The cleansing effect of minimum wages
Minimum wages, firm dynamics and aggregate productivity in China*

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Abstract

We here consider how Chinese firms adjust to higher minimum wages and how these affect aggregate productivity, exploiting the 2004 minimum-wage reform in China. We find that higher city-level minimum wages reduced the survival probability of firms which were the most exposed to the reform. For the surviving firms, thanks to significant productivity gains, wage costs rose with at most modestly negative employment effect. At the city-level, our results show that higher minimum wages positively affect aggregate productivity growth via both productivity growth in incumbent firms and the net entry of more productive firms. Hence, in a fast-growing economy like China, there is a cleansing effect of labor-market standards.

Keywords: minimum wages, firm-level performance, aggregate TFP, China.
JEL codes: O14, J38, O47.

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1 Introduction

Can higher minimum wages ensure that economic development benefits the poorest without hindering growth? The question is controversial in both academic and policy circles. The recent riots in Bangladesh and Cambodia show that the social demand for a more equal distribution of the benefits of growth is high in developing countries. In China, polls reveal that concerns about inequality have grown as "roughly eight-in-ten have the view that the rich just get richer while the poor get poorer" (Pewresearch Center, 2012). The debate is also heated in developed economies: renowned politicians and economists have called for a significant rise in minimum wages in the U.S. (Woellert, 2014), as has Barack Obama in his 2014 State of the Union address. On the other hand, any attempt by authorities to increase minimum wages is opposed by employer federations, who argue that higher wages will erode their margins, forcing them to fire workers or entirely relocate their activities to countries with lower wages. The American Chamber of Commerce states, for example, on its Philippine website that "the relentless upward adjustment in the minimum wages in the Philippines has made minimum wages in the Philippines among the highest minimum wages in ASEAN and caused great harm to the country's domestic and export manufacturing sectors".[1] These two opposing views mirror the lack of consensus among academics on the effects of minimum wages for firms and workers (see Dube et al., 2010; Allegretto et al., 2011 Neumark et al., 2013, for example).

In this paper we use balance-sheet data from over 160,000 industrial firms to analyze both the firm- and aggregate-level effects of higher minimum wages in China, where the minimum wage is set at the city-level. Our empirical strategy exploits the 2004 reform of minimum wages that imposed large but heterogeneous increases in minimum wages across Chinese cities. We combine a triple-difference approach with instrumental-variable techniques. We show that the 2004 reform was binding: the share of Chinese firms complying with the local minimum wage or paying wages just above the minimum level drastically increased after the reform, while no such trend was found pre-2004. Moreover, we find that higher minimum wages reduced the survival probability of local firms between 2003 and 2005. However, in

[1] http://www.amchamphilippines.com/2013/10/24/jfc-statement-on-minimum-wage-increase/.

the surviving firms wages rose with at most a slight negative effect on employment. The main explanation for this finding is that firms improved significantly their productivity following the cost shock, allowing them to absorb the shock without (or modestly) affecting employment or profitability. We show that these results are not consistent with competing explanations. In particular, we do not detect any substitution of less-paid/less protected migrants for incumbent workers. At the aggregate level (our data covering 70% and 90% of overall industrial employment and production respectively), our results suggest that the overall effect of firm-level adjustments in city-level industrial employment is zero. Moreover, higher minimum wages increase aggregate productivity growth thanks to productivity improvements among incumbent firms and the net entry of more productive firms. Hence, in a fast-growing economy like China there is a cleansing effect of labor market standards. Minimum wage growth allows more productive firms to replace the least productive firms, and forces incumbent firms to become more competitive. These two mechanisms boost the economy's aggregate efficiency. The effects we measure are economically large. Minimum wage growth between 2003 and 2005 explains on average 20% of firm- and city-level productivity gains in China over the period under consideration.

China is a relevant case to analyze for a number of reasons. First, China, the fastest-growing economy over the past fifteen years, has become a key player in the global economy; as such, understanding the determinants of its competitiveness and industrial dynamics is of interest for both developed and developing countries. Moreover, China is a showcase in terms of low wages: in 2004, average monthly wages in manufacturing were 141 Dollars in China, versus 342 Dollars in Mexico and over 2,500 Dollars in the US.[2]

Second, as shown in Figures A-1 to A-3 in the Appendix, there is considerable variation in both the level and growth-rate of the minimum wage in the 261 Chinese cities in our final sample.[3] In 2003, the minimum wage ranged from 170 Yuan (20 Dollars) in Eerduosi and Hulunbeier (Inner Mongolia) to 600 Yuan (72 Dollars) in Shenzhen; on the other hand, between 2003 and 2005, it rose by up to 147% (also in Eerduosi and Hulunbeier), while re-

[2] Authors' calculations based on LABORSTA ILO data: `http://laborsta.ilo.org/STP/guest`.

[3] China is divided into 4 municipalities (Beijing, Tianjin, Shanghai and Chongqing) and 27 provinces which are further divided into prefectures. As is common in the literature, we use the terms city and prefecture interchangeably, even though prefectures include both an urban and a rural component.

maining constant in some other cities which in 2003 already satisfied the new wage standards introduced in the 2004 reform.

Third, the 2004 reform is of interest as it followed a top-down logic. The express aim of this reform was to increase workers' wages and bring about convergence between localities in terms of the minimum wage: the reform was supposed to foster minimum wages in cities where they were initially lower and to increase firm-level compliance so as to ensure that after 2004, city-level minimum wages fall within a range of 40-60% of the local average wage. We show that Chinese minimum wages consequently increased drastically over a short period of time (the average annual growth rate of city-level minimum wages was 14% between 2004 and 2007, versus 7% between 2000 and 2003), while the dispersion of minimum wages across localities narrowed significantly (the coefficient of variation of city-level minimum wages fell by 25% between 2003 and 2007). We exploit this quasi-natural experimental feature of the reform to carry out IV estimations of the firm- and aggregate-level effects of minimum wages.

We carry out our analysis by identifying two groups of firms based on their exposure to the 2004 minimum-wage reform. Exposed firms are defined as those for which average wages prior to the reform were lower than the subsequent local minimum wage (as in Harrison and Scorse, 2010, and Draca et al., 2011). We then compare the performance of exposed and non-exposed firms, controlling for firm-level initial characteristics (size, productivity, export, ownership etc.) and for city-sector fixed effects. This allows us to account for any potential correlation between minimum-wage growth and local business cycles, and firm and sector characteristics. We focus on the pre- and immediately post-reform period to exploit the large and widely-varying rise in city-level minimum wages induced by the policy. This estimation strategy is close to a triple difference, and amounts to comparing the difference in performance growth between exposed and non-exposed firms in cities where the minimum wage grew sharply to that in cities where it grew more slowly. However, minimum wages may rise faster in cities where the economic situation of low-wage firms is more favorable. To address this remaining endogeneity issue, we propose an IV strategy based on the institutional features of the 2004 reform; more specifically, we use the initial level of the minimum wage and the predicted minimum-wage growth based on the "40% rule" that minimum wages be at least 40% of average wages to estimate the causal effect of minimum wages on firm-level outcomes.[4] We follow a similar instrumentation strategy to analyze the effect of minimum wages on city-level outcomes.

Our work here contributes to the literature in a number of ways. First, it adds to the debate on the effect of minimum wages on employment. Although raising the wage floor should theoretically increase the wages of low-paid workers and adversely affect employment (Borjas, 2004), recent evidence (largely from the US) points to little or no employment effects of minimum wages (Card and Krueger, 1994; Dickens et al., 1999; Dube et al., 2010; see Schmitt, 2013, for a review).[5] However, the question remains controversial (see Dube et al., 2010; Allegretto et al., 2011 Neumark et al., 2013, for example). We here revisit this question using data from Chinese factories, which are often considered as a symbol of "low-cost" production. There is already some work on China in this respect; this has relied on aggregated or semi-aggregated data and has produced mixed results.[6] We differ from this existing work by the use of much more detailed data, so that we can directly link firm-level outcomes to changes in the local minimum wage. The work closest to ours is the firm-level analysis of Huang et al. (2014) on local minimum wages and employment. Our work differs in three important respects. We focus on the 2004 reform, which provides us with an original instrument to address the endogeneity problems that are typical in this area, we consider non-employment outcomes such as firm-level productivity and profitability, and we analyze the aggregate consequences of minimum wages for employment and productivity.

[4]The greater the difference between the lower limit for the city-level minimum wage in 2005 and its actual level in 2003, the larger the increase in the local minimum wage should be.

[5]One of the potential explanations for the lack of an employment effect is that the percentage of workers earning the minimum wage in the countries in question is very small, i.e. under 5% (Neumark et al., 2004), and that the changes in the minimum wage have been only small (often lower than the inflation rate). The situation in China is radically different. Since the promulgation of the new minimum wage regulations in 2004, local governments have been required to implement frequent and substantial increases in minimum wages. The latest illustration is the pledge under China's 12$^{\text{th}}$ Five-Year Plan to raise minimum wages by at least 20% annually, and more than double them by 2015. Such substantial upward adjustments in minimum wages can be expected to have sizable repercussions on firms and workers.

[6]Ni et al. (2011) find some negative effects on overall employment in the prosperous coastal provinces and some positive effects in the less-developed interior provinces. Wang and Gunderson (2011) focus on the employment to population ratio for migrants and find the opposite result (a negative effect in non-coastal zones and no effect in the fast growing Eastern regions). These contradictory results in provincial-level data are confirmed by Fang and Lin (2013), who combine county-level minimum-wage panel data with a longitudinal household survey. Our work differs in that we use balance-sheet data from industrial firms to consider non-employment outcomes. We also focus on the 2004 reform, which provides us with an original instrument to address the endogeneity problems.

Our second contribution is that our analysis of non-employment outcomes allows us to ask why minimum wages have such small firm- and aggregate-level employment effects. Firms can adapt to higher minimum wages in a number of different ways. Some examples are lower labor turnover or profits, greater firm efficiency or small price increases, all of which could limit employment losses (Schmitt, 2013; Hirsch et al., 2011). However, rigorous empirical evidence on such effects is scarce (with the notable exception of Draca et al., 2011, who show that British firms absorbed the shock of the introduction of a national minimum wage in 1999 by reducing their profit margins).[7] In this paper, we propose a careful evaluation of the various ways in which Chinese firms may have adjusted to the 2004 reform, including survival, number of employees, productivity and profitability.

Third, we provide an in-depth analysis of the effect of minimum wages on the various margins of city-level productivity growth. To the best of our knowledge, this is the first paper to investigate how firm-level adjustments to minimum wages help shape aggregate outcomes. By doing so, we contribute to the analysis of the determinants of aggregate efficiency in developing countries. Both firm-level inefficiency and the misallocation of resources across firms have been proposed as explanations of the lower aggregate TFP in developing countries (Hsieh and Klenow, 2009). Regarding the first channel, a number of recent papers have shown that there is a fixed cost of adopting better practices/technologies (Bloom et al., 2013; Duflo et al., 2011).[8] With respect to the second channel, Khandelwal et al. (2013) argue that institutions might play a role in this (mis)allocation of resources.[9] We here argue that labor standards might also determine resource allocation and aggregate efficiency. Indeed, the lower the wages, the smaller the absolute difference in per-unit marginal cost resulting from "high" and "low" production/management technologies. In some developing countries,

[7]However, Draca et al. (2011) do not find firm-level adjustments in terms of productivity.

[8]Bloom et al. (2013) use a randomized experiment to show that adopting better management practices significantly increases firm-level productivity in Indian textile firms. The experiment suggests that informational barriers, as well as procrastination, prevent firms from adopting the best management practices. Duflo et al. (2011) also use a randomized experiment to show that Kenyan farmers do not always use fertilizers even though it is profitable to do so; however, they do adopt them when their delivery (but not the fertilizers themselves) is provided for free immediately following the harvest. This is consistent with a model where agents are present-biased and have a fixed utility cost of fertilizer adoption.

[9]They show that under the Multi Fibre Arrangement, the allocation of export licenses to Chinese textile exporters resulted in serious misallocation, less-productive firms receiving more export licenses than did more-productive firms.

low wages might thus provide incumbent firms with only little incentive to adopt more efficient, but also more costly, technologies or management practices; they may also allow some inefficient firms to survive. Along these lines, we show that increasing minimum wages in a fast-growing economy like China improves aggregate efficiency due to higher productivity among surviving firms and the net entry of more productive firms. However, higher minimum wages do not seem to favor the reallocation of market shares towards initially more productive incumbent firms.

Finally, we also contribute to the literature on the role of labor laws and labor standards in improving the situation of low-paid workers in developing countries. Harrison and Scorse (2010) find that anti-sweatshop activism increased wages without hurting employment in the Indonesian footwear and textile industries, while higher minimum wages tended to reduce employment. We here focus on minimum wages but extend our analysis to the entire manufacturing sector.

The remainder of the paper is structured as follows. The next section describes the Chinese minimum-wage system, and the theoretical effects of higher minimum wages on firm- and aggregate-level outcomes. Section 3 then presents the data and some descriptive statistics, while Section 4 sets out our empirical strategy. Section 5 discusses the firm-level results, and Section 6 provides an analysis of the effects of minimum wages on aggregate employment and productivity. Last, Section 7 concludes.

2 Minimum wages in China and their potential effect on firm- and aggregate-level outcomes

We first describe how minimum wages are set in China and the main features of the 2004 reform. To guide our empirical analysis, we then discuss the various theoretical effects of minimum wages on firm- and aggregate-level outcomes.

2.1 Characteristics of the 2004 minimum-wage reform

Minimum wages were first introduced in China in 1993 following the country's ratification of the International Labor Organization Convention No. 26. However, the 1993 rules did not really cover migrants, and the penalties in the case of non-enforcement were low. As such, minimum wages in the 1990s did not really bind in China.

In March 2004, the Rules for Minimum Wages (2004 Rules) took effect. These extended minimum-wage coverage to migrant workers, and penalties in the case of non-enforcement were dramatically increased. One of the explicit aims of the reform was to increase living standards. As different Chinese regions have very different living standards, China does not have one national minimum wage; minimum wages are rather established following a decision process involving both national and local authorities. Each province, municipality, autonomous region, and even district sets its own minimum wage according to both local conditions and national guidelines.[10] Typically, following the national requirements, provincial governments set out multiple minimum-wage classes for the region as a whole, and each city and county within the region chooses the appropriate minimum-wage level based on its own local economic conditions and living standards. For example, in the latest round of minimum wage increases, Zhejiang set out four minimum-wage classes for the entire province, with some top-tier cities such as Hangzhou, Ningbo and Wenzhou choosing the highest minimum wage (Class A), while other cities, including Jiaxin, Jinhua and Taizhou settled on the next-highest minimum wage (Class B).

The fact that municipalities can adjust the minimum wage to local economic conditions (the distribution of wages, evolution of living costs and prices, and level of economic development and changes in employment) ensures spatial variation in the level of minimum wages but also gives rise to an endogeneity problem, making it difficult to establish the causal effect of higher minimum wages; however, the existence of national guidelines is useful here since it allows us to develop instruments to address this potential endogeneity. Crucially for our analysis, the 2004 Rules expressly encourage minimum-wage convergence across localities,

[10] The definition of minimum wage may also vary across locations. Beijing, Shanghai, Jiangsu, Shanxi and Henan do not include social security payment and housing public funds when calculating minimum wage while other provinces do. In unreported results, which are available upon request, we check that our main message holds when excluding those locations.

yielding unprecedentedly large rises in the minimum wage where they were initially particularly low. As a guideline, the 2004 Rules state that the local minimum wage for full-time employees should fall within a range of 40-60% of the monthly local average wage.[11] This range is quite similar to what we observe in a number of developed countries. In 2011, the French monthly minimum wage was around 1,100 Euros, with the average wage being roughly double that amount at 2,100 Euros,[12] while in the US these figures were 1,250 and 3,600 Dollars respectively.[13] This target was already present in the previous rules for Chinese minimum wages. However, the absence of proper control or sanctions in case of non-enforcement made these rules largely ineffective. As argued in Section 4, this radically changed with the 2004 Reform allowing us to exploit these national guidelines as instruments for local minimum wages in our empirical strategy.

2.2 The theoretical effects of higher minimum wages

Higher minimum wages represent a cost shock for firms (potentially both in terms of the fixed and marginal costs of production). This shock can have a variety of effects on firms, depending on the theoretical framework we have in mind.

In a perfectly-competitive environment where the marginal productivity of labor is decreasing and wages equal the marginal productivity of labor, higher minimum wages should reduce the number of workers that firms employ. Moreover, some firms may no longer be able to sell enough to cover their fixed production costs, and will thus shut down.

