-by-year fixed effect, the

elasticities of minimum wages are impressively high, with a point estimate of 0.351. With the province-by-year fixed effect, the estimated elasticity becomes 0.32, and when neighbor-pair fixed effects are controlled for, the elasticity becomes even larger, up to 0.361.

We also examine the effect of the policy reform on wage elasticities. One noticeable finding is that the effect of the minimum wage on firm employee wages, shown in Panel B of Figure VII, became slightly smaller after the 2004 reform, particularly when region-by-year fixed effects are included. By contrast, the average effect of minimum wages on firm employment is more negative after the reform. This suggests that firms have been more exposed to minimum wage shocks since 2004, in the way that firms mainly choose to reduce employment rather than raise wages for a larger group of affected workers in order to comply with the intensified regulation. Only by considering both the effect of the minimum wage on firm employment and wages can we fully understand the mechanism how the minimum wage exerts its impact on firms.

We provide further evidence in the Online Appendix to show the effect of minimum wages on firm profitability. Firm profitability does not show a significant response to minimum wage hikes.

Table IX also investigates the firm heterogeneity in wage elasticities. It is straightforward to see that high-wage firms respond to minimum wage hikes to the same extent as low-wage firms. For other characteristics, firms with larger sales raise their wages more than other firms due to minimum wage hikes. Foreign firms, relative to state and domestic private firms, have higher wage growth in response to minimum wage hikes. Profit margins, however, do not exhibit the heterogeneity effect for wage growth. Similarly, we also do not find significant industrial heterogeneity of firm concentration and labor intensities.

## 6 Robustness Checks

### Sample Attrition

The rate of attrition of our sample is about 10 percent every year. Because the rate of re-entry is also high at 10 percent, calculated on the basis of previous exit incidents, a significant number of firms may leave the sample not for the reason of shutdown, but because of omissions.

To understand firm exit behavior, we use a probit model to examine firm attrition for the whole sample. The binary dependent variable is whether a firm will remain in the sample in the next period. The explanatory variables are firm characteristics, including sales, employment, ownership, profit margins, firm age, and squared firm age. The set of these explanatory variables is similar to the regressions on firm employment, except that we add firm age and squared firm age to the model and these variables are included without lags. County minimum wages, minimum wage factors at the county level, and city fixed effects are used as additional controls. The probit model is estimated separately for each year, and the results are shown in Table X. Generally, we find that firms with larger sales, greater employment, and higher profit margins are more likely to remain in the sample. Foreign firms are the most persistent in the sample compared to state firms or private domestic firms. Firms with a longer history are more likely to drop out. The coefficients of minimum wages are insignificantly positive for most of the years.

Only in 2004 are the coefficients of minimum wages significantly positive. Therefore, there is no evidence to show that a minimum wage hike leads more firms to leave the sample.

Because the inferior information of firm entry and exit, it is not feasible to study the extensive margin of firm employment with the ASIF firm data. This paper is restricted to examine employment dynamics of existing firms, which is the intensive margin.

**Single-plant Firms**

Five percent of firms in our sample are firms with multiple production units or plants. Literally, a firm is a legal person which assumes legal rights and obligations independently while a production unit may not. In most cases, production units of a multiple-plant firm are located within the same city. As a robustness check, we provide results by using only single-plant firms in the Online Appendix. The results remain the same.

**Delayed Implementation**

Seven provinces did not adjust their minimum wages in 2004, which we consider might also have delayed the reform. In our main analysis, we choose the end of 2005 as the start of the post-reform era. Here we conduct a test by defining the start of the reform by the first year when a county raised its minimum wage after (and including) 2004. Table XI presents three sets of results regarding this issue. Column 1 uses the specification of our main analysis and replicates the result in column 3 of Table VII. The treatment used for the result in column 2 is minimum wage adjustment after 2004. The effect of the reform changes very little. Our main result for the elasticity is -0.17 after the reform, and the estimate in column 2 is the same. The treatment effect is -0.113 and -0.115 in column 1 and column 2. We further exclude the seven provinces that did not adjust minimum wages in 2004 from the sample. Column 3 shows the result. The post-reform elasticity becomes much less negative and the treatment effect is also insignificant from zero. In short, the identification of the policy reform is robust for the estimation. The provinces with delayed implementation are important, but the timing of the implementation is not.

**Political Considerations**

To better control for more subtle factors that are hardly observed but can influence both local labor market development and minimum wage policies, we attempt to capture government idiosyncrasies by using the personal characteristics of the government chief, who is literally the party secretary of local government. Our data include ages and tenures of government chiefs in 308 cities. Notably, we do not include directly controlled municipalities, so the sample used here is different from our main sample. In addition, this data source does not provide information for the years before 2002. The results are shown in Table XII. The result in column 1 is in our main result, which replicates the estimate in column 3 of Table IV. Column 2 introduces the two control variables of government chief characteristics, of which chief age has a significantly positive effect on minimum wage adjustment. Although the sample size reduces to a large extent,

the two results are essentially similar. The statistical significance of the new estimate becomes slightly smaller.

**Placebo Test**

As a placebo test, we set the treatment one year backward for all counties by assuming that the reform was implemented in 2003. The treatment period is assigned arbitrarily so the treatment is not real. In theory, the estimation based on pseudo-treatments should not lead to the same results as the one based on the real treatment if we have identified the real treatment correctly. Since the reform is unanticipated by individual firms, there should not be any anticipation effect. Table XIII compares the results of the three specifications. Although our result for the minimum wage effect differs across the three specifications whether to include the region-by-year fixed effects, we do not find any significant effect for the placebo treatment. Furthermore, these treatment effects are quantitatively smaller than what we estimate from the real treatment time.

## 7 Conclusion

Raising the minimum wage is a polarizing issue. One side of the argument says that raising the minimum wage will lower employment. Those who argue for a minimum wage downplay the impact on employment and emphasize the positive impact on the living standards of the poor.

In emerging markets like China, little is known about the impacts of minimum wage changes on employment and living standards. Our study provides the first comprehensive estimates of these impacts for China, whose experience may be relevant for several other emerging markets.

Our evidence suggests that a 10 percent increase in the minimum wage lowers employment growth by about 1 percent. In economic terms, this represents a sizable impact on the manufacturing industry. We also find significant heterogeneity in the impact of minimum wages on employment and wages across low-wage and high-wage firms. In particular, in low-wage firms, raising the minimum wage lowers employment growth but raises wages more than in high-wage firms. The employment elasticities to the minimum wage differ in terms of other firm characteristics. We find that firms with different profit margins, ownership, and export-to-sales ratios exhibit different employment elasticities. In addition, the hirings of firms in labor-intensive industries respond much more to minimum wage hikes.

We investigate whether the potential source of heterogeneous effects of minimum wages comes from the degree of local market competition: regional differences in labor mobility, and low-wage firm concentration. We find more positive (or less negative) effects of minimum wages on firm employment in labor markets with less competition. The change in the effects of minimum wages due to the policy reform which started in 2004 is significantly larger, which means that the post-reform elasticity is more negative. This is consistent with policy reports arguing that the new policy is effective and that local enforcement after the reform has been more intensive. Therefore, the larger effect of minimum wages on employment can be a consequence of both labor market transitions and the new policy.

We also provide evidence that labor flow across counties is more likely to be influenced by minimum wage adjustment. The sizable impact of minimum wages on firm employment and

its spillover effect are consistent with the coordinated policy of minimum wages in China, often imposed synchronously within provinces.

This research on the effect of minimum wages on employment dynamics helps to shed light on more recent policies and reforms in China's labor market, such as the labor-contract law enacted in 2008 and the proposed reform of China's *Hukou* system. There have been heated debates about whether these regulations are so excessively restrictive that they might raise firm hiring costs and lead to unfavorable consequence for employment. This paper shows that within-industry firm heterogeneity and the degree of labor market competitiveness also play an important role in China's employment dynamics.

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# Main Appendix

## A Variable List

This list describes and explains all the main variables used in estimation.

- County variables (from the Ministry of Human Resource and Security)
  - County is defined as the administrative division at the third level, following the national standard.
  - MW: minimum wage. The minimum wage used in the estimation is the average of monthly minimum wages in a year. Real minimum wages, used in the regression at the firm level, are denominated by the four-digit industry product price index.
- City macroeconomic variables (from the CNKI Yearbook database and other sources)
  - City is defined as the administrative division at the second level, following the national standard.
  - city average wage: average wage per employee. Employees are those who work in the formal sector in the urban area of each city. City average wages are documented in the database. City total wages and a couple of sources for city total employees are used to replace missing values and outliers of city average wages.
  - city GDPPC: city GDP per capita. GDP per capita is documented in the database. GDP and annual population are used to replace missing values and outliers of GDP per capita. Annual population is calculated as the simple average of city population at the beginning and the end of a year.
  - growth rate of GDPPC: growth rate of city GDP per capita.
  - fixed asset investment: the ratio of fixed asset investment to GDP. This variable is winsorized 1% at two sides with replacement.
  - GDP share of 2nd industry: the ratio of output in the secondary industry to GDP.
  - GDP share of 3rd industry: the ratio of output in the tertiary industry to GDP.
  - growth rate of FDI: growth rate of foreign direct investment. FDI is documented in the database. FDI in the urban area is used to replace missing values and outliers of FDI.
  - growth rate of labor: growth rate of urban and rural labor force. A couple of sources for labor force are documented in the database. The one with the fewest missing values and outliers is used and other sources are also used for supplementary information.
  - unemployment rate: registered unemployment rate. The number of registered unemployed is documented in the database. It is further denominated by urban labor force, which is measured from a couple of sources documented in the database.

