Who Pays for the Minimum Wage?*

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Abstract

This paper provides a comprehensive assessment of the margins along which firms responded to a large and persistent minimum wage increase in Hungary. We show that employment elasticities are negative but small even four years after the reform; that around 75 percent of the minimum wage increase was paid by consumers and 25 percent by firm owners; that firms responded to the minimum wage by substituting labor with capital; and that dis-employment effects were greater in industries where passing the wage costs to consumers is more difficult. We estimate a model with monopolistic competition to explain these findings.

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1 Introduction

Despite several decades of microeconometric evidence, the minimum wage remains a highly controversial policy. On the one hand, opponents argue that the minimum wage makes low-skilled workers worse off as many of them lose their jobs (e.g., Stigler 1946; Neumark and Wascher 2010). On the other hand, proponents insist that the minimum wage has no discernible effect on employment and sometimes has a positive effect on it (e.g., Card and Krueger 1995; Dube et al. 2010). In addition to debating the sign and the size of the employment effects, there is also disagreement on whether the minimum wage is passed on to consumers through higher prices, or whether it is paid by firm owners through lower profits (see e.g. Aaranson and French 2008 on prices and Draca et al. 2011 on profits).

In this paper, we present new evidence on the employment effect and the incidence of the minimum wage by exploiting a very large and persistent increase in the minimum wage in Hungary. Figure 1 shows the remarkable recent history of the minimum wage in Hungary. Prior to 2000, the ratio of the minimum wage to the median wage in the country was around 35 percent, comparable to the current ratio in the U.S., while two years later the minimum wage rose to 55 percent — a level only slightly below the current minimum wage in France. The apparent size and permanence of this unique policy change allow us to examine responses to a minimum wage increase in a context where firms have strong incentives to restructure their production process or exit the market as soon as possible because the loss in profit from inaction is significant.

We estimate the employment and wage effects of this unique minimum wage increase by exploiting administrative data on firms filing balance sheet statements to the tax authority. We estimate the firm-level relationship between the fraction of workers who earned below the new minimum wage before the reform and the percentage change in employment relative to year 2000, the last year before the minimum wage hike. We find that firms employing only minimum wage workers had 10 percent lower employment four years after the minimum wage hike than firms with no minimum wage workers. This implies that 1 out of 10 low wage workers lost their job as a result of the reform. The divergence in employment between firms with different levels of exposure emerged only after the minimum wage hike, which underlines that the employment changes are driven by the reform and not something else.

At the same time, the average wage at the highly exposed firms increased by 54 percent more than the average wage at firms with no exposure to the minimum wage. Therefore, the employment responses relative to the wage effects are small even for sizable changes in the minimum wage and so the average earnings of low-wage workers increased considerably. The implied employment elasticity with respect to the workers' *own wage* is -0.18 (s.e. 0.03), which is at the lower end of the estimates in the literature.

The administrative data combined with the very large minimum wage shock allow us to examine

various other margins of adjustment and to assess the incidence of the minimum wage directly. We find a strong positive relationship between changes in total revenue (relative to year 2000) and minimum wage exposure after the reform, while no such relationship was present beforehand. A similar analysis reveals a slight drop in profits after the reform. We calculate that around 25 percent of the increased cost of labor is covered by lower profits, and so paid by the firm owners, and around 75 percent is paid by consumers in the form of higher revenue. Therefore, understanding revenue responses is crucial for the incidence analysis.

The change in total revenue is the product of changes in quantity and prices. To provide direct evidence on the role of price changes we exploit unique firm-product level data for the manufacturing sector and document that firm-level price indices increased considerably in response to the minimum wage. We also find substantial heterogeneity in responses to the minimum wage across sectors consistent with the role of price passthrough. We show that the revenue effects are smaller (and the disemployment effects are larger) in the tradable, in the manufacturing and in the exporting sectors. In these sectors, Hungarian firms are more likely to face foreign competitors which are not hit by the minimum wage shock. Thus the price increase of Hungarian firms leads to a competitive disadvantage and a large fall in output. On the contrary, the minimum wage increased revenue more (and the disemployment effects were smaller) in the non-tradable sector. In this sector, all firms were hit by the minimum wage shock meaning that individual firms could raise their prices without a loss in competitive advantage or a large fall in output.

Understanding responses at various margins also allows us to shed new light on how firms absorbed the minimum wage shock. The main explanations in the literature for the near-zero effect on employment emphasize the importance of labor market frictions (e.g. Dube, Lester and Reich 2014, Flinn 2010, Bashkar, Manning and To 2002, Van Den Berg 2003, Rebitzer and Taylor 1995). However, the increase in prices and the seemingly important role for product market competition highlight the importance of the channels predicted by the standard labor demand model (Aaronson and French 2007). We also document a large increase in capital stock, which suggests that capital-labor substitution – another important margin of adjustment in the standard labor demand model – plays a crucial role.[1]

We propose a simple partial equilibrium model that incorporates these channels of adjustment. To capture the importance of the structure of output market we deviate from the standard labor demand model, which assumes perfect competition, and we introduce market imperfection in the output market. In particular, we assume that monopolistically competitive firms are selling differentiated goods. The model's key predictions are in line with the Hicks-Marshall rule of derived demand

[1]The relatively fast and sizable adjustment also underscores that the minimum wage hike was so radical that firms adjusted their production processes quickly. Since the change in capital stock mainly occurred at firms which existed before the minimum wage hike, such a large response in capital stock is inconsistent with the Putty-Clay model (see Aaronson, French, Sorkin and To 2018)).

(Hamermesh 1993) which suggests that firm-level responses to the minimum wage depend on 1) the cost share of different factors in production (labor, capital, intermediate goods); 2) the substitution elasticity between labor and other factors (capital and intermediate goods); and 3) the relevant output demand elasticity firms face after a minimum wage hike. However, this latter channel depends on the market structure in our model. In markets where only one firm is hit by the minimum wage shock (e.g. exporting markets) the relevant output demand is the firm-level one which tends to be highly elastic. Alternatively, in markets where all firms are hit by the minimum wage shock, the relevant output demand is the market-level one which tends to be less elastic.

We evaluate the model quantitatively by matching the model predictions to our empirical estimates on the effects of the minimum wage increase on labor, capital, revenue and materials (intermediate goods and services). The model performs well in explaining the key moments in the data, especially when we allow the underlying parameters to vary by sector. The best fitting model matches the employment and capital responses very closely. Moreover, the predicted price effects in the manufacturing sector are also very close to their empirical counterparts even though we do not use these moments in the estimation. However, the model fit is not perfect. In some cases we over-predict revenue responses and under-predict responses on materials, which underlines some limitations of this arguably simplistic framework.

Nevertheless, finding the best fitting parameters allows us to translate our reduced form estimates at various margins to easily interpretable structural parameters. We uncover three structural parameters. The substitution elasticity between capital and low wage workers is quite high – it is 3.35 (s.e. 0.62) 4 years after the reform. However, this large substitution elasticity has only a limited effect on employment, because the share of capital expenses in firm-level production is only around 8 percent. The second structural parameter is the substitution elasticity between materials and labor, which we estimate to be close to zero (0.03, s.e. 0.06) even in the medium run. Given that the spending on materials accounts for 74 percent of an average firm's costs, a low level of this elasticity is required for the employment responses to be low.

The output demand elasticity is close to zero (0.11 s.e. 0.22) in the medium term (four years after the reform). Moreover, there is considerable variation in the estimates across sectors. The output demand is more elastic in the manufacturing and in the tradable sector, where the relevant output demand elasticity is the firm-level one. For instance, in the exporting sector, we find that the output demand elasticity is 3.64 (s.e. 0.98).[2] By contrast, in the non-tradable sector we find near-zero output elasticities even in the medium run. This suggests that firms in these sectors can pass the minimum wage to consumers because output demand is inelastic.

This paper contributes to several strands of the minimum wage literature. First, we contribute

[2]The output demand elasticity in the exporting sectors identifies the Armington elasticity, i.e. the elasticity of substitution between products of different countries. Our estimates are in line with the findings in the trade literature which have found that the Armington elasticity is close to 1.4 in the short-run and to 6.2 in the long-run (Ruhl 2005).

to the extensive literature on the employment effects of the minimum wage (e.g., see the surveys by Neumark and Wascher 2010 and Card and Krueger 1995). Many papers in this literature find that the effect of the minimum wage is close to zero (Doucouliagos and Stanley 2009, CBO 2014). However, these papers are criticized on the basis that they rely on small and temporary shocks for identification (Sorkin 2013, Aaronson, French, Sorkin and To 2018) and study only short term responses (Baker, Dwayne and Stanger 1999), and so the lack of immediate responses might simply reflect adjustment costs or inertia (Chetty, Friedman, Olsen and Pistaferri 2011). In this paper, we address these critiques by examining an unusually large and persistent increase in the minimum wage, where costs of inaction or delaying responses are substantial, and show that the effect of the minimum wage is small even for such a large minimum wage change.[3]

This paper also contributes to the literature investigating margins of adjustment to the minimum wage. Previous literature has examined the effect on firm profitability and revenue (Mayneris, Poncet and Zhang 2016, Hau, Huang and Wang 2016, Riley and Bondibene 2018, Draca, Machin and Van Reenen 2011, Allegretto and Reich 2016), on the stock-market value (Card and Krueger 1995, Bell and Machin 2018), on capital stock (Hau et al. 2016), and on output prices in the local service sector (see Lemos 2008 and MaCurdy 2015 for a review). Here we provide a comprehensive study of the different margins adjustment, both across the whole economy and separately by sector. Thanks to the large permanent increase in the minimum wage we have the statistical power to look at the margins of adjustment in sectors where the labor share is low and so a smaller shock to the minimum wage would have only modest impacts on firms (e.g. in the retail sector, see Ganapati and Weaver 2017) or where a smaller minimum wage shock would not be binding (e.g. in the exporting and in the manufacturing sector).

Finally, our paper also contributes to the scant literature on the incidence of the minimum wage. MaCurdy (2015) examines the incidence of the minimum wage in a general equilibrium framework under the assumption that there is no employment effect and the increase in wage cost is fully passed through to the consumers as higher prices. Our estimates suggest that this assumption is inaccurate as only 75 percent of the minimum wage is passed through to consumers, while 25 percent is paid by firm owners. Similarly to MaCurdy (2015), we also examine the consumption of households to better understand who buys the goods produced by minimum wage workers but, contrary to him, we find that rich and poor households spend a very similar fraction of their income on goods produced by minimum wage workers.

The paper proceeds as follows. In Section 2, we describe the institutional context of the minimum wage increase and our data. In Section 3 we present evidence on the employment and wage

[3]Some other studies have exploited very large minimum wage shocks. Reynolds and Gregory (1965) and Castillo and Freeman (1990) study the impacts of imposing the US federal minimum wage on Puerto Rico, which was relatively large but occurred over several years. Moreover, Kertesi and Kï¿œllő (2004) studied the employment effects of the 2001 raise in the minimum wage in Hungary. Although they use different methods and datasets, many of their estimates are close to ours. Recently, Jardim et al. (2017) examine the short term impact of the $13 minimum wage in Seattle.

effects of the minimum wage. In Section 4, we estimate various margins of adjustment by firms. In Section 5 we present a labor demand model with monopolistic competition on the output market and estimate the key parameters of the model. In Section 6 we present robustness checks and address the potential threats to identification, and we conclude in Section 7.

2 Institutional Context and Data

2.1 Institutional Context

The minimum wage in Hungary is negotiated annually by a national-level tripartite council — a consultative body that consists of unions, employers' associations and the government.[4] If the tripartite council fails to agree, the government is authorized to decide unilaterally.

Before 2000 the minimum wage was typically increased by slightly more than the inflation rate each year. However, on April 6th, 2000 the right-wing government announced (and later decided unilaterally) that it would raise the minimum wage from 25,500 HUF to 40,000 HUF in January 2001 and also pledged to increase the minimum wage further to 50,000 HUF in 2002.[5] This announcement was rather unexpected, since the radical increase of the minimum wage had not previously been part of the political discourse.[6] For instance, the unions were demanding a 13 percent increase in minimum wage at the pre-negotiations, so a government proposal to double the nominal minimum wage in two years was above all expectations (Tóth 2001). In fact both unions and employers strongly opposed such a radical change to the minimum wage as they were afraid of the negative consequences for jobs.

Government officials stated that the main objectives of the minimum wage increase were to alleviate income differences, to increase government revenue and to diminish tax evasion (Cserpes and Papp 2008). Political commentators, on the other hand, argued that the real purpose of such a salient and radical change in minimum wage was to "set the political agenda" and to boost party support.

The main opposition parties did not oppose raising the minimum wage, and so the increase was not reversed after the right-wing government lost the 2002 election. This is highlighted in Figure 1 which summarizes the evolution of the minimum wage in relation to the median wage in the private sector between 1996 and 2008. It is clear that the large increase in the minimum wage between 2001 and 2002 represented a permanent regime-shift.

[4]The council sets the the minimum monthly base earnings (total earnings net of overtime pay, shift pay and bonuses) for a full-time worker. For part-timers, accounting for only 5 percent of all employees in Hungary, the minimum is proportionally lower.

[5]The exchange rate was 280 HUF/USD in 2001 January 1st, so the monthly base earnings was increased from $91 to $179.

[6]In the previous general election in 1998 none of the major political parties campaigned for increasing the minimum wage. However, by the next general election in 2002, all major parties described their positions on minimum wage in their election manifesto. The increased prominence of minimum wage policies highlight that the governing right-wing parties were successful in setting the political agenda with its radical minimum wage policy.

The Hungarian economy was performing well and there were no dramatic macroeconomic shocks around the time of the reform (see the Online Appendix Figure A.2 for the details). Real per capita GDP growth was around 4 percent before and after the reform. In line with the positive growth rate, aggregate labor market conditions were gradually improving: the employment to population rate increased by 0.5 percent each year between 1997 and 2004 and the unemployment rate fell to 5 percent by 2001 and then remained at this low level. Inflation (CPI) was relatively high (around 10 percent in 2000) and it was slowly declining. The exchange rate was also stable around the time of the reform.

Other changes in the policy environment could potentially contaminate our results. While our reading of the evidence is that there were no significant changes that could alter our conclusions significantly, we list all relevant policy changes that we are aware of in the Online Appendix Part A.6 and discuss their potential effects on our results. These policy changes are the following: the expansion of higher education from 1996, small minimum wage compensation schemes in 2001 and 2002, exemption of the minimum wage from personal income taxes in 2002, and a 50 percent increase in public sector base wages in 2002 (see Telegdy, 2018). Moreover, throughout the paper we assume that the estimated effects we report are real responses. However, in the presence of tax evasion, some of the estimated effects may reflect only reporting behavior (Elek, Köllő, Reizer and Szabó 2011). In the Online Appendix Part A.6.5 we present various robustness checks which suggest that our estimates are unlikely to be driven by changes in reporting behavior.

Finally, it is unlikely that firing and hiring restrictions substantially prevented firms from responding to the increased minimum wage: in the period we examine, the strength of employment protection in Hungary was in the bottom third of OECD countries, at a level similar to Switzerland or Japan (OECD 2004).

2.2 Data and Descriptive Statistics

The main data source in the paper is the Hungarian Corporate Income Tax Data (CIT) that covers universe of firms with double book-keeping. The data contains information on employment, firms' balance-sheet and income statements. This panel dataset allows us to follow employment, revenue, profitability and the cost structure of firms over time. But it does not contain information on worker-level wages.

We observe individual worker-level information for the subset of firms which are in the Hungarian Structure of Earnings Survey (SES).[7] The SES collects detailed information on worker-level wages, job characteristics, and demographic characteristics. For small firms in the survey (with 5 to 20 employees) we observe all workers, while for larger firms (more than 20 employees) we only

[7]The survey includes 26 percent of all firms in Hungary, representing 70 percent of all workers as larger firms are over-sampled (see the Online Appendix Part A.5.2 about the sample design).

observe a random sample of workers. Using individual-level wage information we calculate the firm-level fraction of the workers below the 2002 minimum wage (adjusted by inflation and GDP growth) for the subset of firms with at least five workers in the SES. We say that these workers were directly affected by the increase in the minimum wage.

To maximize the sample size in our analysis we also predict the fraction of workers affected by the increased minimum wage for the firms not in the SES. We extend our sample in the following steps. First, we estimate the relationship between the fraction of workers affected by the minimum wage (observed in the SES) and the average cost of labor (observed in CIT) for the subset of firms included in both datasets. Second, we calculate the predicted fraction of workers affected by the new minimum wage for all firms in the CIT data using the average cost of labor (observed in the CIT) and the estimated relationship. Third, to reduce noise in the predicted values, we calculate the predicted fraction affected every year between 1997 and 2000 and then we take the average across years.

Our main analysis focuses on the manufacturing, service and construction sectors. We omit the public sector; agriculture; heavily regulated industries (energy, pharmaceuticals); industries where balance sheet items are hard to interpret (finance and insurance); and industries with special excise tax (oil and tobacco), since our revenue measure includes excise taxes. We focus on firms that existed between 1997 and 2000, and we drop firms with the top 1 percent and bottom 1 percent growth rate between 1997 and 2006. We also drop firms where the average wage per worker is less than 90 percent of the minimum wage in any year between 1997 and 2000. None of these restrictions are crucial, but they reduce the impact of outliers on our estimates. Moreover, in our benchmark specification we omit firms with less than 5 employees.[8] In the final sample we have 19,950 firms, representing around a million workers (or one third of the total workforce in Hungary).

In Table 1 we report the means of some firm-level characteristics in 2000 by sector. An average firm in our sample employs 47 workers, 10 percent of its revenue is earned from exports, and its profitability is 3.2 percent of total revenue. The labor share in total production is 18 percent, while the share of materials (intermediate goods and services) is around 74 percent.[9] The fraction of workers affected by the increased minimum wage for an average firm is 43 percent, while the median is 37 percent. The large exposure to the minimum wage is driven by smaller firms where the average cost of labor is often close to the minimum wage. The employment weighted average fraction

[8]We exclude these micro enterprises from our analysis for two reasons. First, the relationship between firm-level fraction affected and average cost of labor was estimated on a sample of firms with at least 5 employees, since the SES does not cover smaller firms. Therefore, the prediction of fraction affected for micro-enterprises might be biased. Second, the CIT data is less reliable for the smallest firms because of tax evasion.

[9] Such a large role for intermediate goods and services at the firm-level is not unusual in European countries (see Appendix Table A.1).

affected is around 20 percent in our sample. The table also highlights some sectoral differences. Firms in the manufacturing, in the exporting and in the tradable sectors employ more workers on average, have higher labor share in production, and are also less exposed to the minimum wage than those in the non-tradable sectors.

For a subset of manufacturing firms in the CIT data we also have information on product-level prices from the Hungarian Annual Survey of Industrial Production (ASIP). We use this data to calculate firm-level Laspeyres price indices.

3 Employment Effects of the Minimum Wage

Identification Strategy. We estimate the employment effects of the minimum wage by comparing the evolution of key outcome variables at firms with many workers affected by the minimum wage increase to those firms with few affected workers. We closely follow Machin et al. (2003) and and Draca et al. (2011) and estimate regression models of the following form:

$$\frac{y_{it} - y_{i2000}}{y_{i2000}} = \alpha_t + \beta_t FA_i + \gamma_t X_{it} + \varepsilon_{it} \tag{1}$$

where the left hand side is the percentage change in outcome y between year 2000, the final full calendar year before the minimum wage increase, and year t.[10] This specification allows time effects and the impact of firm characteristics, γ_t, to vary flexibly over time.

We winsorize the percentage changes, $\frac{y_{it}-y_{i2000}}{y_{i2000}}$, to take values between 1st and the 99th percentile in each year. We include firms that shut down in the analysis as they experienced a 100 percent decline in their employment (and other outcomes). In the main analysis, we measure exposure to the minimum wage, FA_i, by calculating the fraction of workers for whom the 2002 minimum wage binds, while in Section 6 we explore robustness to alternative measures of exposure such as the "wage gap" measure. As we describe in the data section, we predict FA_i from the average cost of labor (observed in CIT) before the minimum wage hike. The regression specification above assumes a linear relationship between exposure to the minimum wage and various outcomes. In the Online Appendix Figures A.4 and A.7 we show that non-parametric estimates of the responses we present here are indeed approximately linear.

We restrict our sample to firms that existed between 1997 and 2000. We estimate robust standard errors[11] and we use the logarithm of the revenue in 2000 as weights in our regressions.[12] In our

[10] The minimum wage hikes were announced in year 2000, so it is possible that outcomes in 2000 were already affected. However, we do not detect any unusual changes in year 2000 and so any anticipation effects must be small.

[11] Using the predicted FA_i instead of the actual FA_i can potentially bias the estimates of our the standard errors. In the Online Appendix Section A.5.3 we show that the bias from predicting FA_i is negligible.

[12] Most papers in the minimum wage literature do not use weights in firm-level regressions (Machin, Manning and Rahman 2003, Draca et al. 2011, Hau et al. 2016, Kertesi and Köllő 2004, Mayneris et al. 2016). A notable exception is Card and Krueger (1994) who report estimates from regressions using employment weights. In our case, using the level of employment or the level of revenue as weights would be problematic as the distributions of these variables are

benchmark regression we control for firm age, the legal form of organization (e.g. limited liability company, publicly traded etc.), and the following variables and their squares: average export share between 1997 and 2000; average profitability between 1997 and 2000; the average share of labor between 1997 and 2000; average depreciation rate between 1997 and 2000; the average share of wage cost in total labor cost between 1997 and 2000; and the average industry level import exposure between 1997 and 2000. In Section 6 we also explore including 3-digit NACE industry dummies.

The key identification assumption in this difference-in-difference type of regression is that changes at firms with fewer minimum wage workers are a valid estimate of the counterfactual for firms with many affected workers and so these firms would follow a parallel trends in the absence of the minimum wage increase. While this assumption cannot be tested directly, we test whether the parallel trends assumption holds before the minimum wage hike. Reassuringly, we cannot reject the presence of differential trends in most specifications.

There are various limitations of the approach presented here. First, β_t identifies responses relative to the untreated firms (which requires the Stable Unit Treatment Value Assumption (SUTVA) assumption). Second, equation 1 only shows the effect on existing firms. In Section 6 we return to these issues and show that these shortcomings are unlikely to affect our key results.

Employment Effects. The estimates for employment from regressions of equation 1 are summarized in Panel A of Table 2. Columns (1) and (2) show the effects of the minimum wage two years after the minimum wage hike. The point estimate in Column (1) indicates that the employment declines by 7.8 percent (s.e. 0.8 percent) more at firms where 100 percent of the workforce is directly affected by the minimum wage relative to firms where there are no exposed workers. Remember, in our analysis we also include firms which shut down. Therefore, the results presented here reflect firms' decisions on both the extensive margin (closing) and intensive margin (lay-offs). The estimated employment loss is slightly smaller (7.6 percent, s.e. 1.0 percent) if we control for the rich set of observable characteristics described above (see Column 2).

In Columns (3) and (4) we examine the "medium term" employment effects by estimating employment changes between 2000 and 2004. The specification with controls shows that employment is around 10.0 percent (s.e. 1.2 percent) lower at firms with 100 percent exposure relative to a firm with no exposure. This highlights that the medium term employment effects are somewhat larger than the short term effects (10.0 percent vs. 7.6 percent), but 76 percent of the total employment loss occurred within two years of the minimum wage hike. This pattern is also underscored in Panel (a) of Figure 2, where we plot the evolution of the relationship between fraction affected and the change in employment over time.

How do these estimates relate to the previous literature? In panel A of Table 2 we report

highly skewed (e.g. the employment has a Pareto tail with $\alpha = 1.5$) and so the mean and the variance of the weights are not finite. Therefore, the central limit theorem does not hold in the level-weighted regressions. To avoid using highly skewed weights we use the logarithm of revenue as weights.

the employment elasticity with respect to the minimum wage for the *directly affected workers* ($\%\triangle Emp/\%\triangle MW$). To compare these estimates to the ones reported in existing literature we need to take into account that elasticities are often reported for a particular group of workers (e.g. teenagers or restaurant workers). As a result, we need to multiply our estimates for the *directly affected workers* by the fraction of workers directly affected in that particular group. For instance, to compare our results to the estimates in the U.S. literature that mainly focus on teenage workers, we need to multiply our estimates by 0.25, which is the share of directly affected teenagers in the U.S. in 2012. Therefore, our estimates in panel A imply that the teen employment elasticity is between -0.02 and -0.04 depending on the specification considered. These employment elasticities are an order of magnitude smaller than the range of -0.1 to -0.3 suggested by Neumark and Wascher (2010) or Brown (1999), but are in line with some recent meta-analyses in the literature (Belman and Wolfson 2014, CBO 2014, Doucouliagos and Stanley 2009, MaCurdy 2015).

Two points should be noted. First, columns (5) and (6) in Table 2 and panel (a) of Figure 2 show the relationship between exposure the minimum wage and employment preceding the minimum wage hike. Consistent with a causal interpretation of our estimates, the pre-reform changes in employment are close to zero and the negative relationship emerged exactly at the timing of the reform.

Second, as we mentioned before, we show in the Online Appendix Figure A.4 that the non-parametric relationship between employment changes and exposure to the minimum wage is linear. Notice that such a linear relationship is hard to reconcile with the presence of imperfect competition and monopsony power in the labor market. If firms face upward sloping labor supply curves, we would expect that small minimum wage shocks would have a small or even positive effect on employment, but for large shocks the effect should be negative (Manning 2003). Therefore, the presence of monopsonistic competition would predict that the relationship between minimum wage exposure and the disemployment effects should be non-linear, contrary to our empirical findings.

Effects on Wages and the Cost of Labor. The size of the employment effect should be compared to the wage effects (Machin et al. 2003). We investigate the effect on wages by estimating the firm-level relationship between fraction of affected workers and the percentage change in the wage for an average worker using equation 1. Since we can only calculate wage changes for the firms that survived we restrict the sample to those.[13]

We use two concepts of remuneration in this section: wages and cost of labor. This latter differs from the former because it does not only include wages, but employer's social security contributions and non-cash employment benefits as well. In Panel B of Table 2 we report the effect of the minimum wage on wages. This is what most papers in the literature estimate and so it is useful for comparing

[13]Firms' closure might not occur at random. In the Online Appendix Table A.2 we report estimates in which we correct for non-random exit by following Johnson et al. (2000). The results are very similar to those presented here.

our results to existing studies. In Panel C of Table 2 we report estimates on the average cost of labor. This measure is what firms take into account when they make their firing and hiring decisions.

Columns (1) and (2) in Panel B of Table 2 highlight that the minimum wage had a very large and statistically significant effect on average wages in the short run. For instance, Column (2) in Panel B shows that firms with 100% fraction affected experienced a 58 percent (s.e. 1 percent) increase in their average wage relative to those with no fraction affected in 2002. The increase in cost of labor was around 15 percent less at 49 percent (see Panel C). The lower impact on labor cost simply reflects that the wage increase is compared to a higher base which includes social security contributions and non-cash benefits. We find no indication that firms tried to offset the wage increase by cutting non-wage benefits.

Columns (3) and (4) of Table 2 show that the effect on average wage is slightly lower in the medium-term, because the real value of minimum wage was somewhat lower in 2004 than in 2002 (see Figure 1). For instance, the wages effects are 54 percent (s.e. 1 percent) in the medium term. Panel (b) in Figure 2 shows the evolution of wage effects and cost of labor effects over time. Two points should be noted. First, before the reform there is no clear relationship between fraction affected and the change in either the wage or the cost of labor, while both the wage and the cost of labor increased dramatically at highly exposed firms after the reform. Second, the time pattern of the wage increase (with the effect highest in 2002 before dropping slightly in 2003) closely resembles the evolution of the minimum wage in Figure 1. This implies that the changes in wages are likely to be related to the minimum wage change and not to something else.

Figure 2 also highlights the size of the wage and cost of labor effects (Panel (b)) relative to the employment effects (Panel (a)). To make these two comparable, we use the same scale in both panels. The large differences in the percentage changes in wage and employment highlight that the wage effect of the minimum wage dominates the employment responses. This is also reflected in the employment elasticities with respect to the wage, i.e. ratios of the (estimated) percentage change in employment and the (estimated) percentage change in wages that we report in panel B of Table 2, and the employment elasticities with respect to the cost of labor that we report in panel C. The short-run elasticity for wages is around -0.13 (s.e. 0.02), while the medium run is slightly higher (-0.18, s.e. 0.03). The employment elasticity with respect to labor cost is slightly higher (in absolute terms) at -0.16 (s.e. 0.02) two years after, and -0.23 (s.e. 0.03) four years after the minimum wage hike. These elasticities are at the lower end of the literature but lie within the 95 percent confidence intervals of most previous estimates.[14] Moreover, the precision of our estimates is an order of magnitude smaller than previous estimates, even though many papers in the literature do not calculate robust standard errors. The relatively small standard errors are the consequence of the uniquely large and persistent minimum wage shock considered here. The magnitude of the

[14] In the Online Appendix Figure A.6 we contrast our employment elasticities with the findings in the previous literature.

reform delivers a large and precisely estimated effect on wages (e.g. 58 percent with 1 percent s.e. in 2002). When we divide the employment effects by this precisely estimated wage effect, the standard errors on our employment elasticities remain small.

It is also worth mentioning that while the employment elasticities gradually increase (in absolute value) up to 2003 they stabilize after. The employment elasticity with respect to labor cost is -0.22 in 2003, which is almost the same as the 2004 estimates (-0.23). This suggests that the "medium term" employment elasticity also reflects long term responses. Moreover, the quick convergence in the elasticities underscores that firms responded quickly to the radical change in the minimum wage.

4 Firms' Margins of Adjustment and the Incidence of the Minimum Wage

The previous section shows that the minimum wage increase had a large positive effect on real wages and a small negative effect on employment. The simple consequence of this finding is that the income of low wage workers increased in response to the minimum wage. However, this income gain must be paid for by others in the economy. In this section we examine behavioral responses of firms at various margins in order to better understand who bears the incidence of the minimum wage.

4.1 Firms' Margins of Adjustment

Labor Cost. We first document the effect of the minimum wage on total labor cost, which is a proxy for total income collected by workers. Again we estimate the relationship between the fraction of workers affected by the minimum wage and the change in total labor cost four years before and four years after the minimum wage increase using equation 1. Table 3, Panel A shows the estimated coefficients, while Figure 3 plots them over time. Figure 3 (and also Column (3) of Table 3) shows that firms with different levels of minimum wage exposure follow a parallel trend before the minimum wage hike. However, this trend broke exactly in 2001, when the minimum wage was raised. The increase in labor cost at firms where 100 percent of the workers earned below the new minimum wage was 32.5 percent (s.e. 1.3 percent) and 23.8 percent (s.e. 2.0 percent) higher two and four years after the minimum wage hike relative to a firm with no workers below the new minimum. This large increase in firms' labor cost is in line with our previous findings on wages and employment.

Revenue. We examine the effect on revenue in Panel B of Table 3 and in Panel (b) of Figure 3. The relationship between the minimum wage and revenue exhibits a similar pattern to the labor cost. Highly exposed and less exposed firms follow a parallel trend before the reform, but this trend breaks exactly at the time of the reform. Total revenue increased by 6.6 percent (s.e. 1.3 percent) more at highly exposed firms two years after the hike and by 3.6 percent (s.e 1.8 percent) four years after. The considerable increase in revenue suggests that a part of the labor cost increase was financed by consumers.

Price. Is the increase in revenue caused by higher output or by higher prices? We examine the effect of the minimum wage on prices in the manufacturing sector where we have access to firm-product level price data for a large sample, covering around 50 percent of firms. We construct a firm-level Laspeyres price index by weighting product-level price changes by the product's revenue share in the firm's output portfolio, and then we estimate the effect of the minimum wage on this price index using equation 1.[15] Column (1) of Table 4 shows the raw correlation between fraction affected and the change in output prices. The estimates show that prices increased by 7.4 percent (s.e. 2.4 percent) in the short term and by 13.4 percent (s.e. 4.5 percent) in the medium term. Controlling for observable characteristics (Column (2)) slightly decreases the estimates to 4.3 percent (s.e. 2.8 percent) in the short term and 10.8 percent (s.e. 4.8 percent) in the medium term. Panel C also reports the relationship between exposure to the minimum wage and prices in the periods before the minimum wage reform, and we do not find evidence for pre-existing trends.[16]

The red dashed line in Figure 4 plots the estimated coefficients from Column (2) of Table 4 over time. The graph provides further support for the findings in Table 4. It demonstrates the absence of a relationship between the minimum wage and price changes before the reform and the emergence of a large and significant positive price effect after the minimum wage hike. The figure also suggests that the price responses to the minimum wage occur gradually as it takes time for firms to adjust their prices.

We also explore further robustness checks related to the price effects in Table 4. In the short-term we have more firms with price data than in the medium term (3252 in 2002 and 2541 in 2004), because some firms shut down or otherwise leave the survey over time. In Columns (3) and (4) we examine whether the differential short and long term price changes are caused by changes in the sample composition and we find no indication for that.

What is the effect on quantity sold? The blue solid line in Figure 4 plots the size of the revenue effects in the manufacturing sector. The figure highlights that the revenue change, which measures the change in the product of price and quantity, is lower than the price change after 2002. This implies that the quantity fell in response to the minimum wage after 2002. Such a drop in output and increase in prices are not in line with the basic predictions of the monopsony model (Aaronson and French 2007), since in those models a minimum wage induces firm to hire more, which eventually leads to higher output and lower prices.

Materials. In Table 3 we also examine the effect on materials (intermediate goods and services). Even though adjustment on that margin is often overlooked in the literature, it is in an important

[15] See the Section A.5.5 in the Online Appendix for further details on how we construct our price index.

[16] Raising prices is likely to be the hardest in the manufacturing sectors, where firms face foreign competition. Therefore, even though we cannot assess the price effects outside of manufacturing, it is likely that price increase played a key role in other sectors as well.

factor as spending on materials is around 74 percent of total revenue (see Table 1).[17] Total spending on materials increased in the short term (4.9 percent, s.e. 1.4 percent),[18] while in the medium term the effect on materials is smaller and insignificant (2.1 percent, s.e. 1.9 percent). Both the short term and long term estimates on materials are lower than the increase in revenue, and so the increase in revenue net of materials was considerable.

Capital. In Panel D of Table 3 we explore the effect on capital.[19] Apart from a recent study on the effect of the minimum wage in China (Hau et al. 2016), existing literature has not examined capital responses to the minimum wage. The point estimates show a large and significant positive effect on the capital stock both in the short and in the medium term. The capital stock had increased by almost 27.0 percent (s.e. 5.4 percent) within four years of the minimum wage hike. This suggests that capital-labor substitution is an important margin of adjustment.

Profits. In Panel E we estimate the effect on accounting profits (Earnings Before Interest and Taxes). Column (1) shows that profits (relative to the revenue in 2000)[20] fall by 1.1 percentage point (s.e. 0.3) at highly exposed firms in the short run (within two years of the reform). This change is around 30 percent of the average profitability in 2000, which was 3.2 percent (see Table 1). The medium-term profit reduction is slightly less at 0.8 percentage points, s.e. 0.4, which is around 20 percent of the average yearly profit level. This suggests that part of the wage increase is paid by firm owners.

4.2 Incidence of the Minimum Wage

Our estimates above can be used to assess the incidence of the minimum wage. Our starting point is the following accounting identity:

$$Profit \equiv Revenue - Material - LaborCost - Depr - MiscItems$$

where $Depr$ is depreciation expenses, while $MiscItems$ includes minor accounting items (e.g.

[17] Table A.1 in the Appendix shows that the share of materials in production is generally high across Europe: it is around 66 percent in Western Europe and 72 percent in Eastern Europe.

[18] The positive effect on materials can be explained by substitution between labor and materials or by a differential increase in the price of the intermediate goods. This latter can emerge if the suppliers of a minimum wage firm tend to be other minimum wage firms and so all firms raise prices throughout the supply chain.

[19] We calculated the capital stock using the perpetual inventory method (see the details in Bï¿œkï¿œs and Harasztosi, 2013). We use the investment flows from 1992 (or the year of establishment for firms established later). In the initial period we take the value of fixed assets as investments. In later periods investments is the sum of depreciation and the change in tangible fixed assets. To turn nominal values into real ones, we use sector level investment deflators from the Central Statistics Office of Hungary. The perpetual inventory method has an unfortunate shortcoming that it does not take into account rented capital. If a firm rents machinery, office space or cars, such items appear as material costs.