The predictions are similar in a model where heterogeneous firms in terms of productivity compete monopolistically with constant markups. Firms will pass all of the higher marginal cost on to higher consumer prices. Overall demand will fall and the least-productive firms will be forced to exit the market, as they will no longer be able to cover their fixed production costs.

These firm-level adjustments should generate unemployment, as the labor demand curve

[11] See the decree available at `http://www.molss.gov.cn/gb/ywzn/2006-02/15/content_106799.htm`.

[12] See `http://www.insee.fr/fr/bases-de-donnees/bsweb/serie.asp?idbank=000879878` and `http://www.insee.fr/fr/themes/tableau.asp?reg_id=0&ref_id=NATTEF04155`.

[13] See `http://www.ssa.gov/oact/cola/AWI.html` and `poverty.ucdavis.edu/faq/what-are-annual-earnings-full-time-minimum-wage-worker`.

is negatively-sloped and wages do not adjust downwards. With heterogeneous workers, stronger layoff effects are expected for workers with lower skills and/or productivity. However, a number of mechanisms may mitigate these negative employment effects from higher minimum wages.

Under efficiency wages, higher minimum wages can increase labor productivity by motivating employees to work harder, allowing firms to absorb the cost shock. In addition, when workers decide to participate in the labor market, and choose their employer as a function of their outside option, higher minimum wages may not necessarily reduce employment due to greater labor-market participation or less worker turnover within firms. Also, under imperfect competition with variable markups, firms can partially absorb any cost shock via lower profit margins. Draca et al. (2011) focus on the minimum wage in the UK and find results consistent with this latter hypothesis.

Last, higher minimum wages may also yield firm-level efficiency gains. Assume that firms have to choose between two production processes: a high-tech process with low constant marginal labor requirements but a high fixed adoption cost, and a low-tech process with high marginal labor requirements but no adoption cost. Higher minimum wages widen the marginal-cost gap between the high- and low-tech technologies. As such, keeping quantities constant, the opportunity cost of adopting the high-tech process falls. Consequently, firms which previously preferred the low-tech process may switch to paying the fixed cost required for the high-tech process. Low wages here act as a disincentive for the adoption of more efficient production techniques.

This brief discussion has underlined that higher minimum wages can affect a number of firm-level outcomes: survival, employment, productivity and profitability. Depending on the framework we have in mind, the mechanisms may act in opposite directions, so that the impact of higher minimum wages on aggregate employment and productivity is a priori ambiguous. The aim of this paper is mainly empirical, and we do not explicitly test theoretical frameworks against each other. However, by considering a variety of firm-level outcomes, we are able to discuss the possible ways in which Chinese firms have adjusted to the 2004 minimum-wage reform and how these affected aggregate productivity.

3 Data and summary statistics

Before discussing our estimation strategy, we here briefly present the data we use and their descriptive statistics.

3.1 Data

Our main data source is the annual surveys conducted by the National Bureau of Statistics (NBS) in China. Those firm-level surveys include balance-sheet data for all industrial state-owned and non-state firms with sales above 5 million Yuan. The industries here include mining, manufacturing and public utilities. A comparison to the 2004 full census of industrial firms reveals that these firms (accounting for 20% of all industrial firms) employ roughly 70% of the industrial workforce and generate 90% of output and 98% of exports (Brandt et al., 2012).[14] We use information on the number of employees, production, capital, intermediate inputs and wages.[15] We use data from the surveys for all years from 1998 to 2007. However, as our paper focuses on the evolution of firm- and city-level performance between 2003 and 2005, our main sample comprises these two years (our main results hold when restricting the period to 2003-2004 or when enlarging it to 2003-2006).

The data on minimum wages at the prefecture level come from various official websites such as China Labour Net.[16] The data contain monthly minimum wages for full-time employees and hourly minimum wages for part-time employees by city and year.[17] Since we do not have information on the total number of hours worked, we include only the former in our regressions.

The macroeconomic indicators at the city-level such as GDP, population, FDI, unemployment, road density and university-student enrollment, which are used as controls in the aggregate regressions, are taken from China Data Online[18], provided by the University of

[14]We follow the routine developed by Brandt et al. (2012) to link firms over time using a unique numerical identifier.

[15]These data aggregate almost perfectly to the totals for the same set of variables reported in the Chinese Statistical Yearbook.

[16]This website (http://www.labournet.com.cn/) was set up by the Ministry of Labour and provides information on national labour and personnel rules.

[17]City-level minimum wage might be adjusted several times in a given year. We define the city-level minimum wage in a year as the highest value the minimum wage takes in that year in the city.

[18]`http://chinadataonline.org/`

Michigan.

3.2 Firm-level indicators and summary statistics

All the information we have is at the firm or city level; we do not have information at the worker level. To compute firm-level average wages, we thus divide the firm's total wage bill by the number of employees.

While labor productivity is our main productivity measure throughout the paper, we also calculate a firm-level TFP index. To do so, we estimate Cobb-Douglas production functions at the 2-digit industry level following the approach developed by Levinsohn and Petrin (2003). Intermediate inputs are used as a proxy for unobserved variables (entrepreneur characteristics or macroeconomic shocks) which could determine the level of both inputs and output.[19]

We clean the data by excluding observations for which value-added, capital or wages is missing, negative or zero, and drop firms with fewer than 5 employees as reported average wages may not be reliable for these firms. In order to avoid measurement issues in the aggregate analysis, we also restrict our attention to localities with at least 20 firms in 2003 and 2005, and for which information on GDP, employment, FDI and so on is available. This leaves us with a sample of 261 cities.

Our final sample contains 167,327 firms active in 2003, of which 21.5% had average wages below the local minimum wage enforced in 2005. As is usual in the few papers considering the effects of minimum wages with firm-level data (Harrison and Scorse, 2010; Draca et al., 2011), we define this group as "exposed", as they are certainly the most affected by the minimum-wage rise. We discuss below the implications for our estimations of defining treatment in this way.

Table A-1 in the Appendix presents statistics on the survival rates and change in the average wage separately for exposed and non-exposed firms. The proportion of firms present in 2003 which survived until 2005 is much lower for exposed firms (66%) than for non-

[19]The results, available upon request, provide credible elasticities. The coefficient on labor is on average lower than that usually found in the literature, but this is not surprising for a developing country such as China where worker productivity is quite low.

exposed firms (78%). Furthermore, wages rose significantly faster between 2003 and 2005 for the low-wage exposed firms. Over this period, the growth rate of firm-level average wages was 92 log points in this latter group, but only 13 log points in the group of firms with higher initial average wages. The gap is similar for the evolution of the median firm-level average wage within each group. These simple descriptive statistics suggest that there is a negative correlation between "exposure" to the 2004 minimum-wage reform and survival, and a positive correlation between "exposure" and the growth-rate of firm-level average wages over the period. Our econometric analysis will then try to assess whether these correlations can be interpreted as causal. By way of contrast, note that the average growth rate of the minimum wage over this period is roughly the same for exposed and non-exposed firms; this suggests that there is no systematic difference in the geographic distribution of exposed and non-exposed firms in our sample.

Table A-2 in the Appendix continues the descriptive analysis by regressing the "exposed" dummy on firm-level characteristics and city-sector fixed effects. Firms with average wages below the subsequent minimum level report (quite intuitively) lower productivity. They are also less likely to be foreign firms and exporters. The correlation with employment is sensitive to the way in which productivity is computed: in column (1), where we use the value of output per employee, employment enters negatively, while in column (2), with the Levinsohn-Petrin approach, the coefficient on employment is positive. The State-ownership dummy is not significant, which could reflect two opposing features which cancel each other out: on the one hand, State-owned firms are more likely to respect minimum-wage laws, and hence pay higher wages than the other firms; on the other hand, they can afford to pay lower wages while remaining attractive to workers since they provide non-pecuniary benefits (such as job security). Finally, all else equal (controlling for size and productivity, in particular), exposed firms are more profitable, which might directly result from their lower wages. All of these results are robust to the exclusion of outliers defined as the top and bottom percentile of firms in terms of 2003 average wages (in column (3)).

To sum up, the firms the most exposed to minimum-wage growth between 2003 and 2005 are more likely to be Chinese domestic firms with low productivity. However, given their productivity and size, these firms tend to be more profitable, this latter feature being consistent with their lower wages.

4 Empirical strategy

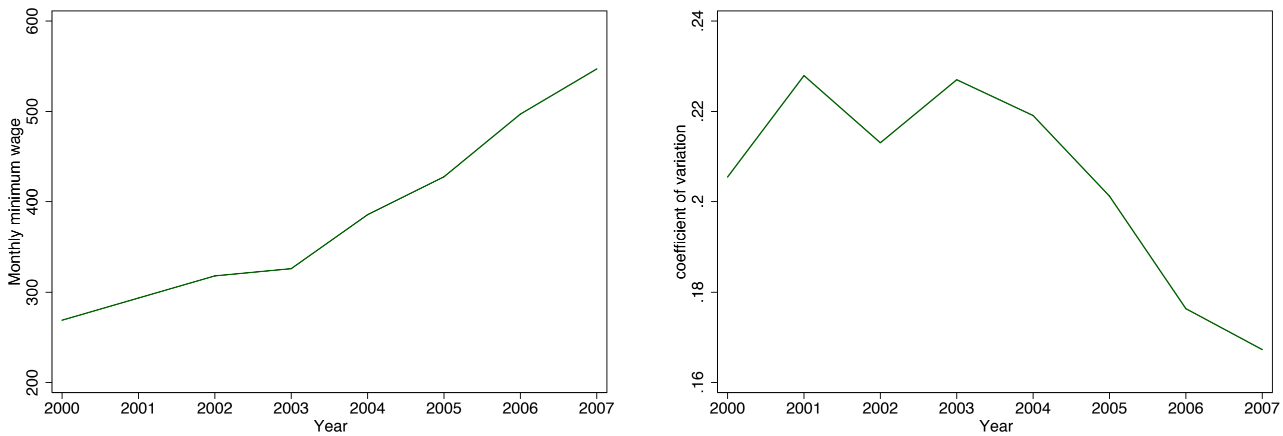
This section shows that the 2004 Chinese minimum-wage reform yields a nice quasi-natural experiment to estimate the effect of minimum wages on firm- and aggregate-level outcomes. We then discuss in detail our estimation strategy.

4.1 The 2004 reform as an experiment to assess the economic effects of minimum wages

Most work on the effect of minimum wage has to deal with two main issues. First, it can be difficult to estimate the effects of minimum wages on firm-level outcomes if the change in the minimum wage is only small, or take place across the country at different but quite similar points in time (when minimum wages are set locally). In this latter case, the cross-section distribution of minimum wages remains on average stable over time, yielding only short time-spans in which to estimate any effect (Meer and West, 2013). This is actually often the case in the empirical analyses of US and UK data.

Another issue, more particular to developing countries, is the extent to which minimum wages are enforced. Massive non-compliance makes it difficult to identify minimum wage effects (see for example Strobl and Walsh, 2003, for the case of Trinidad and Tobago).

The 2004 Chinese reform has a number of advantages with respect to these two issues. First, the reform imposed a massive rise in city-level minimum wages. As shown in Figure 1, city-level minimum wages increased over all of the 2000-07 period, with a clear acceleration from 2004 onwards. While the average annual growth rate in city-level minimum wages was 6.9% between 2000 and 2003, it was 15.5% between 2003 and 2007. The other remarkable feature of post-2004 minimum wages is their convergence across cities. The right-hand panel of Figure 1 shows that the dispersion of city-level minimum wages was stable pre-2004, with a coefficient of variation of 0.23. However, post-reform the coefficient of variation fell sharply to 0.2 in 2005, and 0.17 in 2007. This suggests that the fast city-level minimum wage growth we observe from 2004 onwards is concentrated in cities with lower pre-reform minimum wages; this outcome conforms to the convergence objective which was explicitly pursued by national authorities with the 2004 minimum-wage reform. This feature will be particularly useful for our instrumentation strategy.



Average minimum wage
(in Yuan)

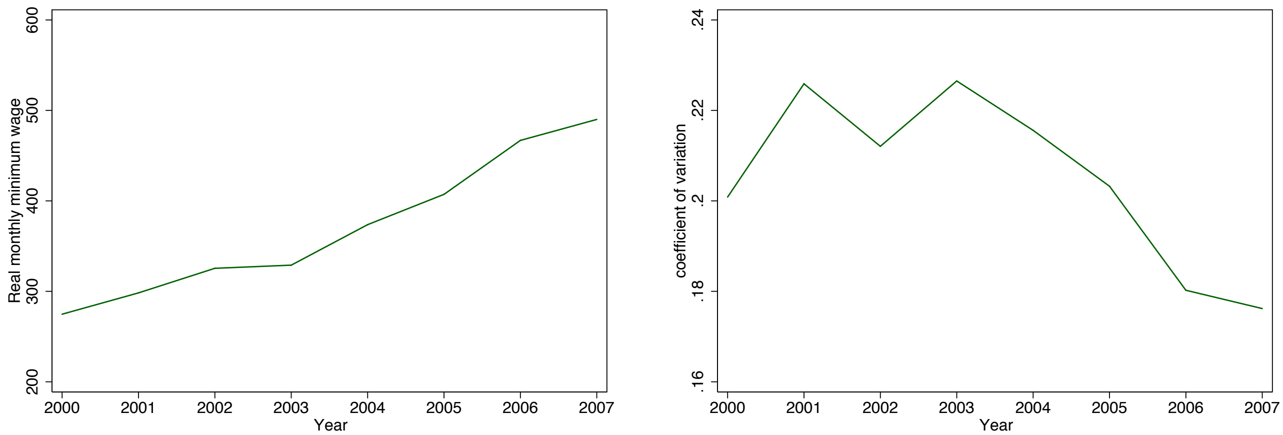
Coefficient of variation
of city-level minimum wages

Figure 1: The change in city-level minimum wages

We might wonder whether these nominal rises in minimum wages are in reality cancelled out by inflation, so that finally there is only little wage pressure on firms. We do not have city-level price indices, and so use provincial price indices to calculate city-level real minimum wages. Figure 2 shows that the movements in city-level real minimum wages are very similar to the nominal movements in Figure 1. City-level real minimum wages rose on average by 6.5% per annum before the 2004 reform and by 12.1% post-reform, this post-reform growth being again concentrated in cities with lower initial real minimum wages. In the econometric analysis, we use real minimum-wage information.[20]

City-level minimum wages may have only little effect for two reasons: a lack of enforcement, or the minimum wage not really binding (if firm-level wages are rising faster than the minimum wage, for example). Neither enforcement nor the degree to which minimum wage binds are observable. However, we do have some information suggesting that firms became

[20] In unreported results, which are available upon request, we check that our main message holds when using nominal-wage information.



Average real minimum wage (in Yuan)

Coefficient of variation of city-level real minimum wages

Figure 2: The change in city-level real minimum wages

more constrained by minimum wage rules following the reform.

First, the 2004 reform aimed to increase firm-level compliance by strengthening controls and reinforcing non-compliance penalties. Prior to 2004, average wages were at least equal to the local city-level minimum wage in roughly 88.5% of active firms. This figure rose to 93.2% after 2004, suggesting that the Chinese minimum-wage reform was accompanied at the local level by greater enforcement.[21]

In addition, Figure 3 shows a growing concentration of firm-level average wages around the level of the city-level minimum wage post-2004. The top part of this figure depicts the distribution of firm-level wages (left panel) and the ratio of firm-level wages to the city-level minimum wage (right panel) in 2003 and 2005. The bottom part of the figure shows the analogous distributions for 2001 and 2003. Firm-level wages rose markedly between 2003 and 2005, with the 2005 wage distribution shifting right from that pre-2004. However, this shift is not uniform across the distribution. The top-right panel of Figure 3 shows that in 2005 fewer firms declared average wages below the local minimum level, as compared to 2003. On the contrary, more firms now declare average wages that are equal to or slightly

[21] Our data include the total wage bill and the number of workers, but not the number of hours worked. Our measure of firm-level average wages is sensitive to the presence of part-time workers in the firm. However, as long as part-time intensity remains constant over time, the change in the share of firms with average wages below the city-level minimum wage can be interpreted as a change in the way minimum wages are enforced.

above the local minimum wage. This concentration of the distribution of firm average wages around the city-level minimum wage does not seem to result from a time trend, since no such pattern is seen between 2001 and 2003 (in the bottom-right panel). Table A-3 in the Appendix additionally shows that the share of firms whose average wage is below the city-level minimum wage, and that whose average wage is at 15% above, fell slightly between 2001 and 2003 (from 12.4% to 10.3% and from 5.2% to 4.5%, respectively).