  - city chief characteristics: age and tenure

- Household Variables
  - The ratio of migrants to total residents, from the 2000 population census
  - The non-compliance rate of local minimum wages, from the Urban Household Survey (18 provinces)

- Province variables (from the CNKI Yearbook database)
  - Province is defined as the administrative division at the first level, following the national standard.
  - CPI: consumer price index.
  - $P_k$: price index of fixed asset investment.

- Industry variables (constructed from the annual survey of industrial firms or other sources)
  - industry wage: real industry wage per employee. Industry is classified at the 2-digit level following the code of GB/T4754-2002. Real variables, same in the following, are denominated by the 4-digit industry product price index.
  - industry output: real industry output per employee. Industry is classified at the 4-digit level following the code of GB/T4754-2002.
  - $\text{HHI}^{\mathbf{IND}}$: Herfindahl index of firm sales in an industry. Industry is classified at the 4-digit level following the code of GB/T4754-2002.
  - $\text{labor share}^{\mathbf{IND}}$: industry labor income share. It is measured by the ratio of total wages to total gross output at the 4-digit industry level following the code of GB/T4754-2002.
  - $P_y$: price index of industry gross output.
  - $P_m$: price index of intermediate input. It is collected by Brandt et al. (2012).

- Firm variables (from the annual survey of industrial firms)
  - $L$: employees, namely, annual firm employment. It is reported as the average of a firm's end-of-month employees in a year. We also use the variable of end-of-year employees to diagnose and replace suspected erroneous data on $L_i$.
  - $S$: sales, annual sales revenue from main business.
  - $W$: firm wage per employee. We compute a firm's total wage bill as the sum of its reported wages, monetary allowances, and unemployment insurance. The average wage per employee is a firm's wage denominated by its annual employment. This variable is winsorized 0.5% from the top and dropped if below 1,000 Yuan a year. We define firm relative wages as the ratio of firm wages to local minimum wages.
  - SOE: dummy variable of state firms (cf. firms controlled by foreigners)

- PRV: dummy variable of domestic, private firms (cf. firms controlled by by foreigners)
- profit margin: the ratio of profit to sales. This variable is winsorized 0.5% at two sides with replacement.
- export/sales: the ratio of export to sales. This variable is winsorized 0.5% from the top.

## B Theoretical Background

By laying the micro-foundations of firm behavior, basic theory can guide us to select relevant explanatory variables and provide sign predictions of their effects in the regression. On the one hand, if the labor supply faced by individual firms is perfectly elastic, the response of firm employment to minimum wages depends on the shape of each firm's labor demand schedule in the range of the minimum wage and, moreover, market prices such as the average wage and the cost of capital investment, due to a firm's ability to substitute one input for another. On the other hand, if labor supply is imperfectly elastic, a firm needs to react to changes on the supply side[26].

We first assume labor supply is perfectly elastic and thus the marginal cost of labor depends mainly on market wages and firm state variables. In this case, a firm's hiring depends on its productivity and product demand. The cost channel suggests that an increase in the market wage must reduce a firm's employment. The second theory allows labor supply to be imperfectly elastic, so the implementation of wage minima may reduce a firm's marginal cost while the total cost of labor rises. As a result, a increase in the market wage raises firm labor demand and expands firm hiring. These two theories correspond to the competitive model and the monopsony model in the literature of minimum wages (Brown, 1999; Neumark and Wascher, 2008; Schmitt, 2013).

### B.1 Labor Demand

If factor markets are competitive, a firm's employment decisions depend on factor prices and how it supplies its product market. It is then straightforward to assume the product market is monopolistically competitive, so a firm determines its own product price and supply.

The following theoretical framework is provided to underpin our variable choice in the estimation. Assume a firm has a production function given by

$$Y = AK^{\alpha}L^{\beta}M^{1-\alpha-\beta},$$

where $Y$, $K$, $M$, and $L$ denote output, capital input, intermediate input, and labor input respectively. $A$ can be any firm characteristic that determines firm size and is in general viewed as firm-specific productivity. In competitive factor markets, $\alpha$, $\beta$, and $1-\alpha-\beta$ can be explained as the cost share of each factor for a firm, or explained as the elasticities of marginal cost to each

[26]Previous studies on regional employment typically interpret the employment equation as demand equations, although many include as explanatory variables supply-side variables because regional employment is determined by the interaction of demand-side factors and supply-side factors (Card and Krueger, 1995, 185).

factor price. Denote aggregate output by $\bar{Y}$. Assume $P_k$ and $P_M$ are market prices of capital input and intermediate goods that measure the firm's nominal marginal cost of each input. The firm also takes market wage rates as given. Denote $\omega$ the firm's nominal marginal cost of labor, which is a function of market wages and a firm's state variables such as labor input in the last period. Labor demand is given by

$$L = \bar{Y}\left[\frac{1}{A}\left(\frac{\omega/\bar{P}}{\beta}\right)^{\beta}\left(\frac{P_k/\bar{P}}{\alpha}\right)^{\alpha}\left(\frac{P_M/\bar{P}}{1-\alpha-\beta}\right)^{1-\alpha-\beta}\right]^{1-\sigma}\frac{\beta}{\omega/\bar{P}}\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma} \tag{3}$$

This equation shows that the fundamental determinants of firm employment are firm characteristics $A$, price elasticity $\sigma$, and market conditions: $\bar{Y}$, $\omega/\bar{P}$, $P_k/\bar{P}$, and $P_M/\bar{P}$.[27] It follows that marginal cost of labor is negatively correlated with firm employment. The elasticity of labor demand to $\omega$ is $-(1+\beta(\sigma-1))$[28].

If marginal cost of labor is set to the wage rate, equation (3) leads to a linear regression model to estimate the wage elasticity of firm employment. With reasonable enforcement and compliance, the minimum wage should be positively related to a firm's marginal cost of labor, and thus should have a negative impact on firm employment.

Labor adjustment frictions are important factors for firm employment even on an annual basis. In the empirical analysis, we control for lagged firm employment to address this issue. In the presence of a large adjustment cost, the marginal cost of labor also depends on a firm's own conditions. This implies that the minimum wage has a heterogeneous effect on the marginal cost of labor, and by extension on firm employment, even under the assumption of a perfectly elastic labor supply.

### B.2 Labor Supply

The more complicated problem is to consider imperfectly elastic labor supply for firms. Stigler (1946) describes a labor market with imperfect competition in which a monopsony may increase employment due to an increase in the minimum wage. Card and Krueger (1995) provide a search model in which the elasticity of labor supply can be reasonably large, which helps to justify the positive or negligible correlations between minimum wages and employment suggested by the New Minimum Wage Research based on regional panel data or firm surveys. Our Online Appendix applies a model with a non-discriminating monopsonist to illustrate this intuition. For a monopsonist, firm employment is likely to be supply-constrained. In response to a minimum wage hike, the optimal decision is to increase hiring along the supply curve, rather than the demand curve.

The ASIF data do not give us ideal indicators to measure the shape of individual labor supply at the firm level. Given a firm's labor demand, its average wage is a straightforward indicator

[27] The importance of controlling for variables measuring output prices and the cost of capital is stressed in Card and Krueger (1995, 184).

[28] Intuitively, the first term "1" in the sum indicates the structure of the constant cost share of labor. The second term $\beta(\sigma-1)$ shows that the effect of wages on a firm's average cost depends on labor share $\beta$ and price elasticity $\sigma$. Finally, the part of $\beta\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}$ in the employment equation implies that firm employment is correlated positively with firm labor share and price elasticity.

of the elasticity of labor supply if its employment is determined mainly by the supply side. This motivates us to use the distribution of lagged firm wages to separate firms and examine the heterogeneous effect of minimum wages on different firm groups in the empirical analysis.

## C Online Appendix

Online Appendix

Table I: Summary Statistics of the Main Variables

This table shows summary statistics of the main variables. Without further notes, we tabulate nominal variables, instead of real variables. The top panel shows statistics for macroeconomic variables at the level of prefectual cities for the period 2001–06. Wage variables and city GDP are converted to monthly values for comparison. Growth rates are calculated by the difference in logs. The number of prefectural cities and directly controlled municipalities amounts to 337. The middle panel shows in-sample summary statistics for firm employees, monthly employee wages, firm sales, firm export-to-sales ratios, and firm profit-to-sales ratios, during the period 2001–06. Sales are measured in 1,000 Yuan. Wages are measured in Yuan. The sample consists of the manufacturing firms in the ASIF data that have consecutive presence for at least three years. The bottom panel shows the share distribution of ownership in the years during the period 2002–06.

| Variable | Median | Mean | STD | Min | Max |
|---|---|---|---|---|---|
| *Macroeconomic Variables* | | | | | |
| Monthly minimum wage | 337 | 351 | 92 | 130 | 750 |
| Monthly wage per employee | 1,027 | 1,123 | 432 | 433 | 3,432 |
| Monthly GDP per capita | 708 | 1,014 | 930 | 134 | 8,000 |
| Growth rate of GDP per capita | 0.13 | 0.13 | 0.09 | -0.78 | 1.21 |
| Fixed asset investment to GDP | 0.38 | 0.41 | 0.17 | 0.11 | 1.54 |
| GDP share of secondary industry | 0.42 | 0.43 | 0.13 | 0.11 | 0.98 |
| GDP share of tertiary industry | 0.37 | 0.37 | 0.08 | 0.09 | 0.76 |
| Growth rate of FDI | 0.17 | 0.19 | 0.81 | -3.93 | 10.14 |
| Growth rate of labor | 0.01 | 0.02 | 0.10 | -0.44 | 1.50 |
| Registered unemployment rate | 0.04 | 0.04 | 0.02 | 0.00 | 0.13 |
| *City Chief Characteristics* | | | | | |
| Age | 52.00 | 51.70 | 3.78 | 40.00 | 60.00 |
| Tenure years | 2.00 | 2.80 | 1.70 | 1.00 | 10.00 |
| *Firm Variables* | | | | | |
| Employees | 106 | 224 | 527 | 2 | 60,834 |
| Sales (in thousand) | 16,033 | 46,295 | 243,015 | 10 | 52,647,208 |
| Monthly firm employee wage | 927 | 986 | 445 | 65 | 3,745 |
| Export/Sales | 0.00 | 0.20 | 0.37 | 0.00 | 1.41 |
| Profit/Sales | 0.02 | 0.02 | 0.13 | -1.83 | 0.68 |

| *Firm Shares over Years* | | | | | |
|---|---|---|---|---|---|
| | 2002 | 2003 | 2004 | 2005 | 2006 |
| State firms | 14% | 10% | 5% | 5% | 4% |
| Private firms | 68% | 71% | 75% | 75% | 76% |
| HMT firms | 11% | 11% | 11% | 11% | 11% |
| Foreign firms | 7% | 8% | 9% | 9% | 9% |

Table II: Minimum Wage Accounting

This table shows how minimum wages adjust to policy variables. The sample is a panel including more than 2,500 counties during the period 2001–06. The dependent variable is the logarithm of annual county minimum wages. At year $t$, a county's annual minimum wage is equal to the sum of monthly minimum wages that take effect at year $t$. Level variables are all in logs.