[20] Since profit can be negative or zero in the base year (in year 2000), we use $\frac{\triangle Profit}{Revenue_{i2000}}$ as an outcome variable in equation 1.

accrual deferrals). This equation leads to the following expression:[21]

$$\frac{\triangle LaborCost}{Revenue_{2000}} = \underbrace{\frac{\triangle Revenue}{Revenue_{2000}} - \frac{\triangle Material}{Revenue_{2000}} - \frac{\triangle MiscItems}{Revenue_{2000}}}_{\text{Consumers Pay}} + \underbrace{-\frac{\triangle Depr}{Revenue_{2000}} - \frac{\triangle Profit}{Revenue_{2000}}}_{\text{Firm Owners Pay}} \tag{2}$$

The equation above highlights that the change in labor cost (relative to the revenue in 2000) can be decomposed into two parts. The first part shows the revenue change net of material (and other) expenses, and so it captures the value added in production. This is the amount firms receive from consumers in exchange of the value they created.[22] The value added is divided between firm owners and workers. The second part shows the effect on firm owners, which is the sum of profits and depreciation expenses. Three points should be noted.

First, our definition of firm owners' incidence is standard in the rent sharing literature (see e.g. Card, Cardoso and Kline 2016; Guiso, Pistaferri and Schivardi 2005). Second, for simplicity we abstract away from the fact that part of the profits are paid to the government through taxes and not to the firm-owners. Third, even if the level of accounting profits and depreciation expenses depend on whether the firm rents capital or directly owns it, the change in profit and depreciation will reflect the incidence on firm owners independently of the ownership structure.

We assess the incidence of the minimum wage by estimating the effect of the reform on various items in equation 2. We report the point estimates in Table 5. The 32.5 percent increase in total labor cost in 2002 (Panel A in Table 3) translates into a 3.8 percentage point increase when we measure it relative to revenue in year 2000 and not to its own value in year 2000. The change in revenue net of materials and miscellaneous items equals to 2.8 percentage points in 2002 and this is the part that is paid by consumers. The remaining 1.0 percentage point is paid from a 1.1 percentage point reduction in profits, partly offset by a 0.1 percentage point increase in depreciation. As a result around 74 percent of the cost increase is paid by consumers while 26 percent paid by firm owners. Column (2) shows that the medium term incidence is very similar to the short term incidence: around 77 percent of the labor cost increase is paid by consumers and 23 percent by firm owners.

Who are these consumers buying the goods produced by the minimum wage workers? While we are not able to connect firm-level production to purchases by final consumers, we can assess consumption at the industry level. Following MaCurdy (2015) we calculate the industry-level cost shares of minimum wage workers. To take into account that some firms produce intermediate goods

[21] This equation can also be derived from the perfectly competitive neoclassical model. Using the envelope theorem, it can be shown that the first-order effect on profit is equal to the change in revenue as a result of higher prices minus the wage bill increase (see Ashenfelter and Smith (1979) who show a special case where prices are fixed).

[22] If firm produces final goods (or services) these consumers are individuals, while if it sells intermediate goods the consumers are other firms.

and services we use input-output linkages across industries to assess the exposure to the minimum wage at the industry level. We then calculate the share of each consumer's spending on various industries using the Hungarian Household Budget Survey from the year 2000 and, based on that, the minimum wage content of their consumption. Figure 5 shows the non-parametric relationship between household income and the minimum wage content of consumption for each household income decile. The figure highlights that the consumption spending of richer households contains a smaller fraction of the goods produces in industries exposed to the minimum wage, although the relationship is weak. While around 4.5 percent of the consumption is related to minimum wage workers in the lowest decile, it is 4.2 percent in the highest decile.[23] Since the minimum wage raised income of low wage workers, while the higher output prices are more or less equally shared among consumers, our evidence underscores that the minimum wage is an effective redistributive policy.

4.3 Heterogenous Responses to the Minimum Wage

Figure 6 explores heterogeneity in the responses to the minimum wage increase. We focus here on the employment elasticity with respect to labor cost (Panel (a)) and the revenue elasticity with respect to labor cost (Panel (b)). We present results on other outcomes in the Online Appendix Table A.4 and A.5.

The top rows in both panels of Figure 6 show the benchmark estimates on the medium term responses (changes between 2000 and 2004). Rows 2-6 shows the effects by industries. We estimate regression equation 1 separately for each of the following sectors: manufacturing, service, tradable and non-tradable, exporting. The exporting sector compromises firms that export at least 40 percent of their total revenue. We classify sectors to tradable and non-tradable categories following Mian and Sufi's (2014) procedure. The tradable sector consists of those industries where the value of imports or exports exceeds 10 percent of total revenue in that industry. The non-tradable sector consists of the retail and the catering sectors and those industries where firms are not geographically concentrated. In the Online Appendix we describe the procedure and list the classification for each industry in detail.

Panel (a) highlights that the disemployment effects are considerably larger in the tradable and in the exporting sectors than in the non-tradable or service sectors. For instance, the employment elasticity in the exporting sector is -0.84, while in the non-tradable sector it is only -0.12 and sta-

[23] MaCurdy (2015) assumes that the effect of a price increase on consumers is the same across sectors. Nevertheless, we find that consumers are more responsive to firm-level price changes in the tradable sector than in the non-tradable sector, which suggests that consumers can substitute between minimum wage producers and non-minimum wage producers more easily in the tradable than in the non-tradable sector. In the Online Appendix we show that even if we take into consideration that the price change in the tradable sector impacts consumers less than the price change in other sectors, the relationship between household income and the consumption content of minimum wage remains quite similar.

tistically indistinguishable from zero. As a result, the benefits of the minimum wage are not shared equally across sectors. Low wage workers in the tradable sector face large disemployment risks, which dampen the effects of the pay increase, but the minimum wage has a clear positive effect on earnings in the local service and non-tradable sectors.

Rows 2-6 in Panel (b) explore the revenue effects across sectors. The revenue effects are negative in sectors where the disemployment effects are larger (e.g. the exporting or tradable sectors), while they are positive in the sectors where the employment changes are close to zero. Such a relationship between employment and revenue responses can emerge if the pressure to raise prices is similar across sectors, but consumers' responses to such a price change differ. In the tradable sector, any price increase will lead to competitive disadvantage relative to foreign companies which were not affected by the minimum wage reform. This causes a large loss in output and a negative effect on revenue. At the same time, in the non-tradable sector raising prices is less problematic as most competitors are also hit by the same cost shock. Therefore, any decrease in output demand following a price increase will be more limited. This can explain why we find a positive revenue effect in the non-tradable sector.

The differences between non-tradable and tradable sectors are hard to reconcile with models emphasizing the productivity enhancing effect of the minimum wage (Mayneris et al. 2016, Riley and Bondibene 2018, Hau et al. 2016) or models relying on monopsony power in labor markets (Bashkar, Manning and To 2002, Manning 2003). The common prediction in these models is that firms absorb the minimum wage shock by increasing their total production. Under the productivity enhancing explanation, firms produce more using the same amount of workers. In monopsony models production is increased since firms respond to the minimum wage by hiring more workers. Nevertheless, whatever the reason behind the increase in production, the prediction on the revenue effects is the same: revenue should increase in sectors where output demand is elastic, and fall in sectors where it is inelastic. For instance, firms in the exporting sector can easily sell the extra production without a substantial price impact. As result, we would expect positive revenue responses. At the same time, in the non-tradable sector, flooding the market with excess production would lead to price reductions, and so we would expect a fall in revenue. The revenue responses that we see in the data clearly contradict these predictions.

Figure 6 also explores heterogeneity in the effect of the minimum wage across various firm characteristics. We assign firms based on their characteristics between 1996 and 2000 and then estimate separate regressions for each group.[24] Rows 7 and 8 in Figure 6 show that the disemployment effect is larger for firms with a higher labor share. This evidence is in line with the role of pass through as

[24] An alternative approach would be to examine the effect of all relevant characteristics at the same time by running one regression with interaction of various firm characteristics. We do this exercise in the Online Appendix and the responses are very similar to the ones presented here in most cases. One notable exception is the profits results, where we find no significant differences once we take into account that more profitable firms tend to be in the exporting sector and tend to be larger.

firms with larger share of labor in production need to raise prices more to cover their labor cost.[25]

Rows 9 and 10 show the difference between highly profitable and less profitable firms. The disemployment effects are slightly larger for profitable firms, which reflects that these firms tend be in the exporting sector. Rows 11 and 12 highlight that responses to the minimum wage are not related to market concentration measured by the Herfindahl index at the 4 digit level. Finally, rows 13-16 highlight that the minimum wage reduces employment (and revenue) at larger firms more than at smaller ones. These differences partially reflect that fact that larger firms tend to be in the exporting and in the tradable sectors.

5 A Hicks-Marshall Style Analysis of the Minimum Wage

The evidence provided so far underlines the importance of output demand in understanding responses to the minimum wage. This is in stark contrast with standard explanations for responses to the minimum wage which mainly focus on labor market frictions. In this section, we present a simple model with imperfect competition on the output market that is consistent with our key empirical findings. Then we assess this model quantitatively by estimating the key parameters using a method of moment estimation. The key advantage of the estimation is that it allows us to translate the "reduced form" responses to easily interpretable structural parameters.

We consider markets consisting of monopolistically competitive firms in a partial equilibrium framework.[26] The monopolistic competition framework has several advantages. First, our approach allows us to model responses to the minimum wage at the level of both firms and the market. The model makes a distinction between minimum wage shocks that hit only a small subset of firms and shocks that affect all firms in the market equally. Second, in the model firms will set prices above the marginal cost and so they earn positive profits. Third, our model can capture that output prices may increase after a minimum wage hike.

It is easy to show that responses to a change in input prices lead to similar predictions as those described by the Hicks-Marshall rule of derived demand (we provide details in the Online Appendix Part A.7). When we have three inputs (labor, capital, materials), the elasticity of labor demand with

[25] We also find that the revenue responses are similar at low and and at high labor share firms. The lack of differences in revenue can emerge in the model presented in Section 5 if the output demand elasticity of low labor share firms is smaller than that of the high labor share ones.

[26] It is possible to extend the model to take general equilibrium effects into account, but for simplicity we do not consider that extension in this paper. The key difference in the general equilibrium model is that the market-level output demand elasticity can be interpreted as a compensated demand elasticity instead of an uncompensated one (this point was made by Harberger, 1962). If the income effects for the goods produced by the minimum wage workers are positive (normal goods) the uncompensated output demand elasticity will be lower than the compensated one. But if the income effect is negative (inferior goods) the opposite would be true.

respect to the minimum wage is equal to:[27]

$$\frac{\partial \log l(\omega)}{\partial \log MW} = \underbrace{-s_L \eta}_{\text{scale effect}} \quad \underbrace{-s_K \sigma_{KL}}_{\substack{\text{substitution} \\ \text{between K and L}}} \quad \underbrace{-s_M \sigma_{ML}}_{\substack{\text{substitution} \\ \text{between M and L}}} \tag{3}$$

where $l(\omega)$ is the low skilled labor demand for the firm producing variety ω, s_L is the share of labor in output, s_K is the share of capital expenses in production, s_M is the share of intermediate goods used in the production, and σ_{KL} and σ_{ML} are the partial elasticities between capital and labor and materials and labor. The first part of equation (3) is the well known scale effect. The model predicts firms will raise their output prices in response to the cost of labor and pass the effect of the minimum wage through to consumers. A key result is that the magnitude of this price response will depend only on the share of labor in the production, s_L. As a result of the price change, output falls and firms must scale back their production, and so they use less labor. The extent of the drop in production depends on the output demand elasticity, η, which is determined by the market structure. If all firms in the market use minimum wage workers, the demand elasticity will depend on the substitution between a market-level composite good and other expenses, which is likely to be small. However, when only a few firms on the market use minimum wage workers, most other firms which do not use minimum wage workers will get a competitive advantage. As a result output falls quite dramatically in the firms affected by the minimum wage increase, and so does employment at these firms.

The second and the third parts in equation (3) show the substitution effects: the possibility of replacing the more expensive labor with other inputs. The second part shows the substitution between capital and labor, while the third part shows the substitution between intermediate goods and labor. This substitution will depend on the Allen-partial elasticity and the share of other inputs in production.

Equation (3) highlights that the disemployment effects of the minimum wage must be negative, but can be quite small under certain parameter values. The importance of scale effects and the substitution effects depend on the factor shares. The labor cost is only 18 percent of total revenue for an average firm, while spending on capital is another 8 percent.[28] Expenses on intermediate goods and services (materials) are around 74 percent. As a result the substitution between intermediate goods and labor, a channel which is often ignored in the literature, potentially plays a crucial role in explaining the disemployment effects caused by the minimum wage.

In the model there is also a tight connection between the price increase and the change in total

[27] In the model a 1 percent increase in minimum wage is associated with 1 percent increase in cost of labor. However, in practice, the 1 percent increase in minimum wage often increases the cost of labor (and the wage) by less than 1 percent. We abstract from this here and use the change in minimum wage and the change in cost of labor interchangeably.

[28] The capital share is the sum of profit and spending on capital depreciation.

revenue, $p(\omega)q(\omega)$ as can be seen in the following equation:

$$\frac{\partial \log p(\omega)q(\omega)}{\partial \log MW} = \underbrace{s_L}_{\text{price effect}} \quad \underbrace{-s_L\eta}_{\text{scale effect}} \tag{4}$$

This equation allows us to translate the observed effect of the minimum wage on revenue into an output effect and a price effect. The key parameters in the employment and revenue equation also determine other outcomes such as demand for capital and intermediate goods:

$$\frac{\partial \log k(\omega)}{\partial \log MW} = s_L(-\eta + \sigma_{KL}) \tag{5}$$

$$\frac{\partial \log m(\omega)}{\partial \log MW} = s_L(-\eta + \sigma_{ML}) \tag{6}$$

Estimation. To identify the key parameters, we estimate the model with a minimum-distance estimator, matching the empirical elasticities of various outcomes with respect to the change in cost of labor to the parameters of this model. We denote by $m(\xi)$ the vector of moments predicted by the theory as a function of the parameters ξ, and by $\hat{m}$ the vector of observed moments. We use four moments: employment elasticity (Equation 3), revenue elasticity (Equation 4), capital elasticity (Equation 5), and materials elasticity (Equation 6). We restrict σ_{KL} and σ_{ML} to be non-negative. The minimum-distance estimator chooses the parameters $\hat{\xi}$ that minimize the distance $(m(\xi) - \hat{m})' W (m(\xi) - \hat{m})$, where W is a weighting matrix. As a weighting matrix, we use the diagonal of the inverse of the variance-covariance matrix. Hence, the estimator minimizes the sum of squared distances, weighted by the inverse variance of each moment.[29]

Table 6 shows the estimated parameters (Panel A) across sectors using our benchmark estimates on medium term responses (between 2000 and 2004). When all firms are considered (Column (1)) we estimate that output demand is quite inelastic (0.11, s.e. 0.22). This implies that the minimum wage was passed through to consumers without a substantial reduction in output. Nevertheless, that output demand is inelastic on average does not mean that all individual firms can raise their prices without affecting their output: there is substantial heterogeneity across sectors, as highlighted in Columns (2)-(5). The output elasticity is quite high in the exporting (3.64, s.e. 0.98) and in the tradable sectors (1.34, s.e. 0.41) where we estimate an elasticity that is closer to the firm-level-one.[30] This highlights that individual firms cannot really raise prices without a large drop in their output.

[29] Under standard conditions, the minimum-distance estimator using weighting matrix W achieves asymptotic normality, with estimated variance $(\hat{G}'W\hat{G})^{-1}(\hat{G}'W\hat{\Lambda}W\hat{G})(\hat{G}'W\hat{G})^{-1}/N$, where $\hat{G} \equiv N^{-1}\sum_{i=1}^{N} \nabla_{\xi} m_i(\hat{\xi})$ and $\hat{\Lambda} \equiv Var[m(\hat{\xi})]$ (Wooldridge 2010). We calculate $\nabla_{\xi} m(\hat{\xi})$ numerically in Matlab using an adaptive finite difference algorithm.

[30] The Armington elasticity represents the elasticity of substitution between products of different countries. The short-term Armington elasticity is thought to be close to one (Blonigen and Wilson 1999, Reinert and Roland-Host 1992), while the long-term estimates are close to five (Ruhl 2008).

Conversely, in the local non-tradable sector all firms are hit by the minimum wage and the relevant output demand elasticity is the market-level one. The estimated elasticities are close to zero (-0.37, s.e. 0.50) which suggests that market-level price changes can be passed through to consumers in those sectors.[31]

Table 6 also reports estimates on the Allen partial elasticities. The estimated substitution between capital and low skilled labor in Table 6 is 3.35 (s.e. 0.62) and varies little across sectors. These estimates are higher than recent estimates in literature (e.g. Karabarbounis and Neiman (2014) found that capital-labor substitution elasticity is 1.25) although the literature has focused on the substitution between aggregate labor and capital. It is also surprising that the large substitution elasticity between capital and low skilled labor does not generate large disemployment effects. The key reason for this is that the share of capital expenses is only 8 percent of total production at the firm level, and so even a large capital labor substitution has only a small effect on employment. At the same time, the crucial factor in generating a low employment effect is the relatively low substitution between materials and employment, which is close to zero in all specifications.[32]

In Panels B and C of Table 6 we report the empirical and the actual moments. The moments predicted by the optimal parameter values match the moments in the data closely, especially for the employment elasticity and capital elasticity. We also report the predicted price effects, which equals the labor share s_L in that sector. Reassuringly, the estimated price effects in the manufacturing sector (0.23) match the actual price effects (0.25) quite well, even though we do not use that moment in the estimation. However, the model fit is not perfect. The model over-predicts the revenue elasticity and under-predicts the materials elasticity, especially for the specification that estimates one parameter for all firms. Once we move to sector-level analysis (Columns (2)-(5)), the model fit improves considerably (e.g. the SSE in the manufacturing sector is 0.76 v.s. 5.64 for all firms). Failing to predict these two moments suggests that our simple model does not capture all relevant aspects of the economy. In particular, the increase in material spending (relative to non-exposed firms) might simply reflect that the price of intermediate goods purchased by minimum wage firms increased relative to the input prices of the non-exposed firms. This can happen, for instance, if minimum wage firms tend to have disproportionately large fraction of suppliers that are also exposed to the minimum wage.[33]

[31] MaCurdy's (2015) review concludes that the output demand elasticity in the minimum wage context is likely to be close to zero in the U.S. (MaCurdy 2015). Given that workers work predominantly in the local service sectors (e.g. restaurants or retail) in the U.S., our evidence is consistent with that conclusion.

[32] The low elasticity of substitution between intermediate goods and labor is consistent with existing empirical estimates. Bruno's (1984) benchmark estimate for σ_{ML} in the manufacturing sector is 0.3, with alternative specifications producing estimates between -0.2 to 0.9. A more recent estimate by Atalay (2017) found 0.05 using all industries in his estimation. Moreover, Berndt and Wood (1979) and Basu (1996) pointed out that these estimates are likely to over-state the true elasticity of substitution between material and labor in the presence of varying capital and labor utilization.

[33] The larger predicted revenue effect might reflect a fall in mark-up that is not allowed if consumers face the standard CES demand function. In the Online Appendix we estimate the model with falling mark-up and we show that the model

6 Robustness Analysis and Threats to Identification

Robustness. We examine the robustness of the results to controlling for industry fixed effects, alternative sample selection and an alternative measure of exposure to the minimum wage. We report the details in the Online Appendix Table A.7 and A.8, but we summarize the most important findings here.

Controlling for 151 three digit industry dummies in equation 1 has a small impact on our estimates. The medium term employment elasticity with respect to the minimum wage is -0.19 (s.e. 0.04) vs. -0.23 (0.03) in our benchmark case. The revenue increase is even more prominent when we partial out industry wide shocks, while the profit reduction is smaller. As a result, nearly 100 percent of the incidence falls on consumers once we control for industry fixed effects.[34]

The medium term employment elasticity with respect to the cost of labor is -0.26 (s.e. 0.03) for all industries including agriculture, highly regulated industries and the government sector. When we include small firms the employment elasticity is somewhat smaller (-0.16, s.e. 0.03) than our benchmark estimate, which reflects that these firms tend to be operating in the local non-tradable sectors.

We also explore using alternative measures of exposure to the minimum wage. We calculate the GAP measure, which is the average wage increase that is needed to comply to the 2002 minimum wage (Card and Krueger 1994, Machin et al. 2003). Similarly to our fraction affected measure, we first estimate relationship between the GAP and average wage on the sample of firms in the Structure of Earnings Survey (SES) and then predict the GAP measure for all firms. The medium term elasticity estimate using GAP is -0.19 (s.e. 0.03) which is very close to the benchmark estimate of -0.22.[35]

Entry rate. A potential problem with our firm-level estimates is that we can only define the exposure to the minimum wage for the firms that existed before the minimum wage hike. As a result we dropped new entrants from the sample, which can potentially bias our estimates on employment. However, Table A.9 and Figure A.9 in the Online Appendix show no indication of a drop (or an increase) in the industry-level entry rate at highly exposed industries relative to industries with less exposure.

Threats to identification. A key identification assumption throughout the paper is that workers and firms with no direct exposure to the minimum wage are unaffected by the minimum wage, the

performance improves with a 70 percent pass-through, though in that case the model under predicts the actual price changes in the manufacturing sector.

[34]Since using industry fixed effects might also discard some valid identifying information, and also rules out potential changes in the industry structure of the economy, we put more faith in the estimates without industry fixed effects when we discuss incidence of minimum wages.

[35]The GAP estimates from 2002 also allow to assess the extent of within firm-level spillover effects of the minimum wage. The point estimate on wages in 2002 is 1.23 (s.e. 0.03), which points to substantial spillover effects within firm.

so-called Stable Unit Treatment Value Assumption (SUTVA). There are several reasons why we think this assumption holds in our case. First, even if the minimum wage bites deep into the wage distribution, the minimum wage workers only represent a small fraction of the economy. In our case around 17 percent of the workers are directly exposed to the minimum wage, and their share in the total wage bill is 5.6 percent. Given that 1/3 of production is related to capital and 2/3 to labor, the cost share of aggregate production hit by the minimum wage is 3.7 percent. This limits the general equilibrium effects of the minimum wage and the potential impacts on the untreated population. Second, any wage or price effect that affects every firm in the same way will be absorbed by changes in the nominal exchange rate in a small open economy. This limits the real consequences of price spillovers on untreated firms.

We also assess the potential violation of the SUTVA assumption empirically. First, we point out that the robustness of the employment estimates to including detailed industry dummies suggests that cross-industry spillover play little role. Second, in the Online Appendix Part A.1., we show that untreated firms did not behave unusually after the reform – the post reform employment change at the untreated firms (between 2000 and 2002) was very similar to the pre-reform change (between 1998 and 2000).

Bunching. The firm-level employment results might overstate the worker-level effects if some workers who are laid-off find jobs at other, less exposed firms. Moreover, the firm-level results might understate the employment consequences as they do not take into account changes in firm entry. While we do not find evidence for changes in entry behavior, we can address these concerns by assessing worker-level employment changes directly. We first examine the evolution of the frequency distribution of monthly earnings over time.[36] Figure 7 panel (a) shows the earnings distribution in 2000 (the last year before the minimum wage hike) and in 2002 (two years after the reform).[37] To normalize the job counts we report the frequencies relative to the total employment in 2000. The logarithm of the minimum wage is raised from the level represented by the brown dashed line (10.1) to the red long-dashed line (10.55), representing a 0.45 log point increase in the minimum wage on the top of nominal GDP growth. This substantial increase in the minimum wage clearly altered the earnings distribution. First, jobs below the 2002 minimum wage disappeared from the earnings distribution, as expected when firms comply with the minimum wage. Second, in 2000 only a small spike was present at the minimum wage. In contrast, a much larger spike appears in the 2002 distribution. Third, we see that additional jobs emerged in the new earnings distribution at and above the new minimum wage.

[36]We use the structure of earnings survey (SES) for this analysis. To ensure the data are consistent over time we restrict the analysis to firms that have at least 10 workers.

[37]To make the wage distributions comparable over time we adjust them by nominal GDP growth. We use the nominal GDP growth for adjustment, and not simply the CPI, because this wage adjustment was better able to match wage growth from the pre-reform years (1996-2000). Moreover, bargaining over wages in Hungary often determined by both expected inflation and expected real GDP growth.

Panel (b) shows the difference between the pre- and post reform distributions. The missing jobs below the minimum wage and the excess jobs above the minimum wage are quite clear. We also report the running sum of employment changes up to each wage bin (red line). The running sum drops to a sizable, negative value just below the new minimum wage, which reflects around 15 percent of pre-treatment employment. The running sum then increases at and above the minimum wage and it goes close to zero before it falls again. Then it converges to a point where 10 percent of the directly affected jobs are destroyed.[38] This is very close to the benchmark firm-level estimates in Table 2 where we found that 10 percent of the jobs destroyed by the minimum wage.

Grouping Estimates. To provide further evidence on worker-level employment we also implement a grouping estimator in the style of Blundell et al. (1998) in the Online Appendix Part A.2. We assign people to mutually exclusive groups formed from combinations of 7 regions, age in five categories, gender, and education. We estimate the relationship between group-level exposure to the minimum wage and the employment to population rate. Our estimates on the implied elasticity with respect to the average wage are in line with the benchmark firm-level estimates, which suggests that our results are robust to using alternative identification strategies.

7 Discussion and Conclusion

This paper provides a comprehensive assessment of the margins of adjustment used by firms in response to a large and persistent increase in the minimum wage. Most firms responded to the minimum wage by raising wages instead of destroying jobs. Our estimates imply that out of 290 thousand minimum wage workers in Hungary, around 30 thousand (0.076% of aggregate employment) lost their job, while the remaining 260 thousand workers experienced a 60% increase in their wages. As a result, firms employing minimum wage workers experienced a large increase in their total labor cost that was mainly absorbed by higher output prices and higher total revenue. We also estimated that firms substituted labor with capital and their profits fell slightly. These results suggest that the incidence of the minimum wage fell mainly on consumers.

Given the relatively small effect on employment, our results also suggest that minimum wages can redistribute income from consumers to low-wage workers without large efficiency losses. Our findings also indicate that the optimal level of the minimum wage is likely to vary across industries, cities and countries. In countries where low-wage jobs are concentrated in the local service sector

[38]This point of convergence is around 75th percentile of the wage distribution, which is very close to what Engbom and Moser (2018) found in Brazil, but substantially larger than recent estimates from the literature using difference-in-difference style estimators (see e.g. Cengiz, Dube, Lindner and Zipperer 2019; Brochu, Green, Lemieux and Townsend 2017; Autor, Manning and Smith 2016). Nevertheless, the point of convergence is quite sensitive to the way we adjust the wage distribution over time. For instance, if we adjust the wage distribution by the nominal GDP growth plus 2.5%, then the before and after distributions converge at the 25th percentile (and not at the 75th percentile as with our benchmark adjustment) where 10% of the directly affected jobs are destroyed. Therefore, even if our estimates on the point of convergence are quite sensitive to the particular wage adjustments we use, the employment estimates are unaffected.

(such as Germany or the U.S.) raising the minimum wage is likely to cause limited disemployment effects or efficiency losses. Moreover, in cities where mainly rich consumers enjoy the services provided by low wage workers this redistribution will be from rich to poor. The heterogenous responses across industries also underline the advantages of sector-specific minimum wage polices used in some European countries such as Italy or Austria. For instance, setting a higher minimum wage in the non-tradable sector than in the tradable sector can push up wages relatively more where it will generate more modest disemployment effects.

Finally, we presented new evidence for the key elasticities between low wage workers and other inputs such as capital and intermediate goods. These parameter estimates can be used to evaluate other polices that affect the cost of labor such as taxes and subsides. Our results also suggest that these policies can induce sizable responses in the exporting and in the tradable sectors.

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Table 1: Summary Statistics of Firm-level Characteristics in 2000

		(1) All	(2) Manufacturing	(3) Tradable	(4) Non-Tradable	(5) Exporting
Average Wage (1000 HUF)	mean	847	841	845	679	1,090
Average Cost of Labor (1000 HUF)	mean	1,358	1,313	1,316	1,099	1,845
Number of Workers	mean	47.1	78.7	80.7	34.9	145
Revenue (1000 HUF) / Labor	mean	17,637	11,047	10,327	20,178	18,110
Capital (1000 HUF) /Labor	mean	3,801	3,560	3,348	3,678	4,659
Export share (Export/Revenue)	mean	0.10	0.21	0.25	0.06	0.71
Profitability (Profit/Revenue)	mean	0.032	0.032	0.039	0.021	0.047
Depreciation Share (Depr/Revenue)	mean	0.026	0.038	0.025	0.023	0.027
Labor Share (Labor Cost/Revenue)	mean	0.18	0.23	0.25	0.12	0.26
Material Share (Material/Revenue)	mean	0.74	0.69	0.67	0.81	0.64
GAP	mean	0.16	0.14	0.13	0.21	0.090
	mean	0.43	0.39	0.38	0.54	0.25
	sd	0.36	0.35	0.34	0.35	0.29
	p5	0	0	0	0	0
Fraction Affected	p25	0.07	0.05	0.20	0.05	0
	p50	0.37	0.31	0.56	0.30	0.14
	p75	0.77	0.69	0.89	0.66	0.40
	p95	1	1	1	1	0.89
Observations		19,485	6,312	4,557	6,196	2,000

Note: This table shows some summary statistics of the firms in our benchmark sample. All characteristics are evaluated in 2000 (1 year before the minimum wage hike). Tradable and non-tradable sectors are defined as in Mian and Sufi (2010). The exporting sector compromises firms that export at least 40 percent of their total revenue. All statistics are weighted by the logarithm of revenue to be consistent with the regression analyses presented in the paper. The GAP measures the increase in average wage needed to comply to the 2002 minimum wage.

Table 2: Employment and Wage Effects

	(1)	(2)	(3)	(4)	(5)	(6)
	Main Changes between 2000 and 2002		Main Changes between 2000 and 2004		Placebo Changes between 2000 and 1998	
Panel A: Change in Firm-Level Employment						
Fraction Affected	-0.078	-0.076	-0.093	-0.100	-0.003	0.002
	(0.008)	(0.010)	(0.012)	(0.012)	(0.008)	(0.009)
Constant	-0.050		-0.105		0.046	
	(0.005)		(0.007)		(0.005)	
Observations	19,485	19,485	19,485	19,485	19,485	19,485
Employment elasticity wrt. *MW* (directly affected)	-0.11	-0.10	-0.15	-0.15		
	(0.01)	(0.01)	(0.02)	(0.02)		
Panel B: Change in Firm-Level Average Wage						
Fraction Affected	0.53	0.58	0.48	0.54	-0.02	-0.03
	(0.01)	(0.01)	(0.01)	(0.01)	(0.003)	(0.01)
Constant	0.08		0.16		-0.08	
	(0.002)		(0.01)		(0.001)	
Observations	18,415	18,415	16,980	16,980	19,485	19,485
Employment elasticity wrt. wage	-0.15	-0.13	-0.20	-0.18		
	(0.02)	(0.02)	(0.03)	(0.03)		
Panel C: Change in Firm-Level Average Cost of Labor						
Fraction Affected	0.47	0.49	0.41	0.43	-0.03	-0.04
	(0.01)	(0.01)	(0.01)	(0.01)	(0.003)	(0.01)
Constant	0.04		0.10		-0.04	
	(0.001)		(0.002)		(0.001)	
Observations	18,415	18,415	16,980	16,980	19,485	19,485
Employment elasticity wrt. cost of labor	-0.17	-0.16	-0.22	-0.23		
	(0.02)	(0.02)	(0.03)	(0.03)		
Controls	no	yes	no	yes	no	yes

Note: This table show the firm-level relationship between the fraction of workers exposed to the the minimum wage and the change in employment (panel A), the change in average wage (panel B) and the change in average cost of labor (panel C). The cost of labor includes wages, social security contributions and non-wage labor expenses. The estimates are based on equation 1. The employment changes include both extensive margin (closing) and intensive margin (lay-off) decisions. Columns (1) and (2) show the short term effects (the change between 2000 and 2002), Columns (3) and (4) the medium term changes (changes between 2000 and 2004). Columns (5) and (6) test for the presence of pre-existing trends by looking at the effect on "placebo" changes, which equal to the year 1998 outcome minus the year 2000 outcome. Columns (1), (3) and (5) show the raw correlations, while Columns (2), (4) and (6) show the estimates when we control for firm age, the legal form of organization (e.g. limited liability company, publicly traded etc.), and the following variables and their squares: average export share between 1997 and 2000; average profitability between 1997 and 2000; the average share of labor between 1997 and 2000; average depreciation rate between 1997 and 2000; the average share of wage cost in total labor cost between 1997 and 2000; and the average industry level import exposure between 1997 and 2000. We winsorized all outcome variables at 1 percent and 99 percent levels for each year. Robust standard errors are reported in parentheses.

Table 3: Firms' Margins of Adjustment

	(1) Main Changes between 2000 and 2002	(2) Main Changes between 2000 and 2004	(3) Placebo Changes between 2000 and 1998
Panel A: Change in Total Labor Cost			
Fraction Affected	0.325	0.238	-0.031
	(0.013)	(0.020)	(0.009)
Panel B: Change in Revenue			
Fraction Affected	0.066	0.036	-0.020
	(0.013)	(0.018)	(0.015)
Panel C: Change in Materials			
Fraction Affected	0.049	0.021	-0.008
	(0.014)	(0.019)	(0.019)
Panel D: Change in Capital			
Fraction Affected	0.148	0.270	-0.006
	(0.034)	(0.054)	(0.015)
Panel E: Change in profits (relative to revenue in 2000)			
Fraction Affected	-0.011	-0.008	0.006
	(0.003)	(0.004)	(0.004)
Observations	19,485	19,485	19,485
Controls	yes	yes	yes

Note: This table shows the firm-level relationship between the fraction of affected workers and the percentage change in various outcomes (see equation 1). The first two columns show our main results by looking at changes between 2000 and 2002 (short-term) and changes between 2000 and 2004 (medium term). The output changes include both intensive margin and firm closure responses. Column (3) tests for the presence of pre-existing trends by looking at the effect on "placebo" changes, which equal to the year 1998 outcome minus the year 2000 outcome. Regressions are weighted by the logarithm of revenue in 2000. We control for firm age, the legal form of organization (e.g. limited liability company, publicly traded etc.), and the following variables and their squares: average export share between 1997 and 2000; average profitability between 1997 and 2000; the average share of labor between 1997 and 2000; average depreciation rate between 1997 and 2000; the average share of wage cost in total labor cost between 1997 and 2000; and the average industry level import exposure between 1997 and 2000.. We winsorized all outcome variables at level 1 percent and 99 percent levels for each year. Robust standard errors are reported in parentheses.

Table 4: Effect on Firm-Level Price Index in the Manufacturing Sector

	(1)	(2)	(3)	(4)
	All Firms		Exists between 2000 and 2004	
Panel A: Change between 2000 and 2002 (short term)				
Fraction Affected	0.074	0.043	0.083	0.061
	(0.024)	(0.028)	(0.026)	(0.032)
Constant	0.16		0.15	
	(0.01)		(0.01)	
Observations	3,252	3,252	2,541	2,541
Panel B: Change between 2000 and 2004 (medium term)				
Fraction Affected	0.134	0.108	0.134	0.108
	(0.045)	(0.048)	(0.045)	(0.048)
Constant	0.28		0.28	
	(0.02)		(0.02)	
Observations	2,541	2,541	2,541	2,541
Panel C: Placebo Change between 2000 and 1998				
Fraction Affected	-0.001	-0.015	-0.008	-0.032
	(0.019)	(0.022)	(0.023)	(0.027)
Constant	-0.10		-0.10	
	(0.01)		(0.01)	
Observations	2,640	2,640	1,822	1,822
Controls	no	yes	no	yes

Note: This table shows the firm-level relationship between the fraction of affected workers and the Laspeyres price index in the manufacturing sector. The price index was calculated from the Producer Price Survey (see the details in the text). Columns (1)-(2) include all firms for which price changes can be calculated, while Columns (3)-(4) restrict the sample to the firms which existed between 2000 and 2004. Panel A shows the short term effects (change between 2000 and 2002), Panel B the medium term (change between 2000 and 2004), while Panel C checks for pre-existing trends by looking at the effect on "placebo" changes, i.e. the year 1998 price-level minus the year 2000 price-level. Columns (2) and (4) control for firm age, the legal form of organization (e.g. limited liability company, publicly traded etc.), and the following variables and their squares: average export share between 1997 and 2000; average profitability between 1997 and 2000; the average share of labor between 1997 and 2000; average depreciation rate between 1997 and 2000; the average share of wage cost in total labor cost between 1997 and 2000; and the average industry level import exposure between 1997 and 2000.. We winsorized the price changes at level 1 percent and 99 percent levels for each year. Regressions are weighted by the logarithm of revenue in 2000. Robust standard errors are reported in parentheses.