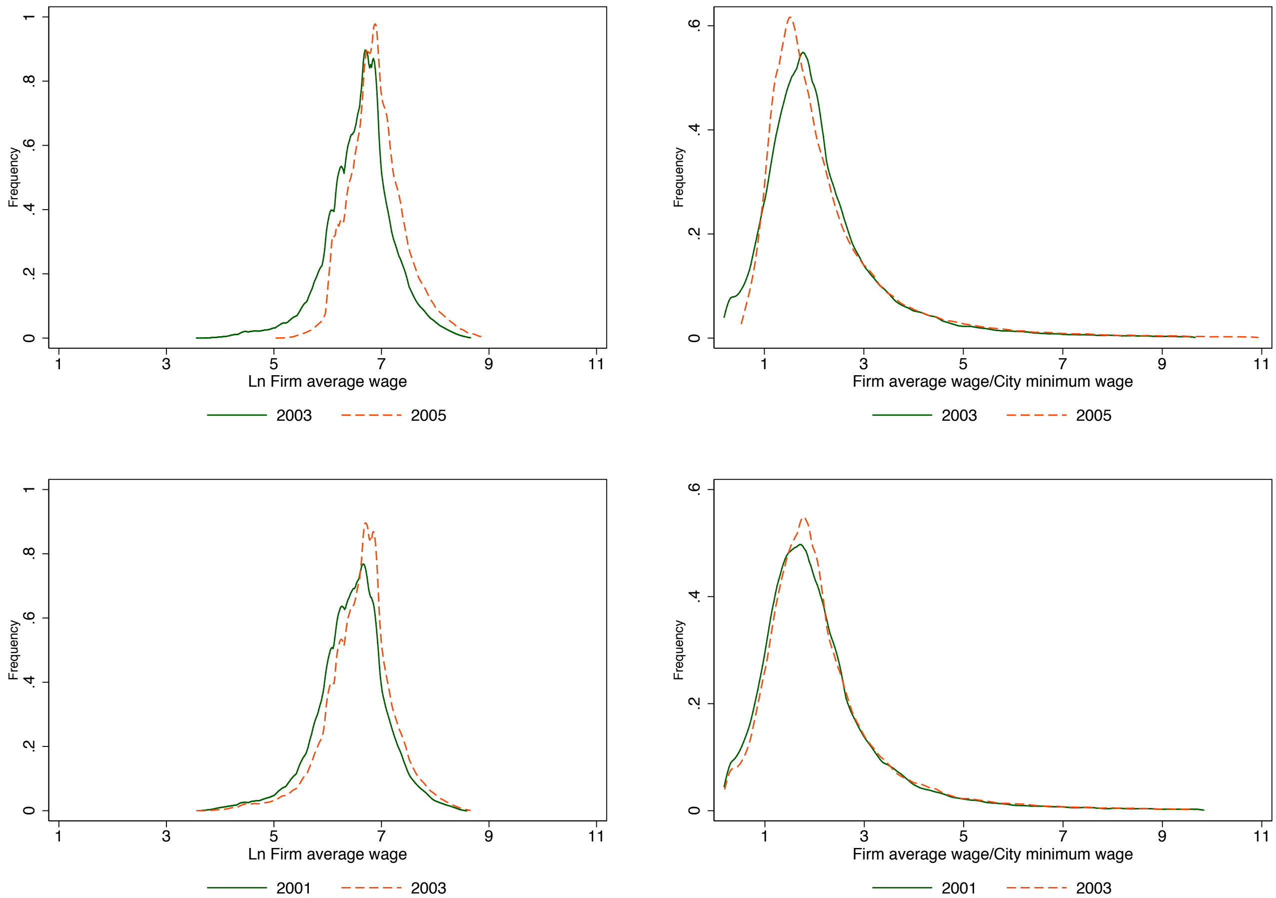


Figure 3: The distribution of firm-level average wages pre and post the 2004 reform

The picture is different for the 2003-2005 period: the share of non-complying firms drops sharply (from 10.3% to 6.3%) while that of firms with average wages just over the city-level minimum wage rises (from 4.5% to 5.7%). These movements are qualitatively similar across firm types (foreign, State-owned and domestic private firms).

The 2004 reform thus produced unprecedented changes in the minimum wage, both in nominal and real terms. Moreover, these changes seem to be binding: the share of complying firms rose sharply, as did the share of firms with average wages that are equal to or only slightly higher than the minimum wage. Such patterns are not observed just before the reform and thus cannot be attributed to a general time trend.

4.2 Empirical specification and instrumentation

We provide both micro (firm-level) and aggregate (city-level) analyses of the effect of real minimum wages on economic performance. We here present in detail the estimation strategy for the firm-level analysis: that for city-level outcomes is very similar. From now on, we will use the expressions "real minimum wage" and "minimum wage" interchangeably.

Whatever the country under consideration, assessing the effect of minimum wages on firm-level performance brings up serious endogeneity issues. In particular, the authorities may fix the minimum wage so as to match existing trends in firm performance, in particular in terms of employment. The common view is that minimum wage rises will be larger when the local economic context is favorable, so as to minimize any potential adverse effect on firms. We would then find upward-bias in the estimated employment impact of the minimum wage. This concern is particularly apt in China, where municipalities can officially adapt the minimum wage to local economic conditions.

We here focus on the 2003-05 period since this is centered on the year of the Chinese minimum-wage reform; however, our results are robust to the choice of alternative time windows.[22] We define "exposed firms" as those for which average wages in 2003 were below the local minimum wage in 2005. These firms are obliged to raise wages in order to comply with the new city-level minimum wage. Note that we do have no information on worker-level wages. Our measure of reform "exposure" is thus potentially noisy: in reality, some fraction of employees will not be exposed to the reform in so-called "exposed" firms and *vice versa* for "non-exposed" firms. However, this is the best way to define exposure with firm-level data; this is also the logic of the estimation proposed by Harrison and Scorse (2010) and Draca et al. (2011) in their empirical analyses of Indonesian and British data, respectively,

[22] In unreported results, which are available upon request, we check that our main message holds when restricting the period to 2003-2004 or enlarging it to 2003-2006.

and represents an improvement over aggregate analysis.[23]

We compare the change in firm-level performance for "exposed" and "non-exposed" firms within cities and sectors (using city-sector fixed effects). This strategy helps to account for the fact that cities with a favorable economic context might be less reluctant to increase the minimum wage than other cities. Comparing exposed firms to other firms in the same locality and industry will control for any local and sectoral level effects.

We further refine our identification strategy by addressing two potential remaining endogeneity issues.

First, exposed firms might have particular characteristics which directly affect the change in their economic performance. With our detailed firm-level data, we can control for initial firm size (in terms of employment), productivity, average wages, exports, as well as firm ownership (State-owned, Chinese private, foreign). These variables help to account for any particular firm-level effects. In particular, controlling for initial performance allows us to capture any potential firm convergence or divergence effects. Most previous work in this area has relied on more aggregate data and so did not control for firm-level characteristics.

Second, local authorities may decide minimum-wage increases based on the (anticipated) particular changes in low-wage firms, and not only the aggregate business cycle. To control for the potential endogeneity of city-level minimum wages to low-wage firm performance growth, we add an IV strategy to the fixed-effect estimation. The 2004 reform partly followed a top-down logic, with the national government imposing constraints on local authorities regarding their minimum wages. As long as national constraints were not designed to reflect particular local conditions, we can use the institutional features of the reform to construct our instruments. There are two variables which are natural candidates.

- First, the pre-reform city-level real minimum wage. One of the aims of the reform was to help harmonize labor regulations across Chinese cities, and we have seen that

[23]If anything, this measurement error in the treatment variable will lead to attenuation bias, driving toward zero the negative effect we find on survival and the positive effect on firm-level average wages and productivity. Regarding firm-level employment growth, we may under-estimate the negative effect of minimum wages. We will show that this is not the case by separating the firms with wages far from the future minimum wage from other exposed firms: we find no significant employment repercussions amongst the strongly-exposed firms for which attenuation bias is less likely. We moreover check that our results qualitatively hold with alternative definitions of exposure (i.e. firm-level average wage in 2003 smaller than 0.9 or 1.1 times the local wage in 2005).

the dispersion in city-level minimum wages fell sharply after 2004; we thus expect a negative relationship between the change in the city-level real minimum wage and its 2003 level.

- Second, the log difference between 0.4 times the 2005 city-level average wage and the 2003 city-level minimum wage, the 2004 reform making binding and enforced the requirement that the minimum wage falls between 40% and 60% of local average wages. However, city-level average wage in 2005 being partly determined by minimum-wage growth, such a log difference might be endogenous. This is why we use as an instrument the following variable: $\text{Ln } 0.4 \times \left[\left(\frac{\text{Avg wage}_{2002}}{\text{Avg wage}_{2001}} \right)^2 \times \text{Avg wage}_{2003} \right]$ - $\text{Ln Avg wage}_{2003}$. The city-level average wage in 2005 is replaced by its predicted value, considering that average wages increase annually between 2003 and 2005 at the same pace as they grew between 2001 and 2002. Since our regressions also control for city-level fixed effects and thus for any local trend common to all firms, we are confident in the exogeneity of this instrument. The wider the gap between this lower bound and the initial city-level minimum wage, the greater the rise in the local minimum wage. We thus expect a positive correlation between predicted growth (from the lower bound imposed by the reform) and the actual rise in local real minimum wages.

We check instrument validity by regressing the growth rate of city-level real minimum wages between 2003 and 2005 on these two variables: this produces a negative estimated coefficient on the initial minimum wage and a positive coefficient on the predicted growth rate of local minimum wages (Table 1, column (1)). This continues to hold when we introduce other city characteristics such as, among others, GDP per capita, population, FDI over GDP, road density or past employment growth, so as to control for any particular other determinants of city-level minimum wages (all these additional variables are those taken into account in the analysis of the effect of minimum wage growth on city-level outcomes). However, when we run the same regression for the 2001-2003 period, the results reported in columns (3) and (4) of Table 1 are notably different: the convergence across cities in terms of minimum wages is much less noticeable, and the predictive power of the regressions explaining city-level minimum wage growth is much lower. Also, our “predicted minimum wage growth" variable fails to be significant between 2001 and 2003. This confirms that the 2004 reform did indeed impose more constraints on cities with lower initial minimum wages.

For our instruments to be valid, they should not be correlated with business cycles which specifically affect low-wage firms.[24] Reassuringly, columns (1) and (2) of Table 2 suggest that neither the city-level minimum wage nor predicted minimum-wage growth significantly explain low-wage firm employment growth between 2003 and 2005. This again contrasts with the results for 2001-2003 in columns (3) and (4) of Table 2. Here, predicted minimum-wage growth positively predicts pre-reform employment growth in low-wage firms. While this is not a formal test, these results suggest that we cannot reject instrument exogeneity, which will be confirmed by the statistical tests during our regression analysis.

We overall take these results as evidence that initial minimum wages and the log difference between 0.4 times the predicted 2005 city-level average wage and the 2003 city-level minimum wage are good candidates for instrumenting city-level minimum wage growth.

We thus estimate an equation relating the 2003-2005 change in firm-level performance to the change in the real minimum wage over the same period in the firm's local area. The outcomes ΔY^f are in turn survival, and (for survivors) the change in average wages, employment, productivity, profitability and output. Our key explanatory variable is the 2003-2005 change in the real minimum wage in the city c where firm f is located, interacted with a dummy identifying whether firm f is exposed. Our specification can be written as follows:

$$\Delta \mathrm{Y}^{f,c,k}_{2003-05} = \alpha \Delta \ln \text{Minimum wage}^{c}_{2003-05} \times \text{Exposed}^{f}_{2003} + \beta Z^{f}_{2003} + \mu_{c,k} + \epsilon^{f}_{c,k} \tag{1}$$

where Δ denotes the 2003-2005 difference. As we exploit differences between exposed and non-exposed firms within a given city-sector pair, we also include city-sector fixed effects, $\mu_{c,k}$. The sectors are defined following the Chinese sectoral classification at the 4-digit level. Our final sample covers 480 sectors and 261 cities. Z is the set of firm-level controls including

[24]Since roughly 20% of the firms in our sample are "exposed", having 2003 average wages below the 2005 minimum wage, we here consider as low-wage firms those in the first quintile of firms in terms of average wage by city.

Table 1: The determinants of city-level minimum wage growth

Dependent variable	Δ Ln real minimum wage			
	2003-05		2001-2003	
	(1)	(2)	(3)	(4)
Ln initial minimum wage	-0.359^a	-0.519^a	-0.098^a	-0.184^a
	(0.043)	(0.054)	(0.026)	(0.036)
Predicted minimum-wage growth	0.095^b	0.075^c	-0.008	-0.013
	(0.047)	(0.045)	(0.008)	(0.009)
Profit over output		0.666^b		0.736^a
		(0.329)		(0.246)
Ln Labor productivity		0.014		-0.001
		(0.028)		(0.019)
Ln Avg wage		-0.043		0.014
		(0.034)		(0.026)
Ln GDP per capita		0.061^a		0.014
		(0.021)		(0.014)
Ln Population		0.026^b		0.030^a
		(0.011)		(0.008)
Ln Road density (per km^2)		0.016^c		-0.001
		(0.008)		(0.006)
Ratio of Univ. students over population		-0.001		0.001
		(0.001)		(0.001)
FDI over GDP		0.028^c		0.004
		(0.017)		(0.003)
Lagged Δ Ln Employment		-0.040		0.036
		(0.043)		(0.026)
R-squared	0.31	0.42	0.05	0.20
Observations	261	261	246	240

Heteroskedasticity-robust standard errors appear in parentheses. ^{a}, ^{b} and ^{c} indicate significance at the 1%, 5% and 10% confidence levels. All right-hand side variables are measured in 2003 in columns (1) and (2) and in 2001 in columns (3) and (4). Predicted minimum-wage growth is equal to Ln $0.4 \times \left[\left(\frac{\text{Avg wage}_{2002}}{\text{Avg wage}_{2001}}\right)^2 \times \text{Avg wage}_{2003}\right]$ - Ln Avg wage$_{2003}$ in the first two columns and Ln $0.4 \times \left[\left(\frac{\text{Avg wage}_{2000}}{\text{Avg wage}_{1999}}\right)^2 \times \text{Avg wage}_{2001}\right]$ - Ln Avg wage$_{2001}$ in the last two columns. Lagged Δ Ln Employment is computed over the period 2001-03 in columns (1) and (2) and 1999-2001 in columns (3) and (4).

Table 2: The determinants of city-level employment growth in low-wage firms

Dependent variable	Δ Ln Employment (low-wage firms)			
	2003-05		2001-2003	
	(1)	(2)	(3)	(4)
Ln Employment in low-wage firms	-0.159[a]	-0.195[a]	-0.042	-0.147[a]
	(0.033)	(0.058)	(0.038)	(0.048)
Ln initial minimum wage	0.180	0.016	0.216	0.233
	(0.159)	(0.167)	(0.159)	(0.178)
Predicted minimum-wage growth	0.136	0.102	0.034	0.080[b]
	(0.163)	(0.183)	(0.042)	(0.040)
Profit over output		2.059[c]		3.201[b]
		(1.210)		(1.464)
Ln Labor productivity		-0.233[b]		0.106
		(0.107)		(0.090)
Ln Avg wage		-0.041		-0.177[b]
		(0.153)		(0.074)
Ln GDP per capita		0.213[b]		-0.079
		(0.085)		(0.069)
Ln Population		0.060		0.086[c]
		(0.056)		(0.046)
Ln Road density (per km^2)		-0.033		0.085[b]
		(0.031)		(0.033)
Ratio of Univ. students over population		-0.001		-0.001
		(0.001)		(0.001)
FDI over GDP		0.153[b]		0.059[b]
		(0.060)		(0.030)
Lagged Δ Ln Employment		-0.169		0.162
		(0.161)		(0.197)
R-squared	0.15	0.22	0.02	0.12
Observations	260	260	240	240

Heteroskedasticity-robust standard errors appear in parentheses. [a], [b] and [c] indicate significance at the 1%, 5% and 10% confidence levels. All right-hand side variables are measured in 2003 in columns (1) and (2) and in 2001 in columns (3) and (4). Predicted minimum-wage growth is equal to $\text{Ln } 0.4 \times \left(\frac{\text{Avg wage}_{2002}}{\text{Avg wage}_{2001}}\right)^2 \times \text{Avg wage}_{2003}$ - Ln Avg wage$_{2003}$ in the first two columns (Ln $0.4 \times \left(\frac{\text{Avg wage}_{2000}}{\text{Avg wage}_{1999}}\right)^2 \times \text{Avg wage}_{2001}$ - Ln Avg wage$_{2001}$ in the last two columns). Lagged Δ Ln Employment is computed over the period 2001-03 in columns (1) and (2) and 1999-2001 in columns (3) and (4).

proxies for initial firm-level performance, such as employment, productivity and average wages (measured in 2003), as well as dummies for ownership type (State or foreign) and firm export status. When estimating Equation (1), we instrument $\Delta \ln \text{Minimum wage}^{c}_{2003-05} \times \text{Exposed}^{f}_{2003}$ by the interaction between the $\text{Exposed}^{f}_{2003}$ dummy and our two instruments described above.