The panel estimation uses difference GMM. Robust standard errors clustered at the city level are shown in the parentheses below the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided).

| | Dependent variable : Log(Minimum Wage) | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| ***Level explanatory variables in logs*** | | | |
| minimum wage (MW)$_{t-1}$ | 0.403*** | 0.687*** | 0.536*** |
| | (0.105) | (0.130) | (0.138) |
| county manufacturing wage$_{t-1}$ | −0.007 | −0.001 | 0.002 |
| | (0.006) | (0.002) | (0.002) |
| city average wage$_{t-1}$ | −0.266 | −0.011 | 0.000 |
| | (0.226) | (0.033) | (0.220) |
| CPI$_{t-1}$ | 0.000 | | |
| | (0.003) | | |
| fixed asset investment$_{t-1}$ | 0.031 | −0.002 | 0.005 |
| | (0.020) | (0.004) | (0.015) |
| secondary industry share$_{t-1}$ | 0.054 | −0.003 | −0.020 |
| | (0.143) | (0.040) | (0.048) |
| tertiary industry share$_{t-1}$ | −0.035 | −0.018 | −0.007 |
| | (0.086) | (0.032) | (0.031) |
| growth of county manufacturing employment$_{t-1}$ | 0.001 | 0.001 | −0.001 |
| | (0.004) | (0.001) | (0.002) |
| growth of city employment$_{t-1}$ | −0.013 | −0.000 | −0.008 |
| | (0.020) | (0.003) | (0.007) |
| unemployment rate$_{t-1}$ | 0.334* | −0.044 | −0.054 |
| | (0.192) | (0.082) | (0.106) |
| age of the city chief | | | 0.001** |
| | | | (0.001) |
| tenure of the city chief | | | −0.002 |
| | | | (0.001) |
| # Counties | 2530 | 2530 | 2166 |
| ***Controls*** | | | |
| Province × Year | N | Y | Y |

Table III: Effect of Minimum Wages on Firm Employment

Bounds under the proportional selection of observables and unobservables based on Oster (2013)

| Baseline Effect | Controlled Effect | Identified Set |
|---|---|---|
| (Std.Error) $\left[R^2\right]$ | (Std.Error) $\left[R^2\right]$ | $\left[\tilde{\beta}, \beta^* \left(2.2\tilde{R}, 1\right)\right]$ |
| $-0.126(0.013)[0.012]$ | $-0.029\,(0.004)[0.926]$ | $[-0.0213, -0.029]$ |

Table IV: Effect of Minimum Wages on Firm Employment

Baseline results

This table estimates the effect of minimum wages on firm employment. The estimation model is based on equation (2) with difference GMM and instruments of lags from one year to two years. The dependent variable $L_t$ is the number of a firm's employees. $\text{MW}_t$ denotes county minimum wages at year $t$. The sample includes firm observations over the period 2001–06. For ownership dummy variables, foreign firms including those from HMT are used as the reference group. The estimation equation is given by

$$L_{it} = \alpha + \beta_1 L_{i,t-1} + X_{[i,c]t}\beta + \gamma MW_{ct} + \mu_i + \tau_t + \varepsilon_{it},$$

where level variables are all in logs.

Robust standard errors clustered at the level of counties are shown in the parentheses below the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided).

| | Dependent variable $L_t$: log(employees) | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| $\text{MW}_t$ | 0.003 | $-0.073^{**}$ | $-0.110^{**}$ | $-0.128^{***}$ | $-0.079^{**}$ |
| | (0.023) | (0.037) | (0.050) | (0.046) | (0.032) |
| $L_{t-1}$ | $0.660^{***}$ | $0.567^{***}$ | $0.562^{***}$ | $0.563^{***}$ | $0.562^{***}$ |
| | (0.037) | (0.015) | (0.014) | (0.014) | (0.014) |
| $\text{sales}_{t-1}$ | $-0.137^{***}$ | $-0.106^{***}$ | $-0.107^{***}$ | $-0.107^{***}$ | $-0.107^{***}$ |
| | (0.011) | (0.005) | (0.005) | (0.005) | (0.005) |
| $\text{SOE}_t$ | 0.011 | 0.009 | 0.008 | 0.008 | 0.007 |
| | (0.011) | (0.010) | (0.010) | (0.010) | (0.010) |
| $\text{PRV}_t$ | $-0.026^{***}$ | $-0.028^{***}$ | $-0.029^{***}$ | $-0.029^{***}$ | $-0.029^{***}$ |
| | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) |
| $\text{profit margin}_{t-1}$ | $0.107^{***}$ | $0.096^{***}$ | $0.095^{***}$ | $0.095^{***}$ | $0.095^{***}$ |
| | (0.010) | (0.008) | (0.009) | (0.009) | (0.009) |
| $\text{export/sales}_{t-1}$ | $-0.020^{***}$ | $-0.014^{***}$ | $-0.013^{***}$ | $-0.013^{***}$ | $-0.013^{***}$ |
| | (0.005) | (0.004) | (0.004) | (0.004) | (0.004) |
| Observations | 427786 | 424872 | 418018 | 418018 | 418018 |
| ***Controls*** | | | | | |
| Neighbor Pairs × Year | | | **Y** | Y | Y |
| Province × Year | | Y | **Y** | Y | Y |
| Firm variables | Y | Y | **Y** | Y | Y |
| Macroeconomic variables | Y | Y | **Y** | Y | |
| Minimum wage factors | Y | Y | **Y** | | Y |

Table V: Effect of Minimum Wages on Firm Employment

Heterogeneous effect

This table estimates the heterogeneous effect of minimum wages on firm employment. The estimation model is based on equation (2) with difference GMM and instruments of lags from one year to two years. The dependent variable $L_t$ is the number of a firm's employees. $\mathrm{MW}_t$ denotes county minimum wages at year $t$. The sample includes firm observations over the period 2001–06. Log firm relative wage is defined as the log difference between firm wages and local minimum wages: $\mathrm{FW}_{t-1} - \mathrm{MW}_{t-1}$. A positive coefficient of firm relative wage indicates that the heterogeneous effect on lower-wage firms is higher. The coefficients of the variables not interacted are not reported.

Robust standard errors clustered at the level of counties are shown in the parentheses below the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided). Level variables are all in logs.

| | Dependent variable $L_t$: log(employees) | | |
|---|---|---|---|
| | Panel A: Firm Heterogeneity | | |
| $\mathrm{MW}_t \times (\mathrm{FW}_{t-1} - \mathrm{MW}_{t-1})$ | $0.066^{***}$ | $0.092^{***}$ | $0.110^{***}$ |
| | (0.009) | (0.012) | (0.011) |
| $\mathrm{MW}_t \times \mathrm{sales}_{t-1}$ | $-0.027^{***}$ | $-0.048^{***}$ | $-0.050^{***}$ |
| | (0.006) | (0.006) | (0.006) |
| $\mathrm{MW}_t \times \mathrm{SOE}_t$ | $-0.154^{***}$ | $-0.153^{***}$ | $-0.152^{***}$ |
| | (0.020) | (0.022) | (0.021) |
| $\mathrm{MW}_t \times \mathrm{PRV}_t$ | $-0.011$ | $-0.007$ | $-0.005$ |
| | (0.016) | (0.018) | (0.017) |
| $\mathrm{MW}_t \times \mathrm{profit\ margin}_{t-1}$ | $0.090^{***}$ | $0.116^{***}$ | $0.119^{***}$ |
| | (0.026) | (0.026) | (0.027) |
| $\mathrm{MW}_t \times \mathrm{export/sales}_{t-1}$ | $-0.023^{*}$ | $-0.043^{***}$ | $-0.042^{***}$ |
| | (0.013) | (0.012) | (0.012) |
| | Panel B: Industry Heterogeneity | | |
| $\mathrm{MW}_t \times \mathrm{HHI}_t^{\mathbf{IND}}$ | $-0.002$ | 0.004 | 0.003 |
| | (0.004) | (0.004) | (0.004) |
| $\mathrm{MW}_t \times \mathrm{labor\ share}_t^{\mathbf{IND}}$ | $-0.032^{***}$ | $-0.027^{***}$ | $-0.027^{***}$ |
| | (0.008) | (0.008) | (0.008) |
| Observations | 427786 | 424872 | 418018 |
| | Panel C: Labor Market Heterogeneity | | |
| $\mathrm{MW}_t \times$ High LIMI | 0.008 | $-0.017$ | $0.065^{**}$ |
| | (0.026) | (0.025) | (0.033) |
| $\mathrm{MW}_t \times$ High ECI | $-0.007^{**}$ | $-0.006^{*}$ | $-0.006$ |
| | (0.003) | (0.003) | (0.004) |
| Observations | 424872 | 425194 | 418018 |
| ***Controls*** | | | |
| Neighbor Pairs × Year | | | **Y** |
| Province × Year | | Y | **Y** |
| Firm variables | Y | Y | **Y** |
| Macroeconomic variables | Y | Y | **Y** |
| Minimum wage factors | Y | Y | **Y** |

Table VI: Effect of Minimum Wages on Firm Employment

Spillover

This table estimates the effect of minimum wages on firm employment. The estimation model is based on equation (2) with difference GMM and instruments of lags from one year to two years. The dependent variable $L_t$ is the number of a firm's employees. $\text{MW}_t$ denotes county minimum wages at year $t$. The sample includes firm observations over the period 2001–06.

