Who Pays for the Minimum Wage?*

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March 2017

forthcoming in *American Economic Review*, 2019

Abstract

This paper analyzes a very large (~60% in real terms) and persistent increase in the minimum wage instituted in Hungary in 2001. By comparing the behavior of highly exposed and less exposed firms four years before and four years after the minimum wage hike, we provide new insight on several aspects of the minimum wage. First, we show that the large minimum wage hike had only a limited effect on employment even four years after the reform. Our preferred estimates suggest that only 1 out of 10 minimum wage workers lost their job, while those who kept their job experienced a 50% wage increase. As a result, the total compensation of low wage workers increased by 23%. Second, we show that around 80% of the wage increase paid by consumers of goods produced by minimum wage workers and only 20% was paid by firm-owners. Third, we show that firms responded to the minimum wage by substituting labor with capital. Fourth, we uncover large heterogeneities in response to the minimum wage increase. Firms in the tradable sector cut a larger fraction of their workforce, while in the non-tradable sector the employment effect is close to zero. These results indicate that the minimum wage is more harmful in industries where passing the wage costs to consumers is more difficult. Overall, our results suggest that the incidence of the minimum wage falls mainly on consumers, while the effect on firm owners is limited.

*We are extremely grateful for David Card, Patrick Kline and Emmanuel Saez for their continuous guidance throughout the project. We would like to thank Alan Auerbach, Tamás Bátyi, Katalin Bodnár, Michael Best, Stefano DellaVigna, Eric French, Hedvig Horváth, Hilary Hoynes, János Köllő, Álmos Telegdy, Gábor Kézdi, Gábor Kőrösi, Alan Manning, John Mondragon, Carl Nadler, Steve Machin, Balázs Muraközy, Suphanit Piyapromdee, Michael Reich, Balázs Reizer, Ana Rocca, Jesse Rothstein, David Silver, Isaac Sorkin, Peter Spittal, Ferenc Szűcs, Chris Walters, Danny Yagan, Owen Zidar and participants in seminars at Bocconi University, Collegio Alberto, Chicago Booth, Duke University, Harris School of Public Policy, Syracuse University, University of Oslo, UC Berkeley, Tinbergen Institute, University of Utah and in conferences at AEA, Royal Academy of Science, IAB in Nurenberg, IZA in Bonn, for very helpful comments. Financial support from the Center for Equitable Growth at UC Berkeley, from the European Research Council (ERC-2015-CoG-682349), and from Firms, Strategy and Performance Lendület Grant of the Hungarian Academy of Sciences is gratefully acknowledged. All errors are our own.
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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 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 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 by way of 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%, comparable to the current ratio in the U.S., while two years later the minimum wage raised to 55% — a level only slightly below the current minimum wage in France.

The apparent size and permanence of this unique policy change allow us to address the concern that many of the minimum wage increases analyzed in the recent labor economics literature are only small and temporary. Such minimum wage changes can easily lead to muted behavioral responses in the presence of adjustment costs or inertia, as the benefits of changing behavior are small (Chetty, Friedman, Olsen and Pistaferri 2011, Sorkin 2013, Aaronson, French, Sorkin and To 2016). In contrast, for large and permanent changes, firms have strong incentives to restructure their production process or exit the market as soon as possible, because the loss in profit from a sub-optimal behavior would be significant.[1]

The large step-like increase in the minimum wage also allows us to implement and test a variety of difference-in-difference style estimators. In this paper, we estimate the behavioral responses to this unique wage shock by comparing firms which are highly exposed to the minimum wage against those with lower exposure. We use administrative data covering all firms which are required to file a balance sheet to the tax authority. Our identification strategy relies on the assumption that the employment rate would have evolved in the same way at firms with higher and lower exposure to the minimum wage in absence of the minimum wage hike. While it is not possible to test this "parallel trends" assumption directly, we show that it holds in the years preceding the minimum wage hike.

[1]The government announced the new minimum wage schedule for 2001 and 2002 in early 2000. Moreover, the governing parties also pledged to keep the minimum wage at the 2002 level if they were reelected in 2002. Therefore, from the beginning of 2000 it was clear that the level of the minimum wage would be higher.

We start our empirical analysis by estimating the employment effects of this unique minimum wage change. 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.[2] We find that firms employing only minimum wage workers had 10% lower employment four years after the minimum wage hike than firms with no minimum wage workers. This means that 1 out of 10 low wage workers lost their jobs as a result of the reform.

At the same time, the average wage at the highly exposed firms increased by 50% more than the average wage at firms with no exposure to the minimum wage. This implies a relatively low and precisely estimated elasticity of employment with respect to *minimum wage* of -0.01 (s.e. 0.01) and an elasticity of -0.17 (s.e. 0.01) with respect to the *workers' wage.* These employment estimates, while being statistically significant, are at the lower end of the estimates in the literature. Therefore, our findings confirm that the effect of the minimum wage is close to zero even for sizable changes in the minimum wage.

We present evidence from several additional analyses which underline our firm-level estimates on employment. First, we plot the (frequency) distribution of wages both before and after the minimum wage hike to better understand the employment changes at the bottom of the wage distribution. We show that while the aggregate distribution was stable over time before the reform, there was a large shift in the earnings distribution after the minimum wage hike. In particular, almost no workers earn below the new minimum wage following the reform, as it is expected when firms comply with the new rules.[3] At the same time, many new jobs appeared at and slightly above the new minimum wage after the reform. In fact, the excess number of jobs at and slightly above the minimum wage is close to the number of jobs that disappeared from the earnings distribution, which suggests that the disemployment effects cannot be large. Moreover, we also show that the composition of the workforce (measured by age, gender, education and location) remained very similar at the bottom of the earnings distribution. This suggests that the extent of labor-labor substitution between demographic groups was limited.

We also implement a grouping estimator a la Blundell et al. (1998), which exploits the differential impacts of the minimum wage on demographic groups (such as age, education and sex) and regions. Using the Hungarian Labor Force Survey we show that the group-level exposure to the minimum wage is associated with a small employment loss after 2000. The implied employment elasticities are similar in magnitude to the firm-level evidence, though

[2]Comparing to year 2000 would be problemetic if firms had responded to the minimum wage already in 2000, however, we do not find evidence for that.

[3]As noted by Ashenfelter and Smith (1979) employers may also choose to not comply with the law. This appears to be a relatively infrequent occurrence in Hungary, although we allow for non-compliance in our empirical approach.

the estimates are less precise.

The large effect on wages and the small effect on employment indicate that the total earnings paid out to low-wage workers increased considerably. In the second part of the paper we turn to the incidence of the minimum wage reform. We examine how the firms absorbed the increase in their total labor cost by estimating the effect of the minimum wage on various firm-level outcomes, such as total revenue, output prices and profits.

First, we show that the revenues of highly exposed and less exposed firms follow a parallel trend before the reform, but this trend breaks exactly at the time of the minimum wage hike. After 2000, total revenue at firms with high exposure to the minimum wage increased considerably relative to the firms with no exposure. A similar analysis reveals no relationship between exposure and profitability before the reform, and a slight drop afterwards. Firms moderately increase spending on materials (intermediate goods and services) after the reform, but this effect vanishes over time. Finally, we also examine firms' investment decisionsand detect a sizable increase in capital stock at firms most exposed to the minimum wage shock.

This evidence highlights that firms responded along several margins to adjust for the increase in their labor costs. The increase in total revenue is consistent withfirms passing the effect of the minimum wage to consumers through higher prices. To provide direct evidence on the price channel we exploit unique firm-product level data for the manufacturing sector. We document that firms exposed to the minimum wage raised their prices by 13% (s.e. 5.8%) more than those with no exposure. Despite this price rise, output in firms using minimum wage workers fell modestly, which is evidence of inelastic product demand.

The effect on profits suggests that firm owners bear part of the incidence too. We estimate that around 80% of the increased cost of labor is covered by higher revenue, with the remaining 20% leading to a reduction in profits. These results suggest that the effect of the minimum wage was mainly passed through to consumers and the effect on firm owners was limited.

Finally, the large positive effect on capital stock provides a strong indication that firms responded to the minimum wage by substituting low skilled workers with capital. The relatively fast and sizable adjustment in capital also suggests that the size of the minimum wage hike was large enough to incentivize firms to adjust their production processes quickly.

After documenting the overall effect of the minimum wage, we turn to the heterogenous responses to the minimum wage hike. Since the minimum wage bites deeply into the wage distribution our set-up allows us to estimate the effect of the minimum wage across the economy. We show that the disemployment effects are larger in the tradable 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. This makes passing the effect of the minimum wage to consumers more costly, as a small price change by the Hungarian firms leads to a compet-

itive disadvantage and to a large fall in output. In line with this explanation, we find that firms' revenues fall in these sectors.

At the same time, in the non-tradable and in the service sectors, the effect of the minimum wage on employment is close to zero. These sectors are protected from foreign competition and all firms are hit by the same minimum wage shocks. Therefore, firms in these sectors can raise prices without loss of competitiveness.

We also explore the heterogenous response to the minimum wage shocks by firm characteristics. In line with our sectoral analysis we find that the employment loss and the fall in revenue is much larger at exporting firms. We also show that the disemployment effect of the minimum wage increases with labor share in production. This is consistent with price pass-through as firms with higher labor share need to raise their output prices more to offset the increased costs. We also show that employment at larger firms falls more in response to the minimum wage shock, since they substitute labor with capital more easily. However, we only find weak evidence that profitability influences the response to the minimum wage, and we do not find any relationship between the effect of minimum wage and market concentration.

To understand the key implications of these results we present a simple framework where monopolistically competitive firms sell differentiated goods to consumers with CES preferences. Firms have constant returns to scale and three inputs: capital, labor, and materials (intermediate goods and services). Firms differ in the type of labor they use for production: some firms rely on low wage workers, while other firms use high skilled ones.[4]

In this model the effect of the minimum wage on firm-level outcomes is determined by the cost share of different inputs, and three key parameters: the substitution elasticity between capital and labor, the substitution elasticity between materials and labor and the output demand elasticity of the minimum wage firms face. However, the relevant demand elasticity depends on the market structure. In markets where only one firm is hit by the minimum wage shock (e.g. exporting) the output demand elasticity is the firm-level demand elasticity. Alternatively, in markets where all firms are hit by the minimum wage the relevant elasticity is demand elasticity of the market-level composite good.

To uncover the three key parameters of the model, we match the model predictions to four empirical moments in the data: employment response, revenue response, material response, and capital response. We estimate the best fitting parameters using a minimum distance estimator. We estimate that the substitution elasticity between capital and low wage workers is 1.33 (s.e. 0.21) in the short-run (2 years after the reform) and 2.66 (s.e. 0.35) in the medium run (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

[4]This assumption restricts the substitution between high skilled and low skilled labor. While this is a strong assumption, it is in line with our empirical results as we find no evidence for labor-labor substitution.

around 7%.

The estimated substitution elasticity between materials and labor is close to zero even in the medium run. Given that materials account for 77% of an average firm's costs, this elasticity must be low to be consistent with the modest employment responses. Such inelastic substitution between materials and labor is also consistent with some recent estimates in the literature (e.g. Atalay, 2014).

Finally, we estimate that the best fitting overall output demand elasticity is close to zero in the short-run (0.02 s.e. 0.12), and it is slightly more elastic in the medium run (0.31 s.e. 0.18). Moreover, there are large variations in the estimates across sectors. In the exporting sector, we find that the output demand elasticity is 1.52 (s.e. 0.59) in the short run (2 years after the reform) and 3.67 (s.e. 0.81) in the medium run (4 years after the reform).[5] By contrast, in the non-tradable and in the service sectors we find close to zero output elasticities even in the medium run. This suggests that firms in these sectors can pass the minimum wage increase through to consumers because output demand is inelastic.

Our paper contributes to several strands of the minimum wage literature. First, we contribute 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 close to zero effect of the minimum wage (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 et al. 2016) and that they consider only the short term effects of the minimum wage (Baker, Dwayne and Stanger 1999). In this paper, we show that the effect of the minimum wage is small even for an unusually large and persistent increase in the minimum wage. We also examine the employment effects up to four years after the minimum wage reform and show that around 80% of the employment loss occurred in the first two years after the minimum wage hike. Moreover, using a large and persistent shock allows us to improve the precision of our estimates, which is an order of magnitude smaller than the state of the art in the literature.[6]

Our paper also contributes to the growing literature in estimating the effect of minimum wage changes on firm-level outcomes. The recent literature examined the effect on firm profitability and revenue (Mayneris, Poncet and Zhang 2016, Hau, Huang and Wang 2016, Riley and Bondibene 2015, Draca, Machin and Reenen 2011, Allegretto and Reich 2016), and on the

[5]Our estimates in the exporting sector uncover 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 Armington elasticity is close to 1.4 in the short-run and to 6.2 in the long-run (Ruhl 2005).

[6]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 Köllő (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.

stock-market value (Card and Krueger 1995, Bell and Machin 2016). However, the evidence on who pays for the minimum wage is inconclusive. Part of this disagreement might be caused by the fact that the sectoral composition of firms hit by the minimum wage differs between these papers. The virtue of our set-up is that minimum wage hike bites deep into the wage distribution and therefore even sectors that pay high wages (e.g. exporting) are affected by the minimum wage change. This allows us to document how sectoral composition matters for incidence.

Our paper is also related to the literature investigating the relationship between the minimum wage and output prices (see Lemos, 2008 and MaCurdy, 2014 for a review). Most of these papers estimate price changes in the local service sector such as restaurants (Card and Krueger 1994, Aaronson, French and MacDonald 2008), where raising prices and passing the minimum wage through to consumers is likely to be easier than in other sectors such as manufacturing or exporting . Here we present evidence for the price effects in the manufacturing sector and show that the minimum wage is also passed through to prices in that sector too.

We also present new evidence on capital-labor substitution in the low wage sector. Most recent estimates in the literature estimates the relationship between capital and labor in general (Chirinko, Fazzari and Meyer 2011, Karabarbounis and Neiman 2014), however these estimates might mask some heterogenous capital-labor substitution across worker types (Cote-Colisson and Legendre 1999, Krusell, Ohanian, Ríos-Rull and Violante 2000). We estimate the relationship between minimum wage exposure and change in capital stock and then separate the scale effect from the substitution effect using a method of moment estimation procedure. We are not aware any other paper estimating capital-labor substitution in the context of minimum wages. A notable exception is Hau et al. (2016) who estimates the effect of the minimum wage on capital stock, but does not disentangle capital-labor substitution from the scale effect.

This paper is also related to the 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 a good approximation since we find small employment effects and that 80% of the minimum wage is passed through to consumers. Similarly to MaCurdy (2015), we also examine the consumption pattern of households to better understand who buys the goods produced by minimum wage workers but, contrary to him, we find that richer households spend a slightly larger 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 raise in Hungary. In Section 3 we present evidence on the employment and

wage effects of the minimum wage. In Section 4, we estimate the incidence of the minimum wage. In Section 5 we present and estimate our model, and we conclude in Section 6.

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.[7] 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 that they 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 in 2002 to 50,000 HUF.[8] This announcement was rather unexpected, since the radical increase of the minimum wage had not previously been part of the political discourse.[9] For instance, the unions were demanding a 13% increase in minimum wage at the pre-negotiations, so a government proposal on doubling 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 minumum wage as they were afraid of the negative consequences for jobs.

Government officials argued that the main purposes of raising the minimum wage were to alleviate income differences, to raise 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 2002, even though the right-wing government lost the elections. This is highlighted on Figure 1 which summarizes the evolution of the minimum wage in relation

[7]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% of all employees in Hungary, the minimum is proportionally lower.

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

[9]In the previous general election in 1998 none of the major political parties campaigned for increasing the minimum wage. In fact, minimum wage was not at all discussed in the general election manifestos of the main parties (on the left or right). However, by the next general election in 2002, all major parties described their positions on minimum wage in their election manifesto. This large change in the election manifestos also highlight that the governing right wing parties were setting the political agenda by announcing such a large change in the minimum wage. (We would like to thank HAS Institute for Political Science for providing us the election manifestos.)

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.

The Hungarian economy was performing well and there were no dramatic macroeconomic shocks around the time of the reform. Real per capita GDP growth was around 4% before and after the reform (see Panel (a) Appendix Figure A-1). In line with the positive growth rate, the aggregate labor market conditions were gradually improving: the employment to population rate increased by 0.5% each year between 1997 and 2004 and the unemployment rate fell to 5% by 2001 and then remained at this low level (Panel (b) Appendix Figure A-1). Inflation was relatively high (around 10% in 2000) and it was slowly declining (Panel (c) Appendix Figure A-1). The exchange rate was also stable around the time of the reform (Panel (d) Appendix Figure A-1).

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 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, the 50% increase in public sector base wages in 2002. 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 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 (see Appendix Figure A-2).