Table 5: Incidence of the Minimum Wage

	(1) Changes between 2000 and 2002	(2) Changes between 2000 and 2004
Change in **Total Labor Cost** relative to Revenue in 2000	0.038	0.021
Change in Revenue relative to Revenue in 2000 ($\triangle Revanue$)	0.066	0.036
Change in Materials relative to Revenue in 2000 ($\triangle Material$)	0.033	0.014
Change in MiscItems relative to Revenue in 2000 ($\triangle MiscItems$)	0.005	0.005
Incidence on Consumers ($\triangle Revenue - \triangle Material - \triangle MiscItems$)	0.028	0.017
Change in Profits relative to Revenue in 2000 ($\triangle Profit$)	-0.011	-0.008
Change in Depreciation relative to Revenue in 2000 ($\triangle Depr$)	0.001	0.003
Incidence on firm-owners ($-\triangle Profit - \triangle Depr$)	0.010	0.005
Fraction paid by consumers (in percent)	74	77
Fraction paid by firm-owners (in percent)	26	23

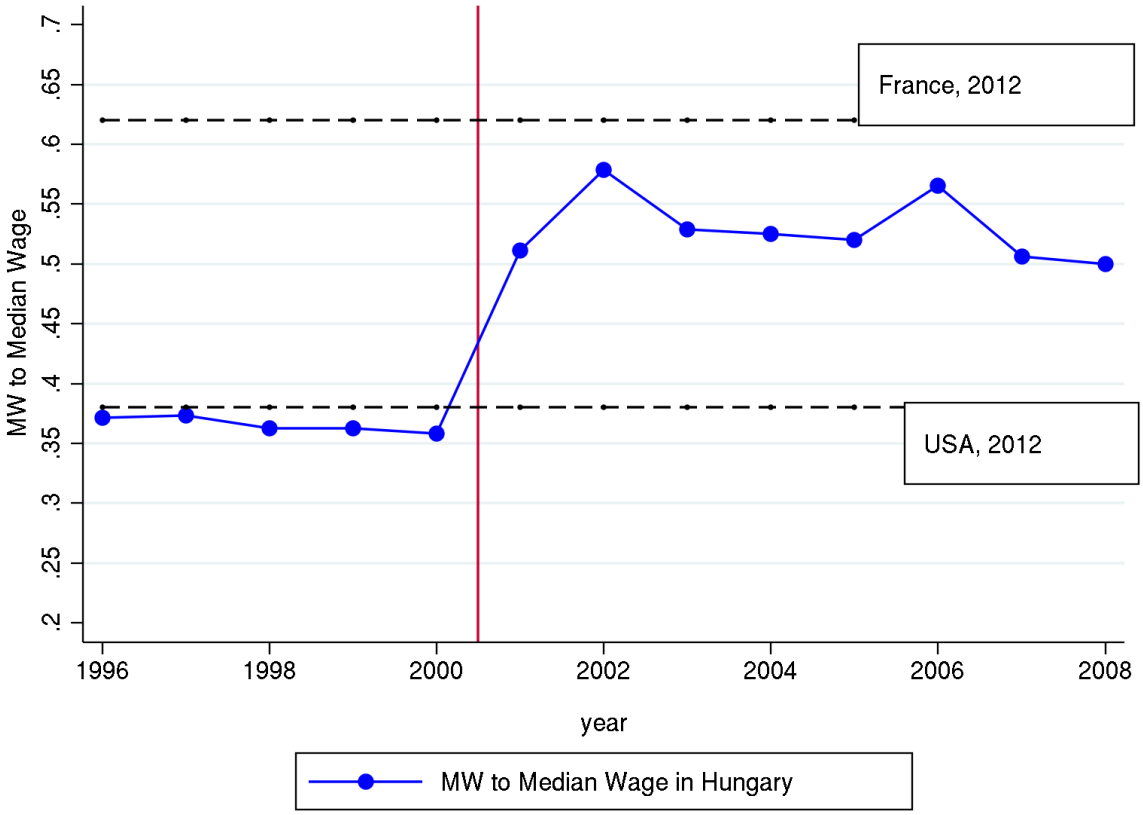
Note: This table assesses the incidence of the minimum wage hike. We estimate the relationship between fraction affected and various balance sheet items in equation 2. We also report the incidence on consumers, which is the revenue minus the sum of materials and other items. The incidence on firm owners is the sum of profits and depreciation multiplied by -1. The fraction paid by consumers is calculated by taking the ratio of the the "consumer incidence" and the change in total labor cost, while the fraction paid by firm owners is the ratio of "incidence on firm owners" and the change in total labor cost. Column (1) shows the change between 2000 and 2002 (short term), while Column (2) shows the change between 2000 and 2004 (medium term). In each regression we control for firm age, the legal form of organization (e.g. limited liability company, publicly traded etc.), and the following variables and their squares: average export share between 1997 and 2000; average profitability between 1997 and 2000; the average share of labor between 1997 and 2000; average depreciation rate between 1997 and 2000; the average share of wage cost in total labor cost between 1997 and 2000; and the average industry level import exposure between 1997 and 2000. We winsorized all outcome variables at level 1 percent and 99 percent levels for each year. Regressions are weighted by the logarithm of revenue in 2000.

Table 6: Method of the Moments Estimates Using Medium-term Responses

	(1) All Firms	(2) Manufacturing	(3) Tradable	(4) Non-Tradable	(5) Export
Panel A: Estimated Parameters					
Output Demand, μ	0.11	0.98	1.34	-0.37	3.64
	(0.22)	(0.46)	(0.41)	(0.50)	(0.98)
Capital-Labor Substitution, σ_{KL}	3.35	2.60	2.34	3.94	4.63
	(0.62)	(1.01)	(0.83)	(1.59)	(2.45)
Material-Labor Substitution, σ_{ML}	0.03	0	0.01	0	0
	(0.06)	(0.10)	(0.13)	(0.09)	(0.26)
Panel B: Empirical Moments					
Employment Elasticity	-0.23	-0.31	-0.49	-0.08	-0.84
Revenue Elasticity	0.08	-0.05	-0.17	0.11	-0.65
Materials Elasticity	0.05	-0.17	-0.26	0.04	-0.73
Capital Elasticity	0.62	0.37	0.28	0.70	0.50
Price Elasticity		0.25			
Panel C: Moments Predicted by the Estimated Parameters					
Employment Elasticity	-0.24	-0.33	-0.51	-0.12	-0.95
Revenue Elasticity	0.16	0.003	-0.09	0.12	-0.49
Materials Elasticity	-0.01	-0.18	-0.33	0	-0.67
Capital Elasticity	0.58	0.29	0.23	0.22	0.1
Price Elasticity	0.18	0.23	0.25	0.12	0.18
Share of Labor, s_L	0.18	0.23	0.25	0.12	0.18
Share of Capital, s_K	0.08	0.07	0.08	0.07	0.08
Share of Materials, s_M	0.74	0.70	0.67	0.81	0.74
No of Moments Used	4	4	4	4	4
No of Estimated Parameters	3	3	3	3	3
SSE	5.64	0.76	1.00	2.20	2.02

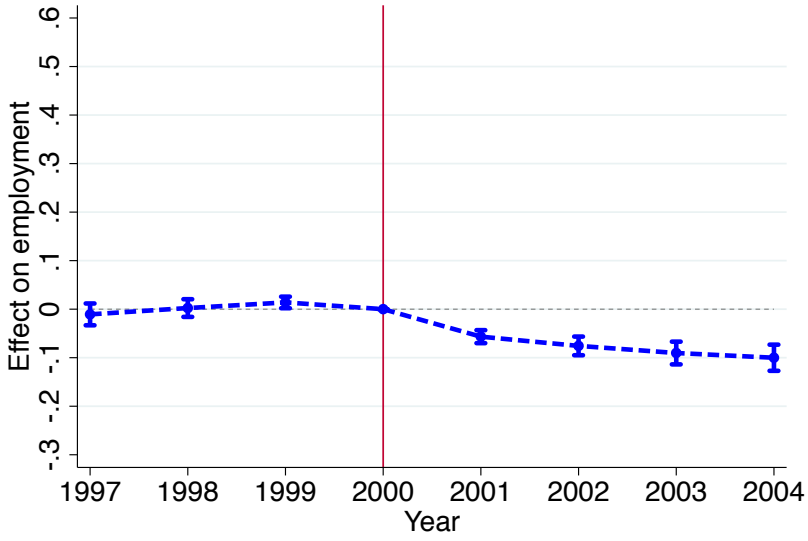
Note: We estimate the parameters of the model presented in Section 6 using a minimum-distance estimator. In each column we use the empirical moments based on our benchmark estimates with controls. The estimated parameters with standard errors can be found in Panel A. Panels B and C report the empirical and the predicted moments, respectively. SSE reports the weighted sum of squared errors.

Figure 1: Minimum Wage in Hungary



Notes: This figure shows the ratio of the minimum wage to median wage in the private sector for Hungary between 1996 and 2008 (own calculations). The two dashed lines depict the ratio of the minimum wage to the median wage for France and the U.S. in 2012 (OECD).

Figure 2: Effect on Employment and on Wages

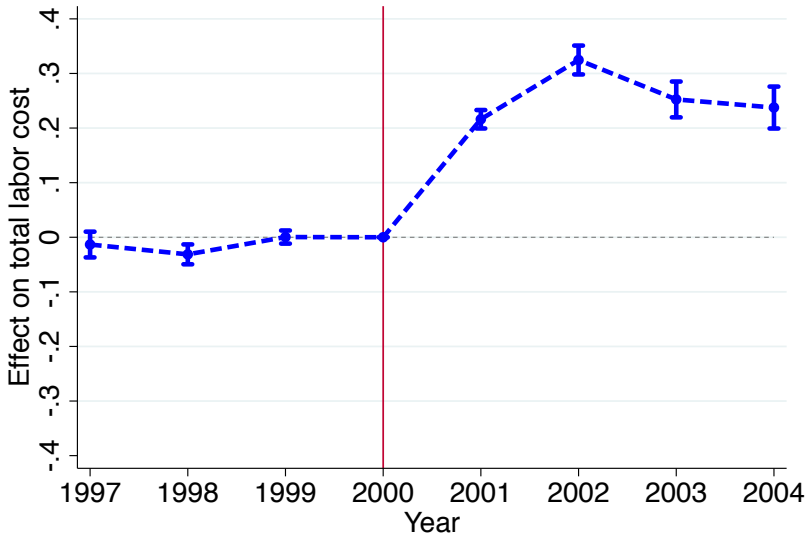


(a) Effect on Employment

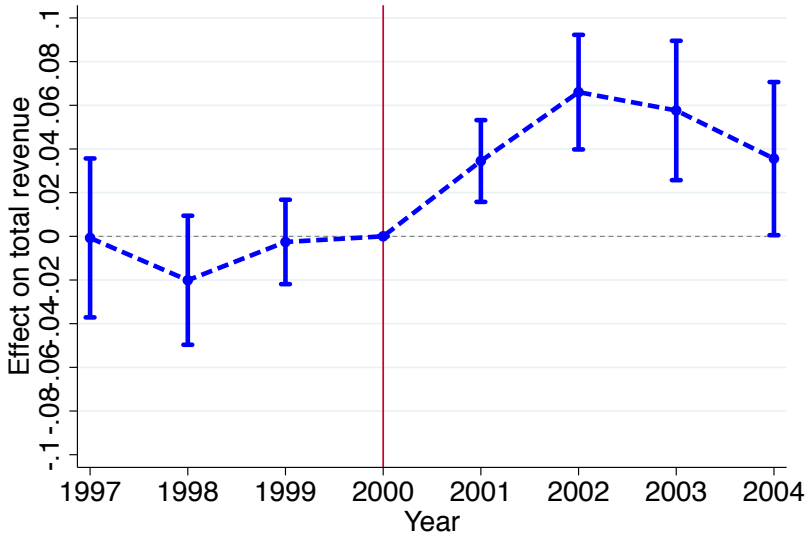
(b) Effect on Average Labor Cost

Notes: This figure shows the relationship between changes in different outcome variables and the fraction of workers affected by the minimum wage hike over time (beta coefficients with its 95 percent confidence intervals from equation (1)). Panel (a) shows the effects on changes in employment. The employment changes include both extensive margin (closing) and intensive margin (lay-off) decisions. Panel (b) shows the effect on firm-level average wage (total wage bill per worker) and average labor cost (total labor cost per worker). The cost of labor includes wages, social security contributions and non-wage labor expenses. The ratio of Panel (a) and Panel (b) determines the employment elasticity. Controls are included in the regressions.

Figure 3: Effect on Total Labor Cost and on Revenue



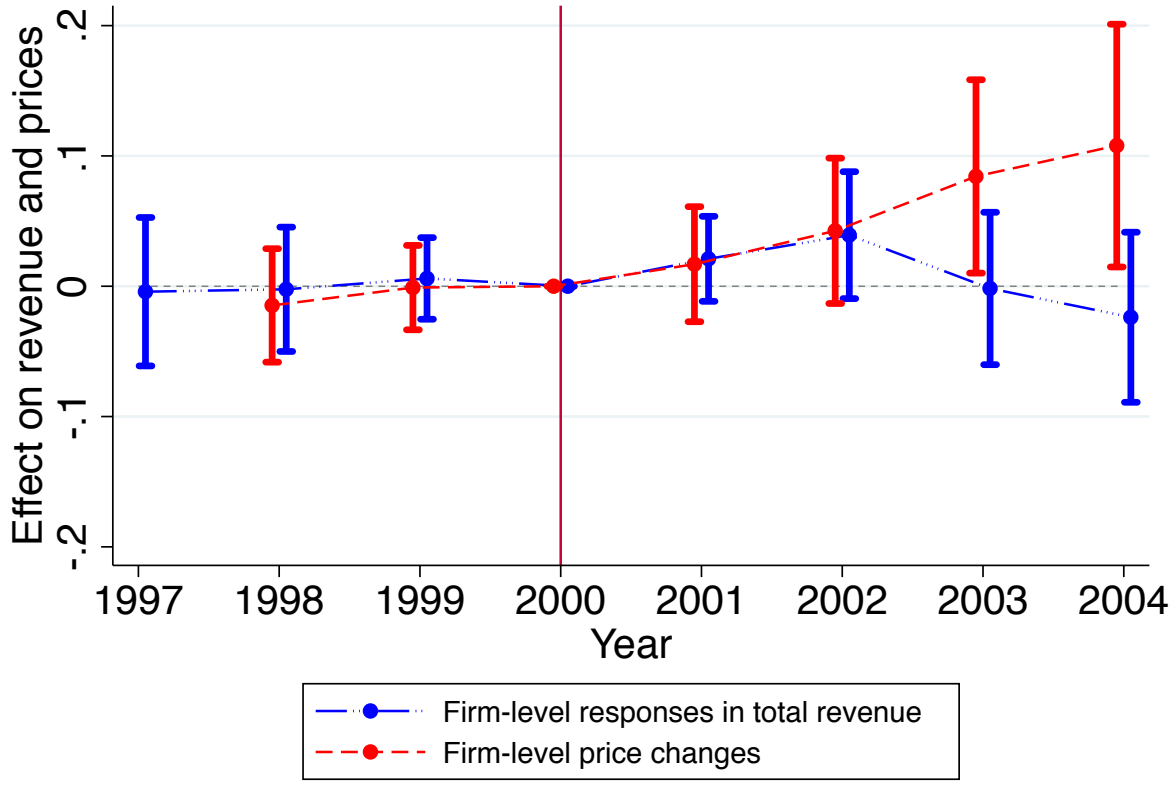
(a) Effect on Total Labor Cost



(b) Effect on Total Revenue

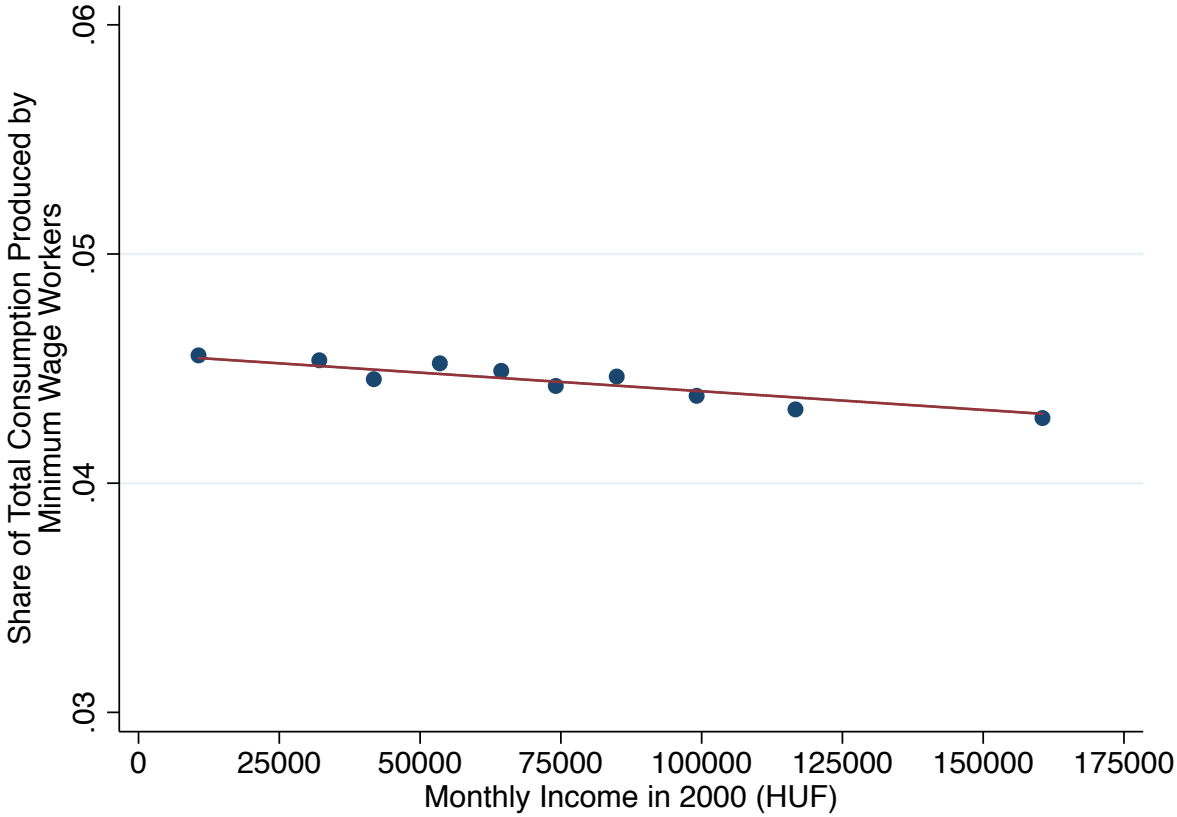
Notes: This figure shows the relationship between changes in different outcome variables and the fraction of workers affected by the minimum wage hike over time (beta coefficients with its 95 percent confidence intervals from equation (1)). Panel a) shows the effects on changes in total labor cost, while panel (b) on changes in total revenue. Both Panel (a) and Panel (b) show regression results which include firms' extensive (firm closure) and intensive margin responses. Controls are also included in the regressions.

Figure 4: Effect on Price Index and Revenue in the Manufacturing Sector



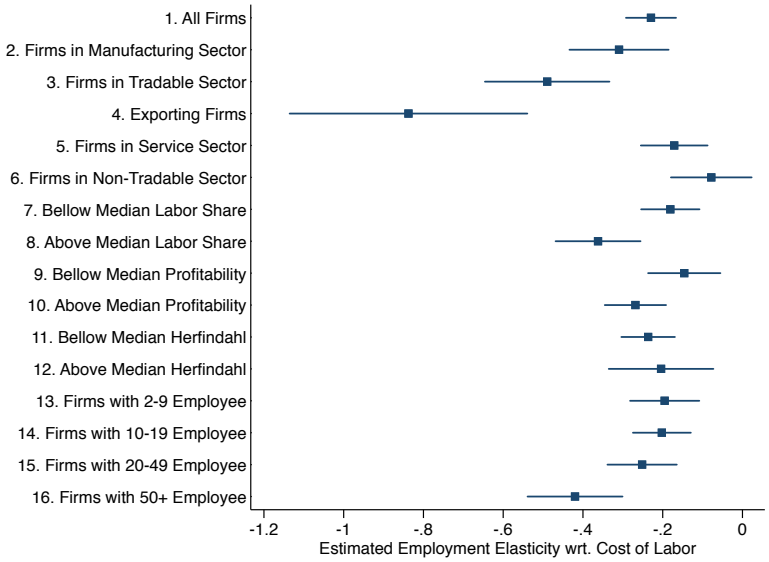
Notes: The figure shows the relationship between changes in different outcome variables and the fraction of workers affected by the minimum wage hike over time (beta coefficients with its 95 percent confidence intervals from equation 1). The red dashed line shows firm-level price changes, while the blue solid line shows the revenue changes. The revenue changes include extensive (firm closure) and intensive margin responses. Since price data is available only for the manufacturing sector, we restrict our analysis to that sector. Controls are also included in the regressions.

Figure 5: The relationship between household income and the minimum wage content of consumption

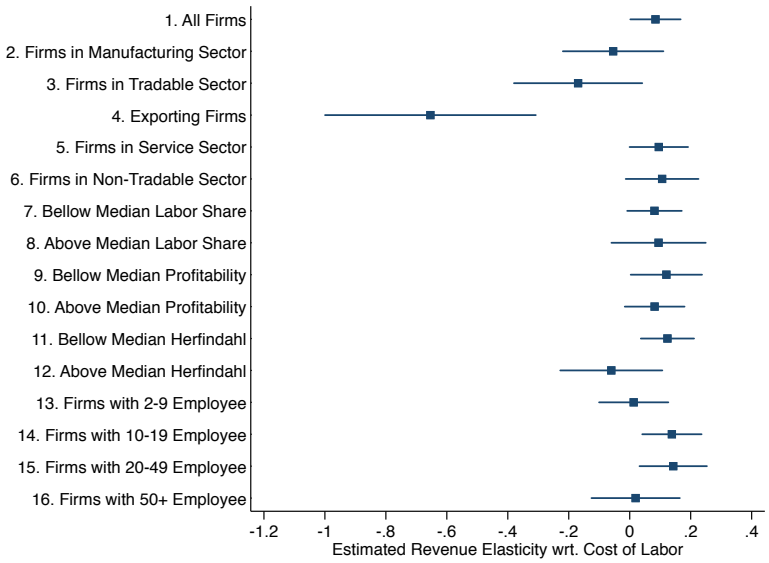


Notes: This figure shows the relationship between minimum wage content of consumption and household income. The blue dots show the share of consumption produced by minimum wage workers for each household decile and the red line is the linear fit. We calculate the minimum wage content of consumption following MaCurdy (2015), see Section A.8 in the Online Appendix for the details.

Figure 6: Heterogenous Responses to the Minimum Wage



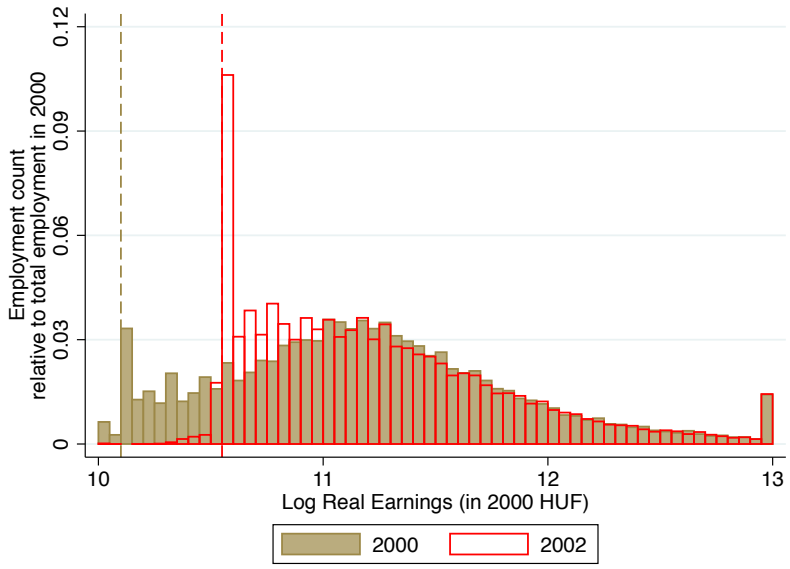
(a) Employment elasticity



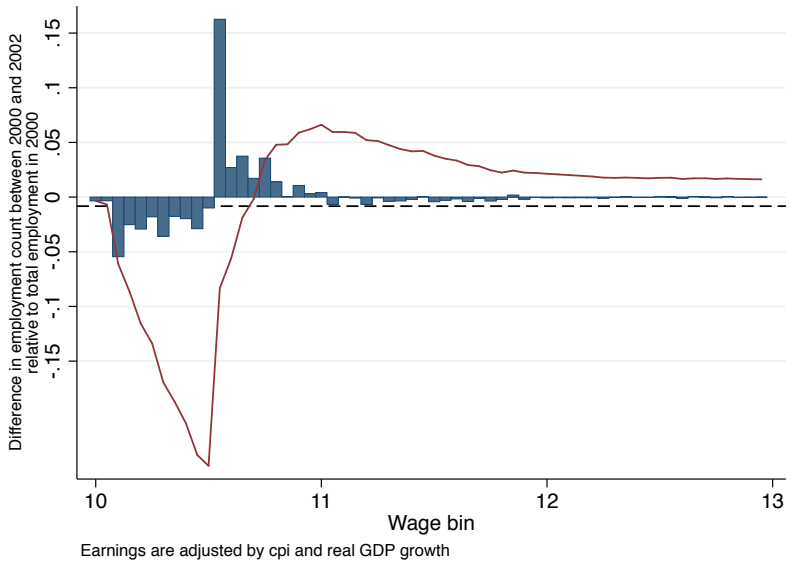
(b) Revenue Elasticity

Notes: Panel (a) shows the point estimates and 95 percent confidence intervals of the medium-term employment elasticities with respect to the cost of labor for various subgroups. Panel (b) shows the same for the revenue elasticity with respect to the cost of labor. We calculate the medium term elasticities by estimating a sperate regression for each subgroup. Medium term elasticities are based on employment (panel a) and revenue (panel b) changes between 2000 and 2004. Controls are also included in each regression. The confidence intervals are calculated based on bootstrapped standard errors.

Figure 7: Frequency earnings distribution in 2000 and in 2002



(a) The 2000 and 2002 frequency distribution of wages



(b) The difference between the 2000 and 2002 frequency distribution of wages

Notes: Panel (a) shows the frequency distribution of monthly log earnings in 2000 (last year before the minimum wage hike), and in 2002 (2 years after the minimum wage hike). The red outlined bars show the earning distribution in 2002, while the brown solid bars in 2000. To make sure that wages are comparable over time we deflate the 2002 earning distribution by the nominal GDP growth. The dotted brown (red) dashed line is at the bar in which the minimum wage is located in 2000 (2002). Panel (b) depicts the difference between the two wage distributions shown in panel (a) for each wage bin. The red solid line shows the running sum of employment changes up to the wage bin it corresponds to. The dashed horizontal lines shows the value where 10 percent of the directly affected jobs is destroyed. In both panels we express the number of jobs in terms of year 2000 total employment.

For Online Publication

A Appendix Content

A.1 Pseudo Experiments in Pre-Policy Periods and Testing for SUTVA

In this section we carry out a pseudo-experiment to provide further evidence on the employment effects of the minimum wage and to test for SUTVA. Using our pre-reform data we apply equivalent sample restrictions as in our benchmark sample, but we assume that the minimum wage increase occurred in 1998. Then we look at the employment changes between 1998 and 2000 and contrast it to our estimates between 2000 and 2002.

To create this new "placebo" sample we drop the following firms from our sample: those in sectors mentioned in the main text (Section 2.2); firms with the highest and lowest 1 percent growth rate in employment between 1997 and 1998; and firms where the average wage per worker is less than 90 percent of their minimum wage. We further restrict the sample to include only firms which existed between 1997 and 1998 and had at lest 5 employees in that period. Due to data limitations we only restrict firms based on their characteristics in the two years before 1998 and not based on the last four years as in our benchmark sample. To reflect this difference we also create an alternative version of the benchmark sample, where we use restrictions on firm characteristics between 1999 and 2000. We will refer to this as the "main sample" in this Section, and we will contrast our estimates on the "placebo sample" to the estimates on this sample.

Panel (a) in Figure A.10 shows the non-parametric binscattered relationship between change in employment between 2000 and 2002 and the fraction of workers who earn below the 2002 minimum wage in 2000 (red squares). The estimated parameters for the linear fit are shown at the bottom left panel. The slope of the line highlights that firms where 100 percent of the workers are directly affected by the minimum wage experience a 10.4 percent (s.e. 0.8 percent) decrease in their employment relative to firms with no direct exposure to the minimum wage. The blue line shows the relationship between employment change between 1998 and 2000 (the pre-minimum wage period) and the fraction of workers who earn below the 2002 minimum wage in 1998 (blue dots). There is a slight negative relationship between exposure to the minimum wage and employment changes even in absence of the minimum wage. The point estimates suggests that 100 percent exposure to the minimum wage leads to a 3.8 percent (s.e. 1.0 percent) decline in employment in years when no minimum wage was introduced.

The differences between the main estimation's slope (red line) and the placebo estimation's slope (blue line) can be interpreted as an effect of the minimum wage on employment. This is 6.6 percent (10.4 percent minus 3.8 percent), which is slightly lower than our benchmark estimate (7.6 percent) in 2002 shown in Column 2 in Table 2. In panel (b) of Figure A.10 we show estimates for the change in cost of labor. The difference in the coefficient on *FA* between the main estimates and placebo estimates is 37.2 percent (55.6 percent minus 18.4 percent) which is also slightly lower than our benchmark estimate (49 percent) in 2002 shown in Column 2 in Table 2.

The implied employment elasticity with respect to cost of labor is -0.18 (-6.6/37.2) based on these estimates on employment and cost of labor. It is notable that even if our sample selection differs from our benchmark sample, the implied employment elasticity is almost the same as our benchmark elasticity estimate (-0.17 in Panel C in Column 2 in Table 2).[39]

Figure A.11 shows the "placebo" estimates and the main estimates when we include industry dummies in the regression. The difference between the main estimate and the placebo estimate

[39]If we only rely on estimates based on the main sample for calculating the elasticity we get -0.19 (-0.104/0.556), which is also very close to our benchmark estimate (-0.17). So even if the disemployment effects and the wage effects in the "main sample" used in this section, which is different from the "benchmark sample" used in the main text, are driven by pre-existing trends the ratio of these two will not be very different from the benchmark estimates.

is 5.9 percent (10.1 percent minus 4.2 percent), which is again slightly lower than the estimated employment effect (6.8 percent) in Panel B of Column 3 in Table A.7. Panel (b) in Figure A.11 shows that the effect on cost of labor is also slightly smaller. As a result, the implied elasticity with respect to cost of labor (-0.16) is very similar to -0.15, which is the estimate based on the benchmark sample shown in Table A.7. These results highlight that alternative sample selections do not alter the main conclusions of the paper.

The pseudo experiment presented here can be also used to test for SUTVA. As discussed in the main text, an important assumption in our regression analysis is that firms with no exposure to the minimum wage, $FA = 0$, are not affected by the minimum wage. We believe it is unrealistic that untreated firms would be substantially affected by the minimum wage, simply because the share of minimum wage workers in their total production is small.

Panel (a) in Figure A.10 shows that the employment change at firms with no exposure to the minimum wage is very similar in the placebo sample (when there was no minimum wage hike) and in the main sample (when there was). The change in employment at the intercept (no exposure to the minimum wage) is -0.042 (s.e. 0.005) in the Placebo sample, while -0.049 (s.e. 0.006) in the main sample. These differences are not statistically different from each other. The differences when industry dummies are used in the regression (see Figure A.11) is even smaller: the intercept in the placebo years is -0.043 (s.e. 0.005), while in the main specification it is -0.047 (s.e. 0.006). Therefore, we do not find any indication that the drop in non-treated firms was particularly large or small after the minimum wage hike. This provides further evidence that the SUTVA assumption holds in our data.

This pseudo experiment on SUTVA complements the other evidence on SUTVA presented in the paper. The bunching evidence used to calculate the employment effect of the minimum wage discussed briefly in Section 6 exploits aggregate data and before-after comparisons, and so it is not reliant on SUTVA. We present further evidence in Appendix A.2 on the effect of the minimum wage by exploiting differences in exposure to the minimum wage across demographic groups and regions. While the SUTVA assumption might not hold in the grouping regression either, the spillovers to the untreated groups are likely to be different in the firm-level and in the group-level regressions. For instance, if the main spillover happens across firms, which is the case in the Burdett and Mortensen (1998) Model, then our group-level estimates will be unaffected. Therefore, the similarity between the findings in Section A.2. and in the main text suggests that the spillovers of the minimum wage to employment in the untreated group ($FA = 0$) must be limited.

A.2 Group-Level Analysis of the Employment Effect of the Minimum Wage

To provide further evidence on employment we also implement a grouping estimator in the style of Blundell et al. (1998). We assign people to mutually exclusive groups formed from combinations of the 7 regions (NUTS 2), age in five categories (16-19, 20-24, 25-34, 45-54, 55-60), gender, and education (low skilled, medium skilled and high skilled). We estimate the following group-level regression:

$$epop_{gt} = \alpha + \beta_1 FA_g \times After_t + \beta_2 FA_g + \gamma X_{gt} + \theta_g + \xi_t + c_g t + \varepsilon_{gt} \quad (7)$$

where $epop_{gt}$ is the employment to population ratio in group g at time t and FA_g is the group-level exposure to the minimum wage measured by the fraction of workers in that group who earn below the 2002 minimum wage in 2000.[40] The β_1 coefficient on $FA_g \times After_t$ measures the effect of the minimum wage on employment. In equation (7) we control for the logarithm of population and the enrollment rate in secondary and higher education. The latter is crucial as the expansion of higher education was quite rapid around this period.[41] We also include age, education, region and sex dummies (denoted with θ_g) in the regression and we allow for group-specific time trends. We cluster the standard errors by group and we weight the regressions by the number observations used in calculating group-level exposure, FA_g.[42]

Table A.10 summarizes the key results. In Panel A, we show estimates of the relationship between exposure to the minimum wage and the employment-to-population rate changes after the minimum wage hike. In Column (1) we report the results without controlling for the expansion in higher education. In that case the employment effect is large and negative (-0.12 percentage point, s.e. 0.04). This effect is driven by a large drop in employment-to-population rate and a similar increase in the school enrollment rate for the younger cohorts. Once we control for school enrollment (Column (2)), group-specific time trends (Column (3)), or both (Column (4)) the strong relationship weakens and the disemployment effects become small and insignificant. In Column (5), we also report separate estimates on only prime-age adults (25-55 years old) to explore whether the presence of the oldest cohorts drives the results. The effects we estimate for this subgroup are similar to those we estimate for all workers.

We also calculated the employment elasticities *with respect to the minimum wage*. To get the percentage changes in employment we divided the estimated effects by the average employment-to-population rate in year 2000. The estimated elasticities are lower than our firm-level estimates in all cases except for the estimates with no controls or group-specific time trends (Column (1)), but the difference is not statistically significant. Given that the group-level exposure is more noisily estimated, the slightly lower elasticities estimated here might be the consequence of attenuation bias in these regressions.

[40] We measure FA_g from the Hungarian Structure of Earnings Survey, while the $epop_{gt}$ is from the Hungarian Labor Force Survey. This latter data covers all workers including the self-employed and the workers at the very small firms. Therefore, our grouping estimates can also be interpreted as evidence on a group of workers that are not covered in our firm-level analysis.

[41] While schooling decisions can be affected by the minimum wage (Neumark and Wascher, 1996), we believe this is not the case here. The enrollment rate in higher education increased from 11 percent in 1996 to 17 percent in 2000. This increase was boosted further by a generous student loan program that was introduced in 2001. As a result, the enrollment rate increased to 24 percent by 2004. We note that the growth in enrollment is very similar between 1996 and 2000 and between 2000 and 2004.

[42] We calculate FA_g from the Hungarian Structure of Earnings Survey (SES) that covers employed workers. Therefore, this weighting adds more weight to groups with higher employment in 2000.