$MW_t$ denotes the county minimum wage at year $t$. In Panel A, the variable $NBMW_t$ is the average minimum wage of neighboring counties at year $t$ (in logs). In Panel B, we use four explanatory variables to measure the spillover effect, each measuring the difference between the local minimum wage and the distance-weighted neighbor minimum wage of different polynomial orders: $MW - NBMW_1$, $MW - NBMW_2$, $MW - NBMW_3$, and $MW - NBMW_4$, where $NBMW_i$ is the neighbor minimum wage weighted by distance to the power of $i$.

Robust standard errors clustered at the level of counties are shown in the parentheses below the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided). Level variables are all in logs.

| | Dependent variable $L_t$: log(employees) | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| | Panel A | | |
| $\text{MW}_t$ | 0.004 | $-0.079^{**}$ | $-0.076$ |
| | (0.023) | (0.038) | (0.055) |
| $\text{SP}_t = \text{MW}_t$ - $\text{NBMW}_t$ | 0.028 | 0.018 | $-0.059$ |
| | (0.038) | (0.036) | (0.061) |
| | Panel B | | |
| $\text{MW}_t$ | 0.014 | $-0.075^{**}$ | $-0.114^{**}$ |
| | (0.022) | (0.037) | (0.050) |
| Observations | 427404 | 424872 | 418018 |
| ***Controls*** | | | |
| Neighbor Pairs × Year | | | **Y** |
| Province × Year | | Y | **Y** |
| Firm variables | Y | Y | **Y** |
| Macroeconomic variables | Y | Y | **Y** |
| Minimum wage factors | Y | Y | **Y** |

Table VII: Effect of Minimum Wages on Firm Employment and Wage

Policy Reform (before and after 2004)

This table estimates the effect of minimum wages on firm employment and wage separately for the periods before and after the 2004 reform. The estimation model is based on equation (2) with difference GMM and instruments of lags from one year to two years. The dependent variable $L_t$ is the number of a firm's employees. $\text{MW}_t$ denotes county minimum wages at year $t$. The sample includes firm observations over the period 2001–06. $MW_t \times (> 2004)$ and $MW_t \times (\leqslant 2004)$ shows separately the effect of minimum wages after and before 2004. For ownership dummy variables, foreign firms including those from HMT are used as the reference group.

Robust standard errors clustered at the level of counties are shown in the parentheses below the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided). Level variables are all in logs.

| | (1) | (2) | (3) |
|---|---|---|---|
| | Panel A<br>Dependent variable $L_t$: log(employees) | | |
| $\text{MW}_t \times (\leqslant 2004)$ | 0.010 | −0.029 | −0.055 |
| | (0.018) | (0.035) | (0.049) |
| $\text{MW}_t \times (> 2004)$ | 0.012 | $-0.113^{***}$ | $-0.170^{***}$ |
| | (0.018) | (0.040) | (0.053) |
| ↳ Diff: $(> 2004) - (\leqslant 2004)$ | 0.002 | $-0.083^{***}$ | $-0.115^{***}$ |
| | (0.004) | (0.017) | (0.019) |
| | Panel B<br>Dependent variable $W_t$: log(firm average wage) | | |
| $\text{MW}_t \times (\leqslant 2004)$ | $0.203^{***}$ | $0.371^{***}$ | $0.392^{***}$ |
| | (0.020) | (0.046) | (0.044) |
| $\text{MW}_t \times (> 2004)$ | $0.205^{***}$ | $0.272^{***}$ | $0.327^{***}$ |
| | (0.019) | (0.050) | (0.046) |
| ↳ Diff: $(> 2004) - (\leqslant 2004)$ | 0.003 | $-0.098^{***}$ | $-0.066^{***}$ |
| | (0.004) | (0.022) | (0.016) |
| Observations | 427786 | 424872 | 418018 |
| ***Controls*** | | | |
| Neighbor Pairs × Year | | | **Y** |
| Province × Year | | Y | **Y** |
| Firm variables | Y | Y | **Y** |
| Macroeconomic variables | Y | Y | **Y** |
| Minimum wage factors | Y | Y | **Y** |

Table VIII: Effect of Minimum Wages on Firm Wage

This table estimates the effect of minimum wages on firm per employee wages. The estimation model is similar to equation (2) with difference GMM and instruments of lags from one year to two years. The dependent variable $W_t$ is a firm's per employee wage. $\text{MW}_t$ denotes county minimum wages at year $t$. The sample includes firm observations over the period 2001–06.

Robust standard errors clustered at the level of counties are shown in the parentheses below the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided). Level variables are all in logs.

| | Dependent variable $W_t$: log(firm average wage) | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| $\text{MW}_t$ | $0.351^{***}$ | $0.320^{***}$ | $0.361^{***}$ |
| | (0.032) | (0.047) | (0.045) |
| Observations | 427786 | 424872 | 418018 |
| ***Controls*** | | | |
| Neighbor Pairs × Year | | | **Y** |
| Province × Year | | Y | **Y** |
| Firm variables | Y | Y | **Y** |
| Macroeconomic variables | Y | Y | **Y** |
| Minimum wage factors | Y | Y | **Y** |

Table IX: Heterogeneous Effect of Minimum Wages on Firm Wage

Heterogeneous effect

This table estimates the heterogeneous effect of minimum wages on firm wages. The estimation model is based on equation (2) with difference GMM and instruments of lags from one year to two years. The dependent variable $W_t$ is a firm's per employee wage. $\text{MW}_t$ denotes county minimum wages at year $t$. The sample includes firm observations over the period 2001–06. Log firm relative wage is defined as the log difference between firm wages and local minimum wages: $\text{FW}_{t-1} - \text{MW}_{t-1}$. A positive coefficient of firm relative wage indicates that the heterogeneous effect on lower-wage firms is higher. The coefficients of the variables not interacted are not reported.

Robust standard errors clustered at the level of counties are shown in the parentheses below the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided). Level variables are all in logs.

| | Dependent variable $W_t$: log(firm average wage) | | |
|---|---|---|---|
| | Panel A: Firm Heterogeneity | | |
| $\text{MW}_t \times (\text{FW}_{t-1} - \text{MW}_{t-1})$ | $-1.103^{***}$ | $-2.896^{***}$ | $-2.832^{***}$ |
| | (0.035) | (0.057) | (0.051) |
| $\text{MW}_t \times \text{sales}_{t-1}$ | $0.077^{***}$ | $0.252^{***}$ | $0.262^{***}$ |
| | (0.007) | (0.009) | (0.009) |
| $\text{MW}_t \times \text{SOE}_t$ | $-0.090^{***}$ | $-0.032$ | $-0.051$ |
| | (0.023) | (0.038) | (0.033) |
| $\text{MW}_t \times \text{PRV}_t$ | $-0.113^{***}$ | $-0.135^{***}$ | $-0.111^{***}$ |
| | (0.020) | (0.035) | (0.028) |
| $\text{MW}_t \times \text{profit margin}_{t-1}$ | 0.030 | 0.059 | 0.043 |
| | (0.025) | (0.040) | (0.039) |
| $\text{MW}_t \times \text{export/sales}_{t-1}$ | $-0.059^{***}$ | $-0.040^{*}$ | $-0.069^{***}$ |
| | (0.016) | (0.021) | (0.017) |
| | Panel B: Industry Heterogeneity | | |
| $\text{MW}_t \times \text{HHI}_t^{\mathbf{IND}}$ | $0.010^{**}$ | 0.007 | $-0.001$ |
| | (0.004) | (0.006) | (0.005) |
| $\text{MW}_t \times \text{labor share}_t^{\mathbf{IND}}$ | $-0.017$ | 0.017 | $-0.009$ |
| | (0.010) | (0.015) | (0.012) |
| Observations | 427786 | 424872 | 418018 |
| | Panel C: Labor Market Heterogeneity | | |
| $\text{MW}_t \times$ High LIMI | $-0.023$ | 0.006 | 0.024 |
| | (0.030) | (0.034) | (0.029) |
| $\text{MW}_t \times$ High ECI | $-0.001$ | $-0.003$ | 0.001 |
| | (0.003) | (0.003) | (0.003) |
| Observations | 424872 | 425194 | 418018 |
| ***Controls*** | | | |
| Neighbor Pairs × Year | | | **Y** |
| Province × Year | | Y | **Y** |
| Firm variables | Y | Y | **Y** |
| Macroeconomic variables | Y | Y | **Y** |
| Minimum wage factors | Y | Y | **Y** |

Table X: Estimation of Firm Attrition in the ASIF Sample, 2001–06

This table estimates how firm attrition is determined in the ASIF data for the period 2001–06.