2.2 Data

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).[10] The SES collects detailed information on

[10]The survey includes 26% of all firms in Hungary, representing 70% of all workers as larger firms are

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 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.[11] We extend our sample in the following steps. First, we estimate the relationship between fraction affected by the minimum wage (observed in the SES) and 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, pharmacy); 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 1996 and 2000, and we drop firms with the top 1% and bottom 1% growth rate between 1997 and 2006. We also drop firms where the average wage per worker is less than 90% of the minimum wage in any year between 1997 and 2006. 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.[12] In the final sample we have 19,950 firms, representing around a million workers (or one third of the total workforce in Hungary).

In the Appendix Table A-2 we report averages of some firm-level characteristics in 2000 by sector. An average firm in our sample employs 47 workers, 10% of its revenue is earned

over-sampled in the SES (see the Online Appendix about the sample design).

[11] In a previous version of the paper we only used firms that were both in the SES and CIT. Most results are not affected by using this restricted sample, though the standard errors are larger. The only exception is the effect on profits, where we find a small positive effect on profits using the restricted sample instead of a small negative effect shown here. Therefore, the incidence on firm-owners is even more limited in SES sample than in the full sample.

[12] We exclude 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. In Appendix Table we report results where we include smaller firms as well in the analysis and show that the employment effects are slightly smaller in that specification.

from exports, and its profitability is 3.3%. The labor share in total production is 17%, while the share of materials (intermediate goods and services) is around 77%. The fraction of workers affected by the increased minimum wage for an average firm is 47%. This number also highlights that the minimum wage reform we consider bites deep into the wage distribution. Moreover, 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 affected is around 20% in our sample.

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 calculate firm-level price changes relative to the previous year using a Laspeyres price index, where the base-weights are the revenue share of the product in the base years.

We also explore the robustness of our employment estimates using various alternative identification strategies. The distributional evidence uses the SES, while the grouping estimator measures group-level employment from the Hungarian Labor Force Survey (LFS) and group-level average wage from the SES. In the Online Appendix we provide further details about these data and we define the key variables used in the empirical analyses.

3 Employment Effects of the Minimum Wage

Identification Strategy. We estimate the employment effects of the minimum wage by by comparing the evolution of key outcome variable 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.[13] We winsorize the percentage changes, $\frac{y_{it}-y_{i2000}}{y_{i2000}}$, to take values between -1 (-100%) and +1 (100%). We include firms that shut down in the analysis as they experienced a 100% decline in their employment (and other outcomes). FA_i measures the fraction of workers for whom the 2002 minimum wage binds and, as we describe in the data section, this variable is predicted from the average cost of labor (observed in CIT) before the minimum wage hike. We restrict our sample to

[13]The minimum wage hikes were announced in year 2000, so it is possible that data from that year was already affected. However, given that we did not find any unusual changes in year 2000, the anticipation effect must be small.

firms that existed between 1997 and 2000.[14] We estimate robust standard errors and we use the logarithm of the revenue in 2000 as weights in our regressions.[15]

In our benchmark regression we control for firm age; the type of business entity (e.g. limited liability company, publicly traded etc.); average export share between 1997 and 2000 and its square; average profitability between 1997 and 2000 and its square; the average share of labor between 1997 and 2000 and its square; depreciation rate between 1997 and 2008; the share of wage cost in total labor cost and its square term, and the industry level import exposure between 1997 and 2008. In some specifications we also include 2-digit NACE industry dummies.

The key identification assumption in this difference-in-difference type of regression is that high FA and low FA 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.

Employment Effects. Parameter estimates from regressions of equation 1 are summarized in Table 1. Columns (1)-(3) in Panel A examines the employment effects of the minimum wage two years after the minimum wage hike. The point estimate in Column (1) indicates that the employment declines by 8.5% (s.e. 0.8%) more at firms where 100% 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-off).

The estimated employment loss is slightly smaller (8%, s.e. 1%) if we control for the rich set of observable characteristics described above (Column (2)). In Column (3) we also add industry fixed effects which have only a moderate effect on the estimated disemployment effects, although controlling for industry fixed effects may eliminate some of the between-

[14]To estimate exposure to the minimum wage we need pre-reform wage information. Therefore, we cannot calculate the exposure, FA_i, for firms which started up after 2000. Since we need to drop new entrants for all years following the reform, we have also droped them years before the reform. In the Online Appendix we explore whether excluding new entrants from the analysis biases our estimates. The Appendix Figure A-7 depicts the relationship between (3 digit) industry level net entry rate and the industry level exposure to the minimum wage for different years. The figure shows that the industry-level relationship between exposure to the minimum wage and the entry rate did not change after 2000.

[15]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 highly skewed (e.g. the employment has a Pareto tail with $\alpha = 1.5$) and so the mean and the variance of the weights sometimes are not finite. Therefore, the central limit theorem might not hold in the level-weighted regressions. To reflect that larger firms are more important, but avoid using a weights with highly skewed distribution, we use the logarithm of revenue (or employment) as weights.

industry employent changes caused by the minimum wage increase. Therefore, throughout the paper we treat the estimates without industry fixed effects as our benchmark one, but we also report specifications with industry fixed effects.

In Columns (4)-(6) we examine the "medium term" employment effects by estimating employment changes between 2000 and 2004. We find that employment is around 10% lower at the highly exposed firms relative to the non-exposed ones four years after the increase in the minimum wage. This highlights that the medium term employment effects are somewhat larger than the short term effects (10% vs. 8%), but around 80% of the total employment loss occurred within two years of the minimum wage hike.

The identification strategy relies on the assumption that employment changes at firms with fewer minimum wage workers are a valid estimate of the counterfactual for firms with many affected workers. While this cannot be tested directly, we examine whether this assumption holds in the period before the minimum wage hike. In Table 1 in Columns (7)-(8) we report the relationship between the employment change before minimum wage hike and the exposure to the minimum wage. All three columns show that the relationship between the exposure to the minimum wage and the pre-reform changes in employment are close to zero, and so employment did evolve similarly in these firms in the period before the reform.

Panel (a) of Figure 2 shows the employment effects for all years between 1997 and 2004. The evolution of β_t for employment underlines that highly and less exposed firms had parallel employment trends before the minimum wage hike that broke when minimum wage was raised: firms with higher exposure to minimum wage experienced a small, but significant decline in employment after 2000. The pattern of β_t provides further evidence that most of the disemployment effects of the minimum wage emerged in the first two years after the minimum wage hike.

Our regression estimates of equation 1 assume linear relationship between exposure to the minimum wage and changes in employment. To test the presence of non-linearity we depict the non-parametric (binned scattered) relationship between percentage change in employment and FA_i in Figure 3. The graph shows that the relationship between exposure and the employment change is close to linear. This result also highlights that the employment effect of the minimum wage is not concentrated in some highly exposed firms (with close to 100% of workers directly affected), but all exposed firms responded to the minimum wage increase (albeit to different extents).

To compare these disemployment effects with the findings of the previous literature we calculate the employment elasticity with respect to the minimum wage ($\%\triangle Emp/\%\triangle MW$).[16]

[16]Researchers typically express the minimum wage in terms of the average or the median wage in the economy. We do the same here and examine the percantge change in the *minimum wage relative to the median wage*. The evolution of that variable is shown in Figure 1.

Most of the literature reports the estimated effect of the minimum wage on a particular group of workers (e.g. teenagers or restaurant workers). Many workers in these groups earn above the minimum wage and so are not affected by it directly. For instance, in the U.S. 75% of teenage workers earned above the minimum wage in 2012 (BLS 2013). However, our estimates express the employment loss as the percentage of *directly affected* workers and not as the percentage of *all* workers in a given group. To compare our results to the estimates in the U.S. literature that mainly focus on teenage workers, we multiply our estimates by 25%, which is the share of directly affected teenagers in the U.S. in 2012.

The employment elasticities with respect to the minimum wage are reported in Table 1. The implied elasticity is found to be between -0.03 and -0.04 depending on the specification considered and all of them are statistically significant from zero. 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 2014, CBO 2014, Doucouliagos and Stanley 2009, MaCurdy 2015).

Effect on Wages. An alternative way to assess the size of the employment effect is to compare it to the impact on wages (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. We use the same specification as the one in equation 1, but we can only run our wage regressions for firms that survived and so we can calculate the average wage. However, firms' closure might not occur at random. In the Online Appendix Table A-3 we report estimates in which we correct for this selection and show that the results are very similar to those presented here.[17]

Columns (1)-(3) in Panel B of Table 1 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 highlights that firms with high exposure experienced a 55% increase in their average wage relative to those with less exposure. Columns (4)-(5) show that the effect on average wage is slightly lower in the medium-term, because the level of minimum wage was somewhat lower in 2004 than in 2002 (see Figure 1). Finally, Columns (6)-(9) explore whether the parallel trend assumption holds in the period before the minimum wage reform. While the change in the average wage is statistically significant in the period before the reform, the estimated magnitude is very small (2%-3%) relative to the effect of the reform (40%-50%).

In Panel (a) of Figure 2 we show the estimated β_t-s from equation 1 with average wage as the dependent variable over time (red dashed line). The graph underlines the results presented

[17] We compute the selection corrected average wage by 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% (average) wage increase for those firms who died. Second, we estimate equation 1 using a least absolute deviation (LAD) estimator on the sample that includes the imputed wage changes as well.

in Table 1: before the reform there is no clear relationship between fraction affected and the change in average wage, while wages increased dramatically at highly exposed firms after the reform. Moreover, the effect of the reform on wages closely follows the path of the minimum wage depicted on Figure 1, which is a strong indication that observed changes were caused by the minimum wage hike and not by something else.

Figure 2 also highlights the size of the wage 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.

In order to demonstrate this latter point we also calculate 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. Table 1 Panel B shows these elasticities and the bootstrapped standard errors. The short-run elasticity is around -0.15 (s.e. 0.02), while the medium run is slightly higher (-0.20, s.e. 0.02).

In Figure 4 we contrast these employment elasticities with the findings in the previous literature. Our point estimates are at the lower end of the literature but lie within the 95% confidence intervals of most previous estimates. Another striking feature of Figure 4 is that our (bootstrapped) standard errors are an order of magnitude smaller than previous estimates, even if many papers do not calculate robust standard errors. The relatively small standard errors are the result of the uniquely large and persistent minimum wage shock considered here. The magnitude of the reform delivers a large and precisely estimated effect on wages (e.g. 55% with 1% s.e. in 2002). When we divide the employment effects by this precisely estimated wage effect, the standard errors on our employment elasticity remain small.

In Figure 2 Panel (b) (blue solid line) and in Panel C of Table 1 we also show the relationship between the fraction of directly affected workers and the labor cost of an average worker. This latter differs from the wage of an average worker, because it includes employer's social security contributions and non-cash employment benefits. The estimated effect on labor cost is around 15% lower than the estimated effect on the wage, which leads to a 15% higher elasticity.

The lower impact on wages could be caused by two factors. First, even if non-cash benefits stay the same, the percentage change in cost of labor would be smaller as the same wage increase would be compared to a higher base. Second, the minimum wage increase might induce some firms to offset the wage increase by cutting non-wage benefits. In the Appendix Figure A-3, we explore separately the effect of the minimum wage on non-wage benefits and social security contributions and we find no indication that minimum wage led to cuts in non-wage benefits.

Robustness. In the Online Appendix in Table A-4 we show the employment effects for alternative sample selections. In Columns (3) and (4) we do not apply the industry restrictions we applied in the benchmark sample. The estimated disemployment effects are very close to our benchmark estimates.[18] In Columns (5) and (6) we show the result of including smaller firms (with at least 2 employees). The estimated disemployment effects are around 80% of the benchmark estimates, which suggests that the employment loss was smaller at micro enterprises. The attenuated effect might be due to the fact that smaller firms are often family businesses or are otherwise less able to lay-off their workers. It is also possible that average wage at these firms is under-reported and so the predicted exposure to the minimum wage, FA_i, is biased. Since we do not know whether the lower disemployment effect is a real response or a reporting issue, we focus on larger firms (at least 5 employees) in our main analysis.

In Columns (7) and (8) we show the results for the firms that survived until 2004. Surprisingly, the employment loss is slightly larger for the existing firms than in our benchmark specification. This is because the highly exposed firms are less likely to exit the market, though this effect is not statistically significant. While an apparently negative effect of exposure to the minumum wage on the firm exit rate seems unintuitive, our estimates are in line with previous findings in the literature. For instance, Draca et al. (2011) also found a small, insignificant negative effect on firms' exit rates in the UK (see Table 5 in their paper).[19]

3.1 Alternative Evidence on Employment

Bunching. To provide further support for our firm-level estimates we present two additional sources of evidence. We start our analysis by examining the evolution of the frequency distribution of monthly earnings over time. Figure 5 shows the earnings distribution in 2000 (the last year before the minimum wage hike) and in 2002 (two years after the reform).[20]

Figure 5 Panel (a) shows the frequency distribution of monthly earnings in 2002 (red empty bar) and in 2000 (brown solid bar).[21] The lograrithm 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),

[18]The main reason for excluding some industries from our analysis is that key variables from the income statements (e.g. revenue or profit) are unreliable in those sectors. However, it is reassuring that the employment effects, which are more reliably estimated, are very similar for the excluded and non-excluded industries.

[19]In the U.S. context Rohlin (2011) finds no effect on exit rates, while Aaronson et al. (2014) find an increase in exit rates.

[20]To make the wage distributions comparable over time we adjust them by nominal GDP growth (real GDP growth multiplied by the CPI). 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 real GDP growth.

[21] We report results for monthly (and not daily or hourly) earnings, because we do not observe hours worked before 1999. However, 95% of the workers work full-time (CSO, 2000) so the distributional graphs on hourly wages looks very similar.

representing a .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 additional jobs in the new earning distribution at and above the new minimum. These changes in the wage distribution provide a strong indication that (many) jobs below the new minimum wage did not disappear from the wage distribution, but instead they were kept, got a pay raise and caused bunching at and slightly above the minimum wage.

In fact, one can infer the number of jobs destroyed (or created) by comparing the size of the bunching in the new earning distribution to the number of jobs below the new minimum wage in old earning distribution (Lindner 2015).[22] In the absence of any behavioral response from the firms (or from workers' side) all jobs below the new minimum wage should appear at (or slightly above) the minimum wage. However, if some low wage jobs are destroyed, the excess number of jobs will be lower than the jobs affected by the minimum wage. Alternatively, if firms respond to the minimum wage by hiring more low wage workers then the excess number of jobs at and above the minimum wage will increase. Therefore comparing the size of the bunching to the number of jobs affected by the minimum wage identifies the extent of behavioral responses to the minimum wage.[23]

Figure 5, Panel (b) reports the size of bunching relative to the number jobs below the minimum wage. To estimate the size of bunching we calculate the excess number of jobs between the minimum wage and the threshold $\bar{W}$ above which no bunching occurred, formally $Emp_{2002}[MW_{2002} < w < \bar{W}] - Emp_{2000}[MW_{2002} < w < \bar{W}]$. Since we do not know the exact value of $\bar{W}$ we try three different values: 20%, 35% and 50% above the new minimum wage. The lack of precise knowledge about $\bar{W}$ means that we can only provide rough estimates on the overall employment effects of the minimum wage. The change in the number of jobs below the minimum wage is calculated as $Emp_{2000}[w < MW_{2002}] - Emp_{2002}[w < MW_{2002}]$.[24]

Figure 5 shows the bunching estimates for the three different thresholds for the 2002

[22]The idea to use the change in the shape of the wage distribution was first proposed by Meyer (1982). We deviate from this seminal paper in two important aspects. First, Meyer (1982) relies on strong functional form assumptions to uncover the counterfactual earnings distribution in absence of the minimum wage and his results are sensitive to these assumptions (Card and Krueger 1995, Dickens, Machin and Manning 1998). Our approach uses the pre-minimum wage earning distribution as a counterfactual and so our estimation on the size of bunching is non-parametric. Second, Meyer (1982) only uses the spike in the wage distribution to estimate bunching. Here we allow existence of ripple (or spill-over) effects, and so some of the bunching occurs slightly above the minimum wage.

[23]This approach is analogous to Saez (2010) who uses the extent of bunching in the neighborhood of tax kinks to infer behavioral responses to tax incentives.

[24]Only a few workers (less than 0.5%) earn below the actual minimum wage in our sample.

minimum wage. When the threshold is set at 20% above the minimum wage, the excess number of workers relative to the number of jobs directly effected is 0.97, which implies that 3 out of 100 workers lost their job. But incrrasing the threshold $\bar{W}$ to 35% and to 50% above the minimum wage the bunching increases the estimate to above one, which suggests positive employment effects.

In Figure 6 we provide further evidence on bunching by showing the evolution of the earnings distribution from 1998 to 2004. The timing of the minimum wage is visible on the histograms. Panels (a) and (b) show that the pre-reform distributions laid on top of each other, indicating that the earning distribution was quite stable preceding the reform. In 2002, minimum wage increased by 0.30 log points, which generated a large excess mass in the 2001 earnings distribution. Depending on the threshold, $\bar{W}$, the size of bunching is between 0.86 and 1.1, so the employment effect falls between -14% and +11%. This range includes our firm-level estimate of around -7% in 2001.