Panel B of Table A.10 reports the relationship between group-level exposure to the minimum wage and the changes in average wage. All specifications highlight that wages significantly increased for highly exposed groups relative to less exposed ones after the reform. However, the estimated effect on wages, similarly to employment, is lower than the firm-level estimates in Table 2, since exposure to the minimum wage is more noisily estimated. We also calculate the implied elasticity *with respect to average wage*. Except for the estimates without controls presented in Column (1), the estimates are between -0.32 (Column (2)) and -0.13 (Column (3)). Overall, these elasticities are in line with the firm-level estimates shown in Table 2, which suggests that our results are robust to using alternative data sources and identification procedures.

A.3 Appendix Tables and Figures

This section present some additional tables and figures.

Table A.1 shows the share of materials in the total production in various European countries (2007-2010). We used the International Corporate Database of Bureau van Dijk (Orbis) to calculate these numbers. The table highlights that expenses on intermediate goods and services are around 66-68 percent of total revenue in Western Europe, while it is 70-74 percent in Eastern Europe. This highlights that the large share of intermediate goods and services in total production is not a uniquely Hungarian phenomenon.

Table A.2 explores alternative ways of dealing with the problem that wage changes are only observed for firms which survived the minimum wage change. Our benchmark method calculates the employment elasticity by taking the ratio of the employment effects estimated for all firms and the wage effects estimated for the firms that survived. This method, therefore, assumes that the firms that survived responded to the minimum wage in terms of wage change similarly to the firms exited. Row (1) shows the benchmark results measuring exposure by fraction affected and row (2) using GAP measure of exposure. Rows (3) and (4) provide estimates with selection correction following Johnson et al. (2000). The key identification assumption of this procedure is that the wage increase of the firms that shut down is above the median wage change. This procedure has two steps. First, we impute a 100 percent (average) wage increase for those firms that shut down. Second, we estimate equation 1 using a least absolute deviation (LAD) estimator on the sample that includes the imputed wage changes as well. Finally, row (5) simply reports the estimated the relationship between employment change and the GAP measure for all firms ("first stage"). Remember, the GAP measure captures the wage increase firms would have experienced in the absence of spillovers in 2002. Therefore, the relationship between the GAP measure and the employment change would capture the actual employment elasticity if there were no wage spillovers. The table highlights that the estimated employment elasticities with respect to the minimum wage are quite robust to alternative ways of dealing with the missing wage problem.

Table A.3 provides more details about the estimates presented in Table 5 ("Incidence of the Minimum Wage"). The table shows the relationship between fraction affected and various items in equation 2. We report the standard errors of the estimates on the changes between 2000 and 2002 and on the changes between 2000 and 2004. We also report the "placebo changes", which equal to the year 1998 outcomes minus the year 2000 outcomes.

Table A.4 provides further details about the heterogeneity in responses to the minimum wage increase. We show the relationship between the fraction affected and various outcomes by sector. We estimate regression equation 1 for each of the following sectors: manufacturing, construction, service, tradable and non-tradable.

In Table A.5 we explore heterogeneity in the effect of the minimum wage across various firm characteristics. Instead of separately examining the effect of various characteristics as in Figure 6, here we include all characteristics in the regression at the same time to disentangle which characteristics drive the results. In particular, we run regressions similar to equation 1 but we include interactions between a set of control variables and the fraction of workers affected by the minimum wage reform as well. We demean all variables in the regression so the coefficients of the interaction terms show the effect of the minimum wage for an "average" firm in the sample. In addition to the control variables we included in our previous analyses, we also control for the industry-level Herfindahl index. In Panel A we show the short term effects (two years after), in Panel B the medium

term effects (four years after), while in Panel C we test the presence of pre-existing trends.

Table A.6 shows additional estimates of the method of the moments estimates in Table 6. The table shows estimates based on the short term effects (changes between 2000 and 2002), based on the estimates with industry fixed effects. Columns (4)-(6) deviate from the model presented in Section 5 and assume imperfect pass-through of the minimum wage. In particular, we assume that prices would only increase by 70 percent of what would be predicted by the benchmark model.

Tables A.7 and Table A.8 present the results that are discussed in Section 6, for the short term changes (2000 to 2002) and medium term changes (2000 to 2004), respectively. The tables include estimates with the GAP measure of the minimum wage, with industry FEs and explore alternative sample selection.

Table A.9 shows the relationship between industry-level exposure to the minimum wage and entry rate in the pre-reform years (1998 and 2000) and the post reform years (2002 and 2004) at various industry levels. The relationship between fraction affected and entry rate is positive even before the reform. This is likely to reflect that newly entering firms tend to be low wage firms, which mechanically creates a (reverse) correlation between entry rate and fraction affected. We do not see any clear change in entry rate after the minimum wage hike (Column 4-7).

Table A.10 shows the results related to the group-level regression discussed in details in Appendix A.2.

Figure A.1 shows the evolution of real minimum wage between 1994 and 2008. The graph shows that there was a clear regime shift in the level of minimum wage between 2000 and 2002.

Figure A.2 plots the evolution of some key macroeconomic variables around the time of the reform. Panel (a) shows that real per capita GDP growth was around 4 percent before and after the reform. In line with the positive growth rate, panel (b) highlights that the aggregate labor market conditions were gradually improving: the employment to population rate increased by 0.5 percent each year between 1997 and 2004 and the unemployment rate fell to 5 percent by 2001 and then remained at this low level. Panel (c) shows that inflation (cpi) was relatively high (around 10 percent in 2000) and it was slowly declining. Finally, panel (c) highlights the exchange rate was also stable around the time of the reform.

Figure A.3 compares the strictness of employment protection legislation in OECD countries. The strength of employment protection in Hungary was in the bottom third of OECD countries, at a level similar to Switzerland or Japan.

Figure A.4 shows the non-parametric relationship between employment and the fraction affected (panels (a) and (b)) and between average cost of labor and fraction affected (panels (c) and (d)). The figure underscores that the linearity assumption made in equation 1 holds.

Figure A.5 plots the effect of the minimum wage on wages, on non-wage benefits, and on social security contributions. Remember in the main text we distinguish two forms of remuneration: wage and labor cost. The latter includes wages, social security contribution expenses, and non–cash benefits. Differences in the percentage changes in the average wage and in the cost of labor can be caused by two reasons. First, the cost of labor has higher value in the baseline and so if non-cash benefits and social security contributions are unaffected by the minimum wage, the same change in average wage yields a lower percentage change in the cost of labor than the percentage change in the average wage. Second, the minimum wage hike might lead to a change in non-cash benefits if firms offset the wage increase by cutting non-cash benefits. The primary goal of A.5 is to disentangle what drives the lower cost of labor effect shown in Figure 2 panel (b). To do that, we estimate the change in wage relative to the cost of labor in 2000 (red solid line), the change in social security contributions

relative to the cost of labor in 2000 (blue dashed line) and the change in non-cash benefits relative to the cost of labor in 2000 (black dotted line). Since we normalize all the outcome variables with the cost of labor in 2000, the magnitudes for the three outcome variables are comparable. The figure shows that the effect of the minimum wage on non-cash benefits is close to zero, which suggests that the firms did not offset the wage increase by cutting non-wage benefits. Therefore, the lower impact on the labor cost simply reflects that the wage increase is compared to a higher base.

Figure A.6 plots various estimates of the employment elasticity with respect to own wage (the labor demand elasticity in the standard model) from the previous literature. We only plot studies where the standard error around the point estimate is less than 1. See the details in Online Appendix Part A.4.

Figure A.7 shows the non-parametric relationship between various outcomes and the fraction affected. The figure underscores that the linearity assumption made in equation 1 holds.

In Figure A.8 we plot the effect on employment (panel (a)) and on revenue (panel (b)) over time in the tradable and in the non-tradable sectors. Even though the pre-existing trends are very similar in the two sectors before 2000, there is a large divergence after the reform. The medium term disemployment effect of the minimum wage is considerably larger in the tradable (-19 percent) than in the non-tradable sector (-4 percent). Moreover, the medium term effect of the minimum wage on revenue is positive in the non-tradable sector but negative in the tradable.

Figure A.9 shows the relationship between the fraction affected and the entry rate at the 2-digit industry level over time. The figure highlights what we concluded based on Table A.9: the industry-level relationship between the entry rate and the fraction affected is not altered after the minimum wage hike.

Figures A.10 and A.11 provide further evidence on the employment effects of the minimum wage by carrying out a pseudo-experiment. Using our pre-reform data we apply equivalent sample restrictions as in our benchmark sample, but we assume that the minimum wage increase occurred in 1998. This analysis also allows us to test for SUTVA. See the details in the Online Appendix Part A.1.

Figures A.12 and A.13 show the evolution of the earnings distribution from 1998 to 2004 relative to the earnings distribution in 2000. The timing of the minimum wage increase is visible on the histograms. Panels (a) and (b) show that the pre-reform distributions laid on top of each other, indicating that the earnings distribution was quite stable preceding the reform. In 2001 the minimum wage increased by 0.30 log points, which generated a large excess mass in the 2001 earnings distribution. The running sum on Figure 2 highlights that employment effect converges to a small but positive number. In 2002, when the minimum wage was raised by 0.13 log points on the top of the 2001 increase, the size of the bunching and the number of workers below the minimum wage increased further. In that year the running sum converges to our benchmark estimate shown in Table 2. In 2003 the minimum wage was slightly lower in real terms than the 2002 minimum wage. The estimated employment effect is slightly larger than the firm-level one. Finally, in 2004 the minimum wage was kept at a similar level as in 2003, but an unrealistically high level of excess jobs showed up in the new earnings distribution. This highlights a limitation of our bunching estimator. Our underlying assumption is that the earnings distribution would be stable without the effect of the minimum wage. As we go further in time from 2000 this assumption is less likely to hold. This can be also seen in Appendix Figure A.14, which shows the kernel densities over time. Overall, the bunching evidence provides further graphical support for the finding that the overall employment effect of the large minimum wage hike was limited.

Table A.1: Share of materials in the total production in various European countries (2007-2010)

	(1) Manufacturing	(2) Service
Austria	0.65	0.66
Belgium	0.70	0.70
Bulgaria	0.69	0.76
Czech Republic	0.70	0.76
Germany	0.66	0.64
Spain	0.62	0.62
Finland	0.60	0.57
France	0.62	0.61
Hungary	0.69	0.78
Italy	0.68	0.68
Poland	0.74	0.74
Portugal	0.58	0.64
Romania	0.72	0.77
Sweden	0.59	0.58
Slovenia	0.67	0.71
Slovakia	0.69	0.72
Mean (all countries)	0.66	0.68
Mean (Eastern Europe)	0.70	0.74

Source: Own calculations from the International Corporate Database of Bureau van Dijk (Orbis). The table shows the material share (intermediate goods and services) in the total production (revenue) in various European countries. We use only firms with at least 5 employees from 2007 and 2010. The table shows that firm-level material share is quite high across Europe and it is somewhat higher in the Eastern European region. The Hungarian material share is in line with the regional average.

Table A.2: Exploring the Effect of Alternative Ways dealing with Missing Wages on the Employment Elasticity with Respect to Cost of Labor Estimates

	(1) **Changes Between 2000 and 2002**	(2) **Changes Between 2000and 2004**
Benchmark (with FA)	-0.16	-0.23
	(0.02)	(0.03)
Benchmark (with GAP)	-0.15	-0.19
	(0.02)	(0.04)
Selection Correction (with FA)	-0.13	-0.18
	(0.02)	(0.04)
Selection Correction (with GAP)	-0.13	-0.18
	(0.02)	(0.03)
GAP (first stage)	-0.15	-0.17
	(0.02)	(0.03)

Note: This table calculates the employment elasticity with respect to cost of labor using alternative ways of dealing with the fact that wages are missing for firms exiting after 2000. Our benchmark method calculates the employment elasticity by taking the ratio of the employment effects estimated for all firms and the wage effects estimated for the firms survived. This method, therefore, assumes that the survived firms responded to the minimum wage in terms of wage change similarly to the firms exited. Row (1) shows the benchmark results measuring exposure by fraction affected and row (2) using GAP measure of exposure. Row (3) and (4) provide estimate with selection correction following Johnson et al. (2000). The key identification assumption of this procedure is that the wage increase of the firms that died is above the conditional median wage change. This procedure has two steps. First, we impute a 100 percent (average) wage increase for those firms that died. Second, we estimate equation 1 using a least absolute deviation (LAD) estimator on the sample that includes the imputed wage changes as well. Finally, row (5) simply reports the estimated the relationship between employment change and the GAP measure for all firms ("first stage"). Remember, the GAP measure captures the wage increase firms would experience in the absence of spillovers in 2002. Therefore, the relationship between the GAP measure and the employment change would capture the actual employment elasticity if there were no wage spillovers. For all elasticities reported in the table we control for firm age, the legal form of organization (e.g. limited liability company, publicly traded etc.), and the following variables and their squares: average export share between 1997 and 2000; average profitability between 1997 and 2000; the average share of labor between 1997 and 2000; average depreciation rate between 1997 and 2000; the average share of wage cost in total labor cost between 1997 and 2000; and the average industry level import exposure between 1997 and 2000. Regressions are weighted by the logarithm of revenue in 2000. Robust standard errors are reported in parentheses.

Table A.3: The Incidence of the Minimum Wage (More Detailed Version of Table 5 in the Main Text)

	Main results		Placebo
	Changes between 2000 and 2002	Changes between 2000 and 2004	Changes between 2000 and 1998
	(1)	(3)	(5)
Panel A: Change in total labor cost (relative to revenue in 2000)			
Fraction Affected	0.038	0.021	-0.005
	(0.002)	(0.003)	(0.002)
Panel B: Change in revenue (relative to revenue in 2000)			
Fraction Affected	0.066	0.036	-0.020
	(0.013)	(0.018)	(0.015)
Panel C: Change in materials (relative to revenue in 2000)			
Fraction Affected	0.033	0.014	-0.013
	(0.011)	(0.014)	(0.013)
Panel D: Change in Miscellaneous Items (relative to revenue in 2000)			
Fraction Affected	0.006	0.005	-0.004
	(0.002)	(0.002)	(0.001)
Panel E: Change in Depreciation (relative to revenue in 2000)			
Fraction Affected	0.001	0.003	-0.002*
	(0.001)	(0.001)	(0.001)
Panel F: Change in Profits (relative to revenue in 2000)			
Fraction Affected	-0.011	-0.008	0.006
	(0.003)	(0.004)	(0.004)
Observations	19,485	19,485	19,485
Controls	yes	yes	yes
Industry	no	no	no

Note: This table provides more details about the estimates in Table 5. The table shows the relationship between fraction affected and various outcome variables from equation 2. Columns (1) shows the effect of fraction affected on the changes between 2000 and 2002, while Column (2) shows between 2000 and 2004. Column (3) tests the presence for pre-existing trends by looking at the effect on "placebo" changes, which equal to the year 1998 outcome minus the year 2000 outcome. We use the same controls as in Table 5 and we also apply the same weighting and winsorizing.

Table A.4: Effect on Firm-level Outcomes by Sectors

	Av. Cost of Labor (1)	Employ-ment (2)	Total Labor Cost (3)	Revenue (4)	Materials (5)	Profit (6)	Capital (7)
Panel A: Change between 2000 and 2002 (short term)							
All Firms	0.485	-0.076	0.325	0.066	0.049	-0.011	0.148
(obs= 19485)	(0.009)	(0.010)	(0.013)	(0.013)	(0.014)	(0.003)	(0.034)
Manufacturing	0.453	-0.078	0.298	0.039	0.007	-0.006	0.074
(obs = 6312)	(0.014)	(0.017)	(0.023)	(0.025)	(0.027)	(0.006)	(0.049)
Construction	0.505	-0.073	0.351	0.231	0.217	0.014	0.188
(obs = 2914)	(0.023)	(0.027)	(0.036)	(0.046)	(0.050)	(0.010)	(0.093)
Service	0.502	-0.070	0.342	0.051	0.041	-0.018	0.190
(obs = 10259)	(0.013)	(0.014)	(0.019)	(0.017)	(0.018)	(0.004)	(0.051)
Tradable	0.441	-0.112	0.240	0.012	-0.002	-0.018	0.050
(obs = 4557)	(0.018)	(0.020)	(0.028)	(0.030)	(0.032)	(0.008)	(0.056)
Non-Tradable	0.538	-0.050	0.410	0.080	0.052	-0.010	0.197
(obs = 6196)	(0.016)	(0.018)	(0.024)	(0.021)	(0.021)	(0.004)	(0.060)
Panel B: Change between 2000 and 2004 (medium term)							
All Firms	0.435	-0.100	0.238	0.036	0.021	-0.008	0.270
(obs= 19485)	(0.011)	(0.014)	(0.020)	(0.018)	(0.019)	(0.004)	(0.054)
Manufacturing	0.403	-0.127	0.166	-0.024	-0.071	-0.002	0.147
(obs = 6312)	(0.019)	(0.024)	(0.034)	(0.033)	(0.036)	(0.007)	(0.082)
Construction	0.459	-0.071	0.269	0.179	0.211	0.002	0.245
(obs = 2914)	(0.028)	(0.036)	(0.051)	(0.055)	(0.060)	(0.011)	(0.146)
Service	0.457	-0.078	0.294	0.043	0.034	-0.013	0.390
(obs = 10259)	(0.016)	(0.019)	(0.028)	(0.023)	(0.025)	(0.005)	(0.081)
Tradable	0.389	-0.192	0.068	-0.069	-0.106	-0.010	0.107
(obs = 4557)	(0.024)	(0.029)	(0.040)	(0.039)	(0.044)	(0.009)	(0.089)
Non-Tradable	0.477	-0.037	0.377	0.050	0.016	-0.008	0.332
(obs = 6196)	(0.020)	(0.025)	(0.035)	(0.030)	(0.031)	(0.005)	(0.100)
Panel C: Placebo Change between 2000 and 1998							
All Firms	-0.035	0.002	-0.031	-0.020	-0.008	0.006	-0.006
(obs= 19485)	(0.005)	(0.009)	(0.009)	(0.015)	(0.019)	(0.004)	(0.015)
Manufacturing	-0.044	-0.019	-0.066	-0.002	-0.003	0.014	-0.073
(obs = 6312)	(0.009)	(0.017)	(0.016)	(0.024)	(0.030)	(0.007)	(0.024)
Construction	-0.024	-0.011	-0.022	-0.007	0.025	0.014	-0.045
(obs = 2914)	(0.017)	(0.026)	(0.028)	(0.047)	(0.058)	(0.010)	(0.042)
Service	-0.036	0.011	-0.024	-0.040	-0.031	-0.002	0.034
(obs = 10259)	(0.008)	(0.013)	(0.013)	(0.021)	(0.026)	(0.005)	(0.022)
Tradable	-0.038	-0.012	-0.054	-0.001	0.015	0.014	-0.083
(obs = 4557)	(0.011)	(0.021)	(0.02)	(0.029)	(0.033)	(0.009)	(0.029)
Non-Tradable	-0.042	-0.031	-0.074	-0.040	-0.027	-0.001	-0.039
(obs = 6196)	(0.009)	(0.016)	(0.016)	(0.025)	(0.032)	(0.005)	(0.025)

Note: We estimate equation 1 for each sector separately. In each regression we control for the same variables as in Table 3, and we also apply the same weighting and winsorizing. Panel C shows the effect on "placebo" changes, which equal to the year 1998 outcome minus the year 2000 outcome. Robust standard errors are in parentheses.

Table A.5: Effect on Firm-level Outcomes by Firm Characteristics

	Av. Cost of Labor (1)	Employ-ment (2)	Total Labor Cost (3)	Revenue (4)	Materials (5)	Profit (6)	Capital (7)
Panel A: Change between 2000 and 2002 (short term)							
Fraction Affected (FA)	0.485	-0.097	0.301	0.058	0.038	-0.011	0.148
	(0.009)	(0.010)	(0.014)	(0.014)	(0.015)	(0.003)	(0.033)
FA×Export share	0.031	-0.082	-0.049	-0.110	-0.131	-0.008	0.211
	(0.049)	(0.043)	(0.065)	(0.064)	(0.074)	(0.013)	(0.159)
FA×Labor share	-0.171	-0.187	-0.531	0.154	0.085	0.007	-0.400
	(0.054)	(0.058)	(0.078)	(0.086)	(0.095)	(0.024)	(0.200)
FA×Profit share	-0.092	0.054	0.228	0.216	0.222	-0.092	0.056
	(0.086)	(0.081)	(0.112)	(0.123)	(0.125)	(0.040)	(0.239)
FA×log(Employment)	-0.038	-0.017	-0.042	-0.036	-0.034	0.004	0.006
	(0.008)	(0.009)	(0.013)	(0.013)	(0.013)	(0.003)	(0.027)
FA×Market Herfindahl	0.085	0.025	0.050	-0.172	-0.205	-0.015	0.183
	(0.105)	(0.113)	(0.161)	(0.162)	(0.174)	(0.036)	(0.341)
Panel B: Change between 2000 and 2004 (medium term)							
Fraction Affected (FA)	0.449	-0.138	0.202	0.017	-0.004	-0.011	0.273
	(0.012)	(0.014)	(0.020)	(0.018)	(0.020)	(0.003)	(0.054)
FA×Export share	0.141	-0.234	-0.138	-0.343	-0.400	-0.023	0.156
	(0.063)	(0.062)	(0.100)	(0.081)	(0.096)	(0.013)	(0.255)
FA×Labor share	-0.242	-0.190	-0.617	0.153	0.118	0.001	-0.681
	(0.068)	(0.078)	(0.108)	(0.112)	(0.131)	(0.027)	(0.306)
FA×Profit share	-0.186	0.029	0.247	0.050	0.123	-0.100	0.022
	(0.103)	(0.106)	(0.149)	(0.156)	(0.160)	(0.044)	(0.335)
FA×log(Employment)	-0.015	-0.046	-0.062	-0.054	-0.064	0.001	0.027
	(0.011)	(0.013)	(0.019)	(0.017)	(0.019)	(0.003)	(0.048)
FA×Market Herfindahl	-0.028	0.151	0.104	-0.310	-0.392	-0.039	0.657
	(0.154)	(0.162)	(0.243)	(0.228)	(0.257)	(0.038)	(0.627)
Panel C: Placebo Change between 2000 and 1998							
Fraction Affected (FA)	-0.045	-0.003	-0.042	-0.041	-0.035	0.007	-0.017
	(0.006)	(0.009)	(0.009)	(0.013)	(0.017)	(0.003)	(0.015)
FA×Export share	-0.033	0.078	0.031	0.030	0.062	0.026	0.024
	(0.025)	(0.040)	(0.042)	(0.056)	(0.073)	(0.011)	(0.060)
FA×Labor share	0.041	0.161	0.175	0.248	0.306	0.081	0.211
	(0.034)	(0.056)	(0.061)	(0.088)	(0.144)	(0.025)	(0.101)
FA×Profit share	0.014	-0.020	-0.032	-0.187	-0.042	0.004	0.060
	(0.050)	(0.097)	(0.101)	(0.176)	(0.228)	(0.042)	(0.150)
FA×log(Employment)	0.012	-0.015	0.009	0.009	0.003	-0.003	-0.035
	(0.005)	(0.009)	(0.009)	(0.011)	(0.014)	(0.002)	(0.014)
FA×Market Herfindahl	0.028	-0.090	-0.091	-0.052	-0.184	0.035	-0.313
	(0.064)	(0.101)	(0.095)	(0.143)	(0.185)	(0.026)	(0.188)

Note: We estimate equation 1 with the interaction terms between *FA* and various firm-level characteristics. In each regression we control for the same variables as in Table 3, and we also apply the same weighting and winsorizing. Panel C shows the effect on "placebo" changes, which equal to the year 1998 outcome minus the year 2000 outcome. Robust standard errors are in parentheses.

Table A.6: Method of the Moments Estimates, Alternative Specifications

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated Parameters						
Output Demand, μ	0.11	-0.12	-0.42	-0.03	1.27	1.75
	(0.22)	(0.15)	(0.23)	(033)	(0.65)	(0.59)
Capital-Labor Substitution, σ_{KL}	3.35	1.43	2.73	3.32	2.70	2.29
	(0.62)	(0.36)	(0.65)	0.63	(1.01)	(0.83)
Material-Labor Substitution, σ_{ML}	0.03	0.13	0.14	0.05	0	0.04
	(0.06)	(0.04)	(0.06)	(0.06)	(0.11)	(0.14)
Panel B: Empirical Moments						
Employment Elasticity	-0.23	-0.15	-0.19	-0.23	-0.31	-0.49
Revenue Elasticity	0.08	0.14	0.26	0.08	-0.05	-0.17
Materials Elasticity	0.05	0.10	0.10	0.05	-0.17	-0.26
Capital Elasticity	0.62	0.30	0.57	0.62	0.37	0.28
Price Elasticity					0.25	
Panel C: Moments Predicted by the Estimated Parameters						
Employment Elasticity	-0.23	-0.16	-0.27	-0.23	-0.32	-0.50
Revenue Elasticity	0.16	0.20	0.15	0.13	-0.03	-0.13
Materials Elasticity	-0.01	0.05	0.01	0.02	-0.16	-0.30
Capital Elasticity	0.58	0.28	0.22	0.60	0.33	0.27
Price Elasticity	0.18	0.18	0.18	0.13	0.16	0.18
Share of Labor, s_L	0.18	0.18	0.18	0.18	0.23	0.25
Share of Capital, s_K	0.08	0.08	0.08	0.08	0.07	0.08
Share of Materials, s_M	0.74	0.74	0.74	0.74	0.70	0.67
No of Moments Used	4	4	4	4	4	4
No of Estimated Parameters	3	3	3	3	3	3
Sum of Squares	5.64	9.24	5.09	1.95	0.17	0.21
Sample	All	All	All	All	Manufact	Tradable
Year	2004	2002	2004	2004	2004	2004
Industry FEs	no	no	yes	no	yes	yes
Pass-Through	Full	Full	Full	70 percent	70 percent	70 percent

Note: Column (1)-(3) estimate the parameters of the model presented in Section 6 using a minimum-distance estimator. In each column we use the empirical moments that are based on our benchmark estimates with controls. The estimated parameters with standard errors can be found in Panel A. Panels B and C report the empirical and the predicted moments, respectively. In Columns (4)-(6) we deviate from the model and assume imperfect pass-through of the minimum wage. In particular, we assume that prices would only increase by 70 percent of what would be predicted by the benchmark model.

Table A.7: Robustness of the Impact of the Minimum Wage, Change between 2000 and 2002

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Wage							
FA or GAP	0.58	1.23	0.59	1.24	0.57	0.60	0.57
	(0.01)	(0.03)	(0.01)	(0.03)	(0.01)	(0.01)	(0.01)
Panel B: Cost of Labor							
FA or GAP	0.49	1.05	0.50	1.06	0.48	0.51	0.49
	(0.01)	(0.03)	(0.01)	(0.03)	(0.01)	(0.01)	(0.01)
Panel B: Employment							
FA or GAP	-0.076	-0.145	-0.068	-0.121	-0.078	-0.059	-0.086
	(0.010)	(0.022)	(0.011)	(0.024)	(0.009)	(0.008)	(0.009)
Panel C: Employment elasticity wrt. Cost of Labor							
Employment elasticity	-0.17	-0.15	-0.16	-0.14	-0.16	-0.11	-0.17
wrt. MW	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)
Panel D: Total Labor Cost							
FA or GAP	0.325	0.692	0.352	0.736	0.315	0.376	0.345
	(0.013)	(0.032)	(0.015)	(0.036)	(0.012)	(0.012)	(0.013)
Panel D: Revenue							
FA or GAP	0.066	0.152	0.100	0.222	0.050	0.093	0.066
	(0.013)	(0.030)	(0.015)	(0.032)	(0.012)	(0.012)	(0.013)
Panel E: Material							
FA or GAP	0.049	0.115	0.080	0.185	0.031	0.079	0.048
	(0.014)	(0.032)	(0.016)	(0.034)	(0.013)	(0.013)	(0.014)
Panel F: Profits							
FA or GAP	-0.011	-0.022	-0.003	-0.005	-0.010	-0.015	-0.007
	(0.003)	(0.007)	(0.004)	(0.008)	(0.003)	(0.003)	(0.003)
Panel G: Capital							
FA or GAP	0.148	0.202	0.156	0.209	0.140	0.148	0.157
	(0.034)	(0.073)	(0.037)	(0.079)	(0.031)	(0.032)	(0.036)
Observations*	19,485	19,485	19,485	19,485	22,766	29,138	16,980
Controls	yes	yes	yes	yes	yes	yes	yes
Exposure Measure	FA	GAP	FA	GAP	FA	FA	FA
NACE 3 dummies	no	no	yes	yes	no	no	no
All Industry	no	no	no	no	yes	no	no
Small Firms	no	no	no	no	no	yes	no
Firms Survived till 2004	no	yes	no	no	no	no	yes

Note: This table estimates the short term relationship between exposure to the minimum wage and various outcomes for alternative specifications. Column (1) reports the benchmark estimates. Columns (2) and (4) show estimates using the GAP measure of exposure. Columns (3) and (4) add three digit industry dummies to the benchmark specification. Column (5) includes all industries in the regressions, Column (6) includes firms with less than 5 employees, while Columns (7) restricts the sample on firms that survived till 2004. Robust standard errors are in parentheses.

Table A.8: Robustness of the Impact of the Minimum Wage, Change between 2000 and 2004

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Wage							
FA or GAP	0.54	1.12	0.57	1.15	0.53	0.59	0.54
	(0.01)	(0.03)	(0.01)	(0.04)	(0.01)	(0.01)	(0.01)
Panel B: Cost of Labor							
FA or GAP	0.43	0.91	0.46	0.94	0.42	0.47	0.44
	(0.01)	(0.03)	(0.01)	(0.03)	(0.01)	(0.01)	(0.01)
Panel B: Employment							
FA or GAP	-0.100	-0.169	-0.087	-0.133	-0.114	-0.079	-0.116
	(0.014)	(0.031)	(0.015)	(0.033)	(0.012)	(0.012)	(0.013)
Panel C: Employment elasticity wrt. Cost of Labor							
Employment elasticity	-0.23	-0.19	-0.19	-0.14	-0.27	-0.17	-0.26
wrt. MW	(0.03)	(0.04)	(0.03)	(0.04)	(0.03)	(0.03)	(0.02)
Panel D: Total Labor Cost							
FA or GAP	0.238	0.506	0.286	0.591	0.207	0.299	0.272
	(0.020)	(0.045)	(0.022)	(0.049)	(0.018)	(0.017)	(0.020)
Panel E: Revenue							
FA or GAP	0.036	0.124	0.083	0.228	-0.005	0.081	0.040
	(0.018)	(0.039)	(0.019)	(0.042)	(0.016)	(0.015)	(0.018)
Panel F: Material							
FA or GAP	0.021	0.090	0.075	0.209	-0.019	0.076	0.025
	(0.019)	(0.042)	(0.021)	(0.045)	(0.017)	(0.017)	(0.020)
Panel G: Profits							
FA or GAP	-0.008	-0.111	-0.0004	0.006	-0.011	-0.013	-0.008
	(0.004)	(0.008)	(0.004)	(0.009)	(0.003)	(0.003)	(0.004)
Panel H: Capital							
FA or GAP	0.270	0.427	0.280	0.488	0.221	0.177	0.304
	(0.054)	(0.120)	(0.060)	(0.132)	(0.050)	(0.049)	(0.060)
Observations*	19,485	19,485	19,485	19,485	22,766	29,138	16,980
Controls	yes	yes	yes	yes	yes	yes	yes
Exposure Measure	FA	GAP	FA	GAP	FA	FA	FA
NACE 3 dummies	no	no	yes	yes	no	no	no
All Industry	no	no	no	no	yes	no	no
Small Firms	no	no	no	no	no	yes	no
Firms Survived till 2004	no	yes	no	no	no	no	yes

Note: This table estimates the medium term relationship between exposure to the minimum wage and various outcomes for alternative specifications. Column (1) reports the benchmark estimates. Columns (2) and (4) show estimates using the GAP measure of exposure. Columns (3) and (4) add three digit industry dummies to the benchmark specification. Column (5) includes all industries in the regressions, Column (6) includes firms with less than 5 employees, while Columns (7) restricts the sample on firms that survived till 2004. Robust standard errors are in parentheses.

Table A.9: Relationship between Entry Rate and Fraction Affected at the Industry Level

	(1) 1998	(2) 2000	(3) 2002	(4) 2004
Panel A: 2-digit level Industries				
FA_k	0.067	0.041	0.073	0.054
	(0.019)	(0.018)	(0.020)	(0.022)
Constant	0.062	0.056	0.037	0.045
	(0.006)	(0.006)	(0.007)	(0.007)
Number of observation	32	32	32	32
R-squared	0.299	0.143	0.308	0.172
Panel B: 3-digit level Industries				
FA_k	0.018	0.027	0.056	0.043
	(0.019)	(0.014)	(0.012)	(0.013)
Constant	0.082	0.059	0.043	0.047
	(0.007)	(0.005)	(0.004)	(0.005)
Number of observation	151	151	151	151
R-squared	0.006	0.026	0.130	0.068
Panel C: 4-digit level Industries				
FA_k	0.020	0.030	0.024	0.050
	(0.013)	(0.010)	(0.010)	(0.009)
Constant	0.079	0.057	0.054	0.041
	(0.005)	(0.004)	(0.004)	(0.003)
Number of observation	373	373	373	373
R-squared	0.006	0.023	0.015	0.078

Note: The table show the relationship between exposure to the minimum wage and firms entry at two-digit industry level in 1998, in 2000, in 2002 and in 2004. Panel B and C shows the same at three-digit and four-digit industry level. Each column represent a separate regression of the entry rate at the industry level on the fraction of affected workers in that sector in a particular year. Regression weighted by the number if firms in the sector in 1997. We only use industries that are in our benchmark sample (see the details on sample restriction in Section 2.2.)

Table A.10: Employment Effect of the Minimum Wage, Grouping Estimator

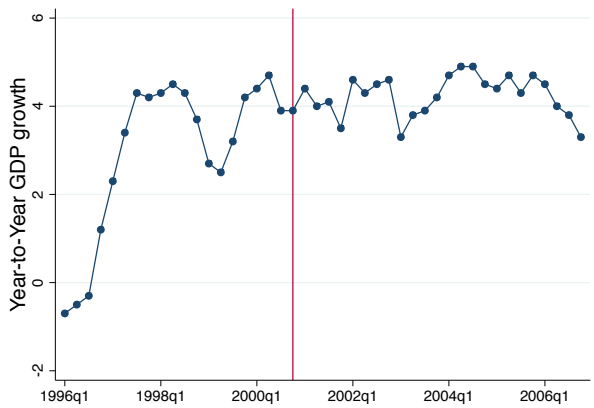
	(1)	(2)	(3)	(4)	(5)
Panel A: Effect on Employment-to-Population (epop)					
After 2000 $\times$ FA_g	-0.12	-0.03	-0.02	-0.02	-0.02
	(0.04)	(0.03)	(0.03)	(0.03)	(0.04)
After 2000	0.05	0.05	0.002	0.001	0.001
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
FA_g	-0.31	-0.22	-0.36	-0.24	-0.31
	(0.13)	(0.10)	(0.13)	(0.10)	(0.14)
Employment elasticity	-0.24	-0.07	-0.05	-0.05	-0.04
wrt. *MW* (directly affected)	(0.08)	(0.07)	(0.06)	(0.06)	(0.08)
Panel B: Effect on the Average Wage					
After 2000 $\times$ FA_g	0.12	0.14	0.24	0.24	0.24
	(0.03)	(0.03)	(0.03)	(0.03)	(0.05)
After 2000	-0.06	-0.06	-0.03	-0.03	-0.03
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
FA_g	-0.87	-0.82	-0.93	-0.87	-0.97
	(0.10)	(0.09)	(0.10)	(0.09)	(0.12)
Employment elasticity	-1.40	-0.32	-0.13	-0.13	-0.14
wrt. wage	0.65	0.35	0.21	0.21	0.24
Time FEs	yes	yes	yes	yes	yes
Demographic-Region FEs	yes	yes	yes	yes	yes
Controls	no	yes	no	yes	yes
Demographic-Region time trend	no	no	yes	yes	yes
Age range	16-60	16-60	16-60	16-60	25-55
Epop in 2000	0.71	0.71	0.71	0.71	0.75
Number of observation	1792	1792	1792	1792	1008

Note: Table shows the group level relationship between exposure to the minimum wage (FA_g) and employment and wages (see regression specifications in equation 7). Groups are created based on demographics, age, education and the region where the workers live. The coefficient on the variable After 2000 $\times$ FA_g estimates the effect of the minimum wage. In Panel A we show the effect on the employment-to-population rate. Panel B shows the effect on the average wage and the implied elasticity wrt. the *wage*. The regressions are weighted by the number of observations used in calculating FA_g. Clustered standard errors at the group-level are reported in parentheses.