The binary dependent variable is whether a firm will stay in the sample in the next period. The explanatory variables are firm characteristics, including sales, employment, ownership, profit margins, firm age, and squared firm age. County minimum wages, county controls, and city fixed effects are used as additional controls. A pooled probit model is estimated separately for each year. Each column shows results for one year denoted on the column header.

Robust standard errors clustered at the city level are shown in the parentheses below the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided). Level variables are all in logs.

| | Dependent variable: firm $\text{stay}_{t+1}$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) 2001 | (2) 2002 | (3) 2003 | (4) 2004 | (5) 2005 | (6) 2006 |
| $\text{MW}_t$ | 0.107 | 0.145 | $0.973^{***}$ | 0.065 | 0.144 | 0.128 |
| | (0.373) | (0.282) | (0.198) | (0.141) | (0.217) | (0.195) |
| $\text{sales}_t$ | $0.227^{***}$ | $0.252^{***}$ | $0.206^{***}$ | $0.184^{***}$ | $0.210^{***}$ | $0.248^{***}$ |
| | (0.013) | (0.012) | (0.009) | (0.034) | (0.021) | (0.015) |
| $L_t$ | $0.115^{***}$ | $0.080^{***}$ | $0.095^{***}$ | $0.126^{***}$ | $0.108^{***}$ | $0.124^{***}$ |
| | (0.011) | (0.010) | (0.008) | (0.008) | (0.010) | (0.010) |
| $\text{SOE}_t$ | $-0.156^{**}$ | $-0.193^{***}$ | $-0.255^{***}$ | $-0.503^{***}$ | $-0.170^{***}$ | $-0.452^{***}$ |
| | (0.065) | (0.062) | (0.035) | (0.062) | (0.037) | (0.052) |
| $\text{PRV}_t$ | $-0.213^{***}$ | $-0.178^{***}$ | $-0.264^{***}$ | $-0.102^{**}$ | $-0.096^{***}$ | 0.032 |
| | (0.046) | (0.039) | (0.032) | (0.050) | (0.023) | (0.023) |
| $\text{HMT}_t$ | $-0.110^{***}$ | $-0.090^{**}$ | $-0.115^{***}$ | $-0.100^{***}$ | $-0.095^{***}$ | −0.034 |
| | (0.030) | (0.041) | (0.029) | (0.025) | (0.020) | (0.022) |
| $\text{profit margin}_t$ | $0.442^{***}$ | $0.497^{***}$ | $0.633^{***}$ | $0.329^{***}$ | $1.026^{***}$ | $1.160^{***}$ |
| | (0.037) | (0.032) | (0.041) | (0.046) | (0.065) | (0.060) |
| $\text{firm age}_t$ | $-0.030^{***}$ | $-0.025^{***}$ | $-0.030^{***}$ | −0.003 | $-0.017^{***}$ | $-0.015^{***}$ |
| | (0.005) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| $\text{firm age}_t^2$ | $0.001^{***}$ | $0.001^{***}$ | $0.001^{***}$ | $0.000^{***}$ | $0.000^{***}$ | $0.000^{***}$ |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Observations | 140,176 | 154,715 | 172,520 | 247,156 | 243,919 | 271,164 |

Table XI: Effect of Minimum Wages on Firm Employment

Robustness checks concerning delayed implementations in 2004

This table estimates the effect of minimum wages on firm employment. The estimation model is based on equation (2) with difference GMM and instruments of lags from one year to two years. The dependent variable $L_t$ is the number of a firm's employees. $\text{MW}_t$ denotes county minimum wages at year $t$. The sample includes firm observations over the period 2001–06. $MW_t \times (> 2004)$ and $MW_t \times (\leqslant 2004)$ shows separately the effect of minimum wages after and before 2004. For ownership dummy variables, foreign firms including those from HMT are used as the reference group.

Column 1 treats the first year of minimum wage adjustment after 2004 as the start of the post-reform period. Column 2 uses the same specification as our main regressions and does not consider reform delays and only treats the year 2004 as the start of the post-reform period. Therefore, column 2 replicates the result in column 3 of Table VII. Column 3 excludes the seven provinces which did not implement minimum wage adjustment in 2004 from the sample.

Robust standard errors clustered at the level of counties are shown in the parentheses below the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided). Level variables are all in logs.

| | Dependent variable $L_t$: log(employees) | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| $\text{MW}_t \times (\leqslant 2004)$ | −0.058 | −0.055 | −0.054 |
| | (0.049) | (0.049) | (0.057) |
| $\text{MW}_t \times (> 2004)$ | $-0.170^{***}$ | $-0.170^{***}$ | −0.071 |
| | (0.052) | (0.053) | (0.055) |
| ↳ Diff: $(> 2004) - (\leqslant 2004)$ | $-0.113^{***}$ | $-0.115^{***}$ | −0.017 |
| | (0.019) | (0.019) | (0.014) |
| Observations | 419866 | 418018 | 328241 |
| ***Controls*** | | | |
| Neighbor Pairs × Year | **Y** | **Y** | **Y** |
| Province × Year | **Y** | **Y** | **Y** |
| Firm variables | **Y** | **Y** | **Y** |
| Macroeconomic variables | **Y** | **Y** | **Y** |
| Minimum wage factors | **Y** | **Y** | **Y** |

Table XII: Effect of Minimum Wages on Firm Employment

Political considerations

This table estimates the effect of minimum wages on firm employment. The estimation model is based on equation (2) with difference GMM and instruments of lags from one year to two years. The dependent variable $L_t$ is the number of a firm's employees. $\text{MW}_t$ denotes county minimum wages at year $t$. The sample includes firm observations over the period 2001–06.

Column 1 uses the same specification as our main regressions by treating the first year of minimum wage adjustment after 2004 as the start of the post-reform period. Therefore, column 1 replicates the result in column 3 of Table IV. Column 2 includes the personal characteristics, namely, the age and tenure, of the local government chief to indicate some political considerations that we cannot observe.

Robust standard errors clustered at the level of counties are shown in the parentheses below the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided). Level variables are all in logs.

| | Dependent variable $L_t$: log(employees) | |
|---|---|---|
| | (1) | (2) |
| $\text{MW}_t$ | $-0.110^{**}$ | $-0.103$ |
| | (0.050) | (0.063) |
| age of city chief$_t$ | | 0.000 |
| | | (0.001) |
| tenure of city chief$_t$ | | 0.001 |
| | | (0.001) |
| Observations | 418018 | 267427 |
| ***Controls*** | | |
| Neighbor Pairs × Year | **Y** | **Y** |
| Province × Year | **Y** | **Y** |
| Firm variables | **Y** | **Y** |
| Macroeconomic variables | **Y** | **Y** |
| Minimum wage factors | **Y** | **Y** |

Table XIII: Effect of Minimum Wages on Firm Employment

Placebo test

This table estimates the effect of minimum wages on firm employment. The estimation model is based on equation (2) with difference GMM and instruments of lags from one year to two years. The dependent variable $L_t$ is the number of a firm's employees. $\text{MW}_t$ denotes county minimum wages at year $t$. The sample includes firm observations over the period 2001–04. $MW_t \times (> 2002)$ and $MW_t \times (\leqslant 2002)$ shows separately the effect of minimum wages after and before 2004.

Robust standard errors clustered at the level of counties are shown in the parentheses below the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level (two-sided). Level variables are all in logs.

| | Dependent variable $L_t$: log(employees) | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| $\text{MW}_t \times (\leqslant 2002)$ | 0.010 | −0.014 | −0.055 |
| | (0.027) | (0.039) | (0.070) |
| $\text{MW}_t \times (> 2002)$ | 0.004 | −0.022 | −0.090 |
| | (0.027) | (0.039) | (0.072) |
| ↳ Diff: $(> 2002) - (\leqslant 2002)$ | −0.006 | −0.008 | −0.035 |
| | (0.004) | (0.021) | (0.025) |
| Observations | 199342 | 197861 | 194945 |
| ***Controls*** | | | |
| Neighbor Pairs × Year | | | **Y** |
| Province × Year | | Y | **Y** |
| Firm variables | Y | Y | **Y** |
| Macroeconomic variables | Y | Y | **Y** |
| Minimum wage factors | Y | Y | **Y** |

Figure I: Spatial Variation of County Minimum Wages, 2001–06

The following figures show the spatial distribution of counties at different quartiles of their minimum wages. The years shown here are from 2001 to 2006. The minimum wage is measured by the end-of-year monthly minimum wage. Counties are grouped according to the quartile that their minimum wages is attributed at the national level. Darker color represents a higher quartile level of minimum wages.