In 2002, when minimum wage was raised by .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 2003 the minimum wage was slightly lower in real terms than the 2002 minimum wage. The estimated employment effect is between -7% and +11%. Finally, in 2004 the minimum wage was kept at a similar level as in 2003, but an unrealistically high level of excess number of 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 seen more directly in Appendix Figure A-4 where we report the kernel densities.[25] Overall, the bunching evidence provide further graphical support that the overall employment effects of the minimum wage of this massive minimum wage hike was limited, as various specifications show that effect of the minimum wage on the workers below the new minimum was somewhere between -14% and +15%.

These estimates reflect the overall employment effect of the minimum wage. However, the jobs showing up in the new earnings distribution might not employ the same "type" of workers as the jobs affected by the minimum wage: the composition of the wage workers in the pre- and post-reform earnings distributions may change? We provide evidence on this by comparing the earnings predicted by observable characteristics in 2000 and in 2002. In particular, we estimate the relationship between observable characteristics (age, education, gender, region) and earnings in year 2000, and use this relationship to predict earnings in 2000 and 2002. In Appendix Figure A-5 we show the distribution of predicted earnings for

[25] In the main analysis we follow the bunching literature and use the frequency distributions of earnings (see Kleven, 2016) instead of the probability density used by Card and Krueger (1995), Meyer (1982), and Dickens et al. (1998).

those workers who earned less than 135% of the 2002 minimum wage. The distribution in the two years are similar to each other indicating that the "type" of workers employed at the bottom of the wage distribution did not change between 2000 and 2002.[26] This suggest that there was no substitution between different type of labors such as low skilled and high skilled in response to the minimum wage.

Grouping Estimates. 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:

$$epop_{gt} = \alpha + \beta_1 FA_g \times After_t + \beta_2 FA_g + \gamma X_{gt} + \theta_g + \xi_t + c_g t + \varepsilon_{gt} \quad (2)$$

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.[27] The β_1 coefficient on $FA_g \times After_t$ measures the effect of the minimum wage on employment. In equation (2) 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.[28] 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.[29]

Table 2 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

[26] We also check whether there was a change in the share of low educated, share of female or in the average age at the bottom of the wage distribution and we do not find evidence for that.

[27] 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.

[28] 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% in 1996 to 17% in 2000. This increase was boosted further by a generous student loan program that was introduced in 2001. As a result, enrollment rate increased to 24% by 2004. We note that the growth in enrollment is very similar between 1996 and 2000 and between 2000 and 2004.

[29] 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.

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 the prime-age adult (25-55 years old) population to explore whether the presence of the oldest cohorts drives the results.[30] 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-specifc 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.

Panel B of Table 2 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 low exposed ones after the reform. However, the estimated effect on wages, similarly to employment, is lower than the firm-level estimates in Table 1, 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), where the elasticity is too imprecise to allow for any conclusions, the estimates are between -0.28 (Column (2)) and -0.09 (Column (3)). Overall, these elasticities are in line with the firm-level estimates shown in Table 1, which suggests that our results are robust to using alternative data sources and identification procedures.

4 The Incidence of Minimum Wages

Our 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 by some other actors in the economy. In this section we go back to our firm-level analysis and examine behavioral responses at various margins in order to better understand who bears the incidence of the minimum wage.

[30] In 1999 a pension reform was introduced (see the details in the Online Appendix). The fact that dropping the oldest cohorts does not affect our results suggests that this pension reform does not contaminate our main results.

4.1 Effect on Revenue, Price, Material, and Capital

Labor Cost. We start our analysis by documenting the effect of the minimum wage on total labor cost, which is a proxy of the total income collected by workers. Again we estimate the relationship between fraction affected by the minimum wage and the change in total labor cost four years before and four years after the minimum wage using equation 1. Table 3, Panel A shows the estimated coefficients, while Figure 7 plots them over time for the specification with no industry fixed effects. Figure 7 (and also Columns (5) and (6) of Table 3) shows highly exposed and less exposed firms followed 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% of the workers earned below the new minimum wage was 33% and 23% higher two and four years after the minimum wage hike relative to a firm with no workers below the new minimum (Columns (1) and (3)).[31] This large increase in firms' labor cost is in line with our previous findings on wages and employment. Moreover, the time pattern of the labor cost increase (with the effect highest in 2002 before dropping slightly in 2003) closely resembles the evolution of the minimum wage depicted in Figure 1. This implies that the changes in wages (and employment) are likely to be related to the minimum wage change and not to something else.

Revenue. We examine the effect on revenue in Panel B of Table 3 and in Panel (b) of Figure 7. The relationship between the minimum wage and revenue exhibits a similar pattern as 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 5.3% (s.e. 1.3%) more at highly exposed firms two years after the hike and by 1.8% (s.e 1.5%) in the medium term (four years after). In specifications where we control for industry fixed effects (Columns (2) and (4)) the effect on total revenue is even larger (7.2% in 2002 and 4.3% in 2004). The considerable increase in the revenues suggests that a part of the labor cost increase was financed by consumers.

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 factor as spending on materials is around 77% of total revenue (see Table A-2).[32] Total spending on materials increased in the short term (3.2%, s.e. 1.2%),[33] while

[31] In the Appendix Figure A-6 Panel (a) and (b) we also show the non-parametric relationship between exposure to the minimum wage and total labor cost. The figures show that the relationship is close to linear.

[32] Table A-1 in the Appendix shows that the share of materials in production is generally high across Europe. The average across European countries is around 66% and it is slightly higher in the Eastern European region (72%).

[33] The positive effect on materials can be explained by substitution between labor and materials or by a differential price increase in the price of the 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 raises prices throughout the

in the medium term the effect on materials is close to zero (0.4%, s.e. 0.02). The effects are slightly larger if we control for industry specific shocks, but the difference is small. Both the short term and long term estimates on materials are lower than the increase in revenue. Therefore, even though the spending increase on materials partly offset the effect of higher revenue, the increase in revenue net of materials was still considerable.

Capital. In Panel E of Table 3 we explore the effect on capital.[34] Apart from a recent study that examines the effect of the minimum wage in China (Hau et al. 2016), the literature does not directly assess the effect of minimum wages on capital. Our estimates highlight the importance of this margin of adjustment. 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 almost by 20% (s.e. 4%) within four years of the minimum wage hike. This evidence suggests that capital-labor substitution plays an important role in the minimum wage context. We explore the implication of these estimates further and provide new estimates on this substitution elasticity in Section 6.

Finally, for each of these estimates we also report the implied elasticity with respect to the labor cost per worker. To calculate these, we divide the estimates on FA_g by the point estimate on the cost per worker and calculate the standard errors by bootstrapping. We use these elasticities to estimate the model presented in Section 6.

4.2 Price effects

In the previous Section we showed that the increase in Hungary's minimum wage had a large positive effect on revenue. Is this increase 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 (around 50%) 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.[35] Column (1) of Table 4 shows the relationship between fraction of workers affected directly by the increased minimum wage and the change in output prices when no controls and no industry dummies are included in the regression. The estimates show that prices increased by 7.6% (s.e. 2.5%, see Panel A) in the short term and by

supply chain.

[34]We calculated the capital stock using the perpetual inventory method (see the details in the Appendix). We proxied real investments in the following way. As a first step we calculated the nominal investment at time t, which is the sum depreciation and the change in tangible fixed assets. In the year, when the firm is established we take the nominal value of fixed assets as investments. We then turn nominal value into real by using investment deflators from 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, cars such items appears as material costs.

[35]See the Online Appendix for further details on how we construct our price index.

13.7% (s.e. 5%, see Panel B) in the medium term. Controlling for observable characteristics (Column (2)) and the time specific industry effects (Column (3)) increases the standard errors but does not affect the point estimates substantially. Panel C also reports the relationship between exposure to the minimum wage and prices in the period before the minimum wage reform, and we do not find evidence for pre-existing trends.

Figure 8 Panel (a) 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 effects after the minimum wage hike: the timing of the change in prices corresponds to the time of the reform. Moreover, the figure also suggests that the price responses to the minimum wage occur gradually as it takes time for firms to adjust their prices. In Figure 8 Panel (b) we contrast the size of the price effects to the size of the revenue effects. 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 the reform. Therefore the quantity response to the minimum wage was negative. This evidence is consistent with the competitive labor market model that predicts a positive price effect and negative quantity effect (Aaronson and French 2007).

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 (3,252 in 2002 and 2541 in 2004), because some firms shut down or otherwise leave the survey over time.[36] In Columns (4)-(6) we examine whether the differential short and long term price changes are caused by changes in the sample composition. We find that the short term effects are larger once we restrict our analysis to a balanced sample.

All of this evidence shows that the main driving factor behind the revenue increase in the manufacturing sector was higher prices. 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 in other sectors directly, it is likely that price increase played a key role in those sectors as well.

4.3 Estimating the Incidence of the Minimum Wage

The positive effect on prices and revenue suggests that the income gain caused by the minimum wage was (partly) paid by consumers. In this section we explore the effect on profits in order to estimate the incidence on firm-owners. The starting point of our analysis is the following

[36]Most of the results presented in this paper take into account that some firms close down and so their outcome variables (e.g. employment, revenue, etc.) go to zero. However, we cannot make this assumption for prices, and so we cannot include firms that shut down in the regression.

accounting identity:

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

where $MiscItems$ include depreciation expenses and minor accounting items (e.g. accrual deferrals). If we drop this latter item and rearrange we get the following expression:

$$\frac{\triangle LaborCost}{Revenue_{2000}} = \underbrace{\frac{\triangle Revenue}{Revenue_{2000}} - \frac{\triangle Material}{Revenue_{2000}}}_{\text{Consumers Pays}} - \underbrace{\frac{\triangle Profit}{Revenue_{2000}}}_{\text{Firm Owners Pay}} \tag{3}$$

The equation above highlights that 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 expenses, and so it captures the amount paid by the consumers who buy the goods produced by the firm.[37] The second part shows the effect on profits, which reflects the incidence on firm owners.

We assess the incidence of the minimum wage by estimating the effect of the reform on various items in equation 3. In particular, we estimate the following regression for various outcomes y_i (such as labor cost, revenue, or materials):

$$\frac{y_{it} - y_{i2000}}{Revenue_{i2000}} = \alpha_t + \beta_t FA_i + \gamma_t X_{it} + \varepsilon_{it} \tag{4}$$

The key difference between this equation and equation 1 is that the outcome variable is measured relative to revenue in year 2000 and not to its own value in year 2000, y_{i2000}.

Table 5 shows the estimated coefficients in 2002 and 2004. Panel A shows the effect on change in total labor cost (relative to $Revenue_{2000}$). The labor cost increase in the short term was around 3.5% (2.3% in 2004) of revenue in 2000. Moreover, the red line in Figure 9 shows the relationship between minimum wage and labor cost over time. The result resembles the impact of the minimum wage reform on total labor cost (relative to labor cost in 2000) shown in Figure 7.

Panel B in Table 5 shows the estimated revenue effects. Note that these figures are the same as those in Table 3. At the same time, in Panel C of Table 5 we report the estimates on materials (relative to $Revenue_{2000}$). Given that share of materials in total revenue is quite large, these estimates closely resemble the estimated the effect of the minimum wage reform on the percentage change in materials (presented in Table 3). In Panel F we report the difference between the estimated effect on the revenue change and the estimated effect on materials. According to equation 3 this captures the incidence on consumers. In the penultimate panel

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

of Table 5, we compare the size of this difference to the estimated effect on labor cost (Panel A). The various specifications highlight that the change in net revenue is between 75% and 110% of the labor cost increase.

In Panel D we estimate the effect on accounting profits (Earnings Before Interest and Taxes). Column (1) in Panel D shows that profits fall by 0.7% (s.e. 0.3%) of the revenue in 2000 at highly exposed firms in the short run (within two years of the reform). This change is around 20% of the average profitability (profit over revenue) in 2000, which is 3.3% (see Table A-2). The medium-term profit reduction is slightly less (0.5%, s.e. 0.3%) and not statistically significant. Columns (2) and (4) in Table 3 also suggest that the effect on profits is close to zero once we control for industry shocks. While the evidence on profits is somewhat mixed, we can rule out substantial profit declines in response to the minimum wage. In the last panel of Table 5 we compare our profit estimates to the changes in labor cost. The panel highlights that the incidence varies somewhat across estimates but firm owners pays at most 20-25% of the labor cost.[38] In Figure 9 we show the evolution of the incidence over time. Panel (a) shows the estimates without industry controls, while Panel (b) includes them. The estimates before 2000 suggest that the parallel trend assumption holds for these variables. Moreover, the graph underlines our key conclusion from Table 5: a large part of the increase in total labor cost is financed from the gap between the revenue increase (blue dashed line) and the materials increase (black dotted line). This evidence suggests that the incidence on firm owners was limited and the main burden of the minimum wage increase fell on consumers.

Who are these consumers who buy 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 exposure to the minimum wage by taking into consideration input-output linkages across industries. The resulting exposure to the minimum wage is shown in the Appendix Table A-10. Industries with high exposure include agriculture, paper and printing, and food processing. 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. The Online Appendix Figure A-12 shows the non-parametric relationship between household income and the minimum wage content of consumption. The figure highlights that richer households spends larger fraction of their consumption on industries exposed to the minimum wage, though that share is also large some of the poorest households. And so, even though consumers bear the majority of the incidence of the minimum wage increase, this burden is borne more by higher income consumers than minimum wage workers. This suggests that the minimum wage may be an

[38] In the Appendix Figure A-6 we present the non-parametric binned scatter plots of the relationship between revenue/profit/total labor cost change and fraction affected by the minimum wage.

effective redistributive policy.

5 Heterogenous Responses to the Minimum Wage

This section explores heterogeneity in the responses to the minimum wage increase to better understand which workers benefit the most (or the least) from the minimum wage and how the incidence varies across industry and firm characteristics. We focus here on the regressions without industry fixed effects, because the fixed effects may eliminate between-industry variation in the causal effects of the minimum wage. We report the results with industry fixed effects in the Appendix.

Heterogenous responses by industry. In Table 6 we show the relationship between the fraction of workers affected directly by the minimum wage and various outcomes by sector. We estimate regression equation 1 separately (without industry fixed effects) for each of the following sectors: manufacturing, construction, service, tradable and non-tradable. 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% 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 Appendix we describe the procedure and list the classification for each industry in detail.

Panel A shows the short term effects (two years after the reform), Panel B shows the medium term effects (four years after), and Panel C checks whether the parallel trend assumption holds before the reform. The first column reports the effect of the minimum wage on the average cost of labor. The estimated impact on that outcome is similar across sectors, although it is slightly higher for non-tradables.

Column (2) reports the the effects on employment. In the short term (two years after) the effects in the construction, service and manufacturing sectors are quite similar. But in the medium term (four years after) a clear difference emerges: the disemployment effects are smaller in the construction (-7%) and in the service (-8%) sectors than in manufacturing (-12%).These differences are even more striking when we compare tradable and non-tradable industries. Panel (a) of Figure 10 shows the effect of the minimum wage on employment over time. While the estimated effects are very similar before the reform (both show a slight positive pre-trend), the two sectors gradually diverge after the reform. The medium term disemployment effect of the minimum wage is considerably larger in the tradable (-17%) than in the non-tradable sector (-5%).

Column (3) in Table 6 shows that these differences in employment are reflected in the total labor costs as well. For instance, the medium term labor cost increase is only 12% in

the tradable sector, while it is 34% for non-tradables. The effect of the minimum wage is also lower in the manufacturing (19%) than in the service (26%) or in the construction sectors (26%). These estimates highlight that 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. At the same time, minimum wage has a more positive effect in the local service and non-tradable sectors than our baseline estimates indicate. Moreover, our findings also imply that the sectoral composition of the minimum wage workers plays a crucial role in welfare assessment and in assessing the efficiency loss related to the minimum wage. Our estimates suggest that in countries or cities where a large fraction of minimum wage workers work in the local service sector, the minimum wage will have a small effect (if any) on employment and large effect on wages. These workers would therefore benefit from the minimum wage hike. And since the change in production is small, the efficiency loss from the raising minimum wage will be also limited. However, in places where minimum wage workers are concentrated in the the manufacturing and tradable sector, we expect the disemployment effect of the minimum wage to be larger and so many workers will be made worse-off. Moreover, the large shift from using low wage labor in the production also suggests that the efficiency loss induced by the minimum wage is large.

In Column (4) we explore the revenue effects across sectors. In line with the employment findings, the revenue increase is lower in sectors where the disemployment effects are larger (e.g. the manufacturing tradable sectors). In Figure 10 Panel (b) we plot the effect on revenue over time in the tradable and in the non-tradable sectors. Similarly to Panel (a), the pre-existing trend is very similar in the two sectors. However, there is a large divergence after the reform: the medium term effect of the minimum wage on revenue is positive in the non-tradable sector but negative for tradables. These differences can emerge if the pressure to raise prices is similar across sectors, but the consumers' responses to such a price change differs. 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 wage shock. Therefore, any decrease in output demand following a price increase will be more limited. This can explain our finding of a positive revenue effect in the non-tradable sector.