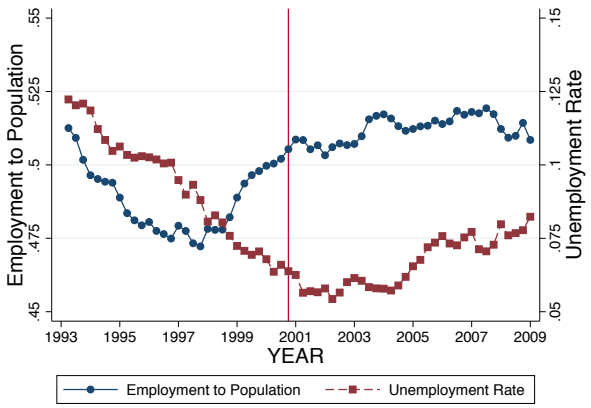
Figure A.1: Evolution of Real Minimum Wage

Notes: This figure shows the evolution of the minimum wage after adjusted by the consumer price index (CPI). The graph shows the radical shift in real minimum wages occurred after 2000.

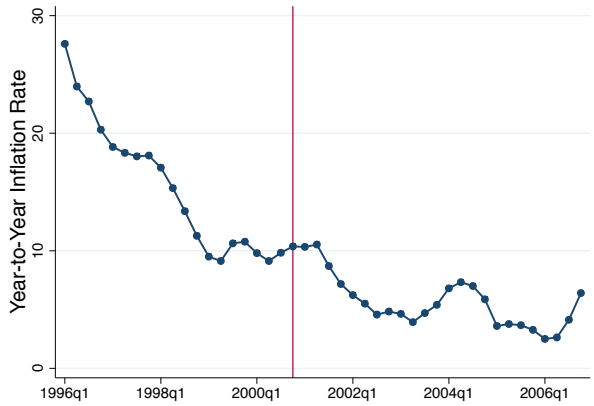
Figure A.2: Macroeconomic Trends



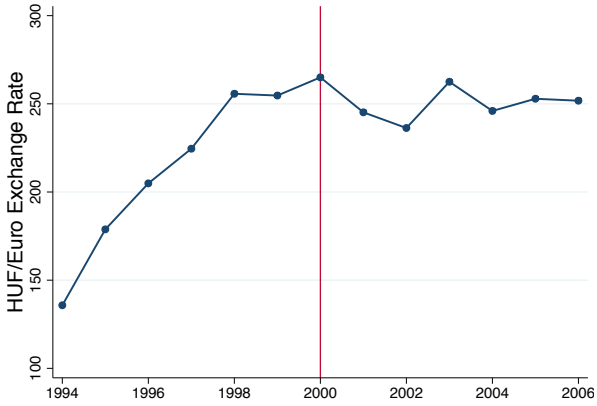
(a) GDP growth



(b) Employment and Unemployment trends



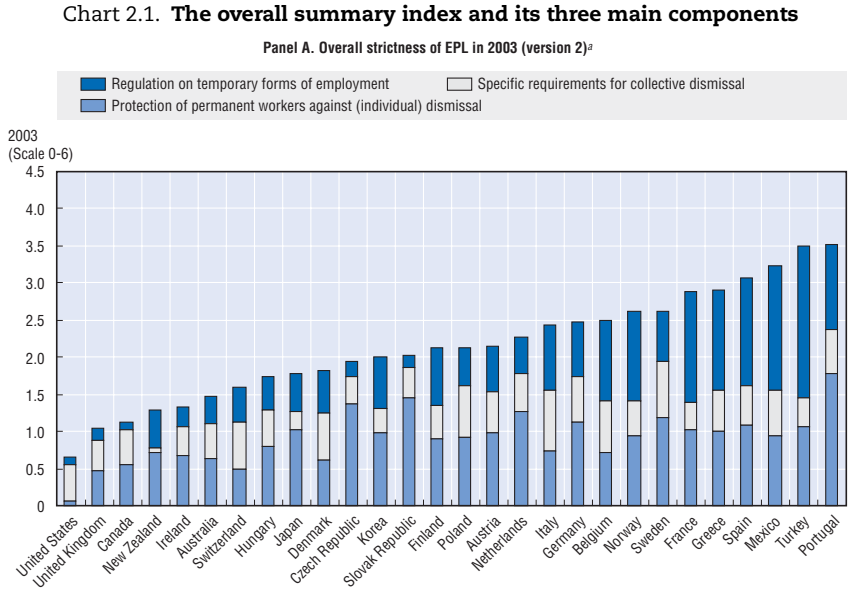
(c) Inflation Rate



(d) EUR/HUF Exchange Rate

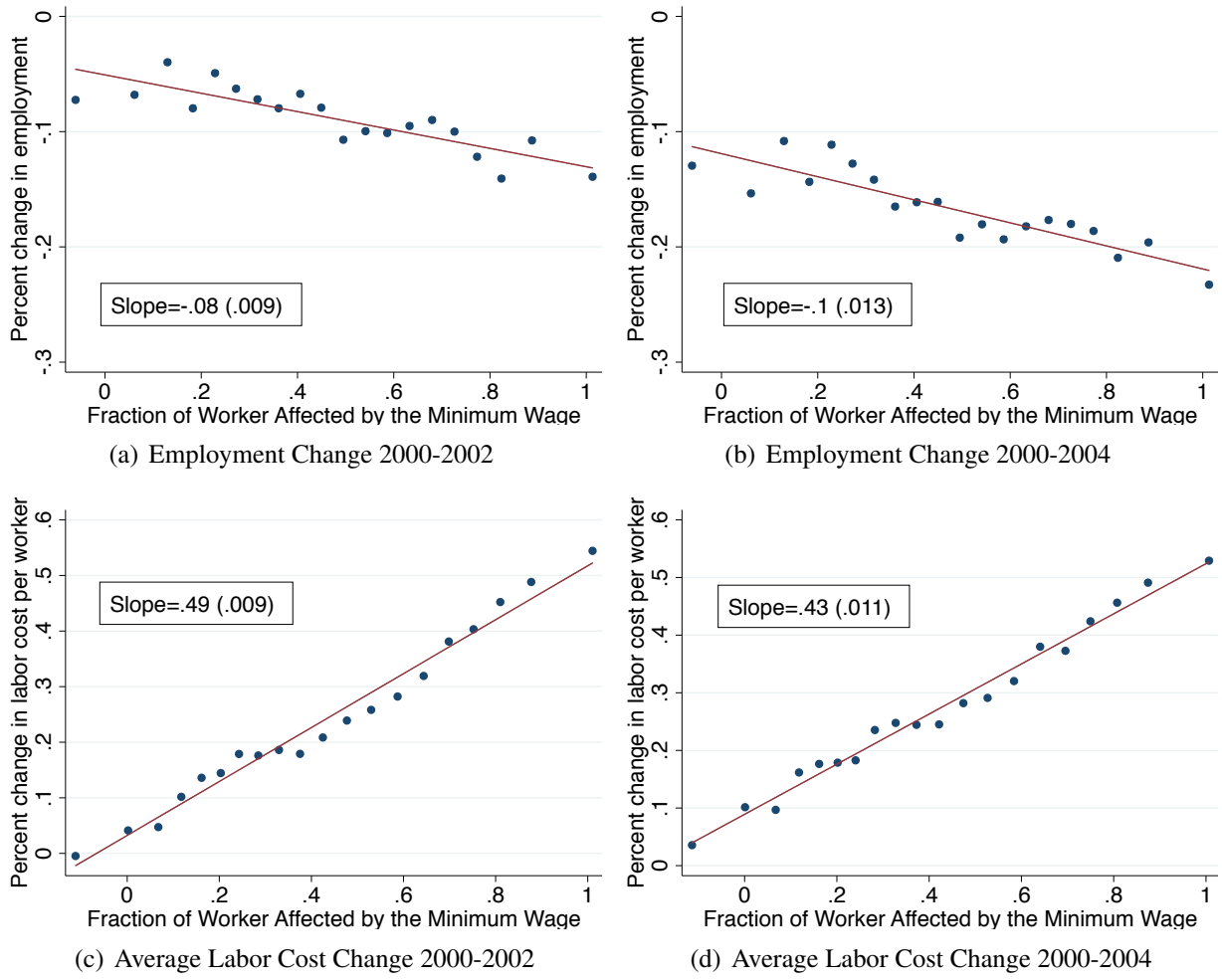
Notes: Panel (a) shows the seasonally adjusted, year to year real GDP growth rate between 1996 and 2006 in Hungary; panel (b) shows the evolution of employment to population rate and the unemployment rate between 1993 and 2009; panel (c) the year-to-year inflation rate (consumer price index), while panel (d) the EUR/HUF (or ECU/HUF before 1999) exchange rate. The major (red) vertical line indicates the 4th quarter in 2000 (or year 2000 in panel d), the last quarter (or year in panel d) before the minimum wage hike. Panel (a) shows that the GDP growth was stable around the examined period. Panel (b) highlights that the labor market was gradually improving around the reform. Panel (c) shows that the inflation rate was stable at around 10% before 2001, and it fell shortly afterwards. Panel (d) shows that the EUR/HUF exchange rate was increasing until 1998 and stabilized afterwards.

Figure A.3: Employment Protection Legislation in OECD Countries



Notes: Source: OECD Employment Outlook in 2004. This figure shows the strictness of employment protection legislation in various OECD countries including Hungary. The data is from 2003, but the ranking was very similar in 1999. The strictness of employment protection is in the bottom third of the OECD countries.

Figure A.4: Non-parametric relationship between employment/average labor cost change and the fraction of affected workers



(a) Employment Change 2000-2002

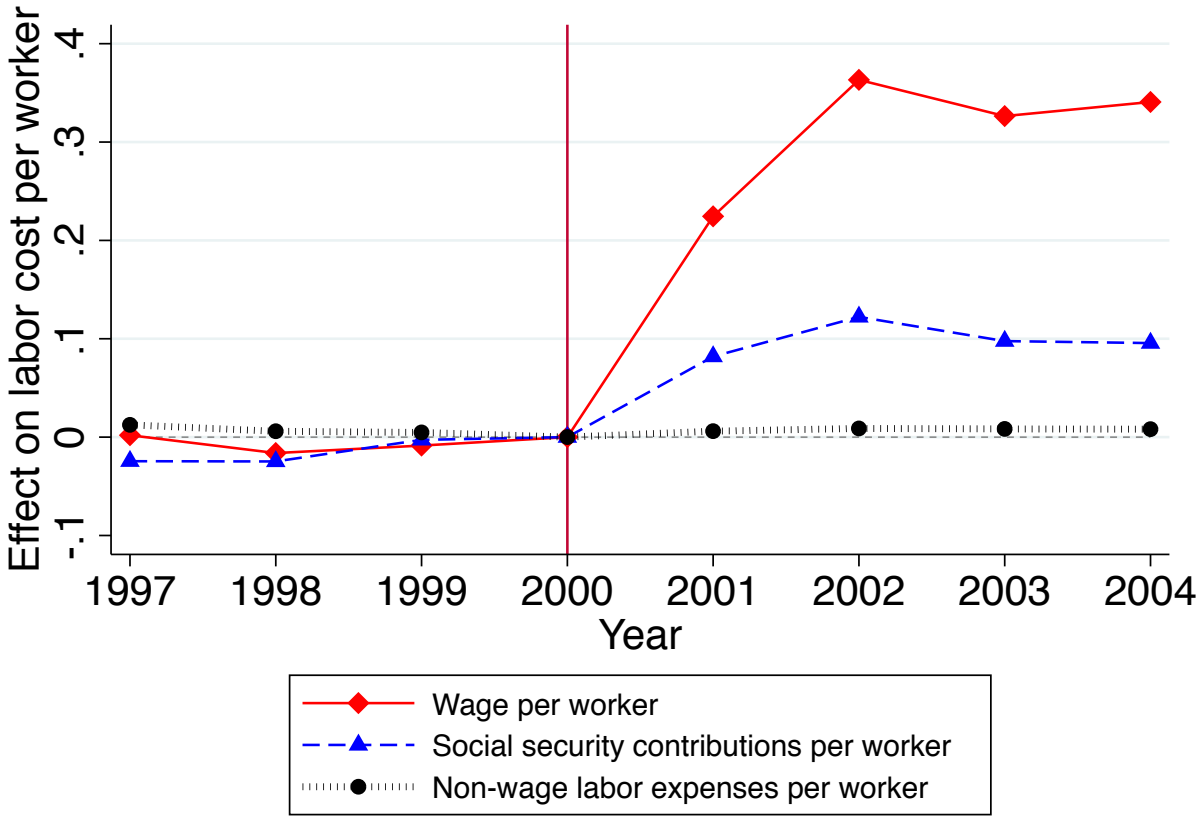
(b) Employment Change 2000-2004

(c) Average Labor Cost Change 2000-2002

(d) Average Labor Cost Change 2000-2004

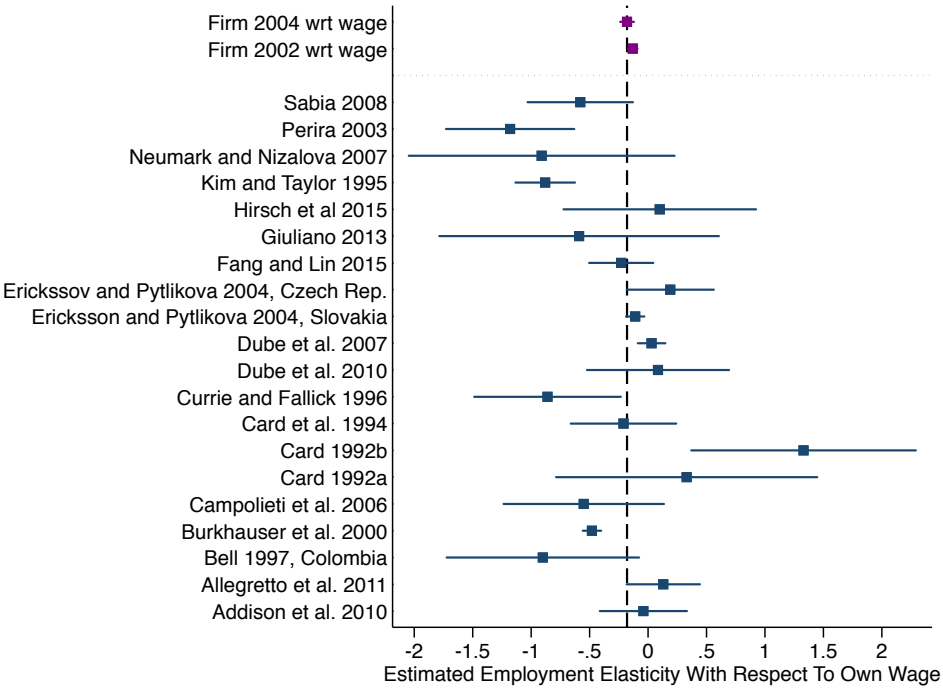
Notes: These figures show the binned scatterplot between the fraction of affected workers by the minimum wage and changes in employment (panel (a) and (b)) and changes in average labor cost (panel (c) and (d)). Panel (a) and (c) show the short-term effects (changes between 2002 and 2000) while panel (b) and (d) show the medium term ones (changes between 2004 and 2000). The red lines represent the best linear fits, while in the boxes we report the slopes of lines. Controls are included in the regression. The figures highlight that the relationships between the fraction affected and changes in employment and between the fraction affected and the changes in average labor cost are approximately linear.

Figure A.5: Effect of the Minimum Wage on Wages, Non-Wage Benefits, and Social Security Contributions



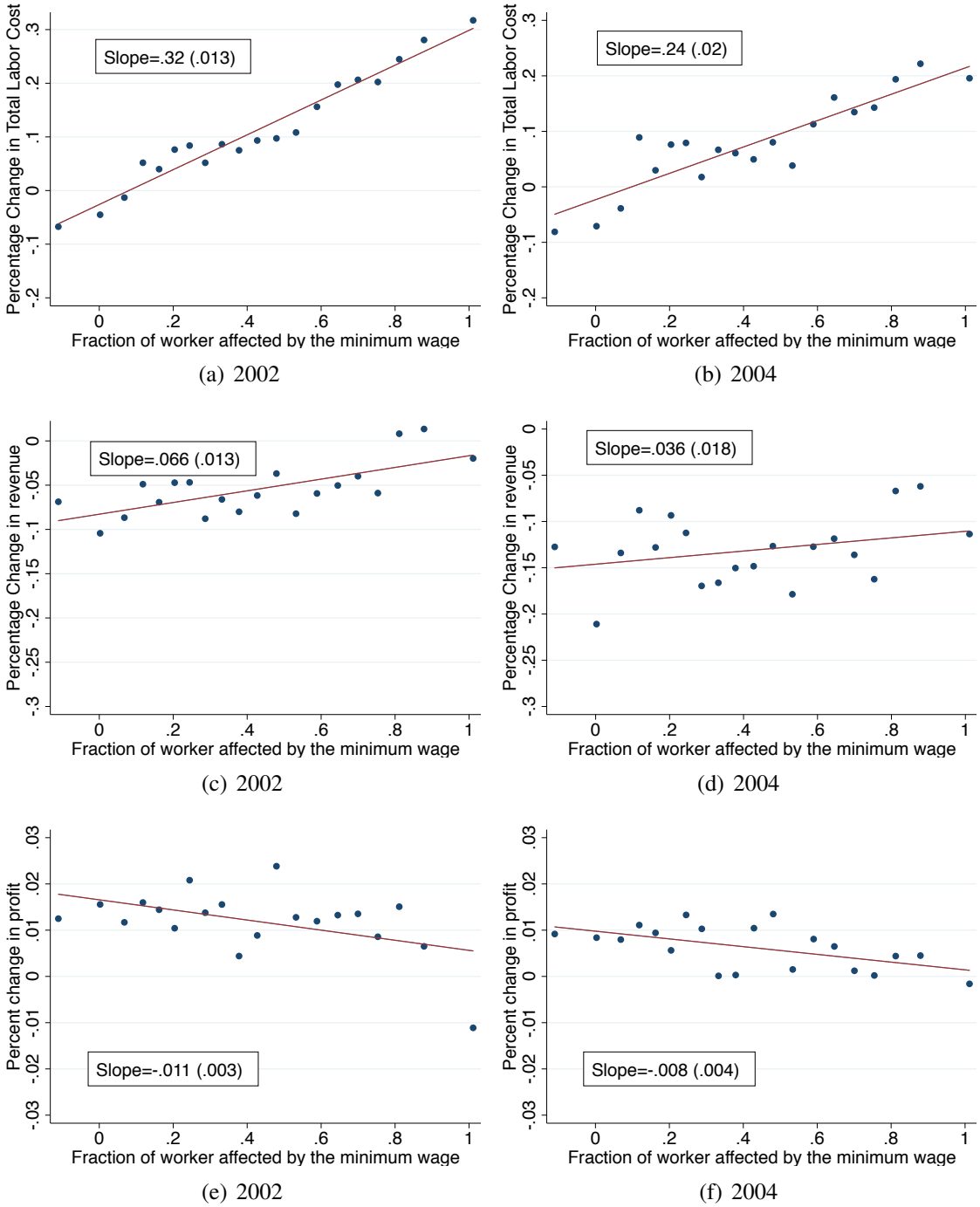
Notes: This figure shows firm-level regressions of percentage change in wage compensation (relative to 2000) on fraction affected by the minimum wage (beta coefficients from equation (1) over time). The red solid line show the effect on wage per worker, the blue dashed line on the social security contribution per worker, while the black dotted line on the non-wage benefits per worker. To make the magnitude of the different outcomes comparable we normalise the changes relative to the total labor cost in 2000. The figure shows the effect of the minimum wage on non-wage benefits was negligible and so we do not find evidence that the increase in wages were offset by cutting non-cash benefits.

Figure A.6: Employment Elasticity in the Literature and in this Paper



Notes: This figure summarizes the estimated employment elasticity with respect to wage and compares it to the previous estimates in the literature. The dashed vertical line shows our preferred estimate for the employment elasticity, which is -0.18. In cases where the standard errors of the labor demand elasticity was not directly reported by the authors we used the delta method to obtain the standard errors (see the details in the Online Appendix Part A.4.).

Figure A.7: Non-parametric relationship between revenue/profit/total labor cost change and fraction affected by the minimum wage



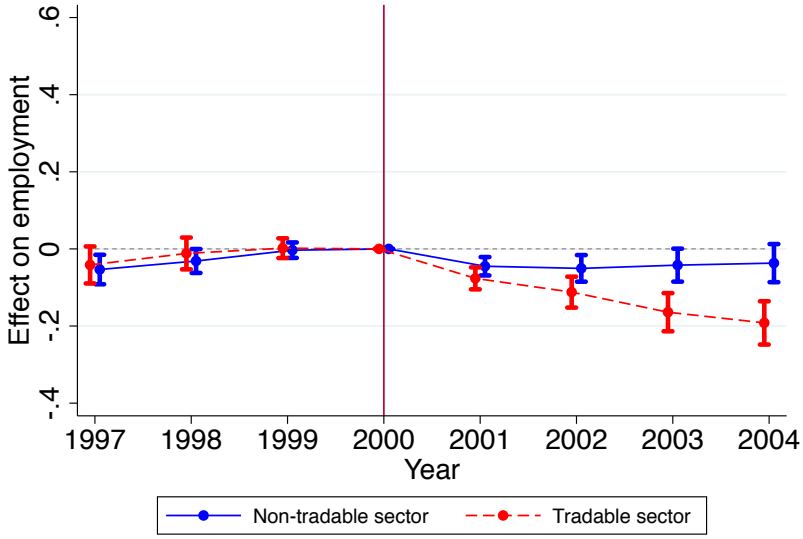
(a) 2002 (b) 2004

(c) 2002 (d) 2004

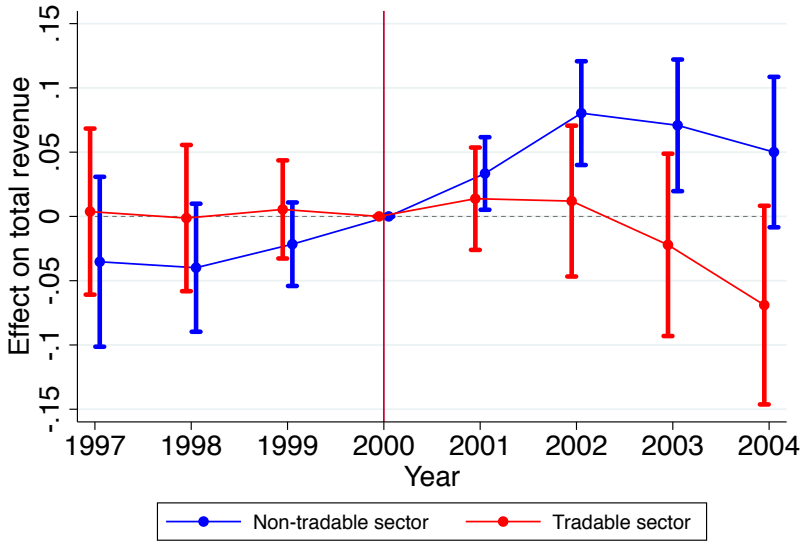
(e) 2002 (f) 2004

Notes: This figure shows the binned scatterplot between fraction affected by the minimum wage and change in total labor cost (Panel (a) and (b)), revenue (panel (c) and (d)) and profits (panel (e) and (f)). Panels (a),(c),(e) show the effect on employment in the short term (changes between 2000 and 2002) while panels (b),(d),(f) show the medium term effects (change between 2000 and 2004). The red line represents the best linear fit, while in the box we report the slope of that line. Controls are included in the regressions.

Figure A.8: Effect on Employment and on Revenue by Tradable and Non-tradable Sectors



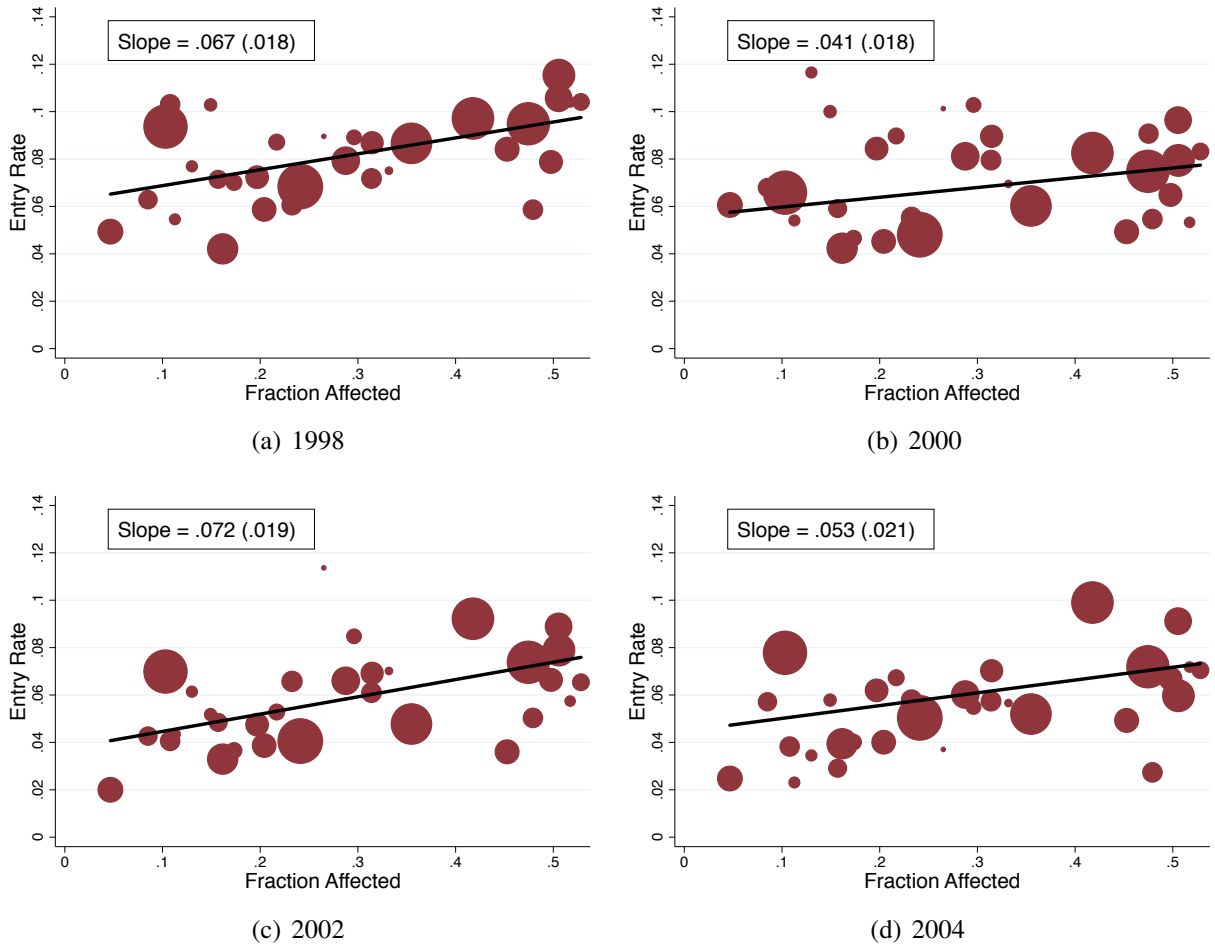
(a) Effect on Employment



(b) Effect on Revenue

Notes: Panel (a) shows the firm-level relationship between fraction affected by the minimum wage and employment changes over time by tradable and non-tradable sectors (we report the beta coefficients with their 95 percent confidence intervals from equation 1). We classify sectors by following the procedure in Mian and Sufi (2010) (see the details in the text). It is clear that disemployment effects are larger in the tradable than in the non-tradable sector. Panel (b) shows the relationship between revenue and exposure to the minimum wage by the tradable and non-tradable sectors. The graph highlights that revenue in the tradable sector drops in response to the minimum wage, while it increases in the non-tradable sectors. Controls are included in the regression.

Figure A.9: Firms Entry and Fraction Affected at the Two-digit Industry Level

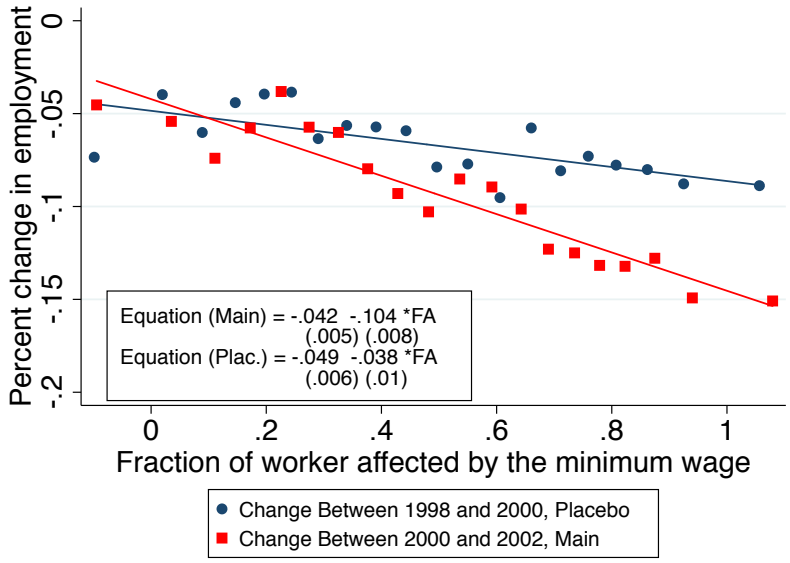


(a) 1998 (b) 2000

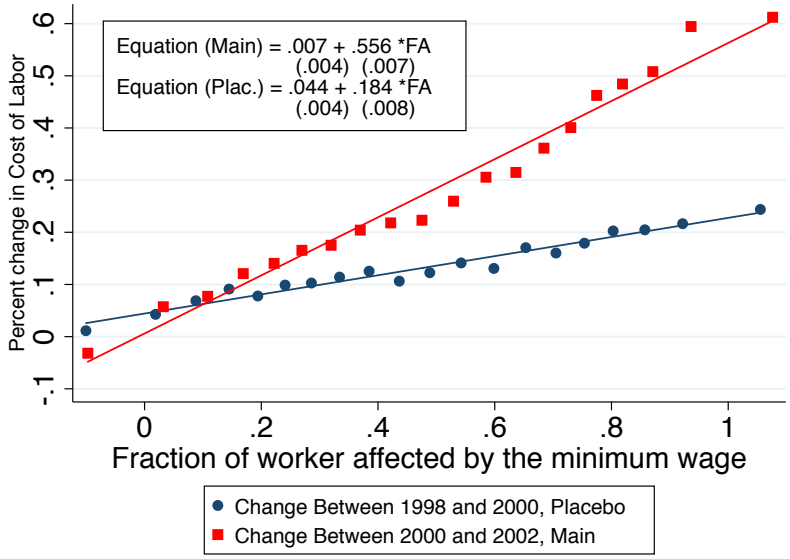
(c) 2002 (d) 2004

Notes: This figure shows the relationship between exposure to the minimum wage and firms entry at two digit industry level in 1998 (panel a), in 2000 (panel b) in 2002 (panel c) and in 2004 (panel d). Each scatterplot relates the entry rate in a two-digit industry to the fraction of affected workers in that sector. In each graph the fitted regression line is the outcome from a corresponding OLS regression weighted by the number if firms in the sector. The regression slope along with the standard errors are indicated in the top left corner.

Figure A.10: Testing for SUTVA, benchmark specification



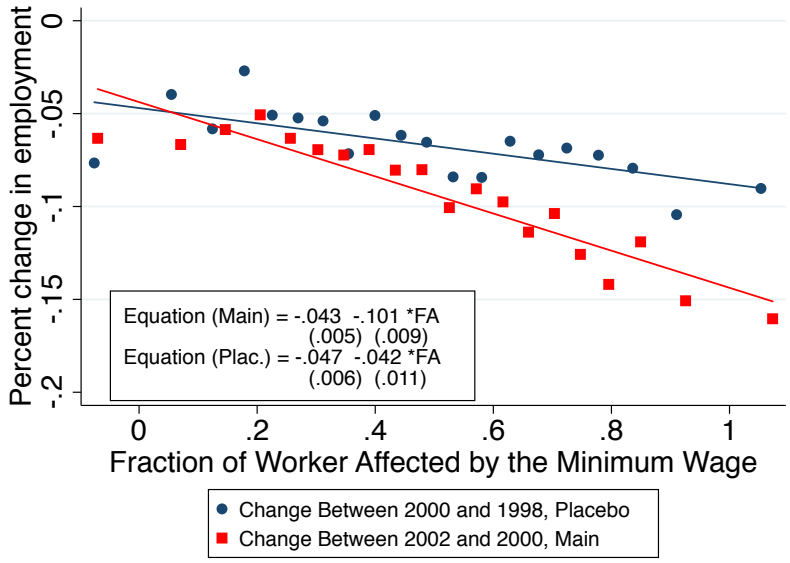
(a) Effect on Employment



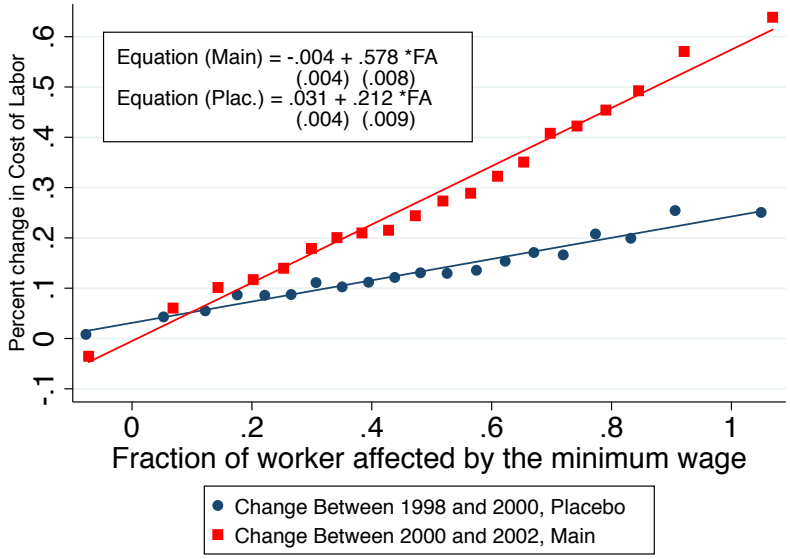
(b) Effect on Average Labor Cost

Notes: Panel (a) shows the non-parametric binscattered relationship between change in employment between 2000 and 2002 and the fraction of workers who earn below the 2002 minimum wage in 2000 (red squares, main sample) and the change in employment between 1998 and 2000 and the fraction of workers who earn below the 2002 minimum wage in 1998 (blue dots, placebo sample). The estimated intercepts and beta coefficients of the linear fits are shown in the bottom left panel. Panel (b) shows the same for the change in cost of labor. The difference between the placebo and the main beta coefficient estimates the employment effect of the minimum wage, while the difference in the intercepts tests for SUTVA. Controls are included in the regressions. Further discussion can be found in the Online Appendix Part A.1.