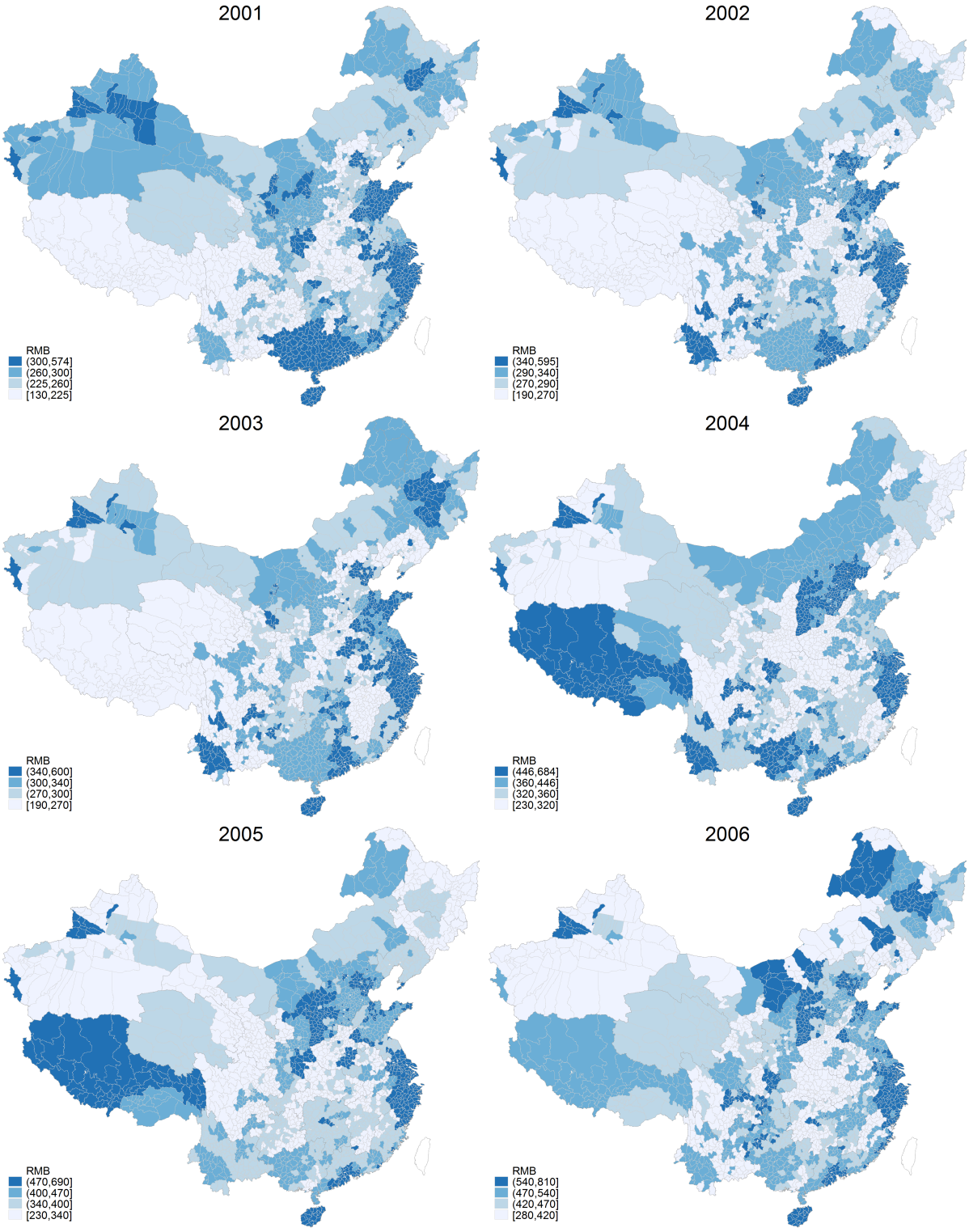

Figure II: Spatial Variation of County Minimum Wage Growth, 2001–06

The following figures show the spatial distribution of counties at different quartiles of their minimum wage growth. The years shown here are from 2001 to 2006. The minimum wage is measured by the end-of-year minimum wage. Counties are grouped according to the quartile their minimum wages belong to at the national level. Darker color means a higher quartile of minimum wage growth rates.

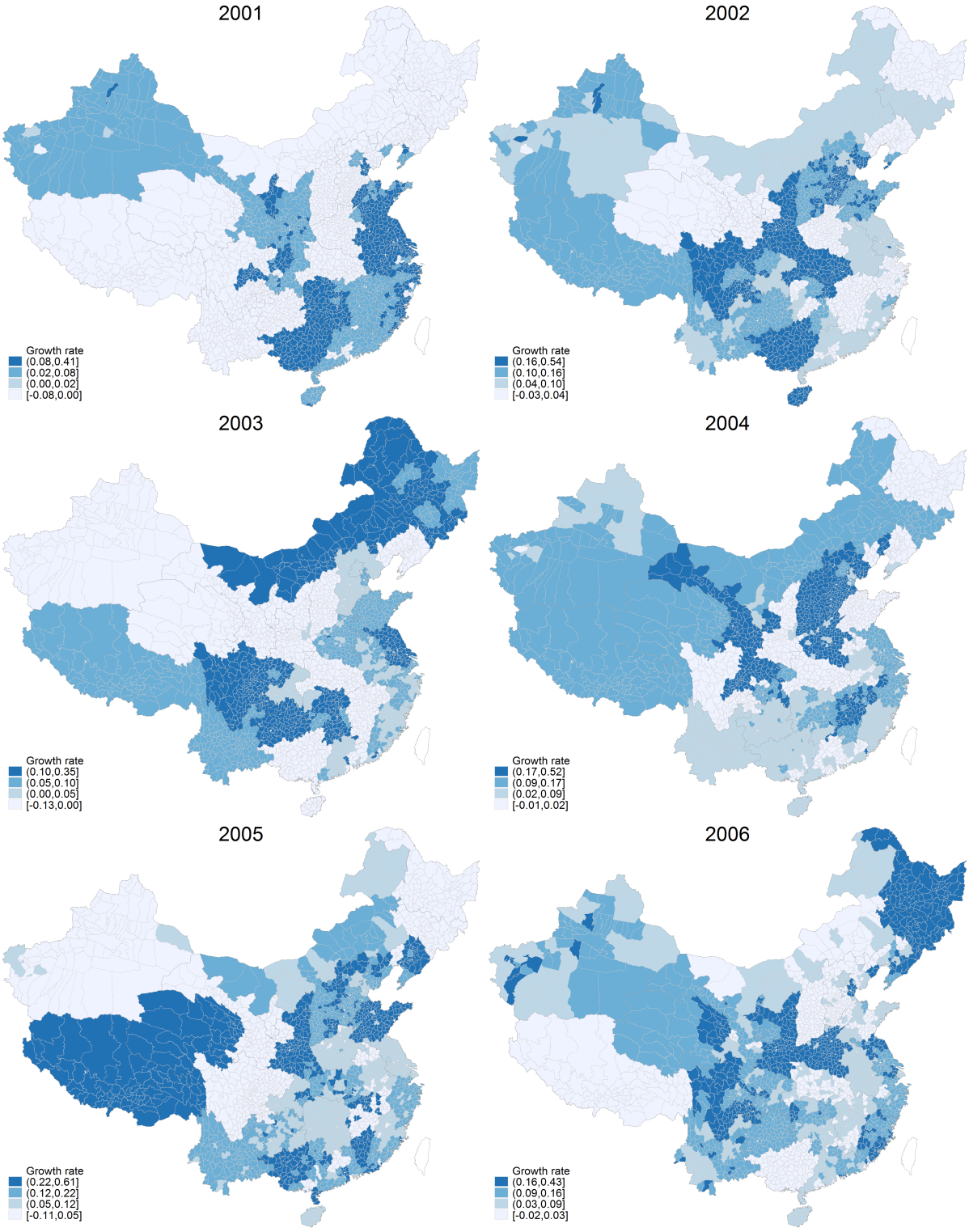

Figure III: Spatial City Distribution According to Within-City Minimum Wage Variations

The figure shows the spatial distribution of China's municipal city capitals, represented by dots (with solid fill color) or squares (with transparent fill color) according to within-city variations of their county minimum wages during the period 2001–06. If a city's counties have same minimum wages during the period, it is represented by a dot. If a city's counties have different minimum wage levels, it is represented by a square. The total number of municipal cities shown here is 337, not including those in Hong Kong SAR, Macau SAR, and Taiwan.