The differences between non-tradable and tradable sectors are also hard to reconcile with the potential productivity enhancing effect of the minimum wage (Mayneris et al. 2016, Riley and Bondibene 2015, Hau et al. 2016). If the minimum wage increases productivity and firm-level output, then prices would fall significantly in sectors where the output demand is inelastic, and in sectors where the output demand is very elastic prices would not change

much. Therefore, the productivity enhancing explanation would predict that in the exporting sector, where output demand is very elastic, we should see an increase in output, a limited price effect, and a positive revenue effect. In contrast, in the non-tradable sector where firms face more inelastic demand, we should see an increase in output, a large price reduction, and a revenue decrease. However, we observe exactly the opposite of this in the data and so it is unlikely that the minimum wage increases productivity.

In Column (5) of Table 6 we explore the effect of the minimum wage on material expenses and show that the results are similar to those for revenue (in Column (4)). In Column (6) we report the effect on profits. In the medium term (Panel B) the profit loss is slightly larger in the service, non-tradable and in tradable sectors, while it is smaller in the manufacturing and in the construction sectors. However, the effects are not statistically different from each other, and so we cannot reject that firm owners are equally affected by the minimum wage change.

In Column (7) we examine the effect on capital. The short term estimates (Panel A) are similar across sectors, although the capital increase is more muted in the tradable sector (8% versus 13% in the non-tradable sector). These differences increase in the medium term, where the effects in the service (24%) and in the non-tradable sectors (25%) are considerably larger than in the manufacturing (17%) and in the tradable sectors (9%). However, these estimates do not necessarily reflect differences in capital-labor substitution as the change in capital is also likely to be affected by the changes in output (a scale effect). In Section 6 we adjust for differential output changes across sectors and provide direct estimates on the capital-labor substitution.

By firm's characteristics. In Table 7 we explore heterogeneity in the effect of the minimum wage across various firm characteristics. We run regressions similar to equation 1 but we also include interactions between a set of control variables and the fraction of workers affected by the minimum wage reform.[39] In addition to the control variables we included in our previous analyses, we also control for the industry-level Herfindhal index. In Panel A of Table 7 we show the short term effects (two years after), in Panel B the medium term effects (4fouryears after), while in Panel C we test the presence of pre-existing trends.

The interaction term between fraction affected and export share (FA×Export share) is negative, which indicates that the disemployment effect of the minumum wage hike is larger for firms with a larger share of revenue derived from exports. The point estimates in Column (2) show that firm with 100% export share (i.e. selling only to the export market) had an 8.3 (s.e. 4) percentage point larger disemployment of the minumum wage hike in the short term (Panel A) and 22 percentage point (s.e. 6) larger effect in the medium term. This means that

[39]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.

the disemployment effect on the exporting firms is double the effect for the non-exporting firms.[40] Column (3) shows the effect of the minimum wage on labor cost. The coefficient on FA×Export in Panel B highlights that the increase in labor cost is 20 (s.e. 7.7) percentage points lower at the exporting than at the non-exporting firms four years after the reform (Panel B). This estimate indicates that total labor cost at exporting firms had decreased by 1%. Therefore, the disemployment effects at these firms was so large that all the benefits from the wage increase were dissipated and the income of the low wage workers in that sector in fell slightly. Moreover, it is not just the workers who were made worse-off: profitsfell by more in the exporting than the non exporting firms (by 2.2 percentage points, s.e. 1).

The differential responses between exporting and non-exporting firms underlines the finding that the main channel through which firms can absorb the minimum wage increase is by raising prices and passing the cost through to the consumers. Exporting firms face foreign competitors who are not hit by the minimum wage shock, and so a price increase leads to a sizable reduction in output. In line with this, Column (4) shows that revenue fell significantly in response to the minimum wage for exporting firms.

The interaction term between the fraction of affected workers and labor share in production shows that the disemployment effect is larger for firms with a higher labor share. The point estimates in Panel B imply that moving from the 10th (4.5%) to the 90th (35%) percentile of firms by labor share leads to a 6 percentage point larger disemployment effect and 16 percentage point lower total labor cost increase in the medium term.[41] This evidence provides further support for the price pass-through channel as firms with larger share of labor in production need to raise prices more to cover their labor cost.

The interaction term between the fraction affected and the profit share shows that total labor cost (Column (3)) increases more at firms that were profitable before the minimum wage reform. The point estimate in Panel B suggests that a firm in the 90th percentile by profit share (13%) had a 4.5 (s.e. 2.3) percentage point higher increase in total labor cost in response to the minimum wage hike than a firm in the 10th percentile of profit share (-5%). This difference is small relative to the medium term labor cost increase that was around 20% for an average firm. Meanwhile, Column (6) in Table 7 shows that profits fell considerably more at highly profitable firms than at less profitable ones. Moving from the 10th to the 90th percentile leads to a 1 (s.e. 0.4) percentage point larger drop in the short term and 1.4 (s.e.

[40]It is worth mentioning that the exporting firms had experienced a 5.5 (s.e. 3) percentage point decline in employment between 1998 and 2000 (Column (2) in Panel C), which could potentially explain part of the differences after the reform. However, the pre-reform employment estimates are likely to be related to the increase in cost of labor (Column 1). In terms of total labor cost (Column 3) and other balance sheet outcomes we do not find evidence for pre-existing trends.

[41]It is worth mentioning that these point estimates should be treated cautiously because the interaction term with labor share shows some signs of pre-existing trend differences before the reform (Panel C).

0.4) percentage point larger fall in the medium term. This is a sizable shift given that the effect of the minimum wage on an average firm is 0.8 percentage points in the short term and 0.7 percentage points in the medium term. Therefore, the evidence presented here suggests that more profitable firm owners suffer more from the minimum wage increase than their less profitable counterparts.

The interaction term between the fraction of workers affected by the minimum wage and the logarithm of employment suggests that larger firms cut employment more than smaller ones in response to the minimum wage. The medium term estimates suggest that doubling the firm size leads to 4 (s.e. 1) percentage point larger employment loss, which is translated to a 6 (s.e. 2) percentage point lower labor cost. Meanwhile, Column (7) shows that larger firms responded to the minimum wage by raising their capital stock: doubling the firm size leads to a 10 (s.e. 3) percentage point larger increase in capital. This evidence suggests that larger firms were more able to substitute their workers with capital, leading to larger disemployment effects.

Finally, we also consider the interaction term between the fraction affected and the market-level Herfindahl index. The concentration measure relies on the assumption that 3 digit industry codes captures the relevant market for each firm.[42] The interaction terms are not significant for all outcomes, which suggests that there is no clear relationship between industry-level market concentration and responses to the minimum wage. This finding is similar to those of Draca et al. (2011) for the UK and Mayneris et al. (2016) for China.

6 A Hicks-Marshall style analysis of the Minimum Wage

In this section we present a simple model and then estimate its key parameters to better understand the implications of our results. We consider markets consisting of monopolistically competitive firms in a partial equilibrium framework.[43] The monopolistic competition framework allows us to model responses to the minimum wage at level of both firms and the market. The model makes a distinction between minimum wage shocks that hit only a small

[42]We are skeptical about that this assumption holds in our context. For instance, if firms in the same industries operate in the same market, we would expect that controlling for industry fixed effects would increase the disemployment effects. However, the opposite is true in the data (see Table 1).

[43]It is possible to extend the model to take general equilibrium effects into account, but for simplicity we do not consider this 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.

subset of firms and shocks that affect all firms in the market equally, and so the effect of the minimum wage depends on whether a firm's competitors are also hit by the minimum wage shock. Moreover, the monopolistic competition model can capture that output prices may increase after a minimum wage hike. We assume that there is perfect competition in the labor market, since generating positive price effects would be challenging in the presence of the market power in the labor market (Aaronson and French 2007).

There is a continuum of firms represented by the unit interval $[0, 1]$ selling differentiated goods. Firms use three production inputs: labor, capital, and intermediate goods. Individual firms differ in the type of labor that they use. Some varieties ω are produced using minimum wage workers l, while other firms use only high-skilled workers h who are not affected by the minimum wage regulation. The production function has a constant return to scale and is given by $q(\omega_i) = f(l, k, m)$ if the firm uses minimum wage workers and $q(\omega_j) = g(h, k, m)$ if the firm relies on high skilled workers. This specification does not allow for labor-labor substitution at the firm-level, but as we showed earlier we do not find evidence for labor-labor substitution in the data (e.g. see the Appendix Figure A-5).

Consumers have a nested CES utility 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. In this utility function κ is the elasticity of substitution between different varieties in the market, while θ is the elasticity of substitution between the composite good produced by the market and other goods. The consumers face the following budget constraint:

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

In the Online Appendix we derive the product demand function implied by these preferences. The effect of the price change on output demand will depend on the fraction of firms in the market raising their prices. If only one firm raises its price then the price elasticity with respect to the minimum wage is given by the following equation:

$$\frac{\partial \log q(\omega)}{\partial \log p(\omega)} = -\kappa \tag{5}$$

Another special case is when all firms in the market raise prices. Then the output demand elasticity depends on the substitution between the market-level composite good and other

expenses,

$$\frac{\partial \log q(\omega)}{\partial \log P} = -1 - \frac{\left(\frac{a}{1-a}\right)^{\theta} (\theta - 1) P^{\theta-1}}{1 + \left(\frac{a}{1-a}\right)^{\theta} P^{\theta-1}}, \tag{6}$$

where P is the composite price index.

Now we derive the effect of a minimum wage hike on firms using minimum wage workers. In the Online Appendix we prove that Hicks-Marshall rule of derived demand holds in this model. A key implication is that firms will raise their output prices in response to a wage increase and pass the effect of the minimum wage through to consumers. Moreover, if the production function has constant return to scale, then the price response for minimum wage firms will depend only on the share of labor in their production, s_L,[44]

$$\frac{\partial \log p(\omega)}{\partial \log MW} = \quad s_L$$

Where $p(\omega)$ is the price charged by a minimum wage firm producing variety ω. The direct effect of the price change is that total revenue, $p(\omega)q(\omega)$, increases by s_L%. However, the change in prices leads to a decline in output. The extent that production is scaled back depends on the elasticity of the demand, η. As we showed earlier this elasticity is determined by the market structure. If all firms in the market use minimum wage workers, the demand elasticity will determined by equation 6, while if only one firm uses minimum wage workers then it will be equal to equation 5. Therefore the effect of the wage change on revenue is given by the following equation:

$$\frac{\partial \log p(\omega)q(\omega)}{\partial \log MW} = \underbrace{s_L}_{\text{price effect}} \quad \underbrace{-s_L\eta}_{\text{scale effect}} \tag{7}$$

where the first part is the price effect and the second part is the extent production scaled back.

The elasticity of labor demand with respect to the cost of labor[45] has the following form:

$$\frac{\partial \log l(\omega)}{\partial \log MW} = \underbrace{-s_L\eta}_{\text{scale effect}} \quad \underbrace{-s_K\sigma_{KL}}_{\text{substitution between K and L}} \quad \underbrace{-s_M\sigma_{ML}}_{\text{substitution between M and L}} \tag{8}$$

[44] All firms employing minimum wage workers will raise their prices by this amount. Meanwhile, firms with high skilled workers will not change their prices.

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

where 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. The first part of equation (8) is the scale effect: as a result of the price change, output falls and firms must scale back their production, and so they will use less labor. The second and the third parts are the substitution effects between labor and other inputsinduced by the increased cost of labor relative to other inputs. The second part shows the substitution between capital and labor. This substitution will depend on the Allen-partial elasticity and the share of capital in production, s_K. The third part caused by the substitution between labor and intermediate goods.

Equation (8) highlights that the importance of scale effects and the substitution effects depend on the factor shares. Table A-2 shows the share of these factors in firms' total production by broad industry categories. The labor cost is only 18% of total revenue for an average firm, while spending on capital is another 6%. Expenses on intermediate goods and services (materials) are around 77%. This indicates that the low labor demand elasticities can only be consistent with the Hicks–Marshall rules of derived demand if the substitutability between labor and materials (σ_{ML}) is sufficiently low.

As we show in the appendix, this model has predictions on the effect on other key firm-level characteristics as well:

$$\frac{\partial \log k(\omega)}{\partial \log MW} = s_L(-\eta + \sigma_{KL}) \tag{9}$$

$$\frac{\partial \log m(\omega)}{\partial \log MW} = s_L(-\eta + \sigma_{ML}) \tag{10}$$

Estimation. 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. 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 (shown in Table 1 and in Table 3). 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. 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.

Table 8 shows the estimated parameters (Panel A) across sectors using our benchmark estimates, while in the appendix Table A-7 we present results controlling for industry fixed

effects.Firm-level responses imply that an average firm with minimum wage workers faces perfectly inelastic output demand in the short term (0.02 s.e. 0.12), and fairly low elasticity in the medium term (0.31 s.e. 0.18).[46] But the output demand elasticity varies across sectors: it is close to zero in the local tradable and in the service sectors, even in the medium term. This implies that firms in these sectors can pass the effect of the minimum wage through to consumers without a substantial reduction in output.[47] In the exporting sector, the short term estimate on output demand is 1.52 (s.e. 0.59), while our medium run elasticity estimate is 3.67 (s.e. 0.81). These estimates are close to the output demand elasticities reported in the trade literature.[48]

The estimated capital-labor substitution in Table 8 is 1.33 (s.e. 0.21) in the short-run and it is even larger in the medium run 2.66 (s.e. 0.35) . These estimates are slightly higher than the recent estimates in literature (e.g Karabarbounis and Neiman (2014) found that capital-labor substitution 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 labor does not generate large employment effects. The key reason for this is that the share of capital expenses is only 6% of total production at the firm-level, and so even a large capital labor substitution has only a small effect on employment.[49]

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 (and is even negative in some). Is a low elasticity of substitution between intermediate goods and labor consistent with existing empirical estimates? Some intermediate goods can be used as substitutes for labor: for instance, the elasticity of substitution between energy expenses and labor have been estimated to be around 0.3-0.7 (Berndt and Wood 1975, Hamermesh 1993). But only a small portion (2-3%) of intermediate goods are related to energy expenses (Basu and Fernald 1997, Hamermesh 1993). Overall estimates on the elasticity of substitution between materials and labor are often found to be much smaller. 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 (2014) found 0.05 using all industries

[46]The medium term output demand elasticity is close to the -0.33 compensated demand elasticity estimated by Seale et al. (2003).

[47]In the U.S., minimum wage workers work predominantly in the local service sectors (e.g. restaurants or retail). While the output demand elasticity is not estimated directly in the U.S. minimum wage literature, MaCurdy (2015) argued that the main findings in the U.S. literature imply that the output demand elasticity in the minimum wage context is close to zero (MaCurdy 2015).

[48]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).

[49]The share of labor expeneses is 17%, while the share of spending on materials and intermediate goods is 77%. Therefore, the share of capital in firm's value added is 26% (6%/(6%+17%)) and the share of labor in firm's value added is 74% (17%/(6%+17%)).

in his estimation.[50] Moreover, Berndt and Wood (1979) and Basu (1995) 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. Therefore, a low elasticity of substitution between intermediate goods and labor is consistent with existing empirical estimates.

In Panels B and C of Table 8 we report the empirical and the actual moments. The moments predicted by the optimal parameter values match closely the moments in the data, especially for the employment elasticity and capital elasticity. However, the model over-predicts the revenue elasticitiy and under-predicts the material elasticity. Failing to predict these two variables leads to a rejection of the model in some specifications. We report the goodness of fit statistics in the final row. The threshold for rejecting the model statistics is 3.84.[51] The model is rejected for all firms and for the service sector suggesting that our model does not capture some important aspects of firm-level responses in these sectors. However, our simple model cannot be rejected for the exporting sector and for the non-tradable sector (and also for the manufacturing and for tradable sector in the medium term).

To sum up, this section showed that our firm-level estimates can be used to uncover some structural parameters such as the output demand elasticity and substitution between capital and low wage labor. We demonstrated that the substitution between intermediate goods and labor, a channel which is often ignored in the literature, plays a crucial role in explaining the small disemployment effects caused by the minimum wage. Our estimates also highlight that the sectoral differences in the effect of the minimum wage are related to the output demand elasticity. The large disemployment effect in the exporting and in the tradable sector is related to the large output demand elasticity that these firms face. On the other hand, the surprisingly low output demand elasticity in the non-tradable and in service sector is puzzling. This might reflect model misspecification, with some important aspects of the market ignored. One such factor might be the willingness for local consumers to absorb price increases that are justified by pushing up wages of the poorest workers.[52]

[50] As reported in Appendix F of Atalay (2014) he finds a plant level elasticity of substitution between materials and value added between 0.45 and 0.8 in the manufacturing sector. The discrepancy between his main estimates and the one presented in his Appendix F might be because the elasticity of substitution is substantially lower in the service sector.

[51] The goodness of fit statistic follows a Chi-squared distribution with one degree of freedom. The critical value of that distribution at 5% level is 3.84.

[52] The importance of fairness in passing through cost shocks is explored in Eyster et al. (2014).