In this specification, α can be estimated using two sources of variation: the performance-growth gap between exposed and non-exposed firms within city-sector pairs, and the real minimum wage growth gap between cities. This strategy is similar to a triple difference: we compare, for a given city-sector, the gap in performance growth between exposed and non-exposed firms, and compare cities with higher and lower real minimum wage growth. Note that in our benchmark analysis, we do not introduce the exposed dummy *per se*. Indeed, first, the specific dynamics of low-wage firms in terms of survival or other outcomes is already captured by the initial firm-level average wage used as a control variable. Moreover, both the within- and the across- city variations are useful for the estimation of the causal effect of minimum wage growth on firm-level performance. Introducing the dummy *per se* would reduce the variability used for the estimation, or more exactly, would decompose the minimum wage effect into two components: an average effect on exposed firms as compared to non-exposed firms within cities (captured by the dummy), and an additional effect depending on the size of the minimum wage increase (captured by the interaction). In unreported regressions, we tested for such a specification: results qualitatively hold but are more noisy and difficult to interpret.

When we apply Equation (1) to aggregate outcomes, we appeal to the same estimation strategy, but do not rely on interaction terms and directly instrument minimum-wage growth via the city-level initial minimum wage and predicted minimum-wage growth (controlling for initial city characteristics). We then compare cities where minimum wage grows fast to cities where it grows more slowly.

5 Firm-level results

We first analyze the effects of minimum wage growth on firm-level performance.

5.1 Baseline results

Table 3 shows the results from the estimation of Equation (1) with survival as the dependent variable;[25] the estimates corresponding to average wages, employment and labor productivity are presented in Tables 4, 5 and 6 respectively.

In column (1), we estimate Equation (1) without the dyadic (city-sector) fixed effects but including sector dummies. This specification allows us to gauge the raw association between local minimum wage growth and the change in firm-level performance for both exposed and non-exposed firms. Column (2) includes city-sector fixed effects which pick up the main effect of minimum wages in the city, leaving us with an estimated coefficient for the interaction with the firm being exposed. Column (3) further controls for firm-level initial characteristics. Column (4) shows the two-stage least squares estimates where the change in the real minimum wage is instrumented as described in the previous section. We check that our instrumental variables are not weak and are valid. We report the underidentification test and the F-test of excluded instruments in the first stage equation to evaluate instrumental weakness. The Hansen J-statistic is also presented, which assesses instrument exogeneity. All of these tests appear at the foot of the tables, and do not reject instrument validity. In column (5), we check that our results are robust to excluding observations from peripheral regions. The literature on China has emphasized an interior-coast divide. Interior locations are significantly different from the rest of the country: they have more inward-oriented economies and limited success in attracting foreign investment. We check that our firm-level real minimum wage results are not driven by these particular locations.

The results in Table 3 suggest that higher real minimum wages are detrimental to firm survival. They moreover show that the survival probability of non-exposed firms is higher in cities where the minimum wage rose faster: these OLS results are thus consistent with the local authorities being more likely to raise the minimum wage in cities with more favorable local economic conditions. On the contrary, exposed firms suffer from higher minimum wages: a 10% higher minimum wage reduces their survival probability by 4.1 percentage points as compared to non-exposed firms. Introducing city-sector fixed effects in column (2) does not affect this result. When we control for firm-level initial characteristics in column (3), the

[25] We use here a linear probability model.

negative effect of minimum wage on exposed firms is considerably reduced, with a coefficient equal to 0.14. Instrumenting minimum wage growth in column (4) makes the negative coefficient for exposed firms stronger; this confirms that minimum-wage rises were larger in cities where low-wage firms benefited from better shocks. Excluding peripheral regions does not change these results.

In our preferred specification, with city-sector fixed effects, firm-level initial characteristics and IV estimation (column 4), a 10% minimum-wage rise between 2003 and 2005 reduces the probability of exposed-firm survival by 2.1 percentage points. This effect is economically large. As the average differential in the survival rate of exposed and non-exposed firms is only 12 percentage points (see Table A-1), the elasticity of this differential to real minimum wage growth is thus -1.75.[26]

The following tables focus on surviving firms. The results in Table 4 show that minimum-wage increases lead to higher average wages in surviving firms. Theoretically, firms paying their employees no more than the minimum wage should increase employee wages by the exact same rate at which the local minimum wage increases. We would then expect an elasticity of one. The expected elasticity would, by way of contrast, be less than one for firms which in 2003 paid average wages between the 2003 local minimum wage and that imposed in 2005. The results in Table 4 are consistent with this latter scenario. The coefficient in our preferred specification is 0.36, suggesting that 10% higher local minimum wages lead to a 3.6% rise in the average wage paid by exposed firms. As such, the 2004 reform succeeded in significantly increasing wages for workers in low-wage firms. This is a further proof that the 2004 reform was binding and put wage pressure on low-wage firms. Note that again, our results hold when excluding peripheral provinces. Moreover, we add a further check. The reform we analyze does not consist in an implementation of minimum wages in cities where there were no minimum wage before, but rather in a change in the rules and in the enforcement of these rules governing minimum wages. We thus cannot run a proper placebo test and apply treatment (minimum wage growth) to pre-reform outcomes. However, in order to check whether the results we obtain are driven by specific trends at play at the firm-level, column (6) of Table 4 focuses on the firms that were already active

[26] This elasticity can be computed as follows: $-\frac{0.21\times 0.1}{0.12} \times 10 = -1.75$.

Table 3: Minimum wages and firm survival

Dependent variable	Survival of firm (2003-05)				
	(1)	(2)	(3)	(4)	(5)
Estimator				IV estimator	IV estimator w/o periphery
Δ Ln Real Minimum wage	0.157[a]				
	(0.054)				
Δ Ln Real Minimum wage $\times$ Exposed	-0.414[a]	-0.382[a]	-0.136[a]	-0.208[a]	-0.218[a]
	(0.038)	(0.034)	(0.027)	(0.031)	(0.033)
Ln Firm employment			0.081[a]	0.081[a]	0.081[a]
			(0.003)	(0.003)	(0.004)
Ln Firm wage			0.026[a]	0.020[a]	0.017[a]
			(0.004)	(0.004)	(0.004)
Ln Firm labor productivity			0.052[a]	0.052[a]	0.053[a]
			(0.003)	(0.003)	(0.003)
Firm profit over output			0.001[b]	0.001[b]	0.001[b]
			(0.001)	(0.001)	(0.001)
State dummy			-0.099[a]	-0.099[a]	-0.084[a]
			(0.018)	(0.018)	(0.027)
Foreign dummy			0.028[a]	0.028[a]	0.031[a]
			(0.006)	(0.006)	(0.007)
Export dummy			0.028[a]	0.028[a]	0.030[a]
			(0.005)	(0.005)	(0.005)
Sector Fixed effects	Yes	n.a.	n.a.	n.a.	n.a.
City-Sector Fixed effects	No	Yes	Yes	Yes	Yes
R-squared	0.01	0.01	0.06	0.06	0.06
Observations	167,327	167,327	167,327	152,226	119,663
Underidentification test				62.3[a]	42.4[a]
First-stage F-test of excluded instruments				394.6[a]	486.9[a]
Overidentification Hansen J-statistic				0.63	1.97
Chi-sq p-value				0.43	0.16

Standard errors are clustered at the city level. [a], [b] and [c] indicate significance at the 1%, 5% and 10% confidence levels. Survival is a dummy for the 2003 firm still existing in the 2005 census. Exposed is a dummy for the average wage in the firm in 2003 being lower than the local minimum wage in 2005. Δ indicates the change between 2003 and 2005. All other right-hand side variables are measured in 2003. The instruments used in the IV procedure for Δ Ln Minimum wage 2003-05 $\times$ Exposed are the interactions of the local minimum wage in 2003 and the predicted minimum-wage change based on the 40% rule (see text) with the exposed dummy. The underidentification test is based on the Kleibergen-Paap rk LM-statistic, with [a] indicating that the p-value (Chi-sq(2)) is below 0.01, suggesting that underidentification is rejected. The F-test of excluded instruments in the first-stage equation is based on the Kleibergen-Paap Wald rk F-statistic, with [a] indicating that the p-value is below 0.01, suggesting that the instruments are not weak. The F-statistic on the excluded instruments is largely above 10, the informal threshold suggested by Staiger and Stock (1997) to assess instrument validity. The Hansen J-statistic is an overidentification test of all instruments, a Chi-sq p-value above 0.10 suggests that the model is overidentified and the instruments are exogenous.

in 2001 and we control for the pre-reform firm-level wage growth. Results are very stable. We are thus confident in the fact that we really capture the causal effect of minimum wage growth on firm-level average wage.

We then investigate in Table 5 the possible repercussions of this non-negligible cost shock on the number of employees in surviving firms. The results in column (1) show that employment growth in non-exposed firms was significantly higher in cities with greater rises in the minimum wage: this again confirms that local authorities are less reluctant to increase minimum wages in cities facing better economic conditions. Regarding exposed firms, the results in columns (1) and (2) seem to suggest a negative effect, but this seems to be entirely related to the characteristics of exposed firms. We find no significant job losses in the exposed firms that remain active as soon as both city-sector fixed effects and firm-level initial characteristics are controlled for. This remains true when we rely on the IV estimation. Only when we focus on firms already active in 2001 and control for past firm-level employment growth do we find a slightly negative effect. Hence, exposed firms do not adjust (or modestly adjust) to higher minimum wages by hiring less or firing more workers than do other firms. Our results confirm, in the context of a developing country, the conclusions of a number of papers showing no negative or at most small employment effects of minimum wages in developed countries.

The results in Table 6 help us to understand the apparent paradox that higher minimum wages bring about significantly higher per employee labor costs but do not harm employment in surviving firms. We estimate Equation (1) using the log of average output per employee as the outcome variable. As in the previous results, the various tests at the foot of the table suggest that the IV procedure is valid and do not reject the null hypothesis that our instruments are appropriate and not weak. The results in Table 6 show that higher real minimum wages are associated with significant productivity gains for exposed firms. In our preferred specification in column (3), a 1% rise in the minimum wage leads to 0.38% higher productivity. Interestingly, this elasticity is very close to that of firm-level average wages to real minimum wage growth (which was 0.36). For surviving firms, the cost shock brought about by higher minimum wages seems to be exactly compensated by greater efficiency.

We examine in Table A-4 in the Appendix the repercussions of the 2004 minimum-

Table 4: Minimum wages and firm average wage

Dependent variable	Δ Ln Firm average wage (2003-05)					
	(1)	(2)	(3)	(4)	(5)	(6)
Estimator					IV estimator	
					w/o periphery	with lag
Δ Ln Real Minimum wage	-0.112^a					
	(0.009)					
Δ Ln Real Minimum wage × Exposed	2.815^a	2.985^a	0.261^a	0.359^a	0.414^a	0.406^a
	(0.131)	(0.149)	(0.100)	(0.115)	(0.138)	(0.113)
Ln Firm employment			0.051^a	0.052^a	0.049^a	0.052^a
			(0.004)	(0.004)	(0.004)	(0.003)
Ln Firm wage			-0.770^a	-0.762^a	-0.746^a	-0.631^a
			(0.030)	(0.031)	(0.037)	(0.035)
Ln Firm labor productivity			0.091^a	0.091^a	0.093^a	0.090^a
			(0.005)	(0.005)	(0.006)	(0.005)
Firm profit over output			0.059^a	0.058^a	0.055^a	0.060^a
			(0.016)	(0.016)	(0.016)	(0.023)
State dummy			0.065^a	0.065^a	0.080^a	0.063^a
			(0.019)	(0.018)	(0.024)	(0.020)
Foreign dummy			0.168^a	0.167^a	0.165^a	0.141^a
			(0.020)	(0.020)	(0.021)	(0.014)
Export dummy			0.017^b	0.017^b	0.018^b	0.018^b
			(0.007)	(0.007)	(0.007)	(0.008)
$\Delta_{2001-2003}$ Ln Firm average wage						-0.112^a
						(0.009)
Sector Fixed effects	Yes	n.a.	n.a.	n.a.	n.a.	n.a.
City-Sector Fixed effects	No	Yes	Yes	Yes	Yes	Yes
R-squared	0.16	0.16	0.47	0.47	0.45	0.43
Observations	125,779	125,779	125,779	112,171	90,714	67,316
Underidentification test				60.5^a	42^a	53.1^a
First-stage F-test of excluded instruments				406^a	478.3^a	318.4^a
Overidentification Hansen J-statistic				0.80	1.13	0.60
Chi-sq p-value				0.37	0.29	0.44

Standard errors are clustered at the city level. ^{a}, ^{b} and ^{c} indicate significance at the 1%, 5% and 10% confidence levels. Exposed is a dummy for the average wage in the firm in 2003 being lower than the local minimum wage in 2005. Δ indicates the change between 2003 and 2005. All other right-hand side variables are measured in 2003. The instruments used in the IV procedure for Δ Ln Minimum wage 2003-05 × Exposed are the interactions of the local minimum wage in 2003 and the predicted minimum-wage change based on the 40% rule (see text) with the exposed dummy. The underidentification test is based on the Kleibergen-Paap rk LM-statistic, with ^{a} indicating that the p-value (Chi-sq(2)) is below 0.01, suggesting that underidentification is rejected. The F-test of excluded instruments in the first-stage equation is based on the Kleibergen-Paap Wald rk F-statistic, with ^{a} indicating that the p-value is below 0.01, suggesting that the instruments are not weak. The F-statistic on the excluded instruments is largely above 10, the informal threshold suggested by Staiger and Stock (1997) to assess instrument validity. The Hansen J-statistic is an overidentification test of all instruments, a Chi-sq p-value above 0.10 suggests that the model is overidentified and the instruments are exogenous.

Table 5: Minimum wages and firm employment

Dependent variable	Δ Ln Firm employment (2003-05)					
	(1)	(2)	(3)	(4)	(5)	(6)
Estimator					IV estimator w/o periphery	with lag
Δ Ln Real Minimum wage	0.261[a]					
	(0.052)					
Δ Ln Real Minimum wage × Exposed	-0.447[a]	-0.552[a]	-0.044	-0.049	-0.044	-0.101[b]
	(0.044)	(0.040)	(0.036)	(0.042)	(0.047)	(0.047)
Ln Firm employment			-0.120[a]	-0.120[a]	-0.121[a]	-0.090[a]
			(0.004)	(0.004)	(0.005)	(0.005)
Ln Firm wage			0.097[a]	0.097[a]	0.098[a]	0.089[a]
			(0.007)	(0.007)	(0.007)	(0.007)
Ln Firm labor productivity			0.116[a]	0.116[a]	0.114[a]	0.119[a]
			(0.005)	(0.005)	(0.006)	(0.006)
Firm profit over output			0.032[b]	0.032[b]	0.044[a]	0.065[a]
			(0.015)	(0.015)	(0.015)	(0.025)
State dummy			-0.058[a]	-0.058[a]	-0.066[a]	-0.056[a]
			(0.011)	(0.011)	(0.014)	(0.013)
Foreign dummy			0.014[c]	0.014[c]	0.018[b]	0.009
			(0.007)	(0.007)	(0.007)	(0.008)
Export dummy			0.047[a]	0.047[a]	0.045[a]	0.043[a]
			(0.006)	(0.006)	(0.006)	(0.007)
$\Delta_{2001-2003}$ Ln Firm employment						-0.045[a]
						(0.009)
Sector Fixed effects	Yes	n.a.	n.a.	n.a.	n.a.	n.a.
City-Sector Fixed effects	No	Yes	Yes	Yes	Yes	Yes
R-squared	0.01	0.01	0.12	0.12	0.12	0.11
Observations	125,779	125,779	125,779	112,171	90,714	67,316
Underidentification test				60.5[a]	42[a]	53[a]
First-stage F-test of excluded instruments				406[a]	478.3[a]	318.1[a]
Overidentification Hansen J-statistic				0.01	0.19	0.03
Chi-sq p-value				0.98	0.66	0.85

Standard errors are clustered at the city level. [a], [b] and [c] indicate significance at the 1%, 5% and 10% confidence levels. Exposed is a dummy for the average wage in the firm in 2003 being lower than the local minimum wage in 2005. Δ indicates the change between 2003 and 2005. All other right-hand side variables are measured in 2003. The instruments used in the IV procedure for Δ Ln Minimum wage 2003-05 × Exposed are the interactions of the local minimum wage in 2003 and the predicted minimum-wage change based on the 40% rule (see text) with the exposed dummy. The underidentification test is based on the Kleibergen-Paap rk LM-statistic, with [a] indicating that the p-value (Chi-sq(2)) is below 0.01, suggesting that underidentification is rejected. The F-test of excluded instruments in the first-stage equation is based on the Kleibergen-Paap Wald rk F-statistic, with [a] indicating that the p-value is below 0.01, suggesting that the instruments are not weak. The F-statistic on the excluded instruments is largely above 10, the informal threshold suggested by Staiger and Stock (1997) to assess instrument validity. The Hansen J-statistic is an overidentification test of all instruments, a Chi-sq p-value above 0.10 suggests that the model is overidentified and the instruments are exogenous.