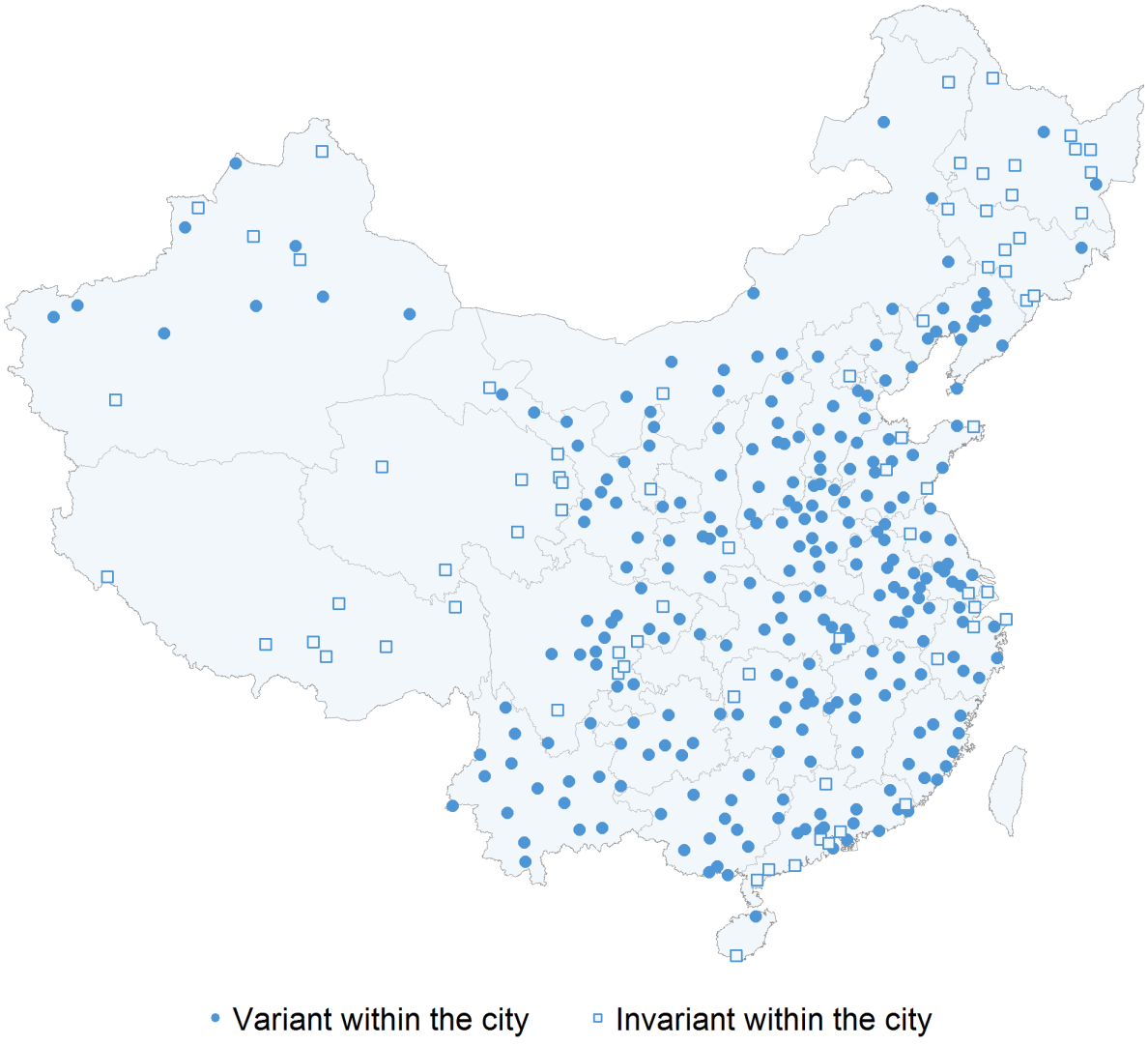

Figure IV: The Trend of China's Minimum Wages and Employee Wages, 1995–2011

The figure shows the trend of median county minimum wages and median county employee wages over the period 1995–2011. County minimum wages are calculated by average monthly minimum wages. Both wages are in nominal terms. The left axis measures the ratio between the two median county wages. The right axis measures the two wage levels.

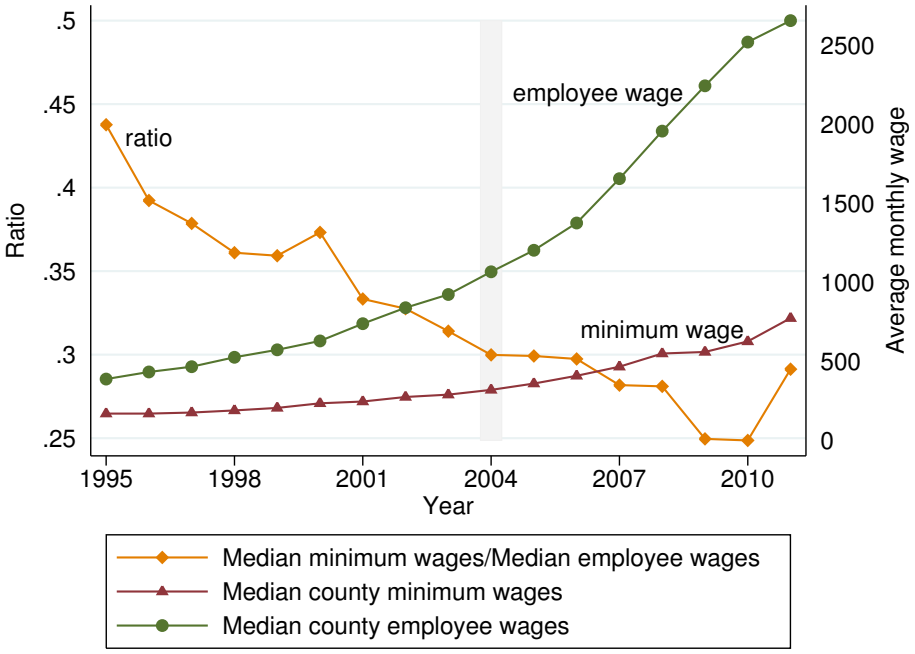


Figure V: Nominal and Real Minimum Wages

The figure shows the trend of median county minimum wages and real median county minimum wages over the period 1998–2011. County minimum wages are denoted by the end-of-year (December) monthly minimum wages.

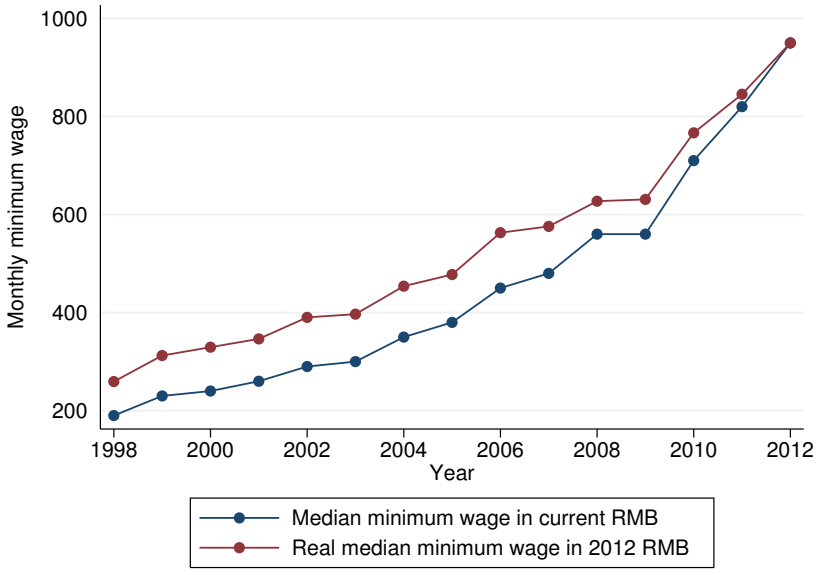

Figure VI: Proportion of Counties with Positive Minimum Wage Hikes, 1996–2012

This figure shows the proportion of counties with positive minimum wages hikes in every year from 1996 to 2012. The number of counties in the nationwide sample is 2,878. Minimum wage hikes are measured by the annual growth rate of each county's minimum wages. Counties with positive minimum wage hikes are further grouped according to the hike range, $(0, 10\%]$, $(10\%, 20\%]$, and $(20\%, \infty)$ respectively. The height of each bar stacked for each year measures the proportion of counties whose minimum wage hikes fall into the corresponding range. The overall bar height for each year measures the proportion of counties with positive minimum wage hikes.

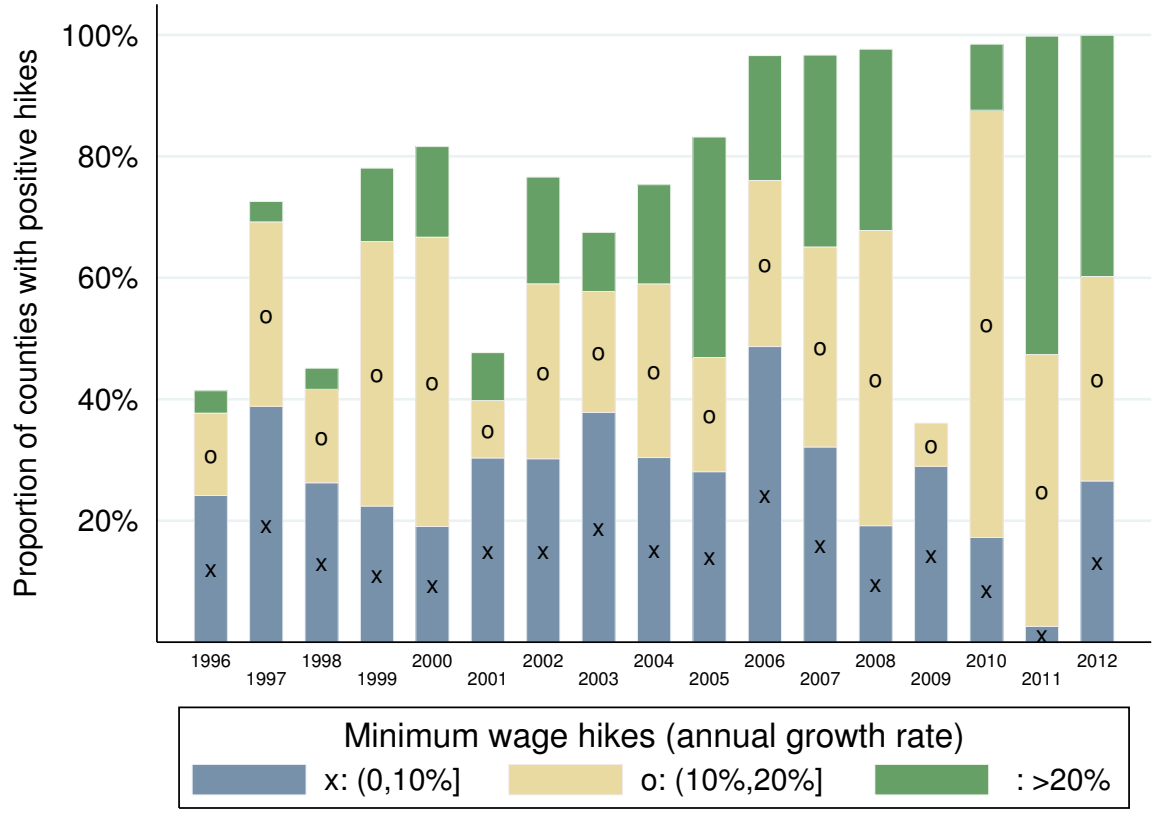

Figure VII: Minimum Wage Non-Compliance Rates, 2002–06

The table shows the average non-compliance rates of the minimum wage policy at the national level during the period 2002–06. The data of annual individual wages are from the Urban Household Survey, which covers 18 provinces (about 60 percent of the total) in China. The non-compliance rate is calculated by the share of the employees with wages lower than their county minimum wages. Our employee sample excludes employers and employees from small businesses that are not legal entities. The sample also excludes those who worked for less than 140 hours or more than 200 hours in the month (December) when they are surveyed. (Notation: Wage - individual wage; MW - local minimum wage)