Figure A.11: Testing for SUTVA (with industry controls)



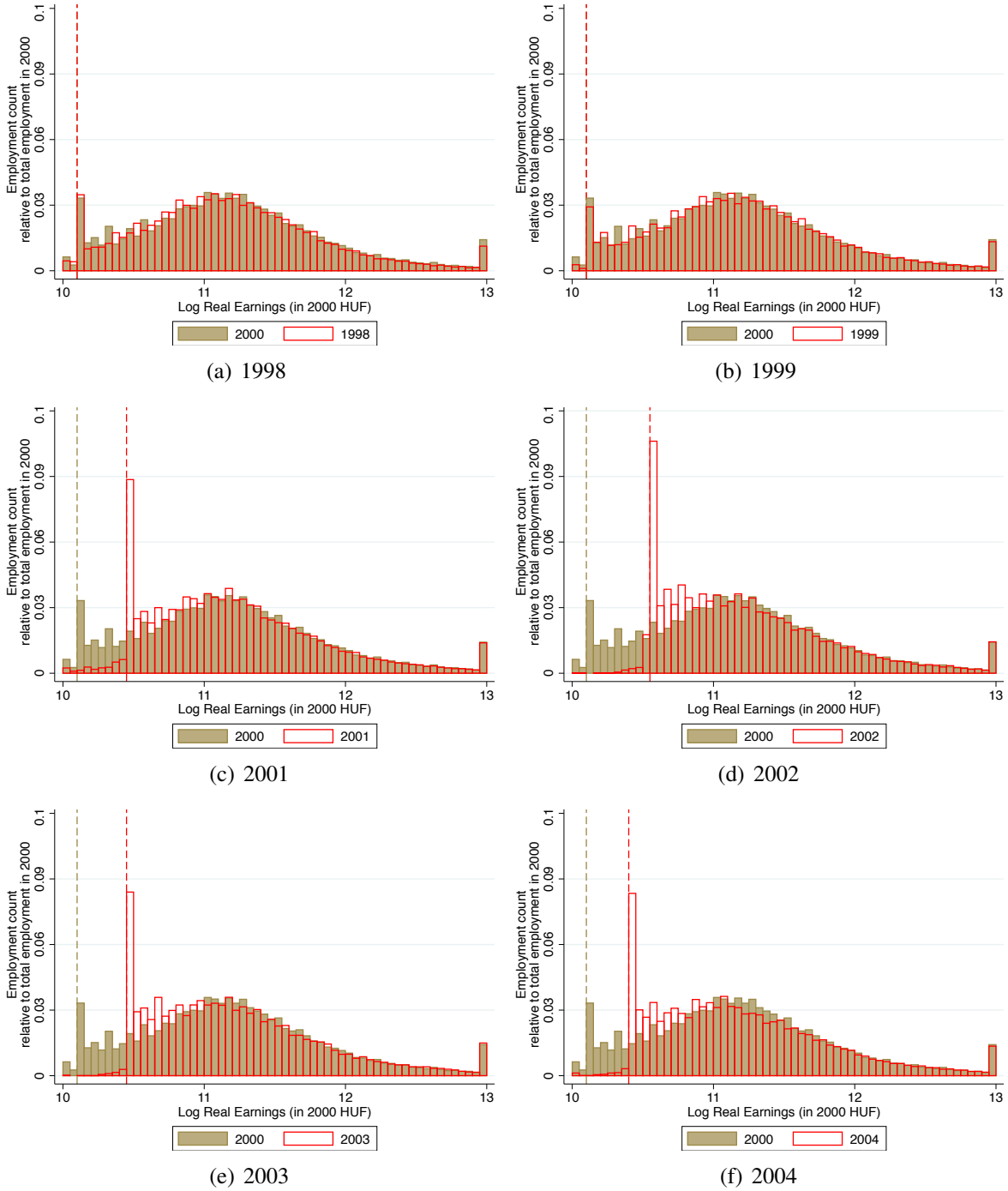
(a) Effect on Employment



(b) Effect on Average Labor Cost

Notes: Panel (a) shows the non-parametric binscattered relationship between change in employment between 2000 and 2002 and the fraction of workers who earn below the 2002 minimum wage in 2000 (red squares, main sample) and the change in employment between 1998 and 2000 and the fraction of workers who earn below the 2002 minimum wage in 1998 (blue dots, placebo sample). The estimated intercepts and beta coefficients of the linear fits are shown in the bottom left panel. Panel (b) shows the same for the change in cost of labor. The difference between the placebo and the main beta coefficient estimates the employment effect of the minimum wage, while the difference in the intercepts tests for SUTVA. Controls and industry dummies are included in the regressions. Further discussion can be found in the Online Appendix Part A.1.

Figure A.12: Evolution of frequency earnings distributions over time



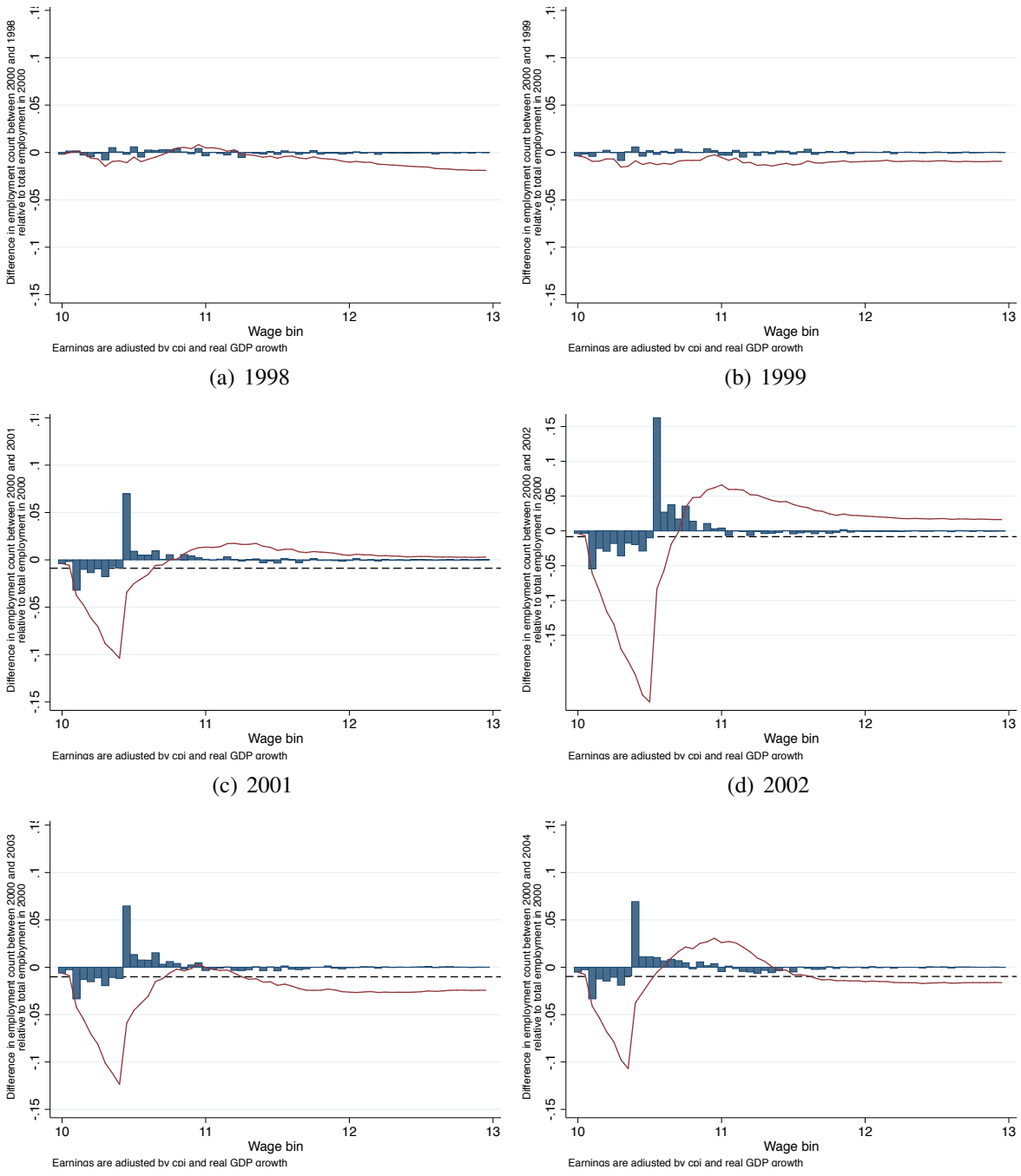
(a) 1998 (b) 1999

(c) 2001 (d) 2002

(e) 2003 (f) 2004

Notes: The figures show the distribution of monthly log earnings over time. Each panel shows the earnings distribution in year t (red outlined bars) compared to 2000 earnings distribution (brown solid bars). We express the number of jobs in terms of year 2000 total employment. The dotted vertical lines (brown in 2000, red in other years) show the bar in where the minimum wage is located in the earnings distribution.

Figure A.13: Evolution of difference between the actual and the year 2000 earnings distribution over time



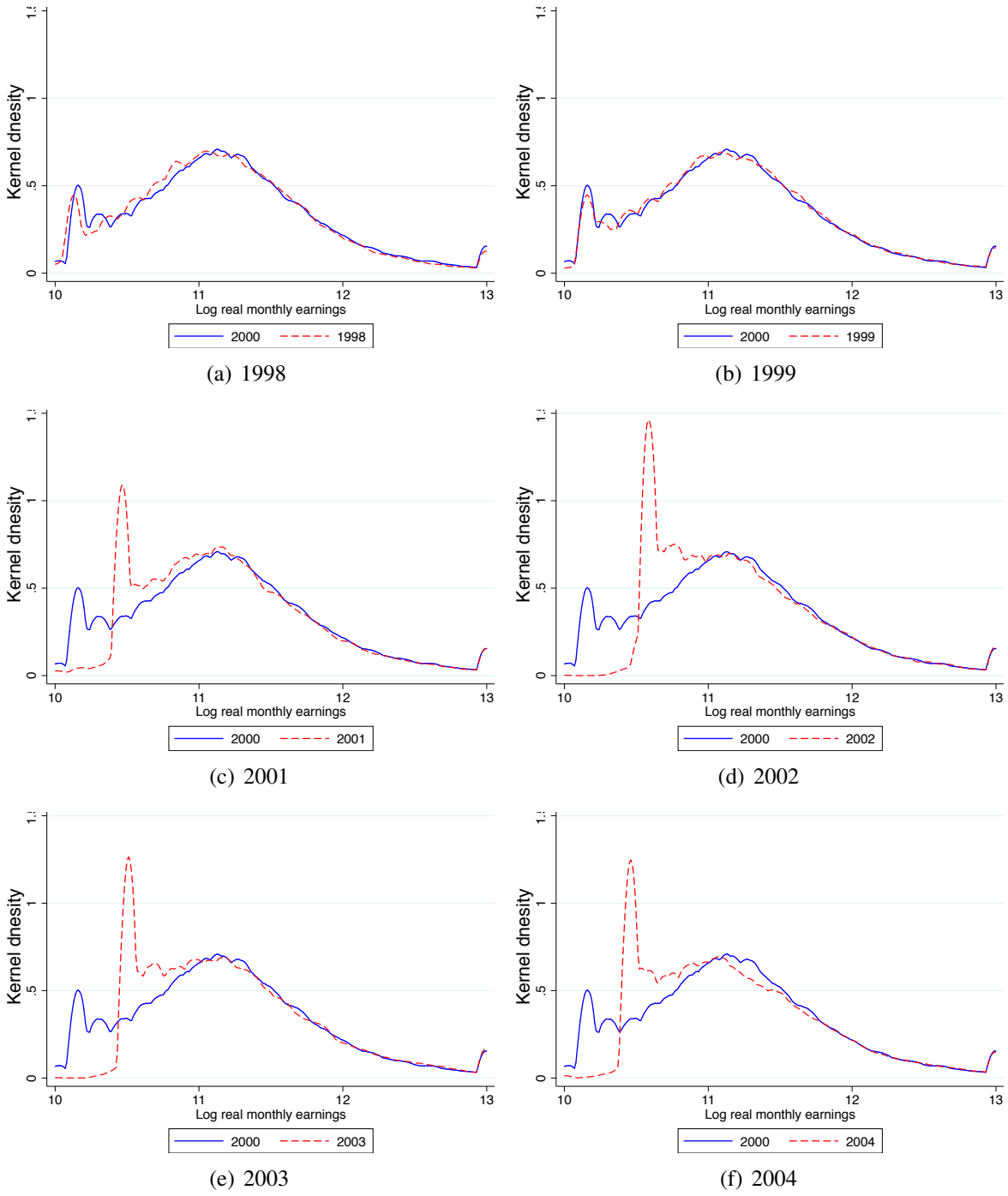
(a) 1998 (b) 1999

(c) 2001 (d) 2002

(e) 2003 (f) 2004

Notes: The figure shows the difference between the year t frequency distribution (red outlined bars in Figure A.12) and the 2000 distribution (brown bars is Figure A.12). We express the number of jobs in terms of year 2000 total employment. In each panel the red solid line shows the running sum of employment changes up to the wage bin it corresponds to. The dashed horizontal lines in the post 2000 panels show the value where 10 percent of the directly affected jobs is destroyed.

Figure A.14: Evolution of kernel densities over time



Notes: The kernel density of monthly log earnings over time are shown between 1998 and 2004 (red dashed line) relative to 2000 (blue line).

A.4 Employment Elasticity with respect to the Wage

In Figure A.6 we compare our estimate on the employment elasticity with respect to the *wage* to the existing evidence in the literature. Notice that this employment elasticity is not the same as the employment elasticity with respect to *the minimum wage*, which is reported in most minimum wage papers. The following table shows the studies published in peer reviewed academic journals where the employment elasticity with respect to the *wage* was reported directly or we were able to calculate it (since both the effect on *wage* and on *employment* is reported).

Reference	Title	Journal	Elasiticty wrt **wage**	Note	Citation as of March, 2017
Addison et al (2010)	The Effect of Minimum Wages on Labour Market Outcomes: County-Level Estimates from the Restaurant-and-Bar Sector	British Journal of Industrial Relations	-0.04 (0.19)	Wage (Table 3 Col 1) Emp (Table 3 Col 2)	45
Allegretto et al. (2011)	Do Minimum Wages Really Reduce Teen Employment? Accounting for Heterogeneity and Selectivity in State Panel Data	Industrial Relations	0.13 (0.16)	Table 3 Column 4	197
Bell (1997), Mexico	The Impact of Minimum Wages in Mexico and Colombia	Journal of Labor Economics	-1.08 (1.42)	Wage (Table 8 Col 5) Emp (Table 8 Col 3)	407
Bell (1997), Colombia	The Impact of Minimum Wages in Mexico and Colombia	Journal of Labor Economics	-0.90 (0.42)	Wage (Table 8 Col 5) Emp (Table 8 Col 6)	407
Burkhauser et al. (2000)	A Reassessment of the New Economics of the Minimum Wage Literature with Monthly Data from the Current Population Survey	Journal of Labor Economics	-0.48 (0.04)	Wage (Table 2 Col 2) Emp (Table 3 Col 3)	256
Campolieti et al. (2006)	Minimum Wage Impacts from a Prespecified Research Design: Canada 1981-1997.	Industrial Relations	-0.55 (0.35)	Table 4 (including prime_age skilled employment rate)	43
Card (1992a)	Using Regional Variation in Wages to Measure the Effects of the Federal Minimum Wage	Industrial and Labor Relations Review	0.33 (0.57)	Table 4, Column 5	560

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Reference	Title	Journal	Elasiticty wrt **wage**	Note	Citation as of March, 2017
Card (1992b)	Do Minimum Wages Reduce Employment? A Case Study of California, 1987-89	Industrial and Labor Relations Review	1.33 (0.49)	Table 4	535
Card et al. (1994)	Comment on David Neumark and William Wascher, 'Employment Effects of Minimum and Subminimum Wages: Panel Data on State Minimum Wage Laws.	Industrial and Labor Relations Review	-0.21 (0.23)	Table 2, Row 2	157
Currie and Fallick (1996)	The Minimum Wage and the Employment of Youth: Evidence from the NLSY	Journal of Human Resources.	-0.86 (0.32)	Wage (Table 4, panel B, Col 2) Emp (Table 2 Col 4)	204
Dube et al (2010)	Minimum Wage Effects Across State Borders: Estimates Using Contiguous Counties	Review of Economics and Statistics	0.08 (0.28)	Table 2, col 6	522
Dube et al (2007)	The Economic Impacts of a Citywide Minimum Wage	Industrial and Labor Relations Review	0.03 (0.06)	Wage (Table 7 Col 1) Emp (Table 2 Col 4)	114
Draca et al. (2011)	Minimum Wages and Firm Profitability	American Economic Journal: Applied Economics	-0.15 (1.46)	Table 5 Col 2	175
Eriksson and Pytlikova (2004) Slovakia	Firm-level Consequences of Large Minimum-wage Increases in the Czech and Slovak Republics	Labour	-0.11 (0.04)	Table 7 Column 3	35
Eriksson and Pytlikova (2004) Czech Republics	Firm-level Consequences of Large Minimum-wage Increases in the Czech and Slovak Republics	Labour	0.19 (0.05)	Table 6 Column 3	35

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Reference	Title	Journal	Elasiticty wrt **wage**	Note	Citation as of March, 2017
Fang and Lin (2015)	Minimum wages and employment in China	IZA Journal of Labor Policy	-0.23 (0.14)	Wage (Table 5 Col 4) Emp (Table 5 Col 4)	52
Giuliano (2013)	Minimum Wage Effects on Employment, Substitution, and the Teenage Labor Supply: Evidence from Personnel Data	Journal of Labor Economics	-0.59 (0.61)	Wage (Table 4 Col 6) Emp (Table 4 Col 6)	56
Hirsch et al (2015)	Minimum Wage Channels of Adjustment	Industrial Relations	0.10 (0.42)	Table 4, Col 7, panel A	83
Kim and Taylor (1995)	The Employment Effect in Retail Trade of California's 1988 Minimum Wage Increase	Journal of Business & Economic Statistics,	-0.88 (0.13)	Table 4	105
Machin et al. (2003)	Where the Minimum Wage Bites Hard: Introduction of Minimum Wage to a Low Wage Sector	Journal of European Economic Association	-0.35 (0.16)	Table 6 Column 7	167
Neumark and Nizalova (2007)	Minimum Wage Effects in the Longer Run	Journal of Human Resources	-0.91 (0.58)	Wage (Table 2 Col 1) Emp (Table 2 Col 2)	85
Pereira (2003)	The impact ofminimum wages on youth employment in Portugal	European Economic Review	-1.18 (0.28)	Wage (Table 1 Col 1) Emp (Table 2 Col 2)	72
Sabia et al (2012)	Are the Effects of Minimum Wage Increases Always Small? New Evidence from a Case Study of New York State	Industrial and Labor Relations Review	-2.13 (1.23)	Wage (Table 2 Col 6) Emp (Table 3 Col 6)	60
Sabia (2008)	The Effects of Minimum Wage Increases on Retail Employment and Hours: New Evidence from Monthly CPS Data	Journal of Labor Research	-0.58 (0.23)	Wage (Table 3 Col 2) Emp (Table 3 Col 5)	39

Where the standard errors of the elasticity are not reported we calculate them using the delta method. To do this we assume that the covariance between the estimated employment effect and the estimated wage effect is zero. In Figure A.6 we report only studies where the standard error on the employment elasticity is less than one.

A.5 Description of the main data sets and the main variables

A.5.1 Corporate Income Tax Data

The Hungarian Corporate Income Tax Data (CIT) covers the universe of firms with double book-keeping. The data contains information on firms' balance sheet and income statements, and so it allows us to assess firms' income and cost structure. Here we list the definitions of our key variables:

Table A.11: Description of the Key Variables

Employment	The average full-time equivalent employment in a calendar year reported by the firm.
Revenue	Total operating revenue including exports. After 2001 reported revenue includes excise taxes. Note that sectors subject to excise taxes are excluded from analysis.
Profit	Operating profit (EBIT): all operating revenues - all operating expenses
Material expenses	Intermediate goods and expenses. It includes cost of goods for resale, cost of raw material and services, and subcontracts.
Labor cost	Sum of all employee's labor costs. This comprises wages, social security contributions. It also includes bonuses, allowances (including travel, housing) and other near cash income.
Wage cost	Sum all wages paid to workers. It includes bonuses, but allowances, social security contributions and near cash income are not part of it
Average cost of labor	Labor cost divided by the employment statistic.
Average Wage	Wage cost divided by the employment statistic.
Value Added:	Value added is calculated in the following way: Profits + Depreciation + Labor cost.
Depreciation expenses	Depreciation is a non-cash expense that represents the declining economic value of an asset. Depreciation is not an actual cash outflow and so depreciation is added back to after tax profit when firm's cash flow is calculated. Depreciation is part of value added.
Miscellaneous items:	This item includes other operating expenses, i.e. losses on bad debts, damages to stocks and inventories, fines and penalties, local taxes and levies, accruals and deferrals.
Capital Stock	Calculated from past real investments using the perpetual inventory method (see the details in Békés and Harasztosi, 2013).We use the investment flows from 1992 (or the year of establishment for firms established later). In the initial period we take the value of fixed assets as investments. In later periods investments is the sum of depreciation and the change in tangible fixed assets. To turn nominal values into real ones, we use sector level investment deflators from Central Statistics Office of Hungary.

A.5.2 Structure of Earnings Survey

The Hungarian Structure of Earnings Survey (SES) is a large annual enterprise survey providing detailed information on worker-level wages, job characteristics and demographic characteristics. The key advantage of the data is that it can be used to calculate both employment and wages. However, the sample covers only firms with at least 10 workers before 2000 and firms with at least 5 workers from 2000 on.

The sample design of the SES is the following. Firms employing 5-20 (10-20 before 2000) workers are randomly selected from the census of enterprises. Individual data are reported on each employee working at these firms as of May 31st in the given year. All firms with more than 20 workers are supposed to report data for the SES. However, in spite of obligatory reporting, some companies do not respond to the survey. The statistical office reports that the non-response rate is around 10 percent for larger firms and 50 percent per cent for the smaller companies. These non-response rates are very similar to the non-response rates for the establishment surveys conducted by the BLS in the U.S (CPAF, 1998). Responding firms report information on a random sample of their workers based on workers' date of birth. Every blue-collar worker born on the 5th or on the 15th day of any month is selected into the sample. For white-collar workers, the 5th, the 15th and the 25th day of any month are used for selecting. Therefore white-collar workers are over-sampled in the SES.

Due to the SES's complex sampling design we weight our observations when we present the distributional evidence in Section 6. Weights are calculated with the following procedure. For large firms, where not all individuals were observed, within-firm weights are calculated based on a blue-collar indicator and a full-time worker indicator. Between-firm weights are calculated based on 1-digit NACE industry codes and 4 firm size categories (11-20, 21-50, 51-300, more than 300) using all double-book keeping firms. To get the individual weights, the within- and between-firms weights are multiplied by each other. Finally, we adjust the weights to follow the aggregate employment trends of firms with more than 20 employees reported by the Hungarian Statistical Office. We decided to use this time-series because this is what the Hungarian Statistical Office has been consistently reporting since 1998.

A.5.3 Construction of the Fraction Affected Variable

The key advantage of the CIT dataset is that it covers the universe of double book-keeping firms, and so we observe the evolution of employment, labor cost, and other balance sheet items for a large part of the private sector. However, the CIT does not record data on individual workers and so it is not possible to directly calculate the fraction of workers affected by the 2002 minimum wage.

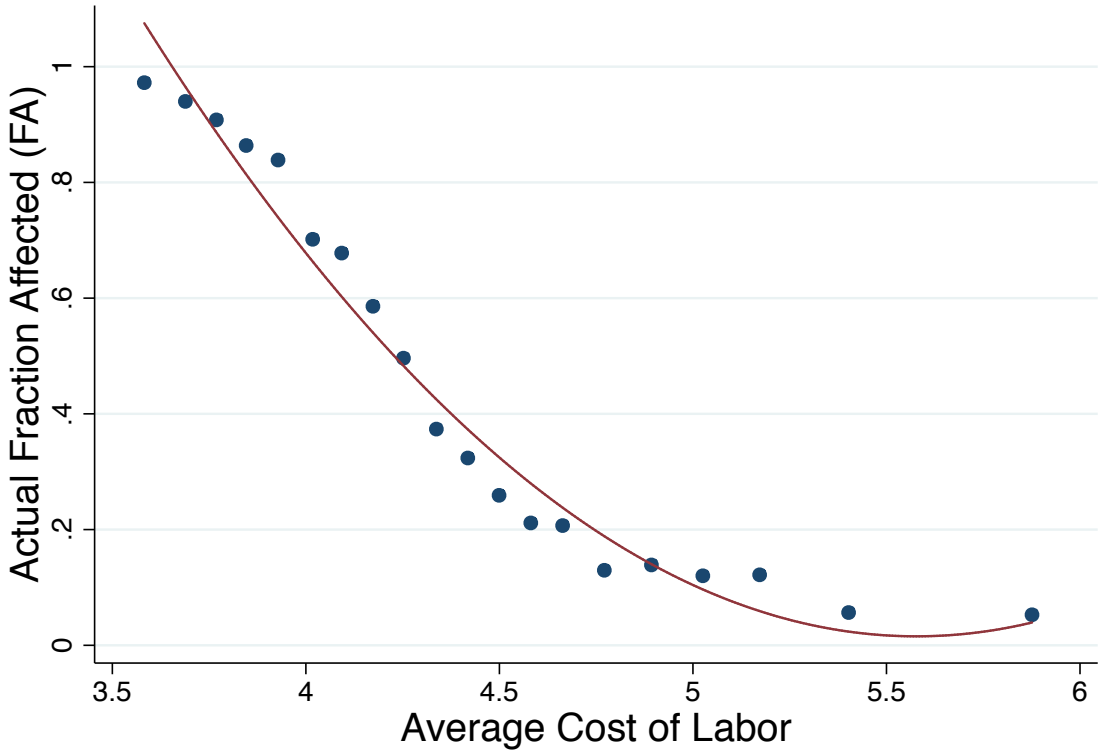
However, we can observe the fraction of affected workers for the subset of firms that are surveyed in the SES. We use this sample to estimate the relationship between the average cost of labor (observed for all firms in the CIT) and the fraction of workers affected (observed in the SES). In particular, we run a tobit regression for the subset of firms where at least 5 employees are observed in the SES data:[43]

[43] We also explored alternative prediction models to equation 8, including estimating equation 8 with an OLS, including higher order terms for average cost of labor, and using control variables besides average cost of labor. The tobit model performed better in terms of R-squared than the one simply estimates using OLS. Moreover, including higher order terms and additional control variables added only a minor improvement to the R-squared. Therefore, we decided to use the more parsimonious model. However, our results are robust to the different prediction models.

$$FA_{it}^{Measured} = \alpha_t + \beta_{1t} AvCostLabor_{it} + \beta_{2t} AvCostLabor_{it}^2 + \varepsilon_{it} \quad (8)$$

where $FA_{it}^{Measured}$ uses the SES data to measure the fraction of workers affected by the 2002 minimum wage increase, while $AvCostLabor_{it}$ uses the CIT data. In each year we adjust $FA_{it}^{Measured}$ and $AvCostLabor_{it}$ by inflation and real GDP growth when we compare it to the 2002 minimum wage. The non-parametric binscattered fit between $FA_{it}^{Measured}$ and $AvCostLabor_{it}$ is shown in the following figure:

Figure A.15: Relationship Between $FA_{it}^{Measured}$ and $AvCostLabor_{it}$ in 2000

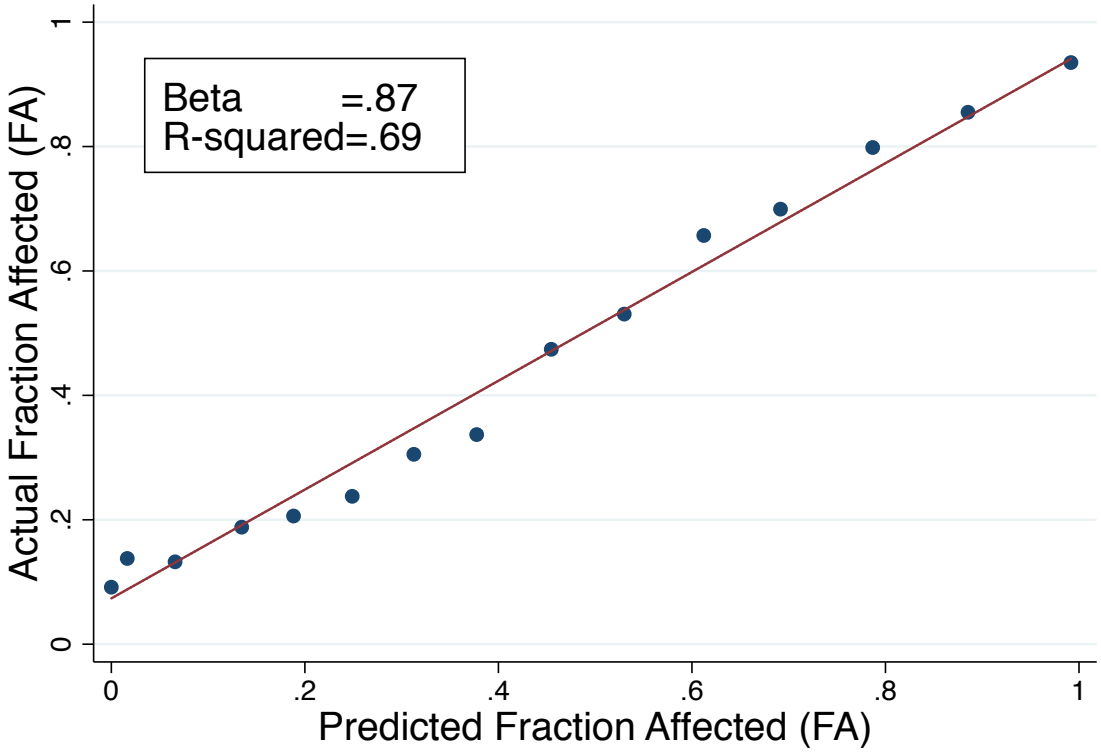


Using the estimated β_{1t} and β_{2t}, we predict $\widehat{FA_{it}}$ for all firms in the CIT data for each year between 1997 and 2000 and cap it between 0 and 1.

$$\widehat{FA_{it}} = min\{0; max\{1; \alpha + \beta_{1t} AvCostLabor_{it} + \beta_{2t} AvCostLabor_{it}^2\}\}$$

The non-parametric binscattered relationship between the measured fraction affected and the predicted one in 2000 is shown in the following figure:

Figure A.16: Relationship Between the Predicted and the Measured Fraction Affected in 2000



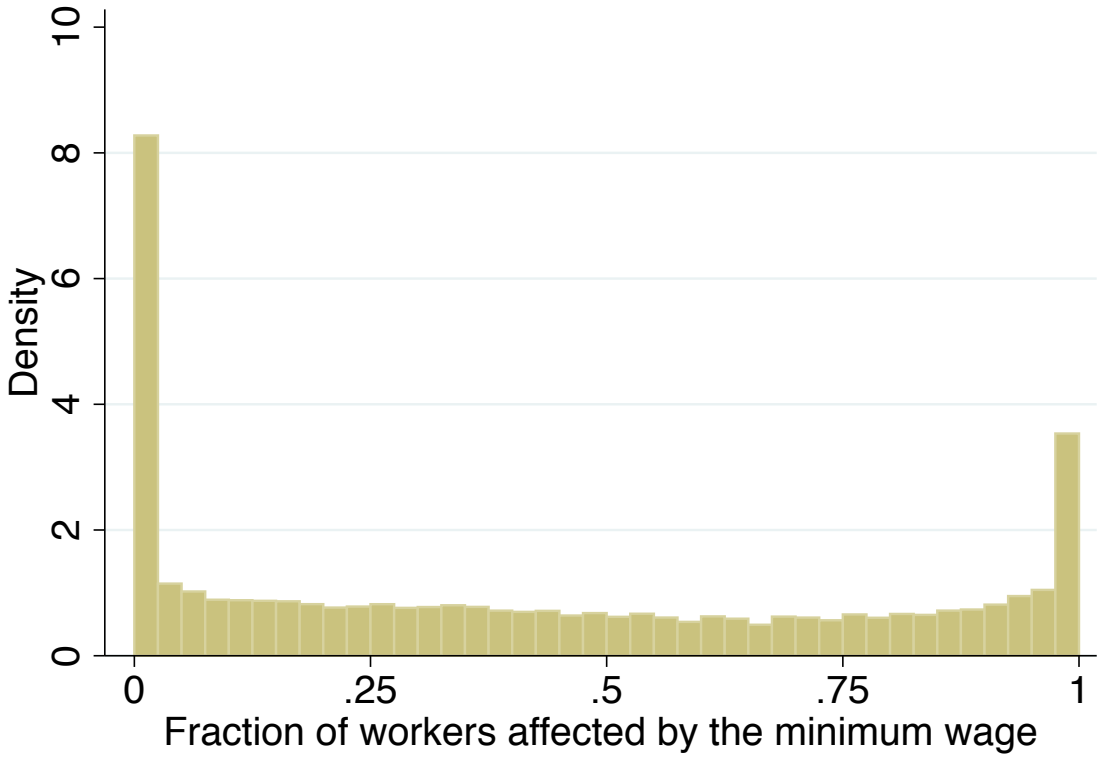
The relationship between the actual and the predicted fraction affected is linear, which suggest that the prediction performs well throughout the distribution of $\widehat{FA_{it}}$. The top-left box in the figure above assesses the accuracy of the prediction model. A perfect match between the actual fraction affected and the predicted fraction affected would yield $R^2 = \beta = 1$. The R^2 is 0.69, which suggests that around 69 percent of the variation in fraction affected can be explained by the prediction model. The β equals 0.87, highlighting that our prediction is biased slightly downward and so our prediction model underestimates the actual exposure to the minimum wage.

Finally, to reduce noise in the measure of fraction of affected workers we take the average between 1997 and 2000. Formally,

$$FA_i = \frac{1}{4} \sum_{t=1997}^{2000} FA_{it}$$

This leads us to the following distribution of the fraction of affected workers:

Figure A.17: The Histogram of Fraction Affected by the Minimum Wage



To assess whether the prediction model causes a bias in our estimates we explore whether using the actual or the predicted fraction affected leads to different estimates. The following table summarizes the estimates on employment and cost of labor for firms where we can calculate both the actual and predicted fraction affected. Here we restrict the analysis to the fraction affected that is based on the 2000 SES data ($\widehat{FA_{i2000}}$).

Table A.12: Results Using Actual vs. Predicted Fraction Affected

	(1)	(2)	(3)	(4)
	Changes between 2000 and 2002		Changes between 2000 and 2004	
	Predicted	Actual	Predicted	Actual
Panel A: Change in Firm-Level Employment				
Predicted Fraction Affected ($\widehat{FA_{i,2000}}$)	-0.137		-0.169	
	(0.022)		(0.031)	
Actual Fraction Affected ($FA_{i,2000}^{Measured}$)		-0.095		-0.139
		(0.020)		(0.028)
Number of Observation	2928	2928	2928	2928
Panel B: Change in Firm-Level Average Cost of Labor				
Predicted Fraction Affected ($\widehat{FA_{i,2000}}$)	0.446		0.403	
	(0.021)		(0.026)	
Actual Fraction Affected ($FA_{i,2000}^{Measured}$)		0.364		0.322
		(0.019)		(0.024)
Number of Observations	2780	2780	2585	2585
Employment Elasticity wrt. cost of labor	-0.30	-0.26	-0.42	-0.43

Note: Standard errors in parentheses.

Panel A shows the employment effects using the actual fraction affected (measured in the SES) and the employment effects using the predicted fraction affected. The employment estimates using the predicted fraction affected (Columns 1 and 3) are larger than for the benchmark specification in Table 2, which comes from the fact that the SES over-sampled larger firms which experienced a larger drop in employment. The differences between the estimates using actual fraction affected in (Columns 1 and 3) and the estimates using predicted fraction affected (in Columns 2 and 4) highlight that the predicted fraction affected leads to higher employment and labor cost estimates than the regressions using the actual figures. The larger estimates are consistent with the fact that the predicted fraction affected understates the actual exposure. However, the differences might simply reflect that the actual fraction affected, which is calculated based on a random sample of workers, is noisier than the predicted fraction affected, which is based on the actual total labor cost. The measurement error in the actual fraction affected variable can potentially induce an attenuation bias in the estimates in Columns 2 and 4.

Nevertheless, the table highlights that the employment elasticity does not depend on whether we use the actual or the predicted fraction affected. This indicates that the bias in the employment and cost of labor estimates cancel each other when we take the ratio and calculate the employment elasticity. It is also worth pointing out that standard errors are very similar in the regression using the

actual and using the predicted fraction affected. This suggests that using predicted fraction affected unlikely to introduce substantial bias in the standard errors.

We also assess whether uncertainty about the prediction model substantially affects the standard errors reported in the main text. We implement a double bootstrap procedure to assess whether the standard errors are over or underestimated:

1. First, we produce 500 bootstrap estimates for the prediction model. We take a random sample with replacement from the Structure of Earnings Survey (SES) and for each sample we estimate the relationship between actual fraction affected and average cost of labor. Using the estimated relationship, we provide a prediction for the fraction affected for all firms. Since the parameters of the prediction model differ slightly for each bootstrap sample, the predicted fraction affected will also differ for each bootstrap sample.

2. Second, using the bootstrap estimates from step 1, we produce a second step bootstrap estimate of the fraction affected on the change in various firm-level outcomes (see equation 1). In this second step we take a random sample with replacement from the 19,485 firms in the benchmark sample and we estimate the relationship between (the bootstrapped) predicted fraction affected and various firm-level outcomes. In each sample we use one of the bootstrap estimates from step 1.