Table 6: Minimum wages and firm productivity

Dependent variable	Δ Ln Firm labor productivity (2003-05)					
	(1)	(2)	(3)	(4)	(5)	(6)
Estimator					IV estimator w/o periphery	with lag
Δ Ln Real Minimum wage	-0.123[a]					
	(0.008)					
Δ Ln Real Minimum wage $\times$ Exposed	0.891[a]	0.907[a]	0.281[a]	0.384[a]	0.386[a]	0.285[a]
	(0.067)	(0.051)	(0.053)	(0.055)	(0.062)	(0.056)
Ln Firm employment			0.031[a]	0.031[a]	0.036[a]	0.045[a]
			(0.006)	(0.006)	(0.006)	(0.006)
Ln Firm wage			-0.067[a]	-0.058[a]	-0.054[a]	-0.031[b]
			(0.012)	(0.012)	(0.013)	(0.012)
Ln Firm labor productivity			-0.285[a]	-0.286[a]	-0.272[a]	-0.191[a]
			(0.012)	(0.012)	(0.013)	(0.009)
Firm profit over output			-0.033	-0.033	-0.046[b]	-0.043
			(0.027)	(0.027)	(0.023)	(0.031)
State dummy			-0.192[a]	-0.193[a]	-0.210[a]	-0.117[a]
			(0.025)	(0.025)	(0.035)	(0.024)
Foreign dummy			0.051[a]	0.051[a]	0.042[a]	0.014
			(0.011)	(0.011)	(0.012)	(0.010)
Export dummy			-0.020[a]	-0.020[a]	-0.017[b]	-0.001
			(0.007)	(0.007)	(0.007)	(0.007)
$\Delta_{2001-2003}$ Ln Firm labor productivity						-0.123[a]
						(0.008)
Sector Fixed effects	Yes	n.a.	n.a.	n.a.	n.a.	n.a.
City-Sector Fixed effects	No	Yes	Yes	Yes	Yes	Yes
R-squared	0.01	0.01	0.14	0.14	0.14	0.12
Observations	125,779	125,779	125,779	112,171	90,714	67,316
Underidentification test				60.5[a]	42[a]	53[a]
First-stage F-test of excluded instruments				406[a]	478.3[a]	317.9[a]
Overidentification Hansen J-statistic				0.30	3.1	0.72
Chi-sq p-value				0.58	0.08	0.40

Standard errors are clustered at the city level. [a], [b] and [c] indicate significance at the 1%, 5% and 10% confidence levels. Exposed is a dummy for the average wage in the firm in 2003 being lower than the local minimum wage in 2005. Δ indicates the change between 2003 and 2005. All other right-hand side variables are measured in 2003. The instruments used in the IV procedure for Δ Ln Minimum wage 2003-05 $\times$ Exposed are the interactions of the local minimum wage in 2003 and the predicted minimum-wage change based on the 40% rule (see text) with the exposed dummy. The underidentification test is based on the Kleibergen-Paap rk LM-statistic, with [a] indicating that the p-value (Chi-sq(2)) is below 0.01, suggesting that underidentification is rejected. The F-test of excluded instruments in the first-stage equation is based on the Kleibergen-Paap Wald rk F-statistic, with [a] indicating that the p-value is below 0.01, suggesting that the instruments are not weak. The F-statistic on the excluded instruments is largely above 10, the informal threshold suggested by Staiger and Stock (1997) to assess instrument validity. The Hansen J-statistic is an overidentification test of all instruments, a Chi-sq p-value above 0.10 suggests that the model is overidentified and the instruments are exogenous.

wage reform on other firm-level outcomes. Results for firm-level total factor productivity calculated following the procedure proposed by Levinsohn and Petrin (2003) confirm the above findings that firms exposed to higher minimum wages react with greater productivity. Moreover, we have shown that labor-productivity gains fully match the higher wage costs resulting from real minimum-wage growth. It consequently comes as no surprise that firm profitability is not significantly affected by higher minimum wages. Finally, real minimum-wage growth leads to higher output for exposed firms, consistent with higher minimum wages generating labor productivity gains without reducing employment amongst surviving firms. Note that this result would certainly not hold in slow-growing economies. In fast-growing economies like China, the additional output from exposed firms via efficiency gains is easily absorbed due to the growth in domestic and foreign demand. In line with this idea, we find in unreported regressions that the effect of minimum wage on firm-level wages and productivity is stronger in city-sectors where GDP grows faster over the period.

Our results hence suggest that one important reason why minimum wages do not reduce employment is the firm's ability to increase productivity. However, we believe that the scope for these productivity gains may be larger in China than in developed countries (Hsieh and Klenow, 2009, Brandt et al., 2013). Higher wages could, for example, increase worker job satisfaction and reduce labor-force turnover within firms, increasing overall productivity.[27] The cost shock could also trigger the adoption of better management or organizational practices which firms had not previously implemented due to their fixed adoption costs (Bloom et al., 2013; Duflo et al., 2011). These mechanisms are probably more relevant in developing countries, and the way in which firms react to higher minimum wages might be very different in developed countries. For example, Draca et al. (2011) consider the introduction of the minimum wage in UK and do not identify any significant productivity effects. As in China, they do not find any significant negative effects on employment either: firms seem to absorb higher labor costs through lower profits.

The effects we measure are economically large. Between 2003 and 2005, real minimum wages rose by an average of 22% in China. Given the elasticities we measured, this brought

[27]The considerable rate of worker turnover in Chinese firms has been the subject of growing concern in China over the past fifteen years (Bloom et al., 2013).

about a 7.9% rise in the average wages of exposed firms, and a 8.4% rise in their labor productivity. Over this same period of time, average wages and productivity in exposed firms rose by 92% and 46% respectively (cf. Table A-1).[28] Thus, for exposed firms, the 2004 minimum-wage reform can explain about one-tenth and one-fifth of the average change in wages and productivity respectively.[29]

Our results are robust to a number of robustness checks. In particular, in spite of the introduction of city-sector fixed effects and our use of an IV strategy, we may still worry that our results are partly explained by particular shocks affecting low-wage firms. These shocks might be directly reflected in city-level GDP changes, or could be correlated with labor-force skill composition. In Table A-5 in the Appendix, we thus add GDP growth and the share of low-skilled workers in the total number of manufacturing workers in the city (measured in 2004, as information on the number of skilled and unskilled workers is only available in the National Business Surveys for that year), both interacted with the exposure dummy.[30] The results barely change from a qualitative point of view.

In Table A-6 in the Appendix we also check that our results are robust to the introduction of polynomials in the firm-level average wage. This test is inspired by a standard practice in regression-discontinuity design frameworks (Lee and Lemieux, 2010) to ensure that the coefficient on the treatment variable does not simply capture some non-linear relationship between the dependent variable and the variable used to define the treatment. Following a recent paper by Gelman and Imbens (2014), we limit ourselves to a quadratic polynomial in firm-level average wage. The results remain qualitatively unchanged for all of the outcome variables, confirming that the coefficient on the interaction between the exposed dummy and real minimum-wage growth captures a real gap in performance growth between exposed and non-exposed firms.

Finally, since we observe the number of employees and not the number of hours worked, our measure of firm-level average wage might be noisy. Given our definition of the "Exposed" dummy, this in turns might generate measurement error in the treatment variable.

[28]For exposed firms, wages increase much faster than productivity. This is in line with Li et al. (2012), who show that since the late 1990s the relative cost of labor has increased in China.

[29]The figures are 8.6% ($0.22 \times 0.361/0.92$) and 18.2% ($0.22 \times 0.381/0.46$).

[30]GDP growth and the share of unskilled workers in the manufacturing labor force are already taken into account by the city-sector fixed effects.

In unreported regressions, we investigate whether results change when we define exposed firms as those for which average wages in 2003 are below 90% or 110% of the local minimum wage in 2005. Results qualitatively hold.

5.2 Alternative explanations

We now investigate whether the absence of a negative employment effect and the positive productivity effect of minimum-wage growth can be explained by alternative mechanisms.

In particular, firms might substitute migrants for local workers in order to absorb the cost shock from higher minimum wages. It is well-known that migrant workers, who are often illegal in the cities where they live, tend to work more hours, are paid less in terms of hourly wages, and are less covered by welfare and fringe benefits (see Du and Pan, 2009 for example). As migrants are overall "cheaper" than local workers, firms can absorb the cost shock by hiring more of them. If firms do not declare their (potentially illegal) migrant workers in the National Business Surveys, due to the substitution effect, we should observe a negative effect of minimum wage growth on firm-level employment, which is inconsistent with what we find. On the opposite, if firms do declare migrants in the National Business Surveys, employment in exposed firms does not change relative to other firms, while the composition of employment does. As migrants work more hours than do local workers, total hours in exposed firms should rise as compared to non-exposed firms, which explains the increase in labor productivity and output that we find.

We test for this second possibility by looking at the effect of minimum wage growth on the fringe benefits (or welfare pay) that firms provide to their employees. With migrants benefiting less from fringe benefits, the substitution of migrants for local workers post-2004 would lead to a relative fall in the share of welfare pay in total pay in exposed firms. Results presented in Table A-7 in the Appendix show that this is absolutely not the case: the effect of minimum wage rise on average welfare pay is not significant, while the effect on the sum of wage and welfare pay is very similar to the effect on wage alone.

The analysis of the evolution of city-level unemployment (as reliable as the information on unemployment in China can be) and the ratio of migrants to residents points in the same direction. If firms substitute migrants for local workers, we should see a relative rise in unemployment and/or the number of migrants as compared to residents in the overall population in cities with higher minimum-wage growth. Results in Table A-8 in the Appendix show that this does not happen.

Finally, Du and Pan (2009) analyze two waves of China Urban Labor Surveys data from 2001 and 2005, and show that all else equal (in particular controlling for age, skills etc.) migrant workers are more likely to be paid less than the hourly minimum wage. However, this probability gap in low pay between migrant and local workers was smaller in 2005 than in 2001, so that the "cost advantage" of migrant workers fell after the 2004 reform, which is in line with the reform's objective of improving migrant coverage in terms of labor standards.

Overall, these firm- and city-level results cast serious doubt on the hypothesis that exposed firms substituted migrants for local workers in response to the reform's higher minimum wages.

Another concern relates to the number of hours worked by employees in exposed firms. To absorb the cost shock of the 2004 reform, firms, and especially those that were the most exposed to the minimum wage hike, might ask both their local and migrant workers to increase their work hours. As we observe the number of employees, but not hours worked, the lack of employment effects and the rise in productivity post-2004 could reflect longer work hours in exposed firms. We cannot directly test for this mechanism. However, Du and Pan (2009) show that work hours fell between 2001 and 2005 in China for both migrants and resident workers. In spite of falling work hours, firm-level output per worker rose by an average of 23% over the 2003-2005 period in our data (46% for exposed firms, and 20% for non-exposed firms, in both cases much faster than inflation). This could not have come about without better firm-level organization or rising worker efficiency. In this context the "number of hours" mechanism seems implausible.

5.3 Heterogeneous effects of minimum wage growth

We here go further in our understanding of the effects of the minimum wage by investigating potential heterogeneity in a number of dimensions.

First, firms which use more unskilled labor should be more affected by minimum wages. We have information on skills from the National Business Surveys for 2004 only. We calculate the share of unskilled workers in the labor force for each city and sector. Results in Table A-9 in the Appendix then show that the elasticity of firm-level average wage and labor productivity growth to minimum-wage growth is higher in low-skill intensive city-sectors. This is consistent with higher minimum wages putting more pressure on firms in city-sectors which employ relatively more unskilled workers, as they are more likely to be paid low wages.

Also, one of the fears expressed by international employer federations regarding minimum wages in developing countries is that foreign firms may be disproportionately hurt, as local authorities are stricter with them. Results in Table A-10 in the Appendix show that this is not the case, at least regarding survival and firm-level average wages. The elasticity of firm-level productivity to minimum wages seems to be lower for foreign firms, consistent with there being less inefficiency in these firms. Regarding employment, the results even suggest that foreign firms benefit from minimum-wage growth (which can theoretically occur under efficiency wages, for example).

We also noted above that probably not all workers in "exposed" firms will actually be hit by the reform; the exposed firms in our sample are thus not equally affected by the shock. In unreported regressions, we split the sample of exposed firms in four groups by the difference between the 2005 city-level minimum wage and 2003 firm-level average wages: the larger this difference, the more exposed the firms (due to a greater share of low-wage workers, or overall lower wages). Results show that the more exposed the firms, the more they are affected by the reform in all dimensions. In particular, the results on the elasticity of firm-level average wages to minimum wage growth underline a compression effect of minimum wages: very low wages increase greatly and catch-up with low wages, so that wage dispersion in the lower tail of the distribution falls. This is visible in Figure 3 which was discussed in Section 4.1. This compression effect had already been noted by Katz and Krueger (1992) and Lee (1999) in the US.

In unreported results, we also check for a non-linear effect of minimum-wage growth. We detect no such patterns: the marginal effect of minimum wage growth is similar for large and small rises in the real minimum wage. Also, in the spirit of Draca et al. (2011), we split the sample depending on the level of market power at the industry level: we find very little difference for employment and TFP but for wage and survival, consistent with the idea of imperfect competition, we find that the effects of the minimum wage on survival (negative) and on wage (positive) are stronger in the less competitive sectors (i.e high market power sectors).

6 Aggregate results

We have so far investigated the effect of minimum wages on firm-level behavior. We would now like to know how these micro-effects add up to aggregate outcomes. In particular, does the fact that minimum-wage growth forces some firms to exit the market reduce overall employment? How do within-firm productivity gains and firm-level entry and exit translate into aggregate productivity? We investigate by first looking at the effect of 2004 minimum wage growth on city-level outcomes. In a second step, we repeat the analysis for city-level productivity growth and decompose the overall movement into its different components (within-firm movements, entry, exit, and reallocations).

Our aggregate analysis relies on the same two instruments (initial minimum wage and predicted minimum-wage growth based on the 40% rule) as the firm-level analysis.

6.1 Minimum wages and city-level employment growth

We analyze city-level employment growth, productivity growth, output growth and profitability growth between 2003 and 2005. For each city and year, city-level outcome (such as employment, output or profits) is the sum of firm outcome.[31] All regressions control for the initial level of the dependent variable as well as a bunch of city-level initial characteristics such as GDP per capita, population, the FDI to GDP ratio, and university-student enrollment. We thus control for potential convergence or divergence factors and differences across cities in terms of size, wealth and attractiveness. We also control for specific dynamics at the city-level by introducing the lagged growth rate of employment, productivity, output or profit.

The results for the 2003-2005 city-level employment change appear in columns (1) and

[31] City-level productivity and profitability are the ratios of city-level output to city-level employment and city-level profit to city-level output respectively.

(2) of Table 7 for the OLS and IV estimators respectively. The IV results suggest that higher minimum wages have no significant employment effects.[32] In line with intuition, the comparison between the OLS and IV regressions suggests that minimum-wage rises were larger in cities experiencing favorable economic shocks. Instrumentation clearly reduces the coefficient on minimum wage growth, which is now insignificant. It is thus important to control for endogeneity by instrumenting minimum wage growth.