7 Discussion and Conclusion

This paper investigated the economic effects of a large and persistent increase in the minimum wage in Hungary. Most firms responded to the minimum wage by raising wages instead of destroying jobs. Hence, the higher minimum wage in Hungary redistributed resources to workers. We also showed that profitability only declined slightly among low-wage employers and so the ultimate incidence of the minimum wage mainly fell on consumers.

Given the relatively small effect on employment, our results suggest that minimum wages may be an effective tool for redistributing income from consumers to the low wage workers without large efficiency losses.[53] But which consumers buy the goods produced by the minimum wage workers? In the Online Appendix we show that the richer households spend slightly larger fraction of their consumption on goods produced by minimum wage workers. This suggests that minimum wage workers benefitted from the reform in the Hungarian case.[54]

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

Finally, we also 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 affects the cost of labor such as taxes and subsides. Our estimates also highlight that these policies can induce sizable responses in the exporting and in the tradable sectors.

[53] Lee and Saez (2012) demonstrate that a binding minimum wage can improve the welfare even in a neoclassical model and even in presence of optimal non-linear tax instruments.

[54] The evidence on who buys the goods produced by the low wage workers is ambiguous in the literature. MaCurdy (2015) shows that it is mainly poor consumers who bear the incidence of the minimum wage, while Leonardi (2015) finds the opposite.

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Table 1: Employment Effect of the Minimum Wage, Firm-level Estimates

	Main results						Placebo Estimates		
	Changes between 2000 and 2002			Changes between 2000 and 2004			Changes between 1998 and 2000		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Change in Firm-Level Employment									
Fraction Affected	-0.085***	-0.080***	-0.076***	-0.101***	-0.100***	-0.094***	-0.0003	0.007	0.005
	(0.008)	(0.010)	(0.011)	(0.011)	(0.013)	(0.014)	(0.007)	(0.008)	(0.009)
Constant	-0.048***			-0.119***			0.025***		
	(0.005)			(0.007)			(0.004)		
Observations	19,485	19,485	19,485	19,485	19,485	19,485	19,485	19,485	19,485
Employment elasticity	-0.033***	-0.031***	-0.030***	-0.039***	-0.039***	-0.037***			
wrt. MW	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.00)			
Panel B: Change in Firm-Level Average Wage									
Fraction Affected	0.50***	0.55***	0.56***	0.44***	0.50***	0.52***	-0.02***	-0.03***	-0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.001)	(0.01)	(0.01)
Constant	0.04***			0.10***			-0.08***		
	(0.002)			(0.003)			(0.002)		
Observations	18,415	18,415	18,415	16,980	16,980	16,980	19,485	19,485	19,485
Employment elasticity	-0.17***	-0.15***	-0.14***	-0.23***	-0.20***	-0.18***			
wrt. wage	(.017)	(.019)	(.018)	(.025)	(.024)	(.027)			
Panel C: Change in Firm-Level Average Cost of Labor									
Fraction Affected	0.44***	0.47***	0.48***	0.39***	0.42***	0.44***	-0.03***	-0.04***	-0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.003)	(0.01)	(0.01)
Constant	0.01***			0.06***			-0.04***		
	(0.001)			(0.002)			(0.001)		
Observations	18,415	18,415	18,415	16,980	16,980	16,980	19,485	19,485	19,485
Employment elasticity	-0.19***	-0.17***	-0.16***	-0.26***	-0.24***	-0.21***			
wrt. cost of labor	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)			
Controls	no	yes	yes	no	yes	yes	no	yes	yes
Industry	no	no	yes	no	no	yes	no	no	yes

Note: *** p<0.01, ** p<0.05, * p<0.1. Columns (1)-(3) (Columns (4)-(6)) show the relationship between the fraction of workers exposed to the the minimum wage and the change in different outcomes in the short (medium) tem between 2000 and 2002 (2004) (see equation 1). The employment changes include both extensive margin (closing) and intensive margin (lay-off) decisions. To estimate trends for the period before the reform we report the change between 1998 to 2000 in Columns (7)-(9). Robust standard errors are reported in parentheses.

Table 2: Employment Effect of the Minimum Wage, Grouping Estimator

	(1)	(2)	(3)	(4)	(5)
Panel A: Effect on Employment-to-Population (epop)					
After 2000 × 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)
Implied Elasticity	-0.13	-0.01	-0.003	-0.01	-0.02
wrt. MW	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)
Panel B: Effect on the Average Wage					
After 2000 × 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)
Implied Elasticity	-1.38	-0.28	-0.09	-0.10	-0.13
wrt. wage	1.27	0.35	0.19	0.19	0.27
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: *** p<0.01, ** p<0.05, * p<0.1. Table shows the group level relationship between exposure to the minimum wage (FA_g) and employment and wages (see regression specifications in equation 2). Groups are created based on demographics, age, education and the region where the workers live. The coefficient on the variable After 2000 × FA_g estimates the effect of the minimum wage. In Panel A we show the effect on the employment-to-population rate. To make our estimates comparable to the U.S. literature on teenage workers we calculate the implied elasticity wrt. the *minimum wage* by assuming that 25% of workers are directly affected by the minimum wage (see the text for details). 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.

Table 3: Effect on Revenue, Materials and Capital

	Main results				Placebo Estimates	
	Changes between 2000 and 2002		Changes between 2000 and 2004		Changes between 1998 and 2000	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Change in Total Labor Cost						
Fraction Affected	0.31***	0.33***	0.23***	0.26***	-0.03***	-0.03***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)
Implied elasticity	0.65	0.69	0.51	0.58		
wrt. cost of labor	(0.03)	(0.03)	(0.05)	(0.05)		
Panel B: Change in Revenue						
Fraction Affected	0.053***	0.072***	0.018	0.043***	-0.011	0.003
	(0.012)	(0.013)	(0.015)	(0.016)	(0.012)	(0.013)
Implied elasticity	0.109***	0.145***	0.041	0.093***		
wrt. cost of labor	(0.023)	(0.024)	(0.034)	(0.035)		
Panel C: Change in Materials						
Fraction Affected	0.032***	0.046***	0.004	0.027	-0.004	0.015
	(0.012)	(0.013)	(0.015)	(0.016)	(0.013)	(0.015)
Implied elasticity	0.065***	0.091***	0.008	0.057*		
wrt. cost of labor	(0.024)	(0.024)	(0.035)	(0.035)		
Panel D: Change in Capital						
Fraction Affected	0.119***	0.122***	0.194***	0.191***	0.024***	0.014
	(0.020)	(0.022)	(0.033)	(0.036)	(0.009)	(0.010)
Implied elasticity	0.246***	0.246***	0.440***	0.401***		
wrt. cost of labor	(0.042)	(0.045)	(0.707)	(0.076)		
Observations	19,485	19,485	19,485	19,485	19,485	19,485
Controls	yes	yes	yes	yes	yes	yes
Industry	no	yes	no	yes	no	yes

Note: *** p<0.01, ** p<0.05, * p<0.1. This table shows the firm-level relationship between the fraction of affected workers and the percentage change in various outcomes (see equation 1): total labor cost (Panel A), revenue (Panel B), expenses on materials (Panel C), and capital stock (Panel E). The first four columns show our main results by looking at changes between 2002 and 2000 (short-term) and changes between 2004 and 2000 (medium term). The output changes include both intensive margin and firm closure responses. We also report the implied elasticity of the various outcomes with respect to the cost of labor (standard errors are calculated by bootstrapping). Columns (5) and (6) test the presence for pre-existing trends by examine changes between 1998 and 2000. Regressions are weighted by the logarithm of revenue in 2000. Robust standard errors are reported in parentheses.

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

	All Firms			Exists between 2000 and 2004		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Change between 2000 and 2002 (short term)						
Fraction Affected	0.076***	0.059*	0.049	0.088***	0.078**	0.068*
	(0.025)	(0.032)	(0.034)	(0.028)	(0.034)	(0.037)
Constant	0.16***			0.14***		
	(0.01)			(0.02)		
Observations	3,252	3,252	3,252	2,541	2,541	2,541
Panel B: Change between 2000 and 2004 (medium term)						
Fraction Affected	0.137**	0.130**	0.146**	0.137**	0.130**	0.146**
	(0.050)	(0.058)	(0.059)	(0.050)	(0.058)	(0.059)
Constant	0.27***			0.27***		
	(0.03)			(0.03)		
Observations	2,541	2,541	2,541	2,541	2,541	2,541
Panel C: Change between 1998 and 2000 (Placebo test)						
Fraction Affected	-0.002	-0.01	-0.004	-0.013	-0.041	-0.024
	(0.019)	(0.025)	(0.028)	(0.024)	(0.031)	(0.034)
Constant	-0.10***			-0.10***		
	(0.01)			(0.01)		
Observations	2,640	2,640	2,640	1,822	1,822	1,822
Controls	yes	yes	yes	yes	yes	yes
Industry	no	no	yes	no	no	yes

Note: *** p<0.01, ** p<0.05, * p<0.1. 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)-(3) include all firms for which price changes can be calculated, while Columns (4)-(6) 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 (change between 1998 and 2000). Regressions are weighted by the logarithm of revenue in 2000. Robust standard errors are reported in parentheses.

Table 5: The Incidence of the Minimum Wage

This table estimate the relationship between fraction affected and various outcome variables from equation 3:

$$\frac{\triangle LaborCost}{Revenue_{2000}} = \underbrace{\frac{\triangle Revenue}{Revenue_{2000}} - \frac{\triangle Material}{Revenue_{2000}}}_{\text{Consumers Pays}} - \underbrace{\frac{\triangle Profit}{Revenue_{2000}}}_{\text{Firm Owners Pay}}$$

	Main results				Placebo Estimates	
	Changes between 2000 and 2002		Changes between 2000 and 2004		Changes between 1998 and 2000	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Change in total labor cost (relative to revenue in 2000)						
Fraction Affected	0.035***	0.036***	0.020***	0.022***	-0.005***	-0.005***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)
Panel B: Change in revenue (relative to revenue in 2000)						
Fraction Affected	0.053***	0.072***	0.018	0.043***	-0.011	0.003
	(0.012)	(0.013)	(0.015)	(0.016)	(0.012)	(0.013)
Panel C: Change in materials (relative to revenue in 2000)						
Fraction Affected	0.027***	0.039***	0.002	0.019	-0.005	0.003
	(0.010)	(0.010)	(0.011)	(0.012)	(0.009)	(0.010)
Panel D: Change in profits (relative to revenue in 2000)						
Fraction Affected	-0.007***	-0.002	-0.005**	-0.001	0.002	0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Panel F: Incidence on consumers (panel B - panel C):						
	0.026	0.033	0.018	0.024		
Fraction paid by consumers (panel F divided by panel A):						
	74%	91%	90%	109%		
Fraction paid by firm-owners (panel E divided by panel A):						
	20%	5%	25%	5%		
Observations	19,484	19,484	19,484	19,484	19,484	19,484
Controls	yes	yes	yes	yes	yes	yes
Industry	no	yes	no	yes	no	yes

Note: *** p<0.01, ** p<0.05, * p<0.1. The first four columns show our main results: Columns (1) and (2) show the effect of fraction of workers affected by the minimum wage on the change between 2002 and 2000, while Columns (3) and (4) show between 2002 and 2004. In Columns (5) and (6) we report the change between 1998 and 2000 in order to check the presence of pre-existing trends in the data. Panels A-E show the estimated effects on the various outcome variables, while the last three panels (from Panel F) calculate the incidence of the minimum wage using these estimates. Regressions are weighted by the logarithm of revenue in 2000. Robust standard errors are in parentheses.

Table 6: Effect on Firm-level Outcomes by Sectors

	Av. Cost of Labor	Employ-ment	Total Labor Cost	Revenue	Materials	Profit	Capital
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Change between 2000 and 2002 (short term)							
All Firms	0.48***	-0.08***	0.31***	0.053***	0.032***	-0.007***	0.12***
(obs= 19485)	(0.01)	(0.01)	(0.01)	(0.012)	(0.012)	(0.003)	(0.02)
Manufacturing	0.47***	-0.07***	0.31***	0.045**	0.018	-0.005	0.13***
(obs = 6312)	(0.01)	(0.02)	(0.02)	(0.022)	(0.022)	(0.005)	(0.04)
Construction	0.50***	-0.08***	0.33***	0.154***	0.127**	0.013*	0.12**
(obs = 2914)	(0.02)	(0.03)	(0.03)	(0.036)	(0.057)	(0.008)	(0.06)
Service	0.49***	-0.08***	0.32***	0.044***	0.028	-0.011	0.11***
(obs = 10259)	(0.01)	(0.01)	(0.02)	(0.015)	(0.015)	(0.003)	(0.03)
Tradable	0.45***	-0.10***	0.26***	0.025	0.014	-0.013	0.08**
(obs = 4557)	(0.02)	(0.02)	(0.03)	(0.027)	(0.027)	(0.006)	(0.04)
Non-Tradable	0.55***	-0.06***	0.40***	0.069***	0.038*	-0.011	0.13***
(obs = 6196)	(0.02)	(0.02)	(0.02)	(0.020)	(0.020)	(0.004)	(0.04)
Panel B: Change between 2000 and 2004 (medium term)							
All Firms	0.44***	-0.10***	0.23***	0.018	0.004	-0.005**	0.19***
(obs= 19485)	(0.01)	(0.01)	(0.02)	(0.015)	(0.015)	(0.003)	(0.03)
Manufacturing	0.42***	-0.12***	0.19***	-0.014	-0.047	-0.003	0.17***
(obs = 6312)	(0.02)	(0.02)	(0.03)	(0.028)	(0.028)	(0.005)	(0.06)
Construction	0.46***	-0.07*	0.26***	0.110**	0.120***	0.001	0.12
(obs = 2914)	(0.03)	(0.03)	(0.05)	(0.045)	(0.047)	(0.007)	(0.09)
Service	0.46***	-0.08***	0.26***	0.025	0.013	-0.007**	0.24***
(obs = 10259)	(0.02)	(0.02)	(0.03)	(0.020)	(0.020)	(0.003)	(0.05)
Tradable	0.40***	-0.17***	0.12***	-0.044	-0.069**	-0.010*	0.09
(obs = 4557)	(0.02)	(0.03)	(0.04)	(0.034)	(0.034)	(0.006)	(0.07)
Non-Tradable	0.50***	-0.05*	0.34***	0.023	-0.007	-0.010**	0.25***
(obs = 6196)	(0.02)	(0.02)	(0.03)	(0.027)	(0.027)	(0.004)	(0.06)
Panel C: Change between 1998 and 2000 (Placebo test)							
All Firms	-.04***	0.01	-0.03***	-0.011	-0.004	0.002	0.02***
(obs= 19485)	(0.01)	(0.01)	(0.01)	(0.012)	(0.013)	(0.003)	(0.01)
Manufacturing	-0.05***	-0.02	-0.08***	-0.010	0.007	0.003	-0.02
(obs = 6312)	(0.01)	(0.01)	(0.02)	(0.021)	(0.023)	(0.005)	(0.02)
Construction	-0.01	-0.0001	-0.01	0.013	0.019	0.008	-0.01
(obs = 2914)	(0.02)	(0.02)	(0.03)	(0.038)	(0.042)	(0.007)	(0.02)
Service	-0.04***	0.02	-0.02	-0.018	-0.015	-0.001	0.05***
(obs = 10259)	(0.01)	(0.01)	(0.01)	(0.016)	(0.018)	(0.003)	(0.01)
Tradable	-0.05***	-0.02	-0.08***	-0.021	0.009	0.001	-0.03
(obs = 4557)	(0.01)	(0.02)	(0.019)	(0.026)	(0.029)	(0.006)	(0.02)
Non-Tradable	-0.04***	-0.02	-0.06***	-0.022	-0.004	-0.004	-0.001
(obs = 6196)	(0.01)	(0.02)	(.015)	(0.021)	(0.022)	(0.004)	(.017)

Note: We estimate equation 1 for each sector separately. In each regression we control for all observable characteristics except for industry fixed effects. Regressions are weighted by the logarithm of revenue in 2000. Robust standard errors are in parentheses.