In Table A.13 we compare our benchmark estimates on employment and cost of labor to the bootstrapped estimates. We report "1-step bootstrap" which only bootstraps the samples for the prediction model (step 1), but does not bootstrap the benchmark sample (step 2). These estimates show the error that would be introduced by the imputation procedure if the benchmark regression (with the true FA) were error free. The standard errors around these estimates are extremely low, which highlights that the uncertainty about the prediction model adds very little noise to our estimates.

The "double bootstrap" standard errors in column (3) can be compared to the robust standard errors estimated in the benchmark analysis (column 1). The table shows that the standard errors are identical up to 2 decimal places in all cases. This highlights that the imputation had only a negligible effect on our estimates. Since the double bootstrapping procedure is computationally intensive, we report the robust standard errors throughout the paper.

Table A.13: Standard Errors with Bootstrapped prediction

	(1) Benchmark Estimate	(2) 1-Step Bootstrap	(3) Double Bootstrap
FA on emp in 2002 (Table 2, Column 2, Panel A)	-0.076	-0.076	-0.076
	(0.008)	(0.0006)	(0.009)
FA on emp in 2004 (Table 2, Column 4, Panel A)	-0.100	-0.100	-0.100
	(0.012)	(0.0008)	(0.013)
FA on cost of labor (Table 2, Column 2, Panel C)	0.49	0.49	0.49
	(0.01)	(0.002)	(0.01)
FA on cost of labor in 2004 (Table 2, Column 4, Panel C)	0.43	0.43	0.43
	(0.01)	(0.002)	(0.01)
FA on elasticity in 2002 (Table 2, Column 2, Panel C)	-0.16	-0.16	-0.16
	(0.02)	(0.001)	(0.02)
FA on elasticity in 2004 (Table 2, Column 4, Panel C)	-0.23	-0.23	-0.23
	(0.03)	(0.001)	(0.03)

Note: Standard errors in the parentheses. Robust standard errors estimated in Column (1) and bootstrapped standard errors in Column (2) and (3).

A.5.4 Final Sample Based on Imputed Fraction Affected

The working age population in Hungary is 7.6 million out of which 3.8 million have a job. Of these, around 1 million work in the public sector (public administration, education, healthcare) and 0.7 million are self-employed according to the Hungarian Labor Force Survey. The CIT covers 2.1 million workers who work at around 200,000 firms. Around 1.7 million of these work at the 44,000 firms with at least 5 employees in 2000. When we omit the publicly owned, agricultural and other sectors mentioned above our sample shrinks to 1.3 million workers at 32,000 firms. Our main regression uses firms which existed between 1997 and 2000 and had at least 5 workers on average. The 22,000 firms which satisfy these criteria represent around 1.1 million workers. Finally, the remaining sample restrictions discussed in Section 2.2 lead to our final sample which includes almost 20,000 firms employing 1 million workers.

A.5.5 Annual Survey of Industrial Production

The Hungarian Annual Survey of Industrial Production (ASIP) is an annual firm-level survey of manufacturing firms and contains product-level information on the total volume and value of production. We calculate firm-level Laspeyres price changes, P_{it}^{L}, relative to the previous year, formally,

$$P_{it}^{L} = \frac{\sum_j p_{j,t} s_{j,t-1}}{\sum_j p_{j,t-1} s_{j,t-1}}$$

where j is the product at firm i and $s_{j,t-1}$ the revenue share of the product j from the previous (base) years. This price change can only be calculated for a product j which was present at times t and $t-1$. Therefore, we calculate the revenue share for that subset of goods only and so $\sum_j s_{j,t-1} = 1$. Then we calculate the price change between 2000 and year t using the the following formula (if

$t > 2000$)

$$\triangle P_{it} = \sum_{i=2001}^{t} P_{it}^{L}$$

and if $t < 2000$

$$\triangle P_{it} = \frac{1}{\sum_{i=t}^{2000} P_{it}^{L}}$$

This $\triangle P_{it}$ is used in the regressions shown in Table 4.

A.5.6 Labor Force Survey (LFS)

The Hungarian LFS is a large household sample survey which provides quarterly information on self-reported employment status. While the sample covers all workers (e.g. self-employed and workers at small firms), there is no wage information in the survey. To relate group-level employment status to minimum wage exposure, therefore, we rely on the SES data.

A.5.7 Hungarian Household Budget Survey (HBS)

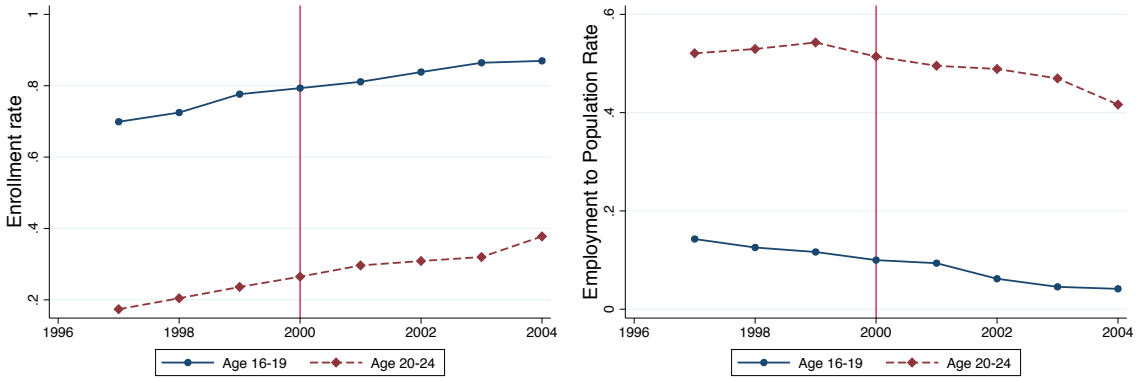
To assess the distributional consequences of the minimum wage in Section 4 of the Appendix we exploit the Hungarian Household Budget Survey. This dataset contains detailed income and consumption measures of broadly 10,000 households per year.

A.6 Institutional Context and Policy Changes

A.6.1 Expansion of Higher Education

Between 1990 and 2001, the number of students in higher education in Hungary increased three-fold, from 101,000 to 298,000 (Farkas 2002). Moreover, the Hungarian government introduced a generous student loan system in 2001 that made access to higher education easier (Berlinger 2009). The following graph shows the enrollment rate (into any education institution) and employment to population rate for the 16-19 and for the 20-24 year olds between 1996 and 2004.

Figure A.18: Enrollment Rate and Employment to Population Between 1996 and 2004



Source: Hungarian Labor Force Survey (2nd quarter from each year)

For both age groups there is a clear upward trend in the enrollment rate, while at the same time there is a downward trend in the employment to population rate. Moreover, given that we do not see a break in these trends around the year 2000, schooling decisions are unlikely to have been affected by the minimum wage hike. The presence of strong pre-trends in the employment rate of the younger population highlights the importance of including group specific trends in the grouping estimator in Online Appendix Part A.2.

A.6.2 Large increase in public sector wages

On September 1, 2002, the newly elected left-wing government executed a sudden and large wage increase in the public sector Telegdy (2018). We exclude the public sector from our analysis and so this change does not have a direct effect on our results. Still, the sudden salary rise in the public sector could potentially influence our estimates indirectly. First, the increase in the purchasing power of the public sector workers could work as a Keynesian stimulus in the economy. However, if the public sector consumption pattern is not tilted towards minimum wage goods our difference-in-difference estimates are not affected by this change. Second, the higher wages in the public sector might push up wages in the private sector as well. Telegdy (2018) estimates that the effect of public sector wage increase had a small effect on private sector wages.

A.6.3 Exemption of the minimum wage from personal income taxes in 2002

In 2002 the newly elected left-wing government decided to exempt the minimum wage from income tax. This policy did not affect the cost of labor, but increased workers' after tax salary. The higher

salary might have attracted more workers and increased the number of workers searching for jobs. To test for this, we report the effect of the minimum wage on the inactivity rate in the following table.

Table A.14: Unemployment Effect of the Minimum Wage, Grouping Estimator

	(1)	(2)	(3)	(4)	(5)
Panel A: Effect on Inactivity Rate					
After 2000 $\times$ FA_g	-0.08**	-0.03	-0.01	-0.01	0.01
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
After 2002 $\times$ FA_g	-0.08**	-0.01	-0.03	-0.01	-0.00
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
After 2000	0.03	0.03	-0.01	-0.00	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
After 2002	0.01	0.01	-0.01	-0.01	-0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
FA_g	-0.34	-0.24	-0.40	-0.26	-0.37
	(0.14)	(0.10)	(0.14)	(0.10)	(0.14)
Time FEs	yes	yes	yes	yes	yes
Demographic-Region FEs	yes	yes	yes	yes	yes
Controls	no	yes	no	yes	yes
Demographic-Region time trend	no	no	yes	yes	yes
Age range	16-60	16-60	16-60	16-60	25-55
Epop in 2000	.76	.76	.76	.76	.8
Number of observation	1792	1792	1792	1792	1008

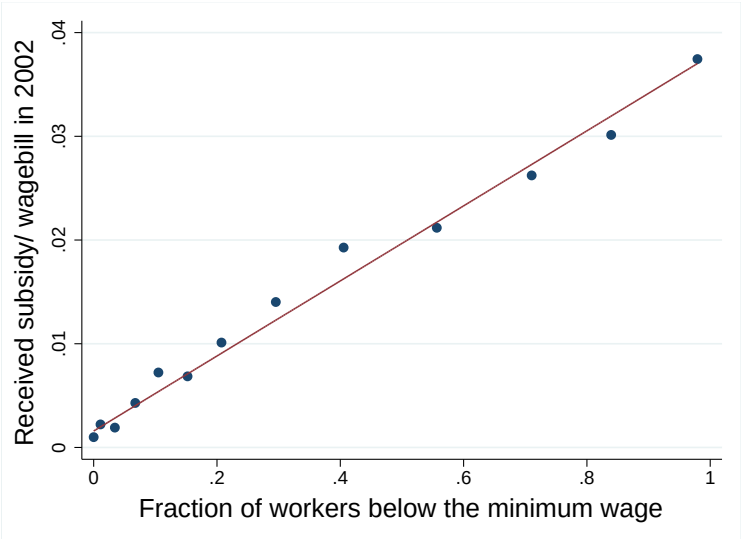
Note: p<0.01, ** p<0.05, * p<0.1. Table shows the group level relationship between group-level exposure to the minimum wage (FA_g) and inactivity rate. Groups are created based on demographics, age, education and the region where the workers live. The coefficient on the variable After 2000 $\times$ FA_g estimates the short term effect of the minimum wage, while the After 2002 $\times$ FA_g estimates the combination of long-term effect and exemption of the minimum wage from income taxes. The regressions are weighted by the number of observations used in calculating FA_g. Clustered standard errors at the group-level are reported in parentheses.

The table shows that apart from the estimates in Column (1) which are likely to be contaminated by the expansion of higher education (see the text for details), there is no relationship between the exposure to the minimum wage and the inactivity rate. This suggests that the exemption of the minimum wage in 2002 did not pull many inactive workers to the labor market.

A.6.4 Small subsidies in 2001 and 2002

The Hungarian government introduced small compensation schemes in 2001 and 2002 to help firms absorb the massive minimum wage shock. Firms needed to apply for the subsidy and the government decided case by case. The 2001 compensation scheme spent 208 million HUF and reached altogether 1099 firms. The average subsidy per firm was 189 thousand HUF, which covered the cost of less than two minimum wage workers. The 2002 scheme reached more than 4000 firms and the average subsidy per firm was 404 thousand HUF (which covered four minimum wage workers). We obtained firm-level data on the amount of subsidy received in 2002 and we merged it to the corporate income tax data. The following figure shows the relationship between exposure to the minimum wage and the size of the subsidy relative to the total wage bill.

Figure A.19: The relationship between the subsidy and exposure to the minimum wage



We draw attention to two features of Figure A.19. First, there is a strong relationship between the size of the subsidy and our measure of exposure to the minimum wage. This suggests that the fraction of affected workers indeed captures the "real" exposure to the minimum wage. Second, the amount of subsidy is very low relative to the effect on wages. As we showed in Panel A of Table 3 the effect of the minimum wage on total labor cost was 33 percent in 2002. If we subtract the 4 percent extra subsidy at highly exposed firms, then the wage bill still increases by 29 percent. This highlights that the size of the subsidy was trivial in comparison to the minimum wage shock.

There was no compensation scheme after 2002. Therefore, our medium term estimates are not contaminated by the subsidies.

A.6.5 Tax Evasion

There are two basic forms of tax evasion in our context: (1) not registering employment and (2) registering employment, but under-reporting actual earnings. These two modes of tax evasion would affect our results differently. If an employed person is not registered then neither she nor her employer pays any taxes or social security contributions. Such undeclared employment is estimated to be 16-17 percent in Hungary (Elek, Scharle, Szabï¿œ, Szabï¿œ, 2009). In response to the minimum wage hike, registered workers might be pushed into the informal sector for cost saving purposes. Our firm-level estimates show the effect of the minimum wage on registered employment, but do not take into consideration that some jobs might be created in the informal sector. Therefore, in the presence of unregistered employment, the firm-level estimates overstatethe total employment losses (informal plus formal).

The other form of tax evasion is when a worker is registered, but receives some of her salary "under the table" (Elek, Kï¿œllő, Reizer, Szabï¿œ, 2011). Firms and workers with under-reported earnings could absorb the minimum wage shock by reporting previously undeclared earnings. While declaring income increases labor costs to some extent, the change in reported wages would overstate the actual wage change. Moreover, this could also explain why the employment responses are relatively small. However, if the main response to the minimum wage is simply reporting, it is not clear why firms would adjust their capital stock or raise their prices. Moreover, under-reporting of wages

is usually associated with over-reporting of other cost items either by reporting personal consumption as company cost items, or by securing additional invoices. This over-reporting helps to reduce tax payments on profits (Mosberger, 2016). If our firm-level results were driven by such a behavior then we would expect the minimum wage to have a negative effect on materials (intermediate goods and services). However, material expenses in the data did not decline in response to the minimum wage.

Throughout the paper we use various data sources which are exposed to tax evasion and reporting issues to different extents. For instance, firms in the corporate income tax data have incentives to lie about their key variables. Therefore, to alleviate these concerns, we exclude the smallest firms (less than 5 employees from the analysis). At the same time, firms and workers have no incentive to lie in the Structure of Earning Survey or in the Labor Force Survey. Finding similar employment responses across different data sources suggests that any effects of tax evasion are likely to have only a limited effect on our results.

Finally, it is worth discussing two recent papers that examine the effect of tax evasion in the minimum wage context in Hungary. Using the Household Budget Survey, Tonin (2011) shows that households who appeared to benefit from the 2001 minimum wage hike actually experienced a drop in their food consumption. Tonin (2011) explains this finding by arguing that the main effect of minimum wage hike was reporting previously undeclared income, which lead to a fall in after-tax income. However, the drop in non-durable consumption might simply reflect a change in the consumption pattern. For instance, if households buy expensive durable goods (e.g. a vehicle) as a result of the upward shift in their income trajectory then food consumption could fall even in the absence of any tax evasion (see Aaronson, Agarwal, French, 2012 for recent evidence on that). Moreover, the sample used by Tonin (2011) is not comparable to our sample. Tonin (2011) uses all workers (including self-employed and those working at micro enterprises) who moved from the old to the new minimum wage. However, in our data (SES) we have very few of those workers as the spike at the minimum wage is small in 2000 (see Figure 7). Therefore, the results reported by Tonin (2011) are unlikely to hold in our sample where we exclude self-employed and micro enterprises.

Another important study is Elek, Kï¿œllő, Reizer, Szabï¿œ (2011) which identifies cheaters and non-cheaters by estimating a structural double hurdle model using data from 2006. Elek, Kï¿œllő, Reizer, Szabï¿œ (2011) exploit a policy change that increased incentives to report true wages and show that their structural model performs well in identifying workers with under-reported earnings. Unfortunately, we cannot directly assess the relevance of Elek, Kï¿œllő, Reizer, Szabï¿œ (2011), since their structural model did not converge in year 2000. The main reason why their model fails in our context is the lack of a (substantive) spike in the 2000 minimum wage distribution (see Figure 7 in the paper). Their model predicts that in the presence of substantial tax evasion a large fraction of workers should earn exactly at the minimum wage. However, in the data we find only a small spike in 2000 (see Figure 7 in the paper).

Our employment results are only affected by tax evasion if cheaters and non-cheaters responded differently to the minimum wage. However, if this was the case, we would expect that the composition of workers at the bottom of the wage distribution would change. The share of high skilled workers (who are more likely to have cheated, conditional on reporting low earnings) would increase. However, we do not find evidence that the composition at the bottom of the wage distribution changed in response to the minimum wage.

A.7 Derivations for the "Hicks-Marshall Style" Analysis

We derive here the key empirical moments shown in Section 5. First we derive the output demand elasticity given consumer preferences. Then we show that consumer preferences imply that firms set a constant mark-up. As a result, the key steps in deriving the Hicks-Marshall rule of derived demand holds. To prove that we follow the steps in Hamermesh (1993).

A.7.1 Consumer's decision

We consider a demand function for a market where firms sell differentiated goods. Consumers buy goods produced by this market and they also spend their money on other goods X. The consumers' preferences are determined by the following nested CES function.

$$U = \left(a \left[\left(\int_0^1 q(\omega)^{\frac{\kappa-1}{\kappa}} d\omega \right)^{\frac{\kappa}{\kappa-1}} \right]^{\frac{\theta-1}{\theta}} + (1-a) X^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}}$$

where $q(\omega)$ is the consumption of variety ω, and X is the spending on other goods. Denote $Q = \left(\int_0^1 q(\omega)^{\frac{\kappa-1}{\kappa}} d\omega \right)$. The consumers face the following budget constraint:

$$\int_0^1 p(\omega) q(\omega) d\omega + X = I$$

where I is income and X is chosen as a numeraire.

It is relatively straightforward to derive the demand for variety ω. The consumer's constrained optimization problem can be solved by the Lagrangian

$$\mathscr{L} = \left(a \left[\left(\int_0^1 q(\omega)^{\frac{\kappa-1}{\kappa}} d\omega \right)^{\frac{\kappa}{\kappa-1}} \right]^{\frac{\theta-1}{\theta}} + (1-a) X^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} - \lambda \left[\int_0^1 p(\omega) q(\omega) d\omega + X - I \right]$$

Take the FOCs:

$$\frac{\partial L}{\partial q(\omega)} = \left(a \left(Q^{\frac{\kappa}{\kappa-1}} \right)^{\frac{\theta-1}{\theta}} + (1-a) X^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}-1} a \left(Q^{\frac{\kappa}{\kappa-1}} \right)^{\frac{\theta-1}{\theta}-1} Q^{\frac{\kappa}{\kappa-1}-1} q(w)^{\frac{\kappa-1}{\kappa}-1} - \lambda p(\omega) = 0 \tag{9}$$

$$\frac{\partial L}{\partial X} = \left(a \left(Q^{\frac{\kappa}{\kappa-1}} \right)^{\frac{\theta-1}{\theta}} + (1-a) X^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}-1} (1-a) X^{\frac{\theta-1}{\theta}-1} - \lambda = 0 \tag{10}$$

Taking the ratio of equation 9 for two varieties ω_1 and ω_2 yields relative demand:

$$\frac{q(\omega_1)^{-\frac{1}{\kappa}}}{q(\omega_2)^{-\frac{1}{\kappa}}} = \frac{p(\omega_1)}{p(\omega_2)}$$

which can be rearranged to

$$q(\omega_1) = \left(\frac{p(\omega_1)}{p(\omega_2)} \right)^{-\kappa} q(\omega_2)$$

Multiplying both sides by $p(\omega_1)$ and taking the integral with respect to $p(\omega_1)$:

$$\int_0^1 p(\omega_1)q(\omega_1)d\omega_1 = p(\omega_2)^{\kappa}q(\omega_2)\int_0^1 p(\omega_1)^{1-\kappa}d\omega_1$$

The left-hand side is consumers' total expenditure on all varieties – the consumers' income minus spending on X.

$$q(\omega_2) = (I-X)\frac{p(\omega_2)^{-\kappa}}{\int_0^1 p(\omega_1)^{1-\kappa}d\omega_1} = (I-X)P^{\kappa-1}p(\omega_2)^{-\kappa}$$

where we denote $P = \left(\int_0^1 p(\omega_2)^{1-\kappa}dw_2\right)^{\frac{1}{1-\kappa}}$.

Using the optimal $q(\omega_2)$ one can easily express $Q^{\frac{\kappa}{\kappa-1}}$:

$$Q^{\frac{\kappa}{\kappa-1}} = \left(\int_0^1 \left[(I-X)\frac{p(\omega_2)^{-\kappa}}{\int_0^1 p(\omega_1)^{1-\kappa}d\omega_1}\right]^{\frac{\kappa-1}{\kappa}} d\omega_2\right)^{\frac{\kappa}{\kappa-1}} = (I-X)\left(\int_0^1 p(\omega_2)^{1-\kappa}\right)^{-\frac{1}{1-\kappa}}$$

Denote $P = \left(\int_0^1 p(\omega_2)^{1-\kappa}dw_2\right)^{\frac{1}{1-\kappa}}$ the composite price index for the market-level production of Q and then $Q^{\frac{\kappa}{\kappa-1}} = (I-X)P^{-1}$.

Now we calculate the optimal X using equation 10 and 9:

$$a\left(Q^{\frac{\kappa}{\kappa-1}}\right)^{\frac{\theta-1}{\theta}-1}Q^{\frac{\kappa}{\kappa-1}-1}q(\omega) = (1-a)X^{\frac{\theta-1}{\theta}-1}p(\omega)$$

Multiplying both sides by $q(\omega)$ and taking the integral between 0 and 1 leads to the following expression:

$$a\left(Q^{\frac{\kappa}{\kappa-1}}\right)^{\frac{\theta-1}{\theta}} = (1-a)X^{\frac{\theta-1}{\theta}-1}\int_0^1 p(\omega)q(\omega)d\omega$$

We solve for X by plugging into this expression $Q^{\frac{\kappa}{\kappa-1}} = (I-X)P^{-1}$ and using that $\int_0^1 p(\omega)q(\omega)d\omega = I-X$ gives

$$X = \frac{\left(\frac{1-a}{a}\right)^{\theta}P^{\theta-1}}{1+\left(\frac{1-a}{a}\right)^{\theta}P^{\theta-1}}I$$

and

$$I-X = \frac{1}{1+\left(\frac{1-a}{a}\right)^{\theta}P^{\theta-1}}I$$

Therefore the firm level demand for good $q(\omega)$ is given by the following expression:

$$q(\omega_2) = I\frac{1}{1+\left(\frac{1-a}{a}\right)^{\theta}P^{\theta-1}}P^{1-\kappa}p(\omega_2)^{-\kappa}$$

Define $h(q(\omega_2)) \equiv \left(I \frac{1}{1+\left(\frac{1-a}{a}\right)^{\theta} P^{\theta-1}} P^{\kappa-1} \right)^{\frac{1}{\kappa}} q(\omega_2)^{-\frac{1}{\kappa}}$. This equation also implies

$$\frac{\partial \log p(\omega_2)}{\partial \log q(\omega_2)} = -\frac{1}{\kappa}$$

Define $q(p(\omega_2)) \equiv I \frac{1}{1+\left(\frac{1-a}{a}\right)^{\theta} P^{\theta-1}} P^{\kappa-1} p(\omega_2)^{-\kappa}$. This equation implies that the elasticity of demand with respect to its own price change is

$$\frac{\partial \log q(\omega)}{\partial \log p(\omega)} = -\kappa \tag{11}$$

The percentage demand change in response to a market-level price change:

$$\frac{\partial \log q(\omega)}{\partial \log P} = -1 - \frac{\left(\frac{1-a}{a}\right)^{\theta} (\theta-1) P^{\theta-1}}{1+\left(\frac{1-a}{a}\right)^{\theta} P^{\theta-1}} \tag{12}$$

A.7.2 Firms' problem

Firms producing variety ω maximize the following objective function

$$\text{Max } p(q(\omega),\omega)q(\omega) - C(w,r,p_m,q(\omega))$$

If the production function has constant returns to scale then $C(w,r,p_m,q(\omega)) = c(w,r,p_m)q(\omega)$. The first order condition of this problem is:

$$p_q(\omega)q(\omega) + p(\omega) - c(w,r,p_m) = 0$$

$$\left(\frac{p_q(\omega)q(\omega)}{p(\omega)} + 1 \right) p(\omega) - c(w,r,p_m) = 0$$

In the previous section we derived that $\frac{p_q(\omega)q(\omega)}{p(\omega)} = -\kappa = \mu$ and so

$$p(\omega) = \frac{c(w,r,p_m)}{1+\mu}. \tag{13}$$

Notice that the optimally set prices only depend on the mark-up, μ, and the input prices (wage, interest rate, price of materials). As long as these variables are constant, the price set by the firms remains the same. This implies that when the minimum wage is raised, the prices for firms without minimum wage workers will remain the same.[44] And, in particular, the price charged by a minimum wage firm producing variety ω is given by

$$p(\omega) = \frac{c(MW,r,p_m)}{1+\mu}.$$

[44]Remember that we are in a partial equilibrium framework and so we treat the wages of the high-skilled workers, interest rates and the price of materials as fixed. In a general equilibrium framework, these prices can also change and may be affected by the minimum wage. In that case, the all firms may change their prices.

What is the effect of changing the minimum wage on prices charged by minimum wage firms? First we take the logarithm and the derivative with respect to wage MW:

$$\frac{\partial \log p(\omega)}{\partial MW} = \frac{\partial \log c(MW, r, p_m)}{\partial MW} - \frac{\partial \log(1+\mu)}{\partial MW}$$

Given that mark-up $\mu = -\kappa$ is constant, $\frac{\partial \log(1+\mu)}{\partial MW} = 0$ and this expression simplifies to

$$\frac{\partial \log p(\omega)}{\partial MW} = \frac{c_{MW}}{c}$$

using Shephard's lemma ($l = c_w q$) this expression leads to the price equation in Section 6.

$$\frac{\partial \log p(\omega)}{\partial \log MW} = \frac{MW \times l}{c q^l(\omega)} = \frac{MW \times l}{C} \equiv s_L$$

where s_L is the share of labor cost in total cost of minimum wage firms.

Based on this it is relatively straightforward to derive the effect on total revenue (pq):

$$\frac{\partial \log p(\omega) q(\omega)}{\partial \log MW} = \frac{\partial \log p(\omega) q(\omega)}{\partial \log MW} + \frac{\partial \log q(\omega)}{\partial \log p(\omega)} \frac{\partial \log p(\omega)}{\partial \log MW}$$

which leads to equation 4 in the paper:

$$\frac{\partial \log p(\omega) q(\omega)}{\partial \log MW} = s_L - \eta s_L$$

where we denote $\frac{\partial \log q(\omega)}{\partial \log p(\omega)} \equiv -\eta$. As we showed in the previous section, the effect of the price on output depends on the extent to which other prices move as a result of the minimum wage change. If only one firm employs minimum wage workers, then that firm will face demand elasticity $\eta = \kappa$. However, if all firms are using minimum wage workers, every firm raises prices by s_L and so the relevant demand elasticity is determined by equation 12.

Now we turn to deriving the effect of the wage change on the optimal choice of labor for a minimum wage firm producing variety ω. Taking the logarithm of Shephards' lemma ($l = c_w q$) and the derivative with respect to w leads us to the following equation:

$$\frac{\partial \log l(\omega)}{\partial MW} = \frac{c_{ww}}{c_w} + \frac{\partial \log q(\omega)}{\partial MW} \tag{14}$$

Using that $MW \frac{\partial \log q(\omega)}{\partial MW} = \frac{\partial \log q(\omega)}{\partial \log p(\omega)} \frac{\partial \log p(\omega)}{\partial MW} MW = -\eta s_L$, gives

$$\frac{\partial \log l(\omega)}{\partial \log MW} = MW \frac{c_{ww}}{c_w} - \eta s_L. \tag{15}$$

Now we express $MW \frac{c_{ww}}{c_w}$ in terms of the Allen partial elasticity of substitution. The Allen partial elasticity between two inputs has the following form by definition:

$$\sigma_{ij} = \frac{CC_{ij}}{C_i C_j} = \frac{cc_{ij}}{c_i c_j}$$

Moreover, the cost function, $qc(w, r, p_m) = wl + rk + p_m m$, and Shephard's lemma imply that

$$c(MW, r, p_m) = MW c_w + r c_r + p_m c_{p_m}$$

Taking the derivative with respect to the wage leads to

$$0 = MW c_{ww} + r c_{rw} + p_m c_{p_m w}$$

which can be rearranged to

$$MW c_{ww} = -\frac{r c_r}{c}\frac{c c_{rw}}{c_w c_r} - \frac{c_{p_m} p_m}{c}\frac{c c_{p_m w}}{c_w c_{p_m}}$$

By Shephard's lemma:

$$MW \frac{c_{ww}}{c_w} = -\frac{r c_r}{c}\frac{c c_{rw}}{c_w c_r} - \frac{c_{p_m} p_m}{c}\frac{c c_{p_m w}}{c_w c_{p_m}}$$

and so using the definition of the Allen Partial elasticity we can express:

$$MW \frac{c_{ww}}{c_w} = -s_K \sigma_{KL} - s_M \sigma_{ML}$$

where $s_l = \frac{rk}{qc} = \frac{rk}{C}$ is the share of labor in total cost in minimum wage firms and $s_m = \frac{mp_m}{qc} = \frac{mp_m}{C}$ is the share of material expenses in total cost in minimum wage firms. Plugging this expression on $MW \frac{c_{ww}}{c_w}$ into equation 15 leads to equation 3 in the paper:

$$\frac{\partial \log l(\omega)}{\partial \log MW} = -s_K \sigma_{KL} - s_M \sigma_{ML} - \eta s_L.$$

Now we show the effect of the wage change on optimal capital choice in minimum wage firms (the derivation for materials follow similar steps). We start from Shephard's lemma ($k = c_r q$) and take the logarithm and the derivative with respect to w.

$$\frac{\partial \log k(\omega)}{\partial Mw} = \frac{\partial \log c_r}{\partial MW} + \frac{\partial \log q}{\partial MW}.$$

Using again that $MW \frac{\partial \log q}{\partial MW} = \frac{\partial \log q(\omega)}{\partial \log p(\omega)} \frac{\partial \log p(\omega)}{\partial MW} MW = -\eta s_L$ this equation can be rearranged to

$$\frac{\partial \log k(\omega)}{\partial \log MW} = MW \frac{c_{rw}}{c_r} - \eta s_L.$$

Using that the Allen partial elasticity between capital and labor is $\sigma_{kl} = \frac{c c_{rw}}{c_r c_w}$ this can be rewritten to

$$\frac{\partial \log k(\omega)}{\partial \log MW} = \frac{MW c_w}{c}\frac{c c_{rw}}{c_r c_w} - \eta s_L.$$

and using Shephard's lemma again ($k = c_r q$) we get equation 5 in the paper:

$$\frac{\partial \log k(\omega)}{\partial \log MW} = s_L \sigma_{KL} - \eta s_L.$$

A.8 Who Buys the Goods Produced by the Minimum Wage Workers?

We follow MaCurdy (2015) to assess who buys the goods produced by the minimum wage workers. Similarly to MaCurdy (2015) we make three crucial assumptions:

1. consumers do not reduce consumption as prices rise;
2. all increased labor costs are passed onto consumers as higher prices; and
3. low-wage workers remain employed at the same number of hours after the minimum wage increases.

Our results show that these assumptions hold approximately, since we have shown that (1) consumer demand is very inelastic (see Table 6); (2) revenue (see Table 3) and prices (see Table 4) increased in response to the minimum wage; and (3) the disemployment effect of the minimum wage is limited (see Table 2 and Table A.10).[45]

Under these assumptions, the effect of the minimum wage on consumers can be assessed in the following steps (see MaCurdy, 2015 for details):

1. We begin by determining the industries that employ low-wage workers. From the Hungarian Structure of Earning Survey we calculate the share of workers who earn below the 2002 minimum wage in total production, sh_s^{MW}, at the industry-level. To obtain sh_s^{MW} we divide the wage bill of the directly affected workers by the total wage bill in that industry. Then we muliply that measure by 2/3, the share of labor in value added (with the remaining 1/3 of expenses related to capital). The obtained measure estimates the minimum wage content in the industry-level value added.

2. The next step is to translate the value-added exposure to the total exposure by taking the minimum wage content of the intermediate goods into consideration. Using Hungarian Input-Output tables from 2000, we construct matrix B, where the (i,j) element represents the share of commodity j produced by industry i, and matrix U, where the (i,j) element represents the proportion of commodity i's output used by industry j. Then we calculate the total exposure as $(I-BU)^{-1}B \cdot sh_s^{MW}$. Table A.15 shows the share of affected workers in production, the direct exposure to the minimum wage $B \cdot sh_s^{MW}$, and the total exposure to the minimum wage.

3. We take the Household Budget Survey and match each product to a particular industry. Then, for each individual, we calculate spending on goods produced in each industry. The minimum wage content of total consumption measures the spending weighted total exposure for each individual. Figure 5 shows the non-parametric relationship between household income and the minimum wage content of the consumption bundle. The figure highlights that poorer households spend slightly more of their income on goods produced by minimum wage workers than richer households.

It is worth highlighting that MaCurdy (2015) in Step 2 also takes into account that some of the final goods are used for producing capital and not spent on final consumption. As a result, capital also

[45] We have not shown the effect on hours here. In the SES data we see hours worked and most people in the data work 40 hours per week. We do not find evidence that group-level exposure to the minimum wage is related to changes in average hours after the reform. This suggests that responses at that margin were likely to be limited.

has some minimum wage content and so the cost of capital might also be affected by the minimum wage. To address the effect of this channel he uses detailed capital flow tables. Unfortunately, no comparable table exists for Hungary and so we had to skip that step.

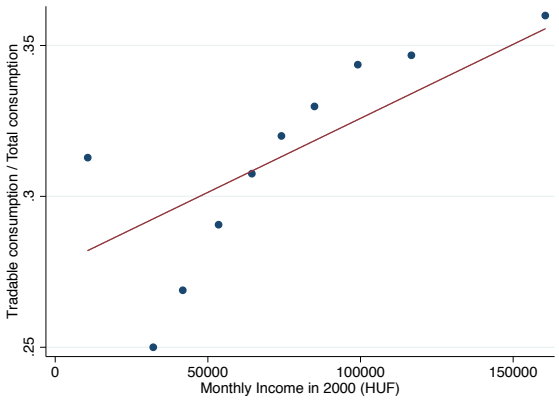
MaCurdy's (2015) procedure assumes that the effect of the minimum wage on consumer prices is the same across all sectors. However, it is possible that the firm-level price changes in the tradable sector affect consumers less than the firm-level price changes in the non-tradable sectors. This might be because in the tradable sectors consumers can substitute easily the goods hit by the minimum wage hike to cheaper ones that were not hit by the minimum wage (e.g. by importing goods from other countries). To explore the potential effect of this on our results, first we examine whether spending on tradable and non-tradable goods are related to household income. Figure A.20 highlights that poor households spend larger fraction of their income on non-tradable goods and so they might be more exposed to the output prices changes.

What is the effect of these differences in spending patterns on the minimum wage content of consumption? To evaluate the extent to they affect our estimates, we calculate the minimum wage content of consumption by assuming that the effective price increase in the tradable sector is zero as consumers simply replace the more expensive minimum wage producers with producers which are not hit by the minimum wage. The key findings summarized in Figure A.21. The figure shows the minimum wage content of consumption under the benchmark assumption (shown in Figure 5 in the main text) and under the assumption that the price increase in the tradable sector does not affect the final consumers (red dots). Under the alternative price passthrough assumption, the minimum wage content of consumption falls as we expect and the relationship between household income and minimum wage content become slightly steeper. Nevertheless, the overall picture about the relationship between household income and the minimum wage content remains very similar.