While higher minimum wages were associated with lower survival probability in the firm-level results and with no or slightly negative employment effects, there is no effect on aggregate manufacturing employment in the city-level results.

Regarding aggregate productivity, columns (3) and (4) show that it is positively affected by minimum wage growth. We investigate in the next subsection through which channels it is. Since productivity increases and employment remains stable following a minimum wage shock, it comes as no surprise that city-level output is boosted by the shock (columns (5) and (6)). Finally, in line with firm-level results, city-level profitability does not seem to be affected by minimum wage.

[32]The various tests reported at the bottom of the table do not reject the validity of our IV strategy.

Table 7: Minimum wages and city-level outcomes

Explained variable	Δ Ln Employment 2003-05		Δ Ln Labor Productivity 2003-05		Δ Ln Output 2003-05		Δ Profit over output 2003-05	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δ Ln Real minimum wage	0.610[a]	0.086	0.263[a]	0.487[a]	0.766[a]	0.350[c]	0.036[b]	0.039
	(0.162)	(0.220)	(0.043)	(0.158)	(0.131)	(0.182)	(0.016)	(0.024)
Ln Employment	-0.187[c]	-0.185[c]	-0.093[a]	0.025	0.030	0.024	-0.043[a]	-0.043[a]
	(0.100)	(0.102)	(0.021)	(0.069)	(0.095)	(0.097)	(0.015)	(0.015)
Ln output	-0.173	-0.164	0.037[c]	-0.049	-0.366[a]	-0.358[a]	0.032[b]	0.032[a]
	(0.105)	(0.106)	(0.020)	(0.065)	(0.100)	(0.101)	(0.013)	(0.012)
Profit over output	0.483	0.727	0.150	0.201	0.593	0.748	-0.710[a]	-0.711[a]
	(0.899)	(0.929)	(0.205)	(0.645)	(0.949)	(0.956)	(0.171)	(0.169)
Ln Avg wage	-0.015	-0.048	-0.070[b]	-0.112	-0.019	-0.038	-0.002	-0.002
	(0.094)	(0.096)	(0.028)	(0.084)	(0.087)	(0.087)	(0.012)	(0.012)
Ln GDP per capita	0.339[a]	0.333[a]	-0.029	0.025	0.368[a]	0.363[a]	0.024[c]	0.024[c]
	(0.076)	(0.076)	(0.018)	(0.050)	(0.071)	(0.072)	(0.013)	(0.013)
Ln Population	0.178[a]	0.162[a]	0.060[a]	0.049	0.209[a]	0.201[a]	-0.001	0.001
	(0.050)	(0.051)	(0.012)	(0.033)	(0.044)	(0.044)	(0.005)	(0.005)
Ln Road density (per km^2)	0.006	0.010	0.012	-0.010	0.005	0.012	-0.003	-0.003
	(0.028)	(0.028)	(0.008)	(0.019)	(0.025)	(0.026)	(0.003)	(0.003)
Ratio of Univ. students over population	-0.001[b]	-0.001[b]	0.001[a]	0.001[a]	-0.001	-0.001	-0.001	-0.001
	(0.0005)	(0.0005)	(0.0001)	(0.0001)	(0.001)	(0.001)	(0.001)	(0.001)
FDI over GDP	0.093[c]	0.076	-0.056[a]	-0.076[b]	0.005	-0.015	-0.020[b]	-0.020[a]
	(0.048)	(0.048)	(0.015)	(0.036)	(0.053)	(0.052)	(0.008)	(0.007)
Δ Ln Employment 2001-2003	-0.068	-0.122						
	(0.120)	(0.128)						
Δ Ln Labor productivity 2001-2003			-0.489[a]	-0.490[a]				
			(0.055)	(0.134)				
Δ Ln Output 2001-2003					0.125	0.142		
					(0.098)	(0.101)		
Δ Profit over output 2001-2003							-0.118	-0.118
							(0.142)	(0.138)
R-squared	0.39	0.35	0.27	0.25	0.43	0.41	0.32	0.32
Observations	261	261	261	261	261	261	261	261
Underidentification test		33.8[a]		36.2[a]		39.2[a]		39.1[a]
First-stage F-test		84.2[a]		87[a]		86.4[a]		87.2[a]
Overid. Hansen J-stat		0.91		0.01		1.21		1.29
Chi-sq p-value		0.34		0.92		0.27		0.26

Heteroskedasticity-robust standard errors appear in parentheses. Standard errors are clustered at the city level. [a], [b] and [c] indicate significance at the 1%, 5% and 10% confidence levels. Δ indicates the change between 2003 and 2005. All other right-hand side variables are measured in 2003. Instruments used in the IV procedure for Δ Ln Minimum wage 2003-05 are the local minimum wage in 2003 and the predicted minimum-wage change based on the 40% rule (see text). The underidentification test is based on the Kleibergen-Paap rk LM-statistic, with [a] indicating that the p-value (Chi-sq(2)) is below 0.01, suggesting that underidentification is rejected. The F-test of excluded instruments in the first stage equation is based on the Kleibergen-Paap Wald rk F-statistic, with [a] indicating that the p-value is below 0.01, suggesting that the instruments are not weak. The F-statistic on the excluded instruments is largely above 10, the informal threshold suggested by Staiger and Stock (1997) to assess instrument validity. The Hansen J-statistic is an overidentification test of all instruments, a Chi-sq p-value above 0.10 suggests that the model is overidentified and the instruments are exogenous.

6.2 Minimum wages and aggregate productivity: a decomposition analysis

Our estimates of the effect of minimum wages on city-level productivity growth follow Foster et al. (2001). As summarized in the equation below, we decompose the city-level change in aggregate labor productivity using three categories of firms, *Survivors*, *Exiters* and *Entrants*:

$$
\begin{aligned}
\Delta\overline{\mathrm{y}^c}_{2003-05} = & \underbrace{\sum_{\mathrm{f} \in \mathrm{Survivors}_c} \theta^f_{2003}\Delta \mathrm{y}^f_{2003-05}}_{\text{Within}} \\
& + \underbrace{\sum_{\mathrm{f} \in \mathrm{Survivors}_c} \Delta\theta^f_{2003-05} \times [\mathrm{y}^f_{2003} - \overline{\mathrm{y}^c}_{2003}]}_{\text{Between}} \\
& + \underbrace{\sum_{\mathrm{f} \in \mathrm{Survivors}_c} \Delta\theta^f_{2003-05} \times \Delta \mathrm{y}^f_{2003-05}}_{\text{Covariance}} \\
& + \underbrace{\sum_{\mathrm{f} \in \mathrm{Entrants}_c} \theta^f_{2005} \times [\mathrm{y}^f_{2005} - \overline{\mathrm{y}^c}_{2003}] - \sum_{\mathrm{f} \in \mathrm{Exiters}_c} \theta^f_{2003} \times [\mathrm{y}^f_{2003} - \overline{\mathrm{y}^c}_{2003}]}_{\text{Net entry}}
\end{aligned} \tag{2}
$$

Average labor productivity in city c in 2003, $\overline{\mathrm{y}^c}_{2003}$, is given by the weighted average of the labor productivity y^f_{2003} of firms f located in city c (in log), with the weights θ^f_{2003} being the share of firm f in total employment in city c. The first three components in Equation 2 are calculated over the population of surviving firms. The first term is the within component, i.e. the productivity growth of surviving firms between 2003 and 2005, keeping their shares constant. The second term is the between component, which accounts for the reallocation of labor between firms with different initial productivities. A positive change here reflects a reallocation of labor from initially less-efficient to initially more-efficient firms (as compared to the city-level average). The third term is the covariance between the within-firm and between-firm changes. A positive value here shows that expanding firms are those which report greater productivity gains. The last two terms refer to entrants and exiters. These show how productivity in these two groups compares to the city-level average. A positive value for the entry (exit) term reflects that new entrants (exiters) are systematically more efficient than the average local firm in 2003.

Table 8 shows the IV results for these five terms. We again control for a number of proxies for initial city size, wealth, productivity, attractiveness and productivity growth before the implementation of the policy. The results confirm that cities in which the minimum wage rose faster experienced the greatest productivity gains.

The results in column 1 suggest that a 1% difference in minimum-wage growth leads to a 0.39% gap in productivity. As shown in columns (3) and (5), aggregate productivity growth mainly comes from two channels: higher within-firm efficiency among survivors and net entry. The first channel is consistent with the firm-level results. The latter is suggestive of a cleansing effect of minimum wage: the cost shock from higher real minimum wages forces less-productive firms to exit and new entrants to be more productive than average. However, minimum-wage growth does not seem to affect the allocation of employment across incumbent firms: neither the between nor the covariance terms are significantly related to city-level real minimum-wage growth.

Again, the effects we measure are economically large. The elasticity of aggregate productivity to minimum wage growth being equal to 0.394, the average 2003-2005 rise in minimum wages of 21.9% produced a 8.6 percentage point increase in aggregate productivity. City-level labor productivity rose by an average of 35% over the period, so that the contribution of minimum wages to aggregate productivity growth is 25%. Of the four different log additive margins in Equation 2, the decomposition analysis in Table 8 shows that both the within and the net entry margins contribute positively and significantly to the effect of minimum wages on productivity growth. The other two (between and covariance) exhibit negative but insignificant correlations. The overall positive effect of minimum wages on productivity then comes entirely from the within and net-entry terms. As the elasticity of the latter is 60% larger than that of the former (0.343 versus 0.211), their respective contributions to the effect of minimum wage on aggregate productivity growth are 38% and 62%.

Table 8: Minimum wages and the components of city-level labor productivity growth

Estimator	IV						
Explained component	Total	Within	Between	Covariance	Net entry	Entry	Exit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δ Ln Real minimum wage	0.394^{b}	0.211^{c}	-0.072	-0.089	0.343^{b}	0.214	-0.129^{b}
	(0.158)	(0.111)	(0.060)	(0.084)	(0.145)	(0.132)	(0.063)
Ln Labor productivity	-0.070	-0.070^{c}	-0.022	0.051	-0.028	-0.089	-0.061^{b}
	(0.068)	(0.041)	(0.028)	(0.032)	(0.074)	(0.063)	(0.027)
Ln Employment	-0.028	-0.038^{c}	0.006	0.058^{a}	-0.054^{b}	-0.039	0.015^{c}
	(0.032)	(0.023)	(0.009)	(0.018)	(0.027)	(0.026)	(0.008)
Profit over output	0.363	0.102	-0.014	0.022	0.252	0.091	-0.161
	(0.668)	(0.362)	(0.177)	(0.274)	(0.616)	(0.580)	(0.189)
Ln Avg wage	-0.102	0.021	-0.048^{b}	0.065^{b}	-0.140^{b}	-0.146^{b}	-0.006
	(0.079)	(0.056)	(0.024)	(0.032)	(0.054)	(0.058)	(0.027)
Ln GDP per capita	0.024	0.013	0.007	-0.059^{a}	0.063	0.081^{c}	0.018
	(0.047)	(0.027)	(0.016)	(0.019)	(0.048)	(0.042)	(0.016)
Ln Population	0.060^{b}	0.027	0.019^{c}	-0.045^{b}	0.059^{b}	0.048^{b}	-0.011
	(0.031)	(0.024)	(0.011)	(0.018)	(0.025)	(0.023)	(0.010)
Ln Road density (per km^2)	-0.009	0.005	0.010^{c}	-0.001	-0.023	-0.020	0.004
	(0.017)	(0.013)	(0.006)	(0.010)	(0.016)	(0.016)	(0.006)
Ratio of Univ. students	0.001^{a}	0.001	0.001	-0.001	0.001^{a}	0.001^{a}	-0.001^{b}
over population	(0.0001)	(0.001)	(0.001)	(0.001)	(0.0001)	(0.0001)	(0.0005)
FDI over GDP	-0.054	-0.015	0.004	-0.004	-0.040	-0.027	0.013
	(0.036)	(0.025)	(0.010)	(0.018)	(0.032)	(0.029)	(0.010)
Within 2001-2003	0.015	0.375^{a}	-0.044	-0.080	-0.236	-0.152	0.085
	(0.183)	(0.114)	(0.045)	(0.068)	(0.153)	(0.121)	(0.072)
Between 2001-2003	-0.424^{c}	0.061	0.019	-0.114	-0.390	-0.331	0.060
	(0.255)	(0.162)	(0.089)	(0.114)	(0.240)	(0.206)	(0.100)
Covariance 2001-2003	-0.251	0.237	-0.126	-0.033	-0.328	-0.218	0.111
	(0.280)	(0.177)	(0.081)	(0.133)	(0.246)	(0.197)	(0.113)
Entry 2001-2003	-0.667^{a}	-0.665^{a}	-0.332^{a}	0.601^{b}	-0.271^{a}	-0.322^{a}	-0.051
	(0.116)	(0.248)	(0.120)	(0.242)	(0.072)	(0.075)	(0.072)
Exit 2001-2003	0.337	-0.348^{c}	0.087	0.322^{b}	0.276	0.469^{b}	0.194^{b}
	(0.274)	(0.201)	(0.087)	(0.135)	(0.230)	(0.226)	(0.097)
R-squared	0.32	0.40	0.48	0.51	0.25	0.29	0.18
Observations	261	261	261	261	261	261	261
Underidentification test	35.8^{a}	35.8^{a}	35.8^{a}	35.8^{a}	35.8^{a}	35.8^{a}	35.8^{a}
First-stage F-test	83.9^{a}	83.9^{a}	83.9^{a}	83.9^{a}	83.9^{a}	83.9^{a}	83.9^{a}
Overid. Hansen J-stat	0.06	0.94	0.01	0.91	1.34	1.22	0.19
Chi-sq p-value	0.81	0.33	0.28	0.34	0.25	0.27	0.66

Heteroskedasticity-robust standard errors appear in parentheses. Standard errors are clustered at the city level. ^{a}, ^{b} and ^{c} indicate significance at the 1%, 5% and 10% confidence levels. Δ indicates the change between 2003 and 2005. All other right-hand side variables are measured in 2003. Instruments used in the IV procedure for Δ Ln Minimum wage 2003-05 are the local minimum wage in 2003 and the predicted minimum-wage change based on the 40% rule (see text). The underidentification test is based on the Kleibergen-Paap rk LM-statistic, with ^{a} indicating that the p-value (Chi-sq(2)) is below 0.01, suggesting that underidentification is rejected. The F-test of excluded instruments in the first-stage equation is based on the Kleibergen-Paap Wald rk F-statistic, with ^{a} indicating that the p-value is below 0.01, suggesting that the instruments are not weak. The F-statistic on the excluded instruments is largely above 10, the informal threshold suggested by Staiger and Stock (1997) to assess instrument validity. The Hansen J-statistic is an overidentification test of all instruments, a Chi-sq p-value above 0.10 suggests that the model is overidentified and the instruments are exogenous. For definitions of the various margins (within, between, covariance, entry, exit) see Section 6.2.

7 Conclusion

This paper has shown that higher minimum wages might be one way for developing countries to increase the wages of low-paid workers without necessarily harming their economy. We consider the shock of the 2004 minimum-wage reform in China to evaluate the repercussions of minimum-wage growth on firm survival, employment, productivity and profitability. We identify the causal effect of minimum wage growth via a triple-difference estimator combined with an IV strategy based on the institutional features of the 2004 reform. We find that, at the firm-level, firm survival fell, wages rose and labor productivity significantly increased, allowing surviving firms to maintain their profits and employment (or to decrease the latter slightly at most). Moreover, we show that higher minimum wages boosted city-level aggregate productivity via efficiency improvements among incumbent firms and the net entry of more productive firms. Hence, in a fast-growing economy like China where there is considerable inefficiency, minimum wages might have a cleansing effect and represent one way of boosting aggregate productivity.

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Appendix

Table A-1: Summary statistics on exposure and wage evolution

Firm type	Exposed	Non-exposed
Number present in our sample in 2003	35,659	131,668
of which alive in 2005	23,356	102,423
Survival rate	0.66	0.78
Surviving firms		
Mean Δ ln wage$_{2003-05}$	0.92	0.13
Median Δ ln wage$_{2003-05}$	0.73	0.13
s.d. Δ ln wage$_{2003-05}$	0.84	0.50
Mean Δ ln labor productivity$_{2003-05}$	0.46	0.20
s.d. Δ ln labor productivity$_{2003-05}$	0.20	0.65
Mean Δ ln employment$_{2003-05}$	0	0.01
s.d. Δ ln employment$_{2003-05}$	0.62	0.51
All firms		
Mean Δ ln Minimum wage$_{2003-05}$	0.26	0.24
s.d. Δ ln Minimum wage$_{2003-05}$	0.11	0.10
Mean Δ ln Real Minimum wage$_{2003-05}$	0.20	0.19
s.d. Δ ln Real Minimum wage$_{2003-05}$	0.11	0.09

Authors' calculations from the 2003 and 2005 NBS annual surveys. Real minimum wages are calculated using provincial price indices. See the main text for details.