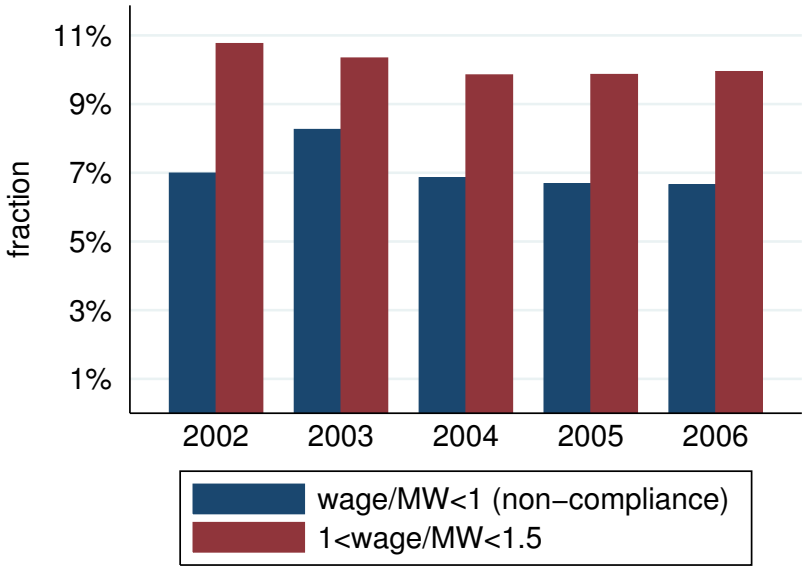


Figure VIII: Firms Paying Less Than the Minimum Wage, 2002–06

The figure shows the shares of manufacturing firms in China that paid wages below county minimum wages.

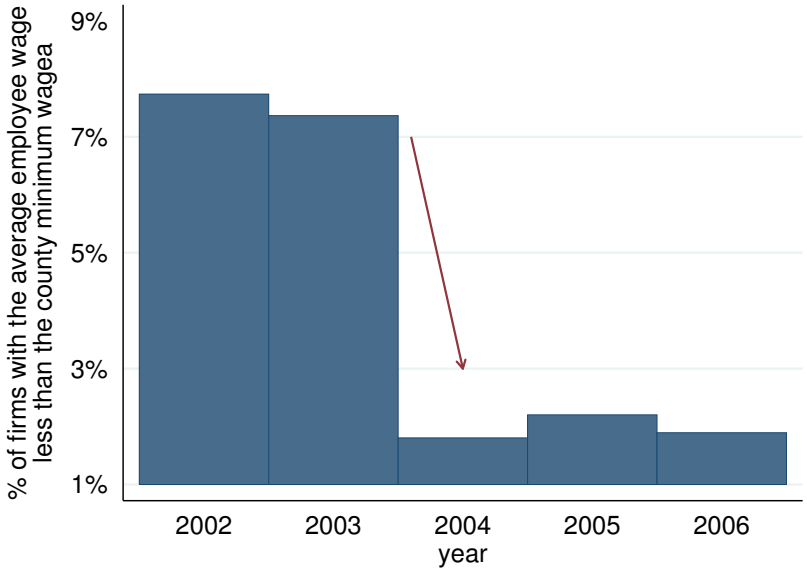

Figure IX: Distribution of Relative Firm Wages, 2001–06

This figure shows annual distributions of relative firm wages during the period 2001–06. The relative firm wage for each firm is denoted by the ratio of the average employee wage to the local minimum wage. Dash lines represent the years from 2001 to 2003. Solid lines represent the years from 2004 to 2006.

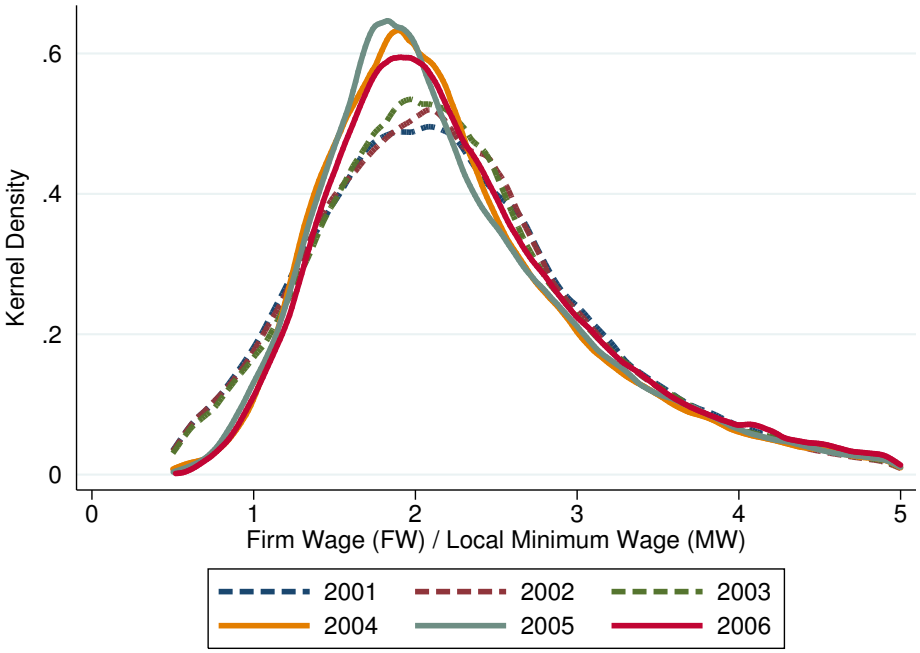

Figure X: Proportion of Neighboring Counties with Positive Hike Difference, 1996–2012

This figure shows the proportion of neighboring counties with positive hike difference in minimum wages from 1996 to 2012. There are 6,965 neighbor county pairs in the nationwide sample, among which 6,223 pairs are within the same province. Minimum wage hikes are measured by the annual growth rate of each county's minimum wages. Neighboring counties with positive hike difference in minimum wages are further grouped according to the difference range, $(0, 5\%]$, $(5\%, 10\%]$, and $(10\%, \infty)$ respectively. The height of each bar stacked for each year measures the proportion of neighboring counties whose minimum wage hike differences fall into the corresponding range. The overall bar height for each year measures the proportion of counties with positive minimum wage hike difference.
The statistics for cross-province and within-province pairs of neighboring counties are calculated separately. For each year, the bar on the left is for cross-province neighboring county pairs, while the bar on the right is for within-province neighboring county pairs.

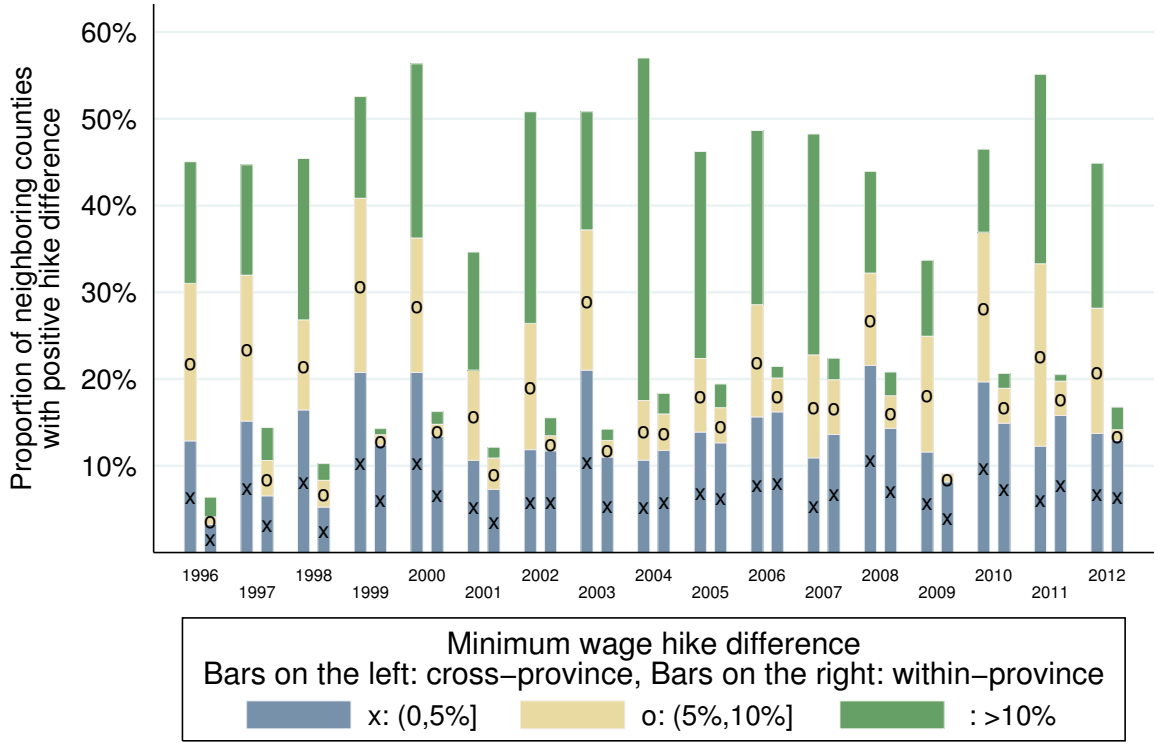

Figure XI: Minimum Wage Hikes in Neighboring Counties

The case of Chongqing Municipality in 2004

The figure shows an example of one directly controlled municipality to clarify how minimum wage hikes vary at the county level. This municipality city is Chongqing, which has 40 counties. Minimum wage hikes are measured by the annual growth rate of each county's minimum wages. Darker color means higher values of growth rates. The left panel shows county minimum wage hikes. The right panel shows county growth rates of GDP per capita.