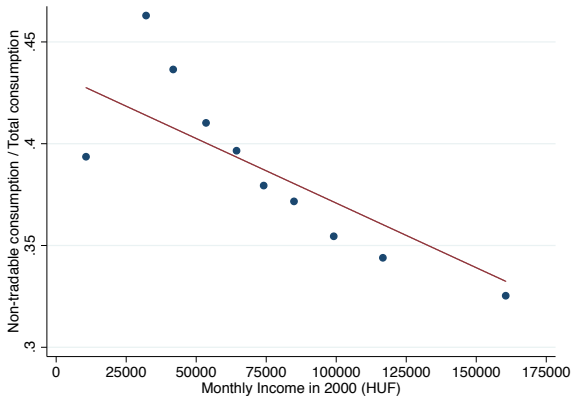
Table A.15: Effect on Firm-level Outcomes by Sectors

		Fraction Affected	Direct Exposure	Total Exposure
AtB	Agriculture, Hunting, Forestry and Fishing	0.102	0.031	0.061
C	Mining and Quarrying	0.016	0.015	0.029
15t16	Food, Beverages and Tobacco	0.049	0.050	0.088
17t18	Textiles and Textile Products	0.147	0.028	0.043
19	Leather, Leather and Footwear	0.129	0.026	0.036
20	Wood and Products of Wood and Cork	0.154	0.038	0.054
21t22	Pulp, Paper, Paper , Printing and Publishing	0.051	0.025	0.045
23	Coke, Refined Petroleum and Nuclear Fuel	0.000	0.010	0.025
24	Chemicals and Chemical Products	0.006	0.015	0.033
25	Rubber and Plastics	0.036	0.016	0.030
26	Other Non-Metallic Mineral	0.030	0.017	0.029
27t28	Basic Metals and Fabricated Metal	0.034	0.017	0.034
29	Machinery, Nec	0.020	0.016	0.030
30t33	Electrical and Optical Equipment	0.017	0.010	0.020
34t35	Transport Equipment	0.011	0.011	0.020
36t37	Manufacturing, Nec; Recycling	0.120	0.028	0.044
E	Electricity, Gas and Water Supply	0.003	0.009	0.024
F	Construction	0.120	0.019	0.033
50	Sale, Maintenance and Repair of Motor Vehicles and Motorcycle	0.125	0.020	0.038
51	Wholesale Trade and Commission Trade, Except of Motor Vehicle	0.062	0.026	0.048
52	Retail Trade, Except of Motor Vehicles and Motorcycles	0.140	0.021	0.040
H	Hotels and Restaurants	0.153	0.029	0.047
60	Inland Transport	0.028	0.012	0.030
61	Water Transport	0.033	0.017	0.023
62	Air Transport	0.001	0.033	0.040
63	Other Supporting and Auxiliary Transport Activities	0.048	0.021	0.037
64	Post and Telecommunications	0.005	0.013	0.034
J	Financial Intermediation	0.007	0.013	0.036
70	Real Estate Activities	0.058	0.011	0.031
71t74	Renting of M&Eq and Other Business Activities	0.067	0.016	0.038
75+	Public Sector	0.070	0.013	0.036
	Imports	0.000	0.000	0.000

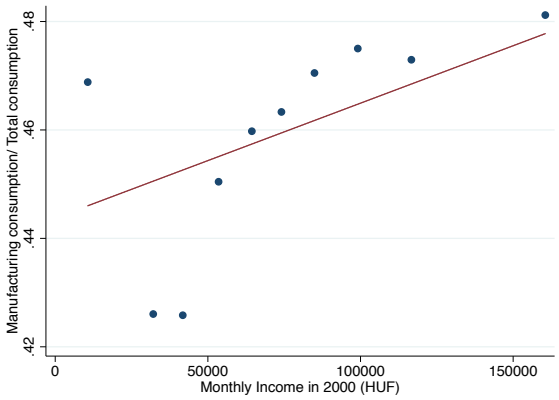
Figure A.20: Relationship Between Household Income and Spending on Tradable Goods, on Non-Tradable Goods, on Services and on Manufacturing



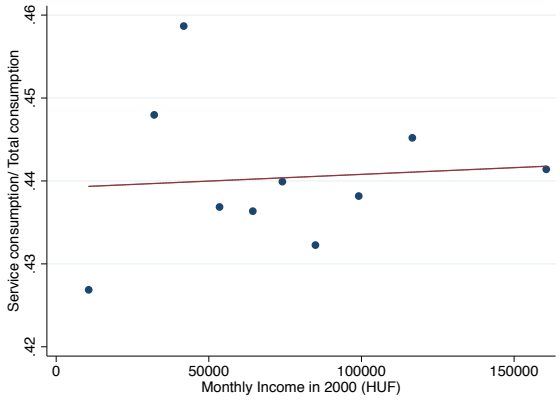
(a) Fraction Spent on Tradable Goods



(b) Fraction Spent on Non-Tradable Goods



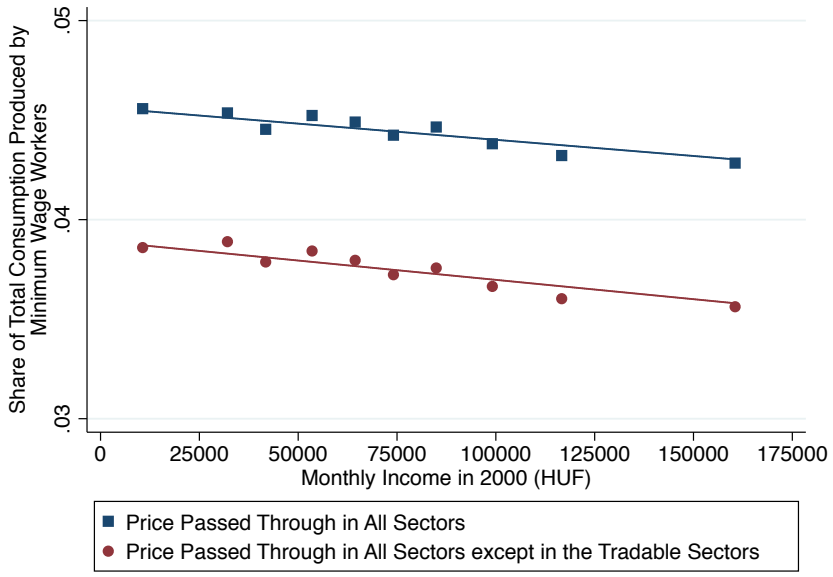
(c) Fraction Spent on Manufacturing



(d) Fraction Spent on Services

Note: This figure shows the relationship between household income and spending on tradable goods (panel a), on non-tradable goods (panel b), on manufacturing (panel c) and on services (panel d).

Figure A.21: Relationship Between Household Income and the Minimum Wage Content of Consumption under Alternative Price Pass-through Assumptions



Note: This figure shows the relationship between minimum wage content of consumption and household income under alternative price pass-through assumptions. The blue squares show the share of consumption produced by minimum wage workers for each household decile under the benchmark assumption (shown in Figure 5 in the main text). In the benchmark case we assume that the price increase has the same effect on consumers in all sectors (service, manufacturing, tradable and non-tradable). The red dots show the share of consumption produced by minimum wage workers for each household decile under the assumption that the price change in the tradable sector has no effect on final consumers. This latter assumption is motivated by our finding that in the non-tradable sectors consumers are more responsive to the firm-level price changes, which suggests that in those sectors it is easier to substitute away from producers by minimum wage workers to producers which are not hit by the minimum wage (e.g. imported goods). We calculate the minimum wage content of consumption following MaCurdy (2015), see Section A.8 in the Online Appendix for the details.

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A.9 Classification of sectors and main characteristics

Table A.16: Classification of sectors and main characteristics

This table lists the four digit sectors used in our analysis. The sector classification is TEAOR 98 which is the Hungarian equivalent of NACE rev 1 used by the Central Statistical Office in Hungary. We follow the classification procedure by Mian and Sufi (2014) and classify tradability as follows. Tradable sectors are where the import-to-sales or export-to-sales ratio is higher than 10 percent. We classify sectors as non-tradable if ratios are both below 10 percent and Geographical Herfindahl index is below median (0.17). The retail (5200-5299) and catering (5530-5999) sectors are also classified as non-tradable. We classify TEAOR codes 4500-4599 as construction and remaining sectors are classified as others. Additional statistics in the table show average employment in the sector for firms with more than 5 employees and the fraction of employment affected by the minimum wage increase. The geographical Herfindahl calculates the (NUTS 3) regional concentration of industries.

Sector	Name	Classification	Employment (5+)	Fraction affected (percent)	Geographical Herfindahl
1511	Production and preserving of meat	Non-tradable	14801	26.7	9.2
1512	Production and preserving of poultry-meat	Tradeable	15332	23.6	15.8
1513	Production of meat and poultry-meat products	Tradeable	5795	26.2	19.9
1520	Processing and preserving of fish and fish products	Tradeable	198	78.4	42.9
1531	Processing and preserving of potatoes	Other	478	13.0	85.8
1532	Manufacture of fruit and vegetable juice	Tradeable	1818	30.0	24.6
1533	Processing and preserving of fruit and vegetables n.e.c.	Tradeable	10084	31.7	13.8
1541	Manufacture of crude oils and fats	Non-tradeable	89	78.3	14.0
1542	Manufacture of refined oils and fats	Other	721	3.0	95.7
1551	Operation of dairies and cheese making	Non-tradeable	8338	17.4	14.4
1561	Manufacture of grain mill products	Non-tradeable	6592	21.5	11.4
1571	Manufacture of prepared feeds for farm animals	Non-tradeable	4569	19.2	10.6
1572	Manufacture of prepared pet foods	Other	617	15.5	80.5
1581	Manufacture of bread; manufacture of fresh pastry goods and cakes	Non-tradeable	18909	60.4	8.7
1582	Manufacture of rusks and biscuits; manufacture of preserved pastry goods and cakes	Other	2311	26.2	25.3
1583	Manufacture of sugar	Other	1891	0.4	22.7
1584	Manufacture of cocoa; chocolate and sugar confectionery	Other	4388	26.0	60.9
1585	Manufacture of macaroni, noodles, couscous and similar farinaceous products	Other	1139	47.2	42.1
1586	Processing of tea and coffee	Other	1540	13.7	54.3

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Sector	Name	Classification	Employment (5+)	Fraction affected (percent)	Geographical Herfindahl
1587	Manufacture of condiments and seasonings	Tradeable	1216	15.6	38.1
1589	Manufacture of other food products n.e.c.	Tradeable	1460	45.3	24.7
1591	Manufacture of distilled potable alcoholic beverages	Other	1665	30.2	34.4
1593	Manufacture of wines	Tradeable	4372	36.0	20.9
1596	Manufacture of beer	Other	3541	7.7	25.9
1598	Production of mineral waters and soft drinks	Other	4903	15.9	37.2
1711	Preparation and spinning of cotton-type fibers	Non-tradeable	2111	46.4	15.9
1712	Preparation and spinning of woollen-type fibres	Other	248	31.0	46.1
1713	Preparation and spinning of worsted-type fibres	Other	480	52.3	48.4
1721	Cotton-type weaving	Other	3192	30.9	35.4
1725	Other textile weaving	Other	374	63.7	35.2
1730	Finishing of textiles	Other	1128	67.7	37.8
1740	Manufacture of made-up textile articles, except apparel	Tradeable	12801	65.0	29.5
1751	Manufacture of carpets and rugs	Tradeable	712	48.6	48.0
1753	Manufacture of non-wovens and articles made from non-wovens, except apparel	Tradeable	531	17.0	28.3
1754	Manufacture of other textiles n.e.c.	Tradeable	3660	37.9	34.7
1760	Manufacture of knitted and crocheted fabrics	Tradeable	1358	45.6	24.5
1771	Manufacture of knitted and crocheted hosiery	Other	886	58.8	15.4
1772	Manufacture of knitted and crocheted pullovers, cardigans and similar articles	Tradeable	2911	71.7	19.7
1810	Manufacture of leather clothes	Tradeable	1708	64.4	32.0
1821	Manufacture of workwear	Tradeable	4871	71.6	15.5
1822	Manufacture of other outerwear	Tradeable	42719	61.4	15.2
1823	Manufacture of underwear	Tradeable	14125	39.0	15.3
1824	Manufacture of other wearing apparel and accessories n.e.c.	Tradeable	4007	65.9	17.9
1830	Dressing and dyeing of fur; manufacture of articles of fur	Tradeable	121	63.4	40.6
1910	Tanning and dressing of leather	Tradeable	649	37.3	31.5
1920	Manufacture of luggage, handbags and the like, saddlery and harness	Tradeable	3526	48.2	17.1
1930	Manufacture of footwear	Tradeable	17887	51.9	14.2
2010	Sawmilling and planing of wood; impregnation of wood	Tradeable	5624	61.6	8.1
2020	Manufacture of veneer sheets; manufacture of plywood, laminboard, particle board, fibre board and other panels and boards	Tradeable	2293	18.1	23.4
2030	Manufacture of builders' carpentry and joinery	Tradeable	8048	55.4	15.1
2040	Manufacture of wooden containers	Tradeable	2450	71.3	11.4
2051	Manufacture of other products of wood	Tradeable	3166	72.3	10.2

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Sector	Name	Classification	Employment (5+)	Fraction affected (percent)	Geographical Herfindahl
2052	Manufacture of articles of cork, straw and plaiting materials	Tradeable	278	59.2	26.9
2112	Manufacture of paper and paperboard	Tradeable	1516	12.1	59.2
2121	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard	Tradeable	4966	26.7	41.3
2122	Manufacture of household and sanitary goods and of toilet requisites	Other	1310	8.8	76.3
2123	Manufacture of paper stationery	Tradeable	844	17.8	44.6
2125	Manufacture of other articles of paper and paperboard n.e.c.	Tradeable	1235	25.4	15.6
2211	Publishing of books	Tradeable	2426	25.0	51.1
2212	Publishing of newspapers	Other	3645	10.1	53.7
2213	Publishing of journals and periodicals	Other	1535	27.6	61.7
2214	Publishing of sound recordings	Tradeable	194	17.5	94.9
2215	Other publishing	Tradeable	536	53.0	40.6
2221	Printing of newspapers	Other	1664	29.8	38.3
2222	Printing n.e.c.	Tradeable	9483	35.7	41.2
2223	Bookbinding	Other	1762	81.6	18.4
2224	Pre-press activities	Other	340	41.1	27.4
2225	Ancillary activities related to printing	Other	3123	55.5	38.2
2232	Reproduction of video recording	Tradeable	126	21.3	82.9
2233	Reproduction of computer media	Tradeable	127	37.9	54.0
2411	Manufacture of industrial gases	Other	1171	0.0	49.3
2412	Manufacture of dyes and pigments	Tradeable	204	10.6	33.1
2413	Manufacture of other inorganic basic chemicals	Tradeable	1058	9.7	34.8
2414	Manufacture of other organic basic chemicals	Tradeable	2275	11.7	33.3
2415	Manufacture of fertilizers and nitrogen compounds	Other	1891	3.4	54.5
2416	Manufacture of plastics in primary forms	Tradeable	6368	4.5	74.5
2420	Manufacture of pesticides and other agro-chemical products	Tradeable	651	9.2	56.8
2430	Manufacture of paints, varnishes and similar coatings, printing ink and mastics	Tradeable	1773	15.6	46.7
2441	Manufacture of basic pharmaceutical products	Tradeable	578	11.4	59.6
2442	Manufacture of pharmaceutical preparations	Tradeable	13955	1.3	50.8
2451	Manufacture of soap and detergents, cleaning and polishing preparations	Other	1933	17.4	86.5
2452	Manufacture of perfumes and toilet preparations	Tradeable	1040	22.4	40.1
2461	Manufacture of explosives	Other	267	22.2	48.8
2463	Manufacture of essential oils	Tradeable	102	7.9	83.7
2466	Manufacture of other chemical products n.e.c.	Tradeable	1048	22.5	31.1

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Sector	Name	Classification	Employment (5+)	Fraction affected (percent)	Geographical Herfindahl
2511	Manufacture of rubber tyres and tubes	Tradeable	3042	3.3	37.6
2512	Retreading and rebuilding of rubber tyres	Non-tradeable	120	62.6	14.8
2513	Manufacture of other rubber products	Tradeable	4355	29.3	19.1
2521	Manufacture of plastic plates, sheets, tubes and profiles	Tradeable	5632	19.9	13.7
2522	Manufacture of plastic packing goods	Tradeable	6520	31.3	11.4
2523	Manufacture of builders' ware of plastic	Tradeable	1986	36.1	19.8
2524	Manufacture of other plastic products	Tradeable	11758	31.6	10.6
2612	Shaping and processing of flat glass	Tradeable	1270	35.1	23.4
2613	Manufacture of hollow glass	Tradeable	4723	30.6	20.9
2615	Manufacture and processing of other glass, including technical glassware	Tradeable	764	33.2	27.2
2621	Manufacture of ceramic household and ornamental articles	Tradeable	4136	22.6	36.2
2625	Manufacture of other ceramic products	Other	227	70.0	64.6
2626	Manufacture of refractory ceramic products	Tradeable	640	7.8	28.1
2630	Manufacture of ceramic tiles and flags	Tradeable	1408	18.9	63.5
2640	Manufacture of bricks, tiles and construction products, in baked clay	Non-tradeable	3526	33.1	29.0
2652	Manufacture of lime	Other	210	37.9	25.3
2661	Manufacture of concrete products for construction purposes	Non-tradeable	3795	23.1	11.7
2663	Manufacture of ready-mixed concrete	Non-tradeable	983	28.7	20.7
2664	Manufacture of mortars	Other	444	2.0	38.5
2665	Manufacture of fibre cement	Other	379	3.5	39.4
2666	Manufacture of other articles of concrete, plaster and cement	Non-tradeable	443	60.7	16.0
2670	Cutting, shaping and finishing of ornamental and building stone	Other	678	67.2	27.9
2681	Production of abrasive products	Tradeable	287	1.8	72.6
2682	Manufacture of other non-metallic mineral products n.e.c.	Tradeable	2228	4.8	28.2
2710	Manufacture of basic iron and steel and of ferro-alloys	Tradeable	6200	4.8	64.9
2722	Manufacture of steel tubes	Tradeable	543	12.4	54.3
2731	Cold drawing	Tradeable	547	19.2	58.9
2735	Wire Drawing	Tradeable	262	11.3	45.3
2742	Aluminum production	Tradeable	4379	31.2	61.7
2751	Casting of iron	Non-tradeable	1757	22.2	28.9

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Sector	Name	Classification	Employment (5+)	Fraction affected (percent)	Geographical Herfindahl
2752	Casting of steel	Non-tradeable	830	23.6	18.9
2753	Casting of light metals	Other	2130	19.8	33.7
2811	Manufacture of metal structures and parts of structures	Tradeable	22070	37.1	8.8
2812	Manufacture of builders' carpentry and joinery of metal	Non-tradeable	1571	38.9	19.8
2821	Manufacture of tanks, reservoirs and containers of metal	Tradeable	1959	23.6	11.5
2822	Manufacture of central heating radiators and boilers	Other	2710	16.9	28.4
2830	Manufacture of steam generators, except central heating hot water boilers	Other	1162	11.1	28.1
2840	Forging, pressing, stamping and roll forming of metal; powder metallurgy	Non-tradeable	1343	19.2	17.4
2851	Treatment and coating of metals	Non-tradeable	2913	41.4	11.6
2852	General mechanical engineering	Non-tradeable	8181	42.9	10.9
2861	Manufacture of cutlery	Tradeable	173	30.9	48.6
2862	Manufacture of tools	Tradeable	3678	24.7	15.3
2863	Manufacture of locks and hinges	Tradeable	1810	21.9	56.8
2871	Manufacture of steel drums and similar containers	Non-tradeable	862	32.2	17.1
2872	Manufacture of light metal packaging	Other	2128	12.9	28.4
2873	Manufacture of wire products	Tradeable	1351	25.6	29.4
2874	Manufacture of fasteners, screw machine products, chain and springs	Tradeable	1146	44.1	15.9
2875	Manufacture of other fabricated metal products n.e.c.	Tradeable	6054	34.0	15.2
2911	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines	Other	1179	41.6	19.1
2912	Manufacture of pumps and compressors	Tradeable	2844	17.6	17.8
2913	Manufacture of taps and valves	Tradeable	2423	14.2	26.2
2914	Manufacture of bearings, gears, gearing and driving elements	Tradeable	2419	16.7	34.6
2921	Manufacture of furnaces and furnace burners	Other	254	37.3	34.7
2922	Manufacture of lifting and handling equipment	Tradeable	3087	28.1	15.1
2923	Manufacture of non-domestic cooling and ventilation equipment	Tradeable	4360	22.1	18.3
2924	Manufacture of other general purpose machinery n.e.c.	Tradeable	8352	22.3	21.2
2932	Manufacture of other agricultural and forestry machinery	Tradeable	7257	21.3	12.6
2940	Manufacture of machine tools	Tradeable	2845	17.5	12.0
2951	Manufacture of machinery for metallurgy	Other	1078	4.9	60.9

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Sector	Name	Classification	Employment (5+)	Fraction affected (percent)	Geographical Herfindahl
2952	Manufacture of machinery for mining, quarrying and construction	Tradeable	4323	9.1	16.4
2953	Manufacture of machinery for food, beverage and tobacco processing	Tradeable	2280	29.0	15.9
2954	Manufacture of machinery for textile, apparel and leather production	Tradeable	741	18.8	23.4
2955	Manufacture of machinery for paper and paperboard production	Tradeable	295	25.4	52.6
2956	Manufacture of other special purpose machinery n.e.c.	Tradeable	4679	18.7	23.9
2971	Manufacture of electric domestic appliances	Tradeable	8078	17.2	62.9
2972	Manufacture of non-electric domestic appliances	Other	2343	20.4	22.1
3001	Manufacture of office machinery	Other	627	22.8	28.3
3002	Manufacture of computers and other information processing equipment	Tradeable	10941	18.3	82.8
3110	Manufacture of electric motors, generators and transformers	Tradeable	7490	17.8	31.8
3120	Manufacture of electricity distribution and control apparatus	Tradeable	9852	15.2	34.7
3130	Manufacture of insulated wire and cable	Tradeable	7323	22.8	51.5
3140	Manufacture of accumulators, primary cells and primary batteries	Tradeable	764	21.8	36.2
3150	Manufacture of lighting equipment and electric lamps	Tradeable	21059	18.2	61.8
3161	Manufacture of electrical equipment for engines and vehicles n.e.c.	Tradeable	17177	13.8	20.0
3162	Manufacture of other electrical equipment n.e.c.	Tradeable	9657	72.8	70.1
3210	Manufacture of electronic valves and tubes and other electronic components	Tradeable	22690	22.7	15.0
3220	Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy	Tradeable	5142	21.5	68.1
3230	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods	Tradeable	14721	12.1	29.4
3310	Manufacture of medical and surgical equipment and orthopaedic appliances	Tradeable	5346	27.6	41.2
3320	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment	Tradeable	5351	15.7	21.0
3330	Manufacture of industrial process control equipment	Other	1375	13.9	39.0
3340	Manufacture of optical instruments and photographic equipment	Tradeable	2156	23.1	41.5

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Sector	Name	Classification	Employment (5+)	Fraction affected (percent)	Geographical Herfindahl
3350	Manufacture of watches and clocks	Tradeable	40	56.9	40.1
3410	Manufacture of motor vehicles	Tradeable	8530	0.9	57.4
3420	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	Tradeable	2259	12.6	39.8
3430	Manufacture of parts and accessories for motor vehicles and their engines	Tradeable	22439	10.0	16.4
3511	Building and repairing of ships	Non-tradeable	217	51.4	16.6
3512	Building and repairing of pleasure and sporting boats	Tradeable	118	62.2	31.0
3520	Manufacture of railway and tramway locomotives and rolling stock	Tradeable	4873	8.9	22.3
3530	Manufacture of aircraft and spacecraft	Other	1301	5.7	71.2
3542	Manufacture of bicycles	Other	621	50.4	44.4
3611	Manufacture of chairs and seats	Tradeable	6428	41.0	10.3
3612	Manufacture of other office and shop furniture	Tradeable	1908	55.6	14.6
3613	Manufacture of other kitchen furniture	Non-tradeable	1440	42.1	21.3
3614	Manufacture of other furniture	Tradeable	7007	60.0	10.5
3622	Manufacture of jewellery and related articles n.e.c.	Other	707	56.3	58.7
3630	Manufacture of musical instruments	Tradeable	176	41.6	26.1
3640	Manufacture of sports goods	Tradeable	578	53.3	44.0
3650	Manufacture of games and toys	Tradeable	2055	73.0	29.1
3662	Manufacture of brooms and brushes	Tradeable	1870	77.0	23.6
3663	Other manufacturing n.e.c.	Tradeable	2495	32.6	26.9
3710	Recycling of metal waste and scrap	Non-tradeable	1249	29.5	30.0
3720	Recycling of non-metal waste and scrap	Other	324	55.5	61.0
4511	Demolition and wrecking of buildings; earth moving	Construction	4227	58.9	16.3
4512	Test drilling and boring	Construction	189	72.4	18.5
4521	General construction of buildings and civil engineering works	Construction	59911	46.3	22.5
4522	Erection of roof covering and frames	Construction	5075	67.7	30.1
4523	Construction of motorways, roads, airfields and sport facilities	Construction	7197	26.4	46.7
4524	Construction of water projects	Construction	1610	32.0	11.2
4525	Other construction work involving special trades	Construction	12028	48.0	29.9
4531	Installation of electrical wiring and fittings	Construction	9031	43.9	22.1
4532	Insulation work activities	Construction	1614	58.2	22.4
4533	Plumbing	Construction	8506	51.1	23.4
4534	Other building installation	Construction	6153	44.1	29.7

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Sector	Name	Classification	Employment (5+)	Fraction affected (percent)	Geographical Herfindahl
4541	Plastering	Construction	437	76.9	18.5
4542	Joinery installation	Construction	819	64.2	24.5
4543	Floor and wall covering	Construction	1296	63.6	22.0
4544	Painting and glazing	Construction	2154	70.7	14.6
4545	Other building completion	Construction	2888	59.2	40.7
4550	Renting of construction or demolition equipment with operator	Construction	561	16.9	63.4
5010	Sale of motor vehicles	Non-tradeable	22146	46.3	27.2
5020	Maintenance and repair of motor vehicles	Other	8274	58.2	21.6
5030	Sale of motor vehicle parts and accessories	Non-tradeable	6257	50.3	23.5
5040	Sale, maintenance and repair of motorcycles and related parts and accessories	Non-tradeable	310	64.5	25.4
5050	Retail sale of automotive fuel	Non-tradeable	5368	68.6	35.3
5111	Agents involved in the sale of agricultural raw materials, live animals, textile raw materials and semi-finished goods	Non-tradeable	1249	55.9	13.9
5112	Agents involved in the sale of fuels, ores, metals and industrial chemicals	Other	577	29.6	50.2
5113	Agents involved in the sale of timber and building materials	Non-tradeable	664	57.2	20.4
5114	Agents involved in the sale of machinery, industrial equipment, ships and aircraft	Other	759	24.2	39.6
5115	Agents involved in the sale of furniture, household goods, hardware and ironmongery	Other	375	66.9	28.2
5116	Agents involved in the sale of textiles, clothing, footwear and leather goods	Other	735	63.5	46.3
5117	Agents involved in the sale of food, beverages and tobacco	Non-tradeable	935	60.0	12.3
5118	Agents specialising in the sale of particular products or ranges of products n.e.c.	Other	912	37.2	51.1
5119	Agents involved in the sale of a variety of goods	Other	4318	35.5	49.8
5121	Wholesale of grain, seeds and animal feeds	Non-tradeable	3523	36.5	23.3
5122	Wholesale of flowers and plants	Non-tradeable	551	84.8	15.7
5123	Wholesale of live animals	Non-tradeable	404	65.5	9.5

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Sector	Name	Classification	Employment (5+)	Fraction affected (percent)	Geographical Herfindahl
5124	Wholesale of hides, skins and leather	Other	39	62.8	14.0
5131	Wholesale of fruit and vegetables	Non-tradeable	2942	48.5	26.1
5132	Wholesale of meat and meat products	Non-tradeable	1990	48.7	14.8
5133	Wholesale of dairy produce, eggs and edible oils and fats	Other	1530	38.0	27.0
5134	Wholesale of alcoholic and other beverages	Non-tradeable	2675	62.3	12.0
5136	Wholesale of sugar and chocolate and sugar confectionery	Non-tradeable	733	58.7	15.4
5137	Wholesale of coffee, tea, cocoa and spices	Other	800	27.6	47.2
5138	Wholesale of other food, including fish, crustaceans and molluscs	Other	5674	32.4	27.5
5141	Wholesale of textiles	Other	2433	70.3	32.0
5142	Wholesale of clothing and footwear	Other	5338	73.4	52.6
5143	Wholesale of electrical household appliances and radio and television goods	Other	2387	41.8	39.7
5144	Wholesale of china and glassware, wallpaper and cleaning materials	Non-tradeable	520	55.4	18.5
5145	Wholesale of perfume and cosmetics	Other	1709	16.4	56.9
5147	Wholesale of other household goods	Other	6110	45.9	31.7
5151	Wholesale of solid, liquid and gaseous fuels and related products	Non-tradeable	622	36.4	90.0
5152	Wholesale of metals and metal ores	Other	1057	24.3	43.0
5153	Wholesale of wood, construction materials and sanitary equipment	Non-tradeable	5817	47.9	19.8
5154	Wholesale of hardware, plumbing and heating equipment and supplies	Other	3993	27.3	22.5
5155	Wholesale of chemical products	Non-tradeable	2982	27.1	24.7
5156	Wholesale of other intermediate products	Other	558	15.4	40.6
5157	Wholesale of waste and scrap	Non-tradeable	1615	48.3	22.1
5161	Wholesale of machine tools	Non-tradeable	532	31.8	15.6
5162	Wholesale of mining, construction and civil engineering machinery	Other	494	20.7	42.3
5163	Wholesale of machinery for the textile industry and of sewing and knitting machines	Other	151	64.3	38.9

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Sector	Name	Classification	Employment (5+)	Fraction affected (percent)	Geographical Herfindahl
5164	Wholesale of computers, computer peripheral equipment and software	Other	2544	23.4	54.9
5165	Wholesale of other machinery for use in industry, trade and navigation	Other	1862	27.2	43.6
5166	Wholesale of agricultural machinery and accessories and implements, including tractors	Other	2209	8.3	25.3
5170	Other wholesale	Other	22898	33.0	53.1
5211	Retail sale in non-specialised stores with food, beverages or tobacco predominating	Non-tradeable	59240	46.5	21.8
5212	Other retail sale in non-specialised stores	Non-tradeable	16093	38.3	27.6
5221	Retail sale of fruit and vegetables	Non-tradeable	610	81.8	32.5
5222	Retail sale of meat and meat products	Non-tradeable	1195	80.6	10.7
5224	Retail sale of bread, cakes, flour confectionery and sugar confectionery	Non-tradeable	653	86.3	20.2
5225	Retail sale of alcoholic and other beverages	Non-tradeable	356	48.2	33.8
5227	Other retail sale of food, beverages and tobacco in specialised stores	Non-tradeable	2425	78.1	22.5
5233	Retail sale of cosmetic and toilet articles	Non-tradeable	1929	28.2	49.1
5241	Retail sale of textiles	Non-tradeable	1513	71.9	25.3
5242	Retail sale of clothing	Non-tradeable	8974	76.0	26.4
5243	Retail sale of footwear and leather goods	Non-tradeable	1618	56.6	43.8
5244	Retail sale of furniture, lighting equipment and household articles n.e.c.	Non-tradeable	3902	55.4	35.2
5245	Retail sale of electrical household appliances and radio and television goods	Non-tradeable	4258	52.2	22.7
5246	Retail sale of hardware, paints and glass	Non-tradeable	6804	62.3	10.2
5247	Retail sale of books, newspapers and stationery	Non-tradeable	4226	35.6	23.4
5248	Other retail sale in specialised stores	Non-tradeable	12041	61.6	28.2

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Sector	Name	Classification	Employment (5+)	Fraction affected (percent)	Geographical Herfindahl
5250	Retail sale of second-hand goods in stores	Non-tradeable	1765	45.0	54.9
5261	Retail sale via mail order houses	Non-tradeable	553	7.2	89.8
5262	Retail sale via stalls and markets	Non-tradeable	369	70.9	49.1
5263	Other non-store retail sale	Non-tradeable	1193	55.1	32.9
5271	Repair of boots, shoes and other articles of leather	Non-tradeable	697	84.6	43.2
5272	Repair of electrical household goods	Non-tradeable	1658	78.3	14.1
5273	Repair of watches, clocks and jewellery	Non-tradeable	206	66.8	38.2
5274	Repair n.e.c.	Non-tradeable	1155	55.7	32.3
5511	Hotels with restaurants	Other	18533	26.4	55.9
5512	Hotels without restaurants	Other	1064	55.7	34.4
5521	Youth hostels and mountain refuges	Other	164	93.8	24.4
5522	Camping sites, including caravan sites	Other	628	36.7	61.4
5523	Other provision of lodgings n.e.c.	Non-tradeable	1016	43.8	12.7
5530	Restaurants	Non-tradeable	23016	75.7	27.5
5540	Bars	Non-tradeable	2546	89.9	19.8
5551	Canteens	Non-tradeable	5104	60.7	35.6
5552	Catering	Non-tradeable	2028	61.9	44.3
6010	Transport via railways	Other	57001	12.4	80.0
6021	Other scheduled passenger land transport	Other	41953	8.0	19.4
6022	Taxi operation	Other	650	67.5	41.2
6023	Other land passenger transport	Non-tradeable	1113	37.0	16.8
6024	Freight transport by road	Non-tradeable	26293	35.2	15.4
6311	Cargo handling	Other	658	34.4	33.9
6312	Storage and warehousing	Other	2495	21.8	41.7
6321	Other supporting land transport activities	Other	5055	15.6	51.7

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Sector	Name	Classification	Employment (5+)	Fraction affected (percent)	Geographical Herfindahl
6322	Other supporting water transport activities	Other	139	19.7	42.5
6323	Other supporting air transport activities	Other	310	8.6	70.2
6330	Activities of travel agencies and tour operators; tourist assistance activities n.e.c.	Other	4001	37.6	70.6
6340	Activities of other transport agencies	Other	7683	15.8	36.9
7011	Development and selling of real estate	Other	808	32.2	70.8
7012	Buying and selling of own real estate	Other	8133	53.6	40.5
7020	Letting of own property	Other	9014	28.5	41.1
7031	Real estate agencies	Other	1911	57.8	34.1
7032	Management of real estate on a fee or contract basis	Other	5103	21.1	40.2
7110	Renting of automobiles	Other	669	14.5	74.3
7121	Renting of other land transport equipment	Non-tradeable	106	22.1	36.3
7131	Renting of agricultural machinery and equipment	Other	64	19.0	33.3
7132	Renting of construction and civil engineering machinery and equipment	Other	1021	30.7	51.6
7133	Renting of office machinery and equipment, including computers	Other	162	15.7	96.4
7134	Renting of other machinery and equipment n.e.c.	Other	507	43.6	38.3
7140	Renting of personal and household goods n.e.c.	Other	559	61.9	38.5
7210	Hardware consultancy	Other	707	44.7	49.9
7220	Publishing of software and consultancy	Other	9626	19.5	65.5
7230	Data processing	Other	4050	37.6	73.7
7240	Database activities	Other	508	25.9	70.0
7250	Maintenance and repair of office, accounting and computing machinery	Other	1555	36.0	35.6
7260	Other computer related activities	Other	2571	21.1	73.6
7310	Research and experimental development on natural sciences and engineering	Other	3744	12.2	59.3
7411	Legal activities	Other	2122	28.4	77.1
7412	Accounting, book-keeping and auditing activities; tax consultancy	Other	8534	42.6	43.2
7413	Market research and public opinion polling	Other	1330	29.3	57.4
7414	Business and management consultancy activities	Other	6795	27.5	58.6
7415	Management activities of holding companies	Other	2351	9.8	60.2
7420	Architectural and engineering activities and related technical consultancy	Other	15969	27.1	45.0
7430	Technical testing and analysis	Other	2930	20.3	43.4
7440	Advertising	Other	3185	36.9	78.5
7450	Labour recruitment and provision of personnel	Other	11410	28.0	33.3

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Sector	Name	Classification	Employment (5+)	Fraction affected (percent)	Geographical Herfindahl
7460	Investigation and security activities	Other	21869	55.8	42.3
7470	Industrial cleaning	Other	16061	68.7	34.4
7481	Photographic activities	Other	853	50.5	39.2
7482	Packaging activities	Other	2353	58.7	27.6
7483	Secretarial and translation and call centre activities activities	Other	559	26.7	55.6
7484	Other business activities n.e.c.	Other	9790	37.5	33.7
8511	Hospital activities	Other	1265	37.9	65.7
8512	Medical practice activities	Non-tradeable	4131	47.1	17.2
8513	Dental practice activities	Non-tradeable	909	64.5	14.7
8514	Other human health activities	Non-tradeable	1350	42.8	34.2
8520	Veterinary activities	Non-tradeable	196	65.5	25.8
8532	Social work activities without accommodation	Other	1733	92.5	24.9