Table A-2: Determinants of firm-level exposure to minimum wage changes (2003-05)

Dependent variable	Firm exposure dummy		
	(1)	(2)	(3)
Sample			w/o outlier
Ln Firm employment	-0.023[a]	0.030[a]	-0.024[a]
	(0.002)	(0.003)	(0.002)
Ln Firm labor productivity	-0.086[a]		-0.081[a]
	(0.006)		(0.006)
Ln Firm TFP		-0.070[a]	
		(0.005)	
Firm profit over output	0.002[a]	0.002[a]	0.002[a]
	(0.001)	(0.001)	(0.001)
State dummy	-0.014	-0.004	-0.016
	(0.011)	(0.010)	(0.011)
Foreign dummy	-0.045[a]	-0.055[a]	-0.046[a]
	(0.008)	(0.008)	(0.008)
Export dummy	-0.037[a]	-0.043[a]	-0.036[a]
	(0.007)	(0.007)	(0.007)
City-Sector Fixed effects	Yes	Yes	Yes
R-squared	0.05	0.04	0.04
Observations	167,327	164,927	163,738

Heteroskedasticity-robust standard errors appear in parentheses. Standard errors are clustered at the city level. [a], [b] and [c] indicate significance at the 1%, 5% and 10% confidence levels. Exposure is a dummy for the average wage in the firm in 2003 being lower than the local minimum wage in 2005. All other right-hand side variables are measured in 2003. Firm-level productivity is measured either as labor productivity (output per employee) or as TFP (based on the Levinsohn-Petrin approach). Column 3 excludes the top and bottom percentiles of average wages in 2003. See the main text for details.

Table A-3: Distribution of the firm-level average wage to city-level minimum wage ratio in %

	All firms			Foreign firms		
	2001	2003	2005	2001	2003	2005
Share of firms with $\frac{\text{Average wage}}{\text{City minimum wage}}<1$	12.4	10.3	6.3	7.3	6.4	4.5
Share of firms with $1\leq \frac{\text{Average wage}}{\text{City minimum wage}}\leq 1.15$	5.2	4.5	5.7	3.5	3.0	3.6
	State-owned firms			**Domestic private firms**		
	2001	2003	2005	2001	2003	2005
Share of firms with $\frac{\text{Average wage}}{\text{City minimum wage}}<1$	21.0	17.8	6.7	12.2	10.8	6.7
Share of firms with $1\leq \frac{\text{Average wage}}{\text{City minimum wage}}\leq 1.15$	6.0	5.2	5.6	5.6	4.9	6.4

Authors' calculations from the 2001, 2003 and 2005 NBS annual surveys. See the main text for details.

Table A-4: Minimum wages and other firm-level outcomes

Dependent variable	Δ Ln Firm TFP 2003-05		Δ Firm profit over output (2003-05)		Δ Ln Firm output 2003-05	
Estimator	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)
Δ Ln Real Minimum wage × Exposed	0.329[a]	0.490[a]	0.114	0.156	0.236[a]	0.335[a]
	(0.085)	(0.100)	(0.096)	(0.134)	(0.055)	(0.054)
Ln Firm employment	0.190[a]	0.190[a]	0.006[c]	0.006[c]	-0.089[a]	-0.089[a]
	(0.011)	(0.011)	(0.004)	(0.004)	(0.007)	(0.007)
Ln Firm wage	0.111[a]	0.125[a]	0.019	0.023	0.030[b]	0.038[a]
	(0.021)	(0.022)	(0.018)	(0.021)	(0.012)	(0.012)
Ln Firm labor productivity			0.030[b]	0.030[b]	-0.169[a]	-0.169[a]
			(0.012)	(0.012)	(0.011)	(0.011)
Ln Firm TFP	-0.439[a]	-0.440[a]				
	(0.013)	(0.013)				
Firm profit over output	0.124[b]	0.124[b]	-0.849[a]	-0.849[a]	-0.001	-0.001
	(0.062)	(0.062)	(0.131)	(0.131)	(0.025)	(0.025)
State dummy	-0.330[a]	-0.331[a]	-0.311	-0.311	-0.251[a]	-0.251[a]
	(0.024)	(0.024)	(0.208)	(0.208)	(0.022)	(0.022)
Foreign dummy	0.078[a]	0.076[a]	0.023	0.022	0.065[a]	0.065[a]
	(0.015)	(0.015)	(0.022)	(0.022)	(0.013)	(0.013)
Export dummy	0.018[c]	0.018[c]	0.015	0.015	0.027[a]	0.027[a]
	(0.010)	(0.010)	(0.015)	(0.015)	(0.010)	(0.010)
City-Sector Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.17	0.17	0.00	0.00	0.05	0.05
Observations	124,111	110,556	125,779	112,171	125,779	112,171
Underidentification test		60.1[a]		60.5[a]		60.5[a]
First-stage F-test of excluded instruments		409.7[a]		406[a]		406[a]
Overidentification Hansen J-statistic		0.17		0.21		0.28
Chi-sq p-value		0.68		0.65		0.60

Standard errors are clustered at the city level. [a], [b] and [c] indicate significance at the 1%, 5% and 10% confidence levels. Exposed is a dummy for the average wage in the firm in 2003 being lower than the local minimum wage in 2005. Δ indicates the change between 2003 and 2005. All other right-hand side variables are measured in 2003. The instruments used in the IV procedure for Δ Ln Minimum wage 2003-05 × Exposed are the interactions of the local minimum wage in 2003 and the predicted minimum-wage change based on the 40% rule (see text) with the exposed dummy. The underidentification test is based on the Kleibergen-Paap rk LM-statistic, with [a] indicating that the p-value (Chi-sq(2)) is below 0.01, suggesting that underidentification is rejected. The F-test of excluded instruments in the first-stage equation is based on the Kleibergen-Paap Wald rk F-statistic, with [a] indicating that the p-value is below 0.01, suggesting that the instruments are not weak. The F-statistic on the excluded instruments is largely above 10, the informal threshold suggested by Staiger and Stock (1997) to assess instrument validity. The Hansen J-statistic is an overidentification test of all instruments, a Chi-sq p-value above 0.10 suggests that the model is overidentified and the instruments are exogenous.

Table A-5: Minimum wages and firm-level outcomes - City controls

Dependent variable	Firm survival 2003-05		Δ Firm avg wage 2003-05		Δ Firm employment 2003-05		Δ Firm labor productivity (2003-05)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δ Ln Real Minimum wage × Exposed	-0.177[a]	-0.134[b]	0.263	0.630[a]	-0.008	0.024	0.376[a]	0.284[b]
	(0.053)	(0.066)	(0.175)	(0.191)	(0.071)	(0.085)	(0.138)	(0.111)
Ln Firm employment	0.081[a]	0.081[a]	0.051[a]	0.052[a]	-0.120[a]	-0.120[a]	0.031[a]	0.031[a]
	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.006)	(0.006)
Ln Firm wage	0.020[a]	0.020[a]	-0.762[a]	-0.763[a]	0.097[a]	0.097[a]	-0.059[a]	-0.058[a]
	(0.004)	(0.004)	(0.031)	(0.031)	(0.007)	(0.007)	(0.012)	(0.011)
Ln Firm labor productivity	0.053[a]	0.052[a]	0.091[a]	0.091[a]	0.116[a]	0.116[a]	-0.286[a]	-0.286[a]
	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)	(0.005)	(0.012)	(0.012)
Firm profit over output	0.001[b]	0.001[b]	0.058[a]	0.057[a]	0.032[b]	0.032[b]	-0.034	-0.033
	(0.001)	(0.001)	(0.016)	(0.016)	(0.015)	(0.015)	(0.027)	(0.027)
State dummy	-0.098[a]	-0.098[a]	0.065[a]	0.065[a]	-0.059[a]	-0.058[a]	-0.195[a]	-0.193[a]
	(0.018)	(0.018)	(0.018)	(0.018)	(0.011)	(0.011)	(0.025)	(0.025)
Foreign dummy	0.028[a]	0.028[a]	0.167[a]	0.167[a]	0.014[c]	0.014[c]	0.051[a]	0.051[a]
	(0.006)	(0.006)	(0.020)	(0.020)	(0.007)	(0.007)	(0.011)	(0.011)
Export dummy	0.028[a]	0.028[a]	0.017[b]	0.017[b]	0.047[a]	0.047[a]	-0.020[a]	-0.020[a]
	(0.005)	(0.005)	(0.007)	(0.007)	(0.006)	(0.006)	(0.007)	(0.007)
Δ Ln City GDP per capita × Exposed	-0.020		0.065		-0.027		0.005	
	(0.032)		(0.071)		(0.040)		(0.082)	
Ln City Skill intensity × Exposed		-0.020		0.065		-0.027		0.005
		(0.032)		(0.071)		(0.040)		(0.082)
City-Sector Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.06	0.06	0.47	0.47	0.12	0.12	0.14	0.14
Observations	152,066	152,226	112,079	112,171	112,079	112,171	112,079	112,171
Underidentification test	8.1[b]	34.9[a]	7.1[b]	36.2[a]	7.1[b]	36.2[a]	7.1[b]	36.2[a]
First-stage F-test of excluded instruments	103.7[a]	107[a]	109.8[a]	406[a]	115[a]	109.8[a]	115[a]	109.8[a]
Overidentification Hansen J-statistic	0.56	0.27	1.05	0.08	0.01	0.07	0.22	0.35
Chi-sq p-value	0.45	0.60	0.31	0.78	0.97	0.79	0.64	0.55

Standard errors are clustered at the city level. [a], [b] and [c] indicate significance at the 1%, 5% and 10% confidence levels. Survival is a dummy for the 2003 firm still existing in the 2005 census. Exposed is a dummy for the average wage in the firm in 2003 being lower than the local minimum wage in 2005. Δ indicates the change between 2003 and 2005. All other right-hand side variables are measured in 2003. The instruments used in the IV procedure for Δ Ln Minimum wage 2003-05 × Exposed are the interactions of the local minimum wage in 2003 and the predicted minimum-wage change based on the 40% rule (see text) with the exposed dummy. The underidentification test is based on the Kleibergen-Paap rk LM-statistic, with [a] indicating that the p-value (Chi-sq(2)) is below 0.01, suggesting that underidentification is rejected. The F-test of excluded instruments in the first-stage equation is based on the Kleibergen-Paap Wald rk F-statistic, with [a] indicating that the p-value is below 0.01, suggesting that the instruments are not weak. The F-statistic on the excluded instruments is largely above 10, the informal threshold suggested by Staiger and Stock (1997) to assess instrument validity. The Hansen J-statistic is an overidentification test of all instruments, a Chi-sq p-value above 0.10 suggests that the model is overidentified and the instruments are exogenous.

Table A-6: Minimum wages and firm-level outcomes - Polynomials

Dependent variable	ΔFirm survival 2003-05	ΔFirm avg wage 2003-05	Δ Firm employment 2003-05	Δ Firm labor productivity 2003-05
	(1)	(2)	(3)	(4)
Δ Ln Real Minimum wage × Exposed	-0.206^a	0.207^a	-0.070^c	0.335^a
	(0.030)	(0.066)	(0.041)	(0.052)
Ln Firm employment	0.081^a	0.049^a	-0.121^a	0.030^a
	(0.003)	(0.003)	(0.004)	(0.006)
Ln Firm wage	0.055^a	-1.715^a	-0.031	-0.361^a
	(0.019)	(0.081)	(0.052)	(0.078)
Ln Firm wage^2	-0.003^c	0.075^a	0.010^b	0.024^a
	(0.001)	(0.007)	(0.004)	(0.006)
Ln Firm labor productivity	0.053^a	0.077^a	0.115^a	-0.290^a
	(0.003)	(0.005)	(0.005)	(0.011)
Firm profit over output	0.001^b	0.054^a	0.032^b	-0.035
	(0.001)	(0.014)	(0.015)	(0.027)
State dummy	-0.098^a	0.048^a	-0.061^a	-0.198^a
	(0.018)	(0.017)	(0.011)	(0.025)
Foreign dummy	0.029^a	0.143^a	0.011	0.043^a
	(0.006)	(0.017)	(0.007)	(0.010)
Export dummy	0.028^a	0.014^b	0.046^a	-0.021^a
	(0.005)	(0.006)	(0.006)	(0.007)
City-Sector Fixed effects	Yes	Yes	Yes	Yes
R-squared	0.06	0.48	0.12	0.15
Observations	152,226	112,171	112,171	112,171
Underidentification test	63.5^a	63.2^a	63.2^a	63.2^a
First-stage F-test of excluded instruments	382.7^a	387.4^a	387.4^a	387.4^a
Overidentification Hansen J-statistic	0.64	1.96	0.01	0.48
Chi-sq p-value	0.42	0.16	0.94	0.48

Standard errors are clustered at the city level. ^{a}, ^{b} and ^{c} indicate significance at the 1%, 5% and 10% confidence levels. Survival is a dummy for the 2003 firm still existing in the 2005 census. Exposed is a dummy for the average wage in the firm in 2003 being lower than the local minimum wage in 2005. Δ indicates the change between 2003 and 2005. All other right-hand side variables are measured in 2003. The instruments used in the IV procedure for Δ Ln Minimum wage 2003-05 × Exposed are the interactions of the local minimum wage in 2003 and the predicted minimum-wage change based on the 40% rule (see text) with the exposed dummy. The underidentification test is based on the Kleibergen-Paap rk LM-statistic, with ^{a} indicating that the p-value (Chi-sq(2)) is below 0.01, suggesting that underidentification is rejected. The F-test of excluded instruments in the first-stage equation is based on the Kleibergen-Paap Wald rk F-statistic, with ^{a} indicating that the p-value is below 0.01, suggesting that the instruments are not weak. The F-statistic on the excluded instruments is largely above 10, the informal threshold suggested by Staiger and Stock (1997) to assess instrument validity. The Hansen J-statistic is an overidentification test of all instruments, a Chi-sq p-value above 0.10 suggests that the model is overidentified and the instruments are exogenous.

Table A-7: Alternative explanations: minimum wages, average wages and welfare pay

Dependent variable	Δ Firm outcome (2003-05)	
Estimator	IV estimator	
Outcome	Per employee	
	Ln Firm average total pay (wage+welfare)	Ln Firm average welfare pay
	(1)	(2)
Δ Ln Real Minimum wage $\times$ Exposed	0.369^{a}	0.098
	(0.113)	(0.165)
Ln Firm employment	0.053^{a}	0.138^{a}
	(0.004)	(0.012)
Ln Firm average total pay	-0.750^{a}	
	(0.032)	
Ln Firm average welfare pay		-0.731^{a}
		(0.018)
Ln Firm average wage		0.106^{a}
		(0.033)
Ln Firm labor productivity	0.093^{a}	0.136^{a}
	(0.005)	(0.020)
Firm profit over output	0.058^{a}	0.174^{a}
	(0.019)	(0.055)
State dummy	0.069^{a}	0.202^{a}
	(0.019)	(0.050)
Foreign dummy	0.144^{a}	-0.605^{a}
	(0.020)	(0.062)
Export dummy	0.017^{b}	-0.023
	(0.007)	(0.030)
City-Sector Fixed effects	Yes	Yes
R-squared	0.45	0.35
Observations	112,171	112,171
Underidentification test	60^{a}	60.5^{a}
First-stage F-test of excluded instruments	407^{a}	406.3^{a}
Overidentification Hansen J-statistic	0.86	0.03
Chi-sq p-value	0.36	0.86

Standard errors are clustered at the city level. [a], [b] and [c] indicate significance at the 1%, 5% and 10% confidence levels. Exposed is a dummy for the average wage in the firm in 2003 being lower than the local minimum wage in 2005. Δ indicates the change between 2003 and 2005. All other right-hand side variables are measured in 2003. Instruments used in the IV procedure for Δ Ln Minimum wage 2003-05 × Exposed are the interactions of the local minimum wage in 2003 and the predicted minimum-wage change based on the 40% rule (see text) with the exposed dummy. The underidentification test is based on the Kleibergen-Paap rk LM-statistic, with [a] indicating that the p-value (Chi-sq(2)) is below 0.01, suggesting that underidentification is rejected. The F-test of excluded instruments in the first-stage equation is based on the Kleibergen-Paap Wald rk F-statistic, with [a] indicating that the p-value is below 0.01, suggesting that the instruments are not weak. The F-statistic on the excluded instruments is largely above 10, the informal threshold suggested by Staiger and Stock (1997) to assess instrument validity. The Hansen J-statistic is an overidentification test of all instruments, a Chi-sq p-value above 0.10 suggests that the model is overidentified and the instruments are exogenous.