Table 7: Effect on Firm-level Outcomes by Firm Characteristics

	Av. Cost of Labor	Employ-ment	Total Labor Cost	Revenue	Materials	Profit	Capital
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Change between 2000 and 2002 (short term)							
Fraction Affected (FA)	0.48***	-0.10***	0.29***	0.052***	0.029**	-0.008***	0.13***
	(0.01)	(0.01)	(0.01)	(0.012)	(0.012)	(0.002)	(0.02)
FA×Export share	-0.02	-0.08**	-0.10*	-0.114**	-0.142***	-0.006	0.06
	(0.04)	(0.04)	(0.05)	(0.048)	(0.049)	(0.010)	(0.08)
FA×Labor share	-0.17***	-0.18***	-0.44***	0.131*	0.040	-0.006	-0.29***
	(0.05)	(0.06)	(0.07)	(0.070)	(0.071)	(0.015)	(0.11)
FA×Profit share	-0.10	0.06	0.21**	0.211**	0.183**	-0.058**	0.08
	(0.08)	(0.07)	(0.11)	(0.101)	(0.093)	(0.025)	(0.14)
FA×log(Employment)	-0.04***	-0.01	-0.04***	-0.022**	-0.017	0.003	0.05***
	(0.01)	(0.01)	(0.01)	(0.010)	(0.011)	(0.002)	(0.02)
FA×Market Herfindahl	0.08	0.05	0.07	-0.132	-0.124	-0.028	0.22
	(0.09)	(0.11)	(0.15)	(0.144)	(0.145)	(0.028)	(0.23)
Panel B: Change between 2000 and 2004 (medium term)							
Fraction Affected (FA)	0.44***	-0.13***	0.20***	0.012	-0.005	-0.007***	0.21***
	(0.01)	(0.01)	(0.02)	(0.016)	(0.016)	(0.002)	(0.03)
FA×Export share	0.05	-0.22***	-0.20***	-0.295***	-0.308***	-0.022**	-0.06
	(0.04)	(0.06)	(0.08)	(0.062)	(0.064)	(0.009)	(0.13)
FA×Labor share	-0.22***	-0.18***	-0.48***	0.163*	0.105	-0.002	-0.59***
	(0.06)	(0.07)	(0.10)	(0.088)	(0.089)	(0.014)	(0.18)
FA×Profit share	-0.19**	0.03	0.25*	0.120	0.116	-0.078***	0.002
	(0.09)	(0.10)	(0.13)	(0.122)	(0.117)	(0.023)	(0.21)
FA×log(Employment)	-0.02**	-0.04***	-0.06***	-0.041***	-0.042***	0.001	0.10***
	(0.01)	(0.01)	(0.02)	(0.014)	(0.014)	(0.002)	(0.03)
FA×Market Herfindahl	-0.07	0.15	0.05	-0.164	-0.203	-0.047*	0.25
	(0.14)	(0.15)	(0.21)	(0.187)	(0.188)	(0.027)	(0.38)
Panel C: Change between 1998 and 2000 (Placebo test)							
Fraction Affected (FA)	-0.04***	0.003	-0.04***	-0.027**	-0.023*	0.003	0.01
	(0.01)	(0.01)	(0.01)	(0.011)	(0.012)	(0.002)	(0.01)
FA×Export share	-0.04*	0.06*	0.003	0.017	0.008	0.012	-0.01
	(0.02)	(0.03)	(0.04)	(0.042)	(0.047)	(0.008)	(0.04)
FA×Labor share	0.02	0.16***	0.16***	0.231***	0.229***	0.052***	0.18***
	(0.03)	(0.05)	(0.05)	(0.065)	(0.077)	(0.013)	(0.06)
FA×Profit share	-0.02	0.01	-0.03	-0.120	-0.057	0.036	0.08
	(0.04)	(0.07)	(0.08)	(0.101)	(0.120)	(0.023)	(0.09)
FA×log(Employment)	0.01**	-0.01*	0.01	0.010	0.011	-0.002*	-0.03***
	(0.004)	(0.01)	(0.01)	(0.009)	(0.010)	(0.001)	(0.01)
FA×Market Herfindahl	0.05	-0.09	-0.05	-0.000	-0.100	-0.003	-0.16
	(0.06)	(0.09)	(0.09)	(0.114)	(0.135)	(0.018)	(0.11)

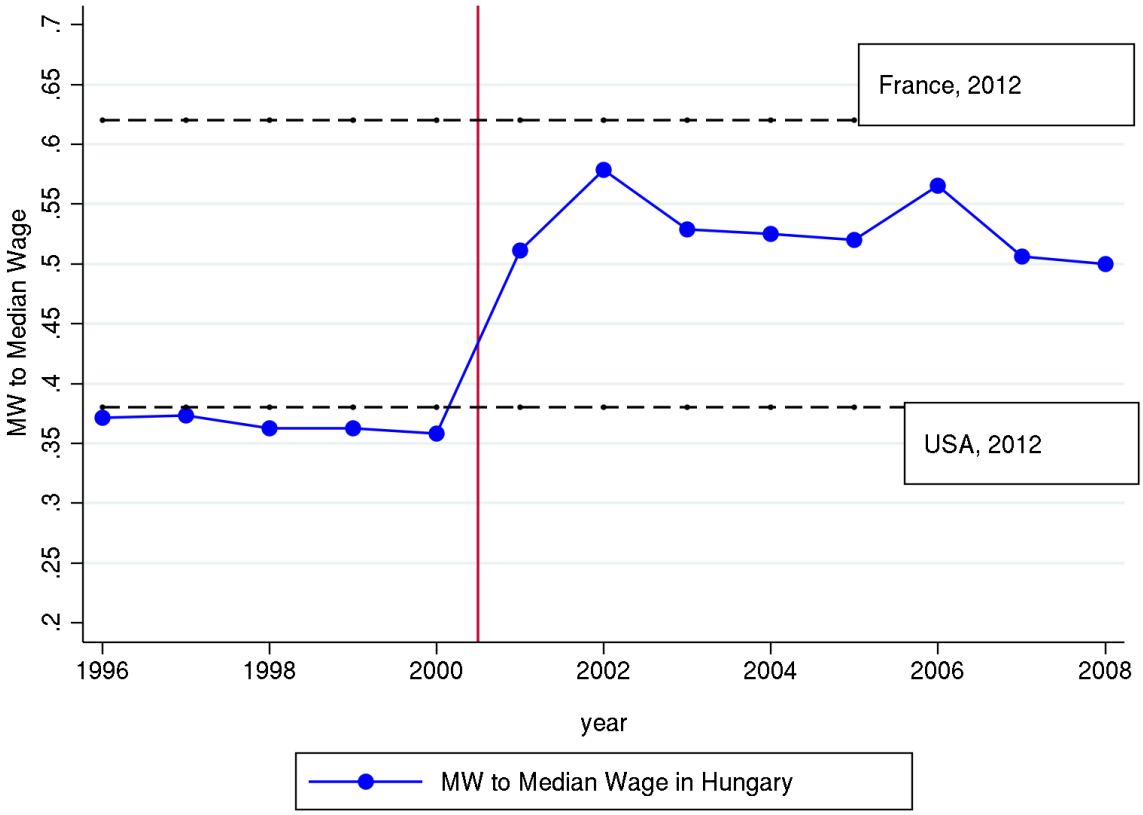
Note: We estimate equation 1 with the interaction terms between FA and various firm-level characteristics. In each regression we control for all observable characteristics except for industry fixed effects. Regressions are weighted by the logarithm of revenue in 2000. Robust standard errors are in parentheses.

Table 8: Estimating the moments of the neoclassical model

	All Firms		Manuf		Service		Trade		Non-Trade		Export	
	2002	2004	2002	2004	2002	2004	2002	2004	2002	2004	2002	2004
	(1)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Panel A: Estimated Parameters												
Output Demand, μ	0.02	0.31	0.18	0.78	-0.01	0.11	0.32	1.08	-0.32	0.19	1.52	3.67
	(0.12)	(0.18)	(0.18)	(0.28)	(0.19)	(0.28)	(0.23)	(0.33)	(0.27)	(0.43)	(0.59)	(0.81)
Capital-Labor Substitution, σ_{KL}	1.33	2.66	1.33	2.35	1.47	3.57	1.02	1.98	1.66	4.29	3.87	5.21
	(0.21)	(0.35)	(0.28)	(0.52)	(0.35)	(0.63)	(0.34)	(0.58)	(0.51)	(0.90)	(1.01)	(1.45)
Material-Labor Substitution, σ_{ML}	0.10	0.005	0.06	-0.03	0.08	-0.09	0.15	0.08	0.05	-0.23	-0.18	-0.38
	(0.03)	(0.04)	(0.05)	(0.07)	(0.04)	(0.06)	(0.06)	(0.08)	(0.05)	(0.08)	(0.15)	(0.18)
Panel B: Empirical Moments												
Employment Elasticity	-0.16	-0.23	-0.15	-0.29	-0.15	-0.18	-0.22	-0.41	-0.10	-0.10	-0.39	-0.70
Revenue Elasticity	0.11	0.04	0.10	-0.04	0.09	0.05	0.06	-0.11	0.13	0.05	-0.15	-0.58
Materials Elasticity	0.07	0.01	0.04	-0.12	0.06	0.03	0.03	-0.17	0.07	-0.01	-0.26	-0.64
Capital Elasticity	0.25	0.44	0.28	0.38	0.23	0.53	0.19	0.24	0.25	0.51	0.43	0.30
Price Elasticity			0.13	0.31								
Panel C: Moments Predicted by the Estimated Parameters												
Employment Elasticity	-0.17	-0.24	-0.16	-0.30	-0.16	-0.19	-0.24	-0.43	-0.11	-0.10	-0.40	-0.71
Revenue Elasticity	0.17	0.11	0.18	0.04	0.14	0.12	0.16	-0.02	0.15	0.08	-0.11	-0.495
Materials Elasticity	0.02	-0.05	-0.03	-0.18	0.02	-0.02	-0.04	-0.24	0.05	-0.04	-0.29	-0.703
Capital Elasticity	0.24	0.43	0.27	0.37	0.22	0.52	0.17	0.23	0.24	0.51	0.42	0.288
Price Elasticity			0.23	0.23								
Share of Labor, s_L	0.18		0.23		0.15		0.25		0.12		0.18	
Share of Capital, s_K	0.07		0.06		0.07		0.05		0.06		0.07	
Share of Materials, s_M	0.76		0.71		0.79		0.70		0.82		0.76	
No of Moments Used	4		4		4		4		4		4	
No of Estimated Parameters	3		3		3		3		3		3	
Goodness of fit statistics	12.46	8.89	6.16	2.72	6.16	5.43	4.74	1.86	1.5	1.43	0.38	0.78

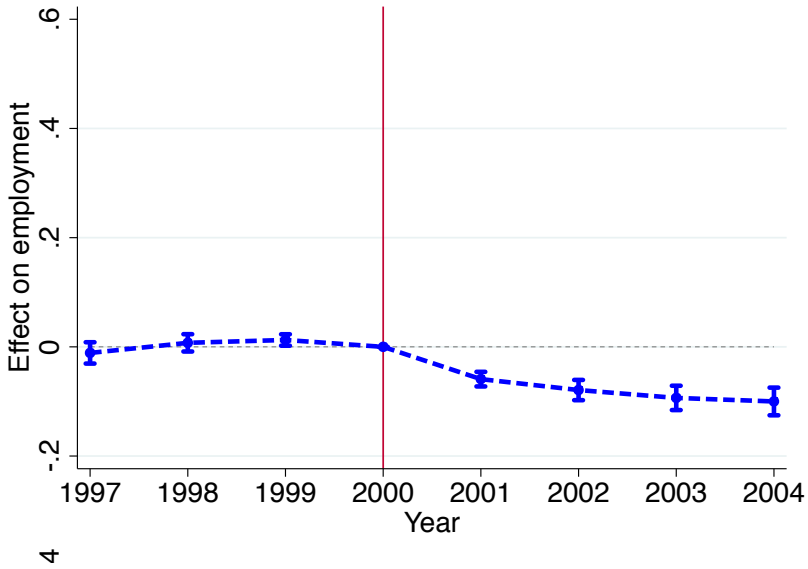
Note: We estimate the parameters of the neoclassical model presented in Section 6 using a minimum-distance estimator. The estimated parameters with standard errors can be found in Panel A. Panel B and C report the empirical and the predicted moments, respectively.

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). The graph shows the large and permanent increase in the minimum wage instituted in 2001.

Figure 2: Effect on Employment and on Wages

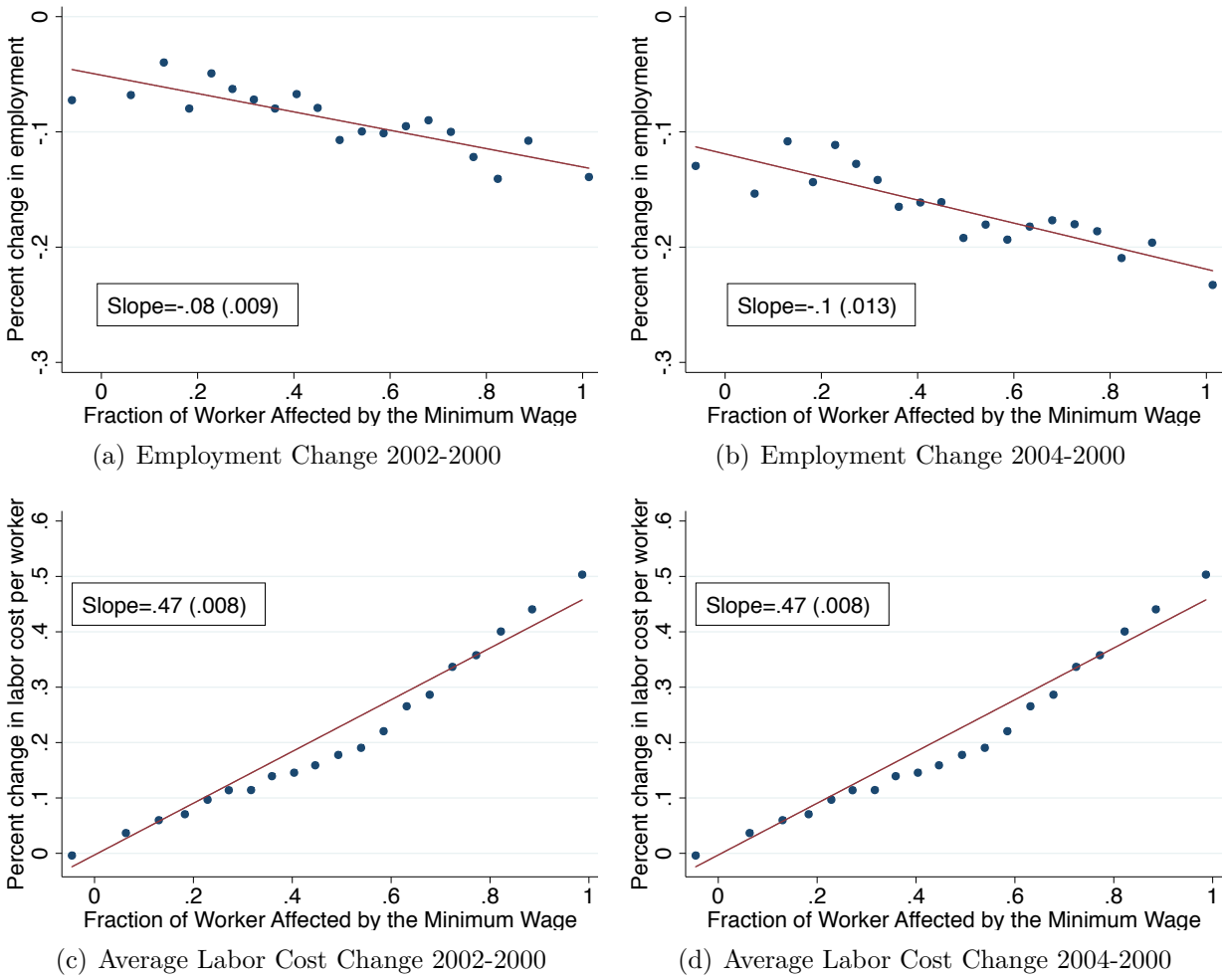


(a) Effect on Employment

(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 new minimum wage hike (beta coefficients with its confidence intervals from equation (1) over time). 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 ratio of Panel (a) and Panel (b) determines the employment elasticity. Controls are included in the regressions.