Table A-8: Alternative explanations: City-level unemployment and the share of migrants

Dependent variable	Δ City-level outcome					
Outcome variable	Unemployment rate 2003-05		Ratio migrants/residents 2000-05			
			Total population		Working age population	
Estimator	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Δ Ln Real minimum wage	0.003	0.005	0.110	-0.061	0.152	-0.034
	(0.002)	(0.003)	(0.077)	(0.079)	(0.105)	(0.106)
Unemployment rate	-0.552[a]	-0.546[a]				
	(0.094)	(0.092)				
Ratio of migrants (total)			-0.547[a]	-0.550[a]		
			(0.183)	(0.180)		
Ratio of migrants (working age)					-0.422[b]	-0.424[b]
					(0.181)	(0.178)
Ln Employment	-0.001	-0.001[c]	0.040	0.044[c]	0.058[c]	0.062[c]
	(0.001)	(0.001)	(0.026)	(0.025)	(0.032)	(0.032)
Ln Labor Productivity	-0.001	-0.001	-0.097	-0.094	-0.100	-0.098
	(0.001)	(0.001)	(0.063)	(0.061)	(0.069)	(0.068)
Profit over output	-0.026[b]	-0.030[a]	-0.195	-0.115	-0.280	-0.194
	(0.012)	(0.011)	(0.355)	(0.331)	(0.456)	(0.423)
Ln Avg wage	0.004[b]	0.004[a]	0.037	0.026	0.029	0.017
	(0.002)	(0.002)	(0.045)	(0.045)	(0.055)	(0.054)
Ln GDP per capita	0.002[b]	0.002[b]	0.134[a]	0.133[a]	0.110[b]	0.109[b]
	(0.001)	(0.001)	(0.051)	(0.050)	(0.049)	(0.048)
Ln Population	-0.001	-0.001	0.037	0.032	0.031	0.026
	(0.001)	(0.001)	(0.027)	(0.025)	(0.032)	(0.030)
Ln Road density (per km^2)	0.001[b]	0.001[c]	-0.024[c]	-0.023	-0.032[c]	-0.031[c]
	(0.0005)	(0.0005)	(0.014)	(0.014)	(0.018)	(0.018)
Ratio of Univ. students over population	0.001	0.001	-0.001[b]	-0.001[b]	-0.001[b]	-0.001[b]
	(0.001)	(0.001)	(0.0005)	(0.0005)	(0.0005)	(0.0005)
FDI over GDP	-0.001	-0.001	0.096[c]	0.091[c]	0.127[b]	0.121[b]
	(0.001)	(0.001)	(0.050)	(0.049)	(0.059)	(0.058)
Δ Ln Employment 2001-03	-0.001	0.001	0.069[c]	0.052	0.076	0.057
	(0.002)	(0.002)	(0.042)	(0.041)	(0.050)	(0.047)
Δ Unemployment rate 2001-03	-0.236[b]	-0.240[a]				
	(0.094)	(0.092)				
R-squared	0.75	0.74	0.54	0.54	0.41	0.40
Observations	258		261			
Underidentification test		33.9[a]		33.4[a]		33.6[a]
First-stage F-test of excluded instruments		63.0[a]		57.6[a]		57.7[a]
Overid. Hansen J-stat		0.15		0.01		0.31
Chi-sq p-value		0.70		0.96		0.58

Heteroskedasticity-robust standard errors appear in parentheses. [a], [b] and [c] indicate significance at the 1%, 5% and 10% confidence levels. Δ indicates the change between 2003 and 2005. All other right-hand side variables are measured in 2003. Instruments used in the IV procedure for Δ Ln Minimum wage 2003-05 are the local minimum wage in 2003 and the predicted minimum-wage change based on the 40% rule (see text). The underidentification test is based on the Kleibergen-Paap rk LM-statistic, with [a] indicating that the p-value (Chi-sq(2)) is below 0.01, suggesting that underidentification is rejected. The F-test of excluded instruments in the first-stage equation is based on the Kleibergen-Paap Wald rk F-statistic, with [a] indicating that the p-value is below 0.01, suggesting that the instruments are not weak. The F-statistic on the excluded instruments is largely above 10, the informal threshold suggested by Staiger and Stock (1997) to assess instrument validity.The Hansen J-statistic is an overidentification test of all instruments, a Chi-sq p-value above 0.10 suggests that the model is overidentified and the instruments are exogenous.

Table A-9: Minimum wages and firm-level outcomes - City skills

Dependent variable	Firm survival 2003-05		Δ Firm avg wage 2003-05		Δ Firm employment 2003-05		Δ Firm lab. productivity 2003-05	
Skill intensity	Low	High	Low	High	Low	High	Low	High
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δ Ln Real Minimum wage $\times$ Exposed	-0.222^a	-0.204^a	0.491^a	0.188^b	-0.081	-0.015	0.463^a	0.281^a
	(0.038)	(0.036)	(0.141)	(0.090)	(0.061)	(0.048)	(0.074)	(0.060)
Ln Firm employment	0.075^a	0.087^a	0.061^a	0.038^a	-0.118^a	-0.125^a	0.038^a	0.022^a
	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.006)	(0.006)
Ln Firm wage	0.022^a	0.016^a	-0.728^a	-0.807^a	0.091^a	0.103^a	-0.047^a	-0.075^a
	(0.004)	(0.005)	(0.036)	(0.024)	(0.008)	(0.010)	(0.015)	(0.011)
Ln Firm labor productivity	0.052^a	0.055^a	0.091^a	0.088^a	0.119^a	0.114^a	-0.283^a	-0.291^a
	(0.003)	(0.004)	(0.006)	(0.007)	(0.005)	(0.007)	(0.012)	(0.014)
Firm profit over output	0.007	0.001^b	0.078^a	0.042^b	0.046	0.021	-0.026	-0.040
	(0.007)	(0.001)	(0.016)	(0.020)	(0.031)	(0.016)	(0.040)	(0.024)
State dummy	-0.094^a	-0.112^a	0.081^a	0.022	-0.053^a	-0.074^a	-0.183^a	-0.213^a
	(0.021)	(0.016)	(0.020)	(0.021)	(0.011)	(0.021)	(0.027)	(0.033)
Foreign dummy	0.028^a	0.027^a	0.191^a	0.149^a	0.006	0.021^b	0.075^a	0.031^a
	(0.008)	(0.007)	(0.025)	(0.017)	(0.009)	(0.010)	(0.015)	(0.011)
Export dummy	0.022^a	0.033^a	0.016^b	0.016^c	0.056^a	0.039^a	-0.007	-0.032^a
	(0.007)	(0.006)	(0.007)	(0.009)	(0.009)	(0.008)	(0.009)	(0.009)
City-Sector Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.06	0.06	0.45	0.49	0.13	0.12	0.14	0.15
Observations	76,573	73,605	57,474	54,200	57,474	54,200	57,474	54,200
Underidentification test	56.1^a	55.3^a	55.6^a	53.6^a	55.6^a	53.6^a	55.6^a	53.6^a
First-stage F-test of excluded instruments	281.5^a	496.4^a	297.7^a	503.8^a	297.7^a	503.8^a	297.7^a	503.8^a
Overidentification Hansen J-statistic	0.87	0.13	0.1	1.16	1.3	2.7	0.11	0.3
Chi-sq p-value	0.35	0.72	0.75	0.28	0.25	0.1	0.74	0.58

Standard errors are clustered at the city level. ^{a}, ^{b} and ^{c} indicate significance at the 1%, 5% and 10% confidence levels. Survival is a dummy for the 2003 firm still existing in the 2005 census. Exposed is a dummy for the average wage in the firm in 2003 being lower than the local minimum wage in 2005. Δ indicates the change between 2003 and 2005. All other right-hand side variables are measured in 2003. The instruments used in the IV procedure for Δ Ln Minimum wage 2003-05 $\times$ Exposed are the interactions of the local minimum wage in 2003 and the predicted minimum-wage change based on the 40% rule (see text) with the exposed dummy. The underidentification test is based on the Kleibergen-Paap rk LM-statistic, with ^{a} indicating that the p-value (Chi-sq(2)) is below 0.01, suggesting that underidentification is rejected. The F-test of excluded instruments in the first-stage equation is based on the Kleibergen-Paap Wald rk F-statistic, with ^{a} indicating that the p-value is below 0.01, suggesting that the instruments are not weak. The F-statistic on the excluded instruments is largely above 10, the informal threshold suggested by Staiger and Stock (1997) to assess instrument validity. The Hansen J-statistic is an overidentification test of all instruments, a Chi-sq p-value above 0.10 suggests that the model is overidentified and the instruments are exogenous.

Table A-10: Minimum wages and firm-level outcomes - Heterogeneous effect for foreign firms

Dependent variable	Firm survival 2003-05	ΔFirm avg wage 2003-05	Δ Firm employment 2003-05	Δ Firm labor productivity 2003-05
	(1)	(2)	(3)	(4)
Δ Ln Real Minimum wage $\times$ Exposed	-0.203^a	0.379^a	-0.085^b	0.421^a
	(0.033)	(0.104)	(0.038)	(0.059)
Δ Ln Real Minimum wage $\times$ Foreign	-0.093	-0.036	-0.075	-0.121
	(0.074)	(0.257)	(0.095)	(0.165)
Δ Ln Real Minimum wage $\times$ Exposed $\times$ Foreign	-0.043	-0.167	0.224^b	-0.265^b
	(0.043)	(0.136)	(0.090)	(0.127)
Ln Firm employment	0.081^a	0.052^a	-0.121^a	0.031^a
	(0.003)	(0.004)	(0.004)	(0.006)
Ln Firm wage	0.020^a	-0.763^a	0.098^a	-0.060^a
	(0.019)	(0.081)	(0.052)	(0.078)
Ln Firm wage^2	0.008^c	-0.673^a	0.107^a	-0.028^b
	(0.004)	(0.031)	(0.007)	(0.011)
Ln Firm labor productivity	0.052^a	0.091^a	0.116^a	-0.286^a
	(0.003)	(0.005)	(0.005)	(0.012)
Firm profit over output	0.001^b	0.058^a	0.033^b	-0.034
	(0.001)	(0.016)	(0.015)	(0.027)
State dummy	-0.098^a	0.065^a	-0.058^a	-0.193^a
	(0.018)	(0.019)	(0.011)	(0.025)
Foreign dummy	0.047^a	0.178^a	0.023	0.081^b
	(0.015)	(0.065)	(0.022)	(0.039)
Export dummy	0.028^a	0.015^b	0.047^a	-0.020^a
	(0.005)	(0.007)	(0.006)	(0.007)
City-Sector Fixed effects	Yes	Yes	Yes	Yes
R-squared	0.06	0.47	0.12	0.14
Observations	152,226	112,171	112,171	112,171
Underidentification test	66.3^a	64.6^a	64.6^a	64.6^a
First-stage F-test of excluded instruments	190.08^a	197.99^a	197.99^a	197.99^a
Overidentification Hansen J-statistic	0.84	3	1.95	0.29
Chi-sq p-value	0.66	0.22	0.38	0.87

Standard errors are clustered at the city level. ^{a}, ^{b} and ^{c} indicate significance at the 1%, 5% and 10% confidence levels. Survival is a dummy for the 2003 firm still existing in the 2005 census. Exposed is a dummy for the average wage in the firm in 2003 being lower than the local minimum wage in 2005. Δ indicates the change between 2003 and 2005. All other right-hand side variables are measured in 2003. The instruments used in the IV procedure for Δ Ln Minimum wage 2003-05 $\times$ Exposed are the interactions of the local minimum wage in 2003 and the predicted minimum-wage change based on the 40% rule (see text) with the exposed dummy. The underidentification test is based on the Kleibergen-Paap rk LM-statistic, with ^{a} indicating that the p-value (Chi-sq(2)) is below 0.01, suggesting that underidentification is rejected. The F-test of excluded instruments in the first-stage equation is based on the Kleibergen-Paap Wald rk F-statistic, with ^{a} indicating that the p-value is below 0.01, suggesting that the instruments are not weak. The F-statistic on the excluded instruments is largely above 10, the informal threshold suggested by Staiger and Stock (1997) to assess instrument validity. The Hansen J-statistic is an overidentification test of all instruments, a Chi-sq p-value above 0.10 suggests that the model is overidentified and the instruments are exogenous.

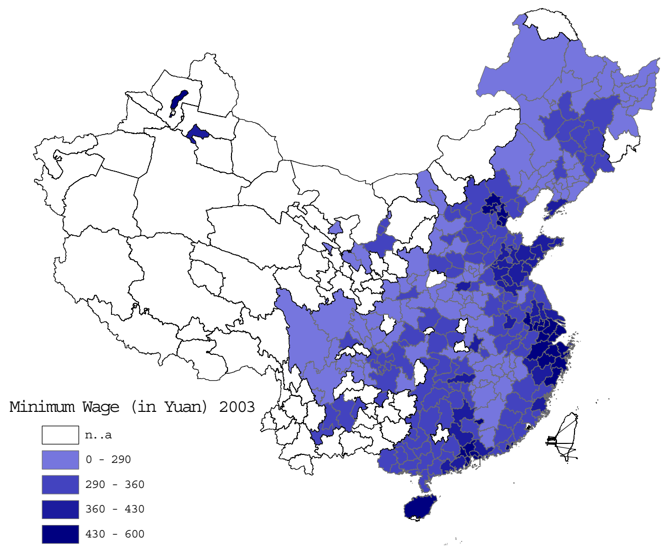

Figure A-1: Monthly minimum wages in 2003 (Yuan)

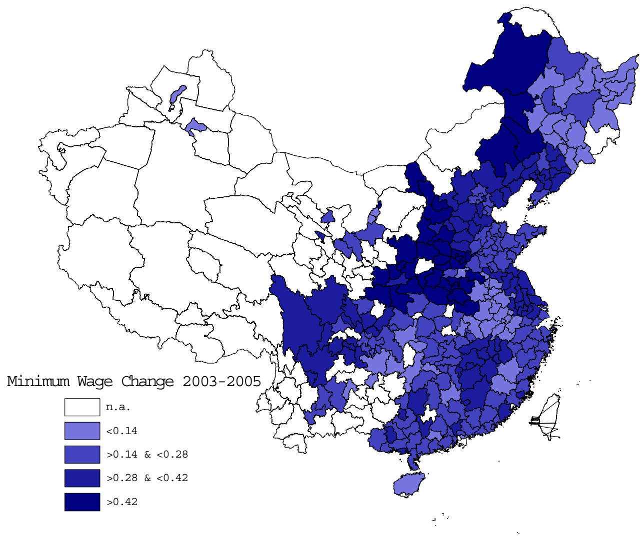

Figure A-2: Δ Monthly minimum wages 2003-05

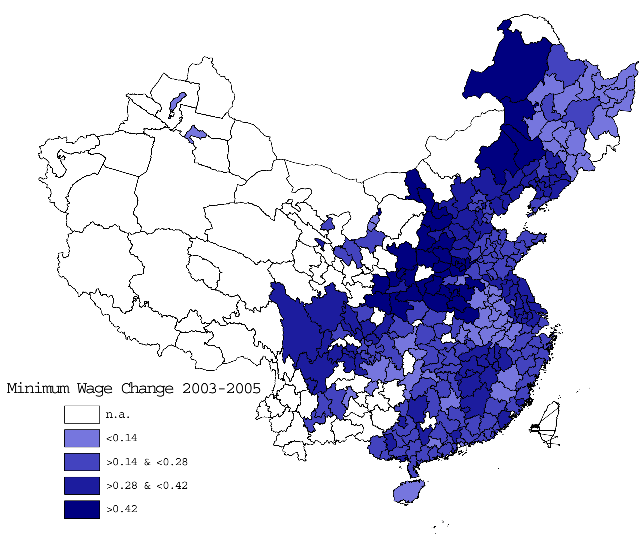

Figure A-3: Δ Monthly real minimum wages 2003-05