Figure 3: Non-parametric relationship between employment/average labor cost change and the fraction of affected workers



(a) Employment Change 2002-2000

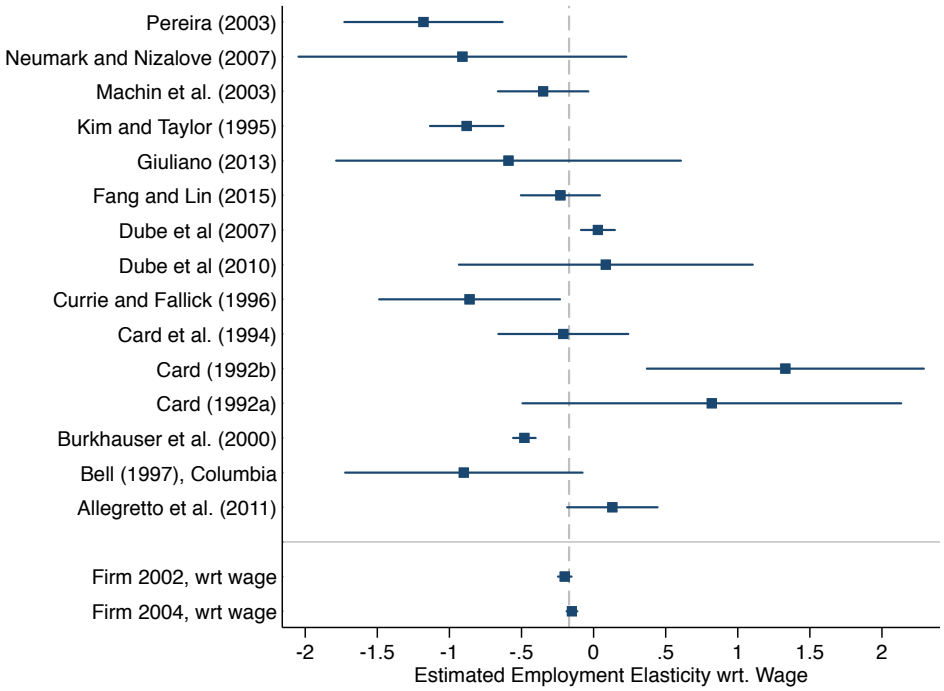
(b) Employment Change 2004-2000

(c) Average Labor Cost Change 2002-2000

(d) Average Labor Cost Change 2004-2000

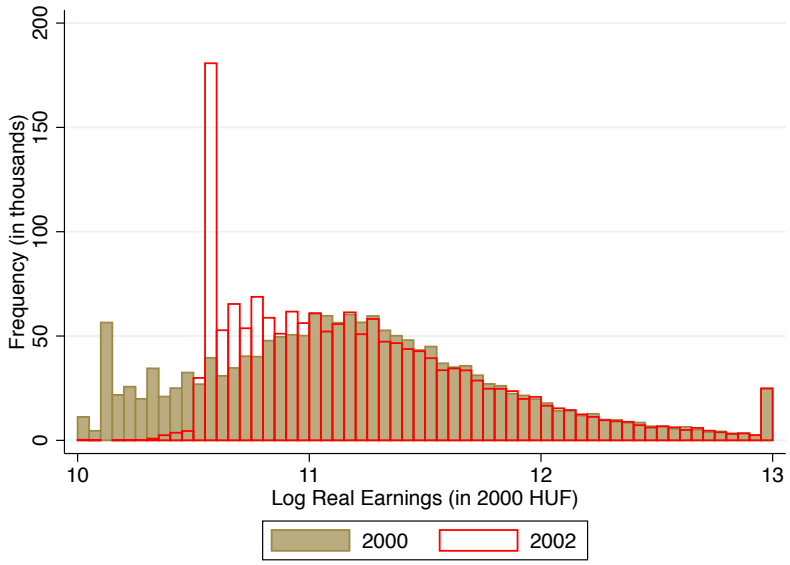
Notes: These figures show the binned scatterplot between the fraction of affected workers by the minimum wage and changes in employment (panel (a) and (b)) and changes in average labor cost (panel (c) and (d)). Panel (a) and (c) show the short-term effects (changes between 2002 and 2000) while panel (c) 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. 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 4: 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 show our preferred estimate for the employment elasticity, which is -0.2. 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).

Figure 5: Log earnings distribution in 2000 and in 2002

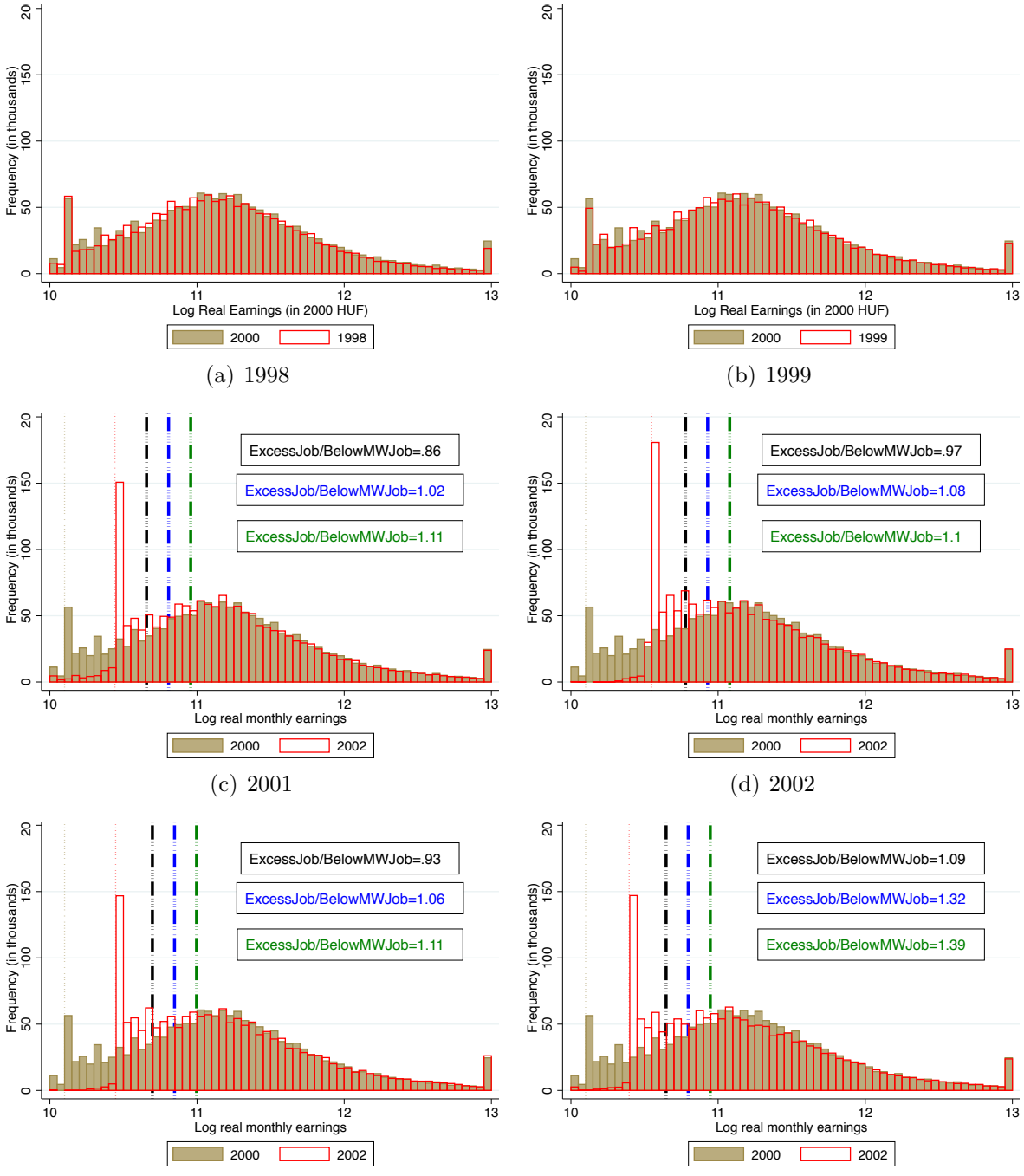


(a) Log earnings distribution in 2000 and in 2002

(b) Log earnings distribution in 2000 and in 2002 with bunching estimates

Notes: Panels (a) and (b) show 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). We adjust the 2002 earning distribution by the nominal GDP growth. The red bars show the earning distribution in 2002, while the brown filled bars in 2000. The dotted brown (red) dashed line is at the bar in which the minimum wage is located in 2000 (2002). In Panel (b) we also report the size of bunching (excess number of workers between the new minimum wage and $\bar{W}$) relative to the number of workers below the new minimum wage in the top right corner. We explore various threshold, $\bar{W}$,selection: 20% (black), 35% (blue),50% (green) above the new minimum wage. If bunching is above one then the minimum wage has a positive effect on employment.

Figure 6: Evolution of log earnings distributions over time



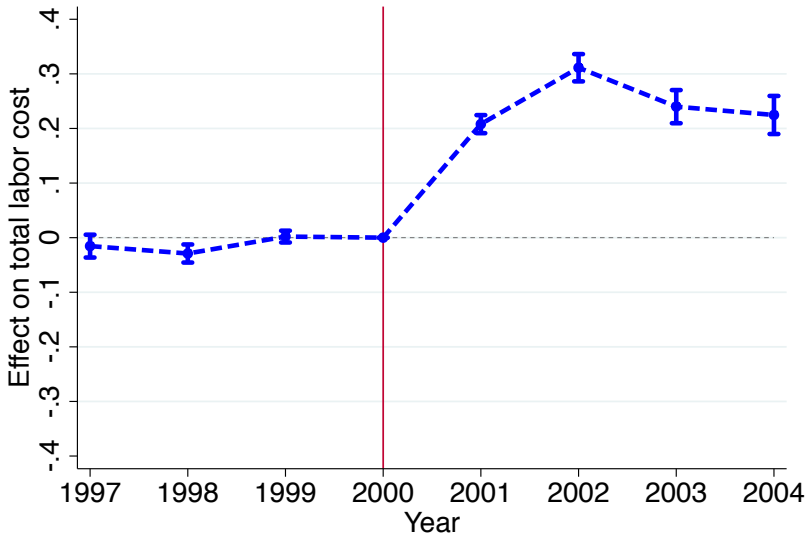
(a) 1998 (b) 1999

(c) 2001 (d) 2002

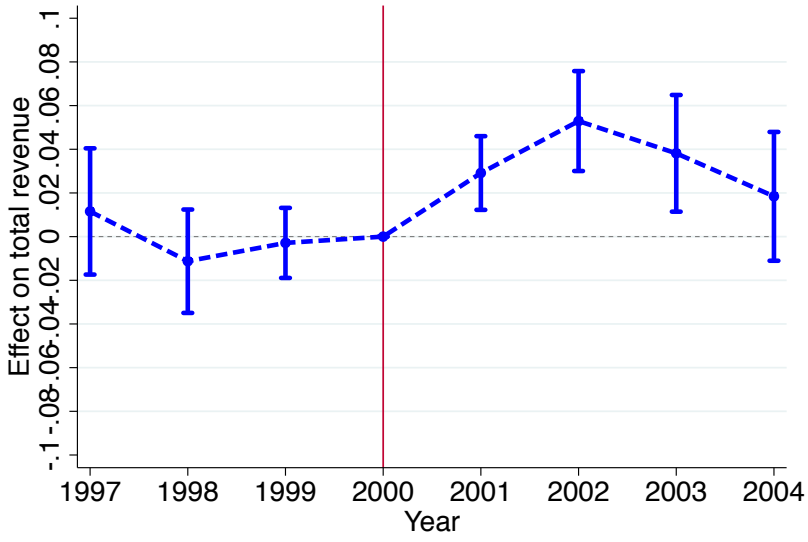
(e) 2003 (f) 2004

Notes: The figures show the distribution of monthly log earnings over time. Each panel shows the earnings distribution in year t (red bars) compared to 2000 earnings distribution (brown filled bars). 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. The size of bunching (excess number of workers relative to the number of workers below the new minimum wage) is reported in the top right corner. We explore various thresholds ($\bar{W}$): 20% (black), 35% (blue),50% (green) above the new minimum wage. If bunching is above one then the minimum wage has a positive effect on employment.

Figure 7: Effect on Total Labor Cost and on Revenue



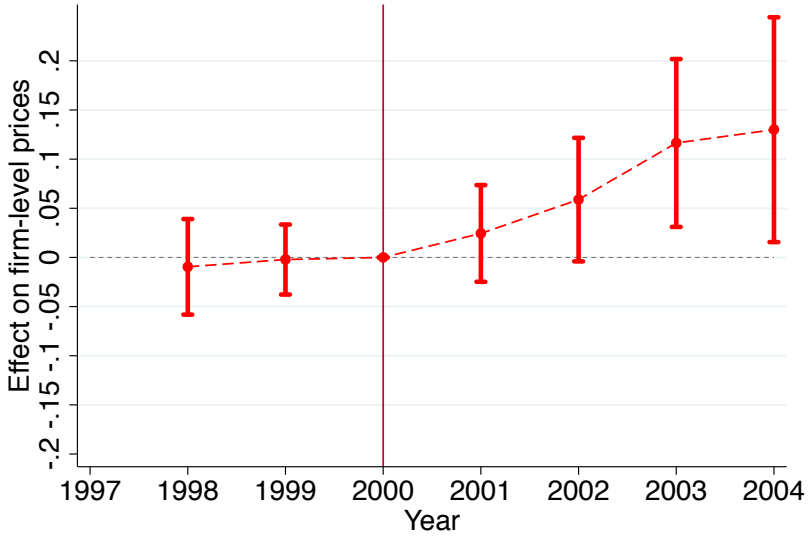
(a) Effect on Total Labor Cost



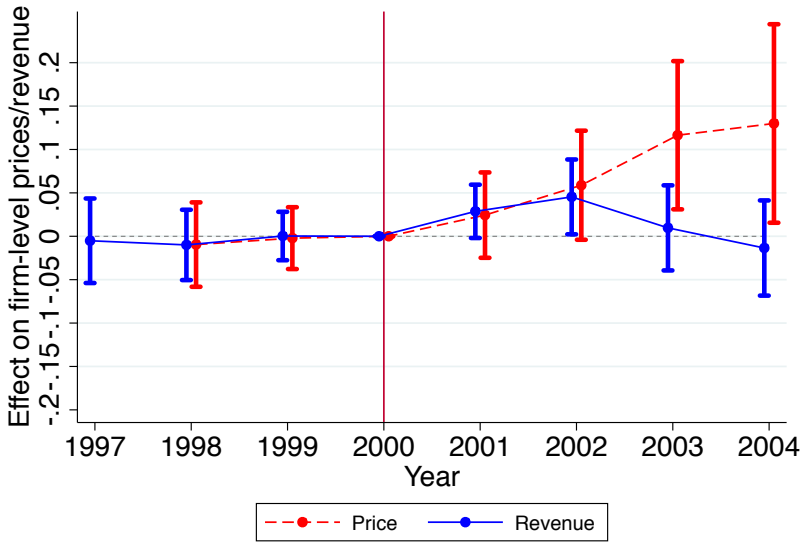
(b) Effect on Revenue

Notes: Panel (a) shows the firm-level relationship between changes in total labor cost and the fraction of workers affected by the minimum wage hike (beta coefficients with their confidence intervals from equation 1). It is clear that firm-level expenses increased substantially at highly exposed firms after the minimum wage hike. Panel (b) depicts the firm-level relationship between revenue and the fraction of affected workers (beta coefficients with their confidence intervals from equation 1). Both Panel (a) and Panel (b) show regression results which include firms that died. Controls are also included in the regressions.

Figure 8: Effect on Price Index and Revenue in the Manufacturing Sector



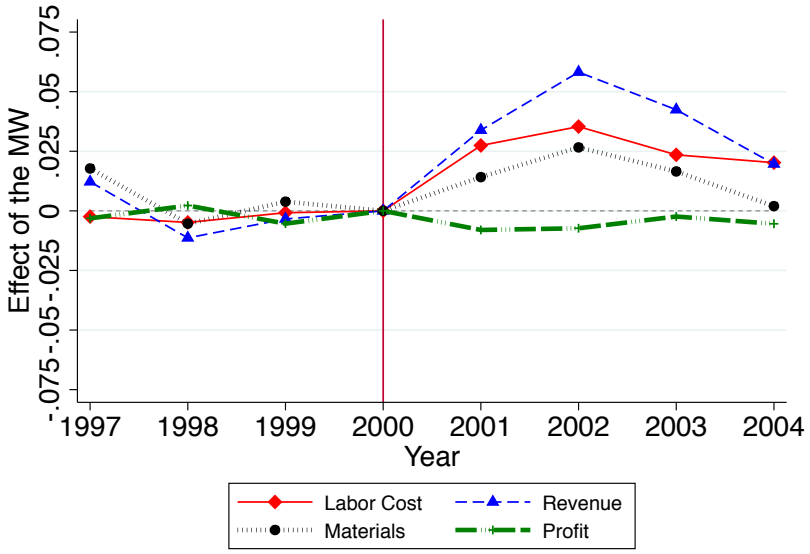
(a) Effect on Firm-Level Price Index



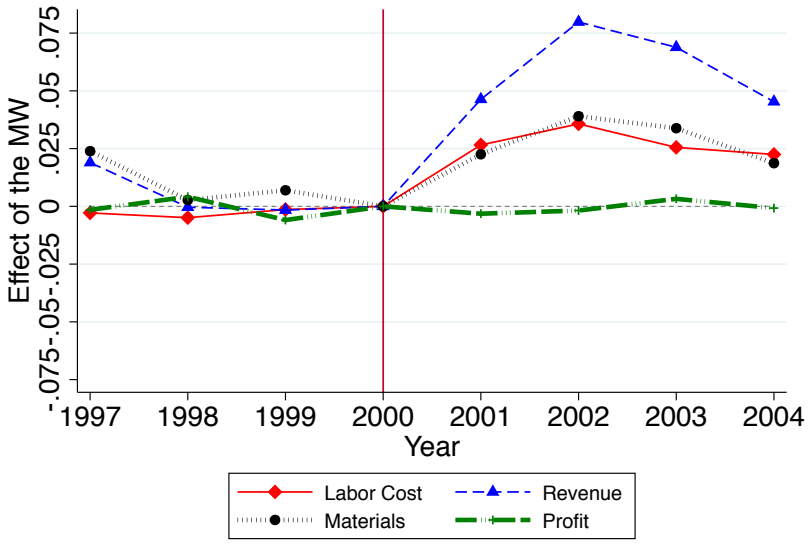
(b) Effect on Firm-Level Price Index and Revenue

Notes: Panel (a) shows the relationship between firm-level prices and the fraction of workers affected by the minimum wage hike (beta coefficients with its confidence intervals from equation 1). Since price data is available only for the manufacturing sector, we restrict our analysis to that sector. The graph highlights that firm-level prices increased more at highly exposed firms after the minimum wage hike. Panel (b) shows the firm-level price changes and compare them to the revenue changes in the manufacturing sector. The fact that price effects are larger than the revenue effects indicate that quantity produced fell at minimum wage firms. Controls are also included in the regressions.

Figure 9: Effect on the Main Balance Sheet Items (Relative to Revenue in 2000)



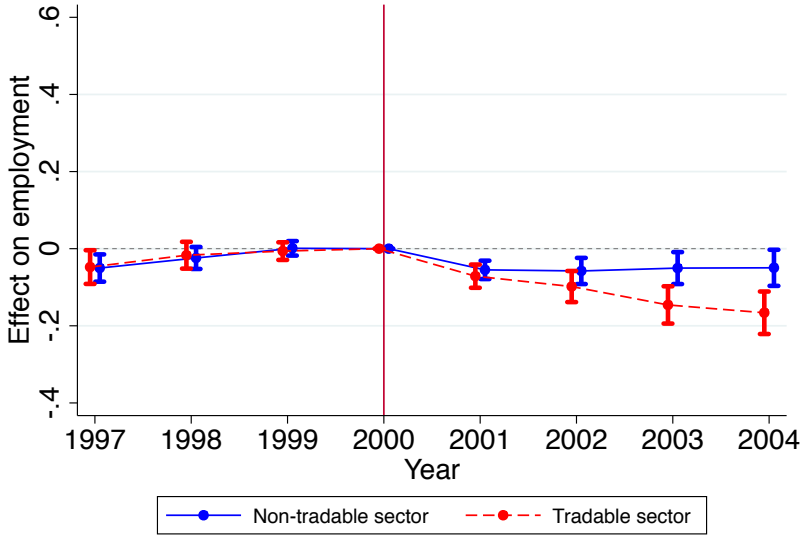
(a) No Industry Controls



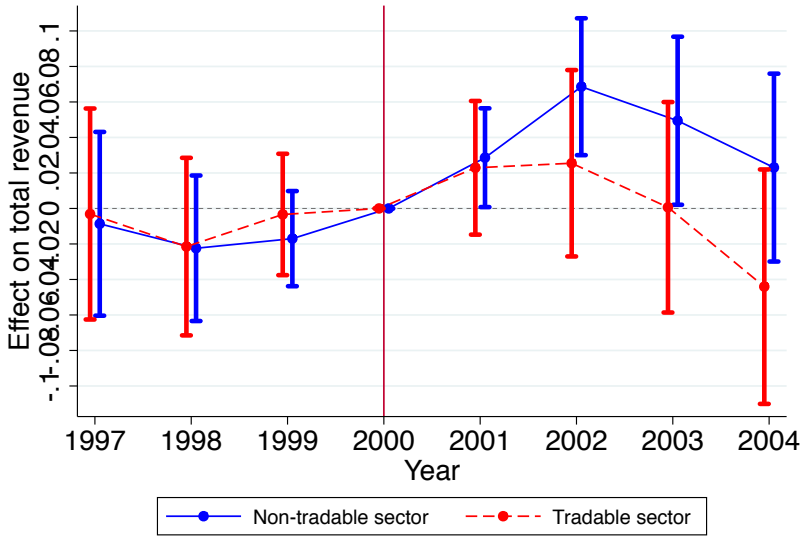
(b) With Industry Controls

Notes: This Figure summarizes the estimated relationship between the fraction of workers directly affected by the minimum wage and four outcomes (labor cost, revenue, profits and materials). Each outcome is normalized by the revenue in 2000, formally $\frac{out_{it}-out_{i2000}}{Revenue_{2000}}$ in order to make the magnitudes comparable to each other (see the regression equation 4).

Figure 10: 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 confidence intervals from equation 1). We classify sectors by following the procedure in Mian and Sufi (2010). We list this classification in the Online Appendix. 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 increases less in response to the minimum wage than the revenue in the non-tradable sectors. Both Panel (a) and (b) show result from regressions that include firms that died and include controls.

Appendix

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

	Manufacturing	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	0.72	0.79
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: Summary Statistics in 2000

	All		Manufact		Service		Tradable		Non-Tradable	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
Average Wage (1000 HUF)	1,358	1,137	1,313	923	1,424	1,283	1,317	917.1	1,099	936
Average Cost of Labor	847	732	841	593	878	834	845	595	679	599
Number of Workers	47.1	97.5	78.7	132.6	31.7	72.8	80.7	133.9	34.9	73.8
Revenue (1000 HUF) / Labor	17,206	23,901	10,751	15,330	22,550	28,210	10,065	14,944	19,784	25,046
Capital (1000 HUF) /Labor	3,789	6,256	3,557	5,485	3,882	6,042	3,345	5,221	3,673	5,150
Export share (Export/Sales)	0.11	0.25	0.22	0.33	0.06	0.18	0.26	0.36	0.06	0.18
Profitability (Profit/Sales)	0.033	0.117	0.038	0.122	0.029	0.114	0.039	0.123	0.021	0.099
Depreciation Share (Depr/Sales)	0.032	0.039	0.034	0.039	0.031	0.039	0.034	0.039	0.028	0.036
Lab or Share (Labor Cost/Sales)	0.18	0.16	0.23	0.17	0.15	0.15	0.25	0.18	0.12	0.12
Material Share (Material/Sales)	0.77	0.19	0.71	0.19	0.80	0.19	0.69	0.19	0.84	0.16
Fraction Affected	0.48	0.34	0.44	0.33	0.49	0.35	0.43	0.32	0.583	0.334
Observations	19,485		6,312		10,259		4,557		6,196	

Source: Own calculations from the Hungarian Corporate Income Tax (CIT) data. All statistics are weighted by the logarithm of revenue to be consistent with the regression analyses presented in the paper.

Table A-3: Effect on Employment and on Selection Corrected Average Wage

	Main results			
	Changes between 2000 and 2002		Changes between 2000 and 2004	
	(1)	(2)	(3)	(4)
Panel A: Change in Firm-Level Employment				
Fraction Affected	-0.085***	-0.080***	-0.101***	-0.100***
	(0.008)	(0.010)	(0.011)	(0.013)
Constant	-0.048***		-0.119***	
	(0.005)		(0.007)	
Observations	19,485	19,485	19,485	19,485
Panel B: Change in Selection Corrected Firm-Level Average Wage				
Fraction Affected	0.54***	0.57***	0.51***	0.54***
	(0.01)	(0.01)	(0.01)	(0.01)
Constant	0.01		0.10***	
	(0.03)		(0.01)	
Observations	19485	19485	19485	19485
Employment elasticity	-0.16***	-0.14***	-0.19***	-0.19***
wrt. wage	(0.016)	(0.018)	(0.025)	(0.021)
Panel C: Change in Selection Corrected Firm-Level Average Cost of Labor				
Fraction Affected	0.47***	0.48***	0.43***	0.44***
	(0.01)	(0.01)	(0.01)	(0.01)
Constant	0.004		0.07***	
	(0.01)		(0.01)	
Observations	19485	19485	19485	19485
Employment elasticity	-0.18	-0.16	-0.23	-0.23
wrt. cost of labor	(0.017)	(0.018)	(0.022)	(0.03)
Controls	no	yes	no	yes
Industry	no	no	no	no

Note: *** p<0.01, ** p<0.05, * p<0.1. Columns (1)-(2) show the relationship between the fraction of workers exposed to the the minimum wage and the change in different outcomes while. Columns (3)-(4) show between 2000 and 2004 (see equation 1). The employment changes include both extensive (closing) and intensive margin (lay-off) decisions. Panel A reports the same estimates as in Table 1. Panels B and C report the selection corrected average wage and the selection corrected average cost of labor, respectively. We correct for selection in firm's death by using Johnson et al. (2000) method (see the text for the details). We also report the implied elasticities with respect to the average wage and average cost of labor. Columns (1) and (3) use no controls, while Columns (2) and (4) control for rich set of observable characteristics. We did were unable to generate estimates which control for industry fixed effects due to limited computational power.

Table A-4: Robustness: Firm-level Employment Effects

	Benchmark		All Industry		Include Small Firms		Firms Survived till 2004	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Change between 2000 and 2002 (short term)								
Employment:								
Fraction Affected	-0.085***	-0.080***	-0.083***	-0.078***	-0.064***	-0.062***	-0.093***	-0.089***
	(0.008)	(0.010)	(0.009)	(0.010)	(0.008)	(0.009)	(0.009)	(0.010)
Cost of Labor:								
Fraction Affected	0.47***	0.48***	0.47***	0.48***	0.50***	0.51***	0.48***	0.49***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Elasticity	-0.17***	-0.17***	-0.18***	-0.16***	-0.13***	-0.12***	-0.20***	-0.18***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)
Panel B: Change between 2000 and 2004 (medium term)								
Employment:								
Fraction Affected	-0.101***	-0.100***	-0.116***	-0.101***	-0.080***	-0.074***	-0.120***	-0.110***
	(0.011)	(0.013)	(.012)	(.013)	(.011)	(.011)	(.012)	(.013)
Cost of Labor:								
Fraction Affected	0.42***	0.44***	0.41***	0.44***	0.44***	0.46***	0.42***	0.45***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Elasticity	0.24***	0.21***	-0.29***	-0.23***	-0.18***	-0.16***	-0.28***	-0.25***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(.02)	(0.03)
Panel C: Change between 1998 and 2000 (Placebo test)								
Employment:								
Fraction Affected	0.007	0.005	0.002	0.005	0.001	0.001	0.007	0.003
	(0.008)	(0.009)	(.007)	(.008)	(.007)	(.007)	(.008)	(.009)
Cost of Labor:								
Fraction Affected	-0.03***	-0.03***	-0.04***	-0.04***	-0.05***	-0.05***	-0.04***	-0.04***
	(0.01)	(0.01)	(.005)	(.006)	(.005)	(.006)	(.006)	(.007)
Observations	19,485	19,485	22,766	22,766	29,138	29,138	16,980	16,980
Controls	yes	yes	yes	yes	yes	yes	yes	yes
Industry	no	yes	no	yes	no	yes	no	yes

Note: *** p<0.01, ** p<0.05, * p<0.1. We estimate the effect of FA_i on employment and the average cost of labor for alternative specifications. Columns (1)-(2) report the benchmark estimates (shown in Table 1). Columns (3)-(4) include all industries in the regressions. Columns (5)-(6) include firms with less than 5 employees, while Columns (7)-(8) estimate restrict the sample on firms that survived till 2004. Robust standard errors are in parentheses.

Table A-5: Effect on Firm-level Outcomes by Sectors

	Av. Cost of Labor	Employ-ment	Total Labor Cost	Revenue	Materials	Profit	Capital
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Change between 2000 and 2002 (short term)							
All Firms	0.49***	-0.08***	0.33***	0.072***	0.046***	-0.002	0.12***
(obs= 19485)	(0.01)	(0.01)	(0.01)	(0.013)	(0.013)	(0.003)	(0.02)
Manufacturing	0.48***	-0.07***	0.33***	0.069***	0.041*	-0.006	0.12***
(obs = 6312)	(0.02)	(0.02)	(0.03)	(0.024)	(0.024)	(0.006)	(0.04)
Construction	0.50***	-0.09***	.32***	0.138***	0.109***	0.011	0.11**
(obs = 2914)	(0.02)	(0.03)	(0.04)	(0.037)	(0.038)	(0.008)	(0.06)
Service	0.50***	-0.07***	0.34***	0.064***	0.040***	-0.003	0.13***
(obs = 10259)	(0.01)	(0.01)	(0.02)	(0.016)	(0.016)	(0.003)	(0.03)
Tradable	0.58***	-0.07***	0.29***	0.056*	0.033	-0.011*	0.07
(obs = 4557)	(0.03)	(0.03)	(0.03)	(0.029)	(0.029)	(0.007)	(0.05)
Non-Tradable	0.55***	-0.05***	0.41***	0.103***	0.069***	-0.004	0.19***
(obs = 6196)	(0.02)	(0.02)	(0.03)	(0.021)	(0.021)	(0.004)	(0.04)
Panel B: Change between 2000 and 2004 (medium term)							
All Firms	0.47***	-0.09***	0.26***	0.043***	0.027*	-0.001	0.191***
(obs= 19485)	(0.011)	(0.02)	(0.02)	(0.016)	(0.016)	(0.003)	(0.04)
Manufacturing	0.45***	-0.11***	0.21***	0.030	-0.003	-0.001	0.15***
(obs = 6312)	(0.02)	(0.03)	(0.04)	(0.030)	(0.031)	(.006)	(0.06)
Construction	0.46***	-0.07**	0.26***	0.104**	0.111**	0.00002	0.10
(obs = 2914)	(0.03)	(0.04)	(0.05)	(0.046)	(0.047)	(0.008)	(0.09)
Service	0.48***	-0.08***	0.29***	0.045**	0.030	-0.001	0.25***
(obs = 10259)	(0.02)	(0.02)	(0.03)	(0.021)	(0.021)	(0.004)	(0.05)
Tradable	0.43***	-0.14***	0.18***	0.016	-0.012	-0.006	0.08
(obs = 4557)	(0.03)	(0.03)	(0.04)	(0.036)	(0.037)	(0.007)	(0.07)
Non-Tradable	0.51***	-0.05**	0.36***	0.062**	0.037	-0.005	0.32***
(obs = 6196)	(0.02)	(0.03)	(0.04)	(0.028)	(0.029)	(0.005)	(0.07)
Panel C: Change between 1998 and 2000 (Placebo test)							
All Firms	-0.04***	0.01	-0.03***	0.003	0.015	0.004	0.014
(obs= 19485)	(0.01)	(0.01)	(0.01)	(0.013)	(0.015)	(0.003)	(0.010)
Manufacturing	-0.05***	-0.02	-0.08***	-0.024	-0.007	0.001	-.028
(obs = 6312)	(0.01)	(0.02)	(0.02)	(0.023)	(0.025)	(0.006)	(.017)
Construction	-0.02	0.002	-0.02	0.010	0.021	0.005	.002
(obs = 2914)	(0.02)	(0.02)	(0.03)	(0.038)	(0.042)	(0.008)	(.026)
Service	-0.04***	0.01	-0.02*	0.005	0.013	0.004	.038
(obs = 10259)	(0.01)	(0.01)	(0.01)	(0.018)	(0.019)	(0.004)	(.014)
Tradable	-0.06***	-0.03	-0.09***	-0.044*	-0.013	-0.003	-.05
(obs = 4557)	(0.012)	(0.03)	(0.02)	(0.027)	(0.030)	(0.007)	(.02)
Non-Tradable	-0.04***	-0.01	-0.04***	-0.004	0.019	-0.002	-.006
(obs = 6196)	(0.01)	(0.02)	(0.02)	(0.023)	(0.024)	(0.004)	(.018)

Note: Robust standard errors are in parentheses. In each regression we control for all observable characteristics and **industry fixed effects**. Regressions are weighted by the logarithm of revenue in 2000.

Table A-6: Effect on Firm-level Outcomes by Firm Characteristics

	Av. Cost of Labor	Employ-ment	Total Labor Cost	Revenue	Materials	Profit	Capital
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Change between 2000 and 2002 (short term)							
Fraction Affected (FA)	0.495***	-0.096***	0.307***	0.074***	0.045***	-0.002	0.133***
	(0.009)	(0.011)	(0.014)	(0.013)	(0.013)	(0.003)	(0.022)
FA×Export share	-0.028	-0.063	-0.075	-0.103**	-0.132***	-0.005	0.085
	(0.039)	(0.039)	(0.054)	(0.048)	(0.050)	(0.011)	(0.082)
FA×Labor share	-0.149***	-0.200***	-0.447***	0.154**	0.050	0.006	-0.343***
	(0.051)	(0.057)	(0.075)	(0.073)	(0.074)	(0.016)	(0.115)
FA×Profit share	-0.097	0.041	0.188*	0.170*	0.149	-0.067***	0.049
	(0.077)	(0.079)	(0.106)	(0.102)	(0.094)	(0.024)	(0.144)
FA×log(Employment)	-0.036***	-0.006	-0.033***	-0.017	-0.014	0.004*	0.057***
	(0.007)	(0.009)	(0.012)	(0.011)	(0.011)	(0.002)	(0.017)
FA×Market Herfindahl	0.098	0.090	0.126	-0.076	-0.052	-0.042	0.268
	(0.096)	(0.116)	(0.158)	(0.152)	(0.152)	(0.030)	(0.250)
Panel B: Change between 2000 and 2004 (medium term)							
Fraction Affected (FA)	0.484***	-0.126***	0.229***	0.045***	0.024	-0.002	0.206***
	(0.012)	(0.014)	(0.020)	(0.017)	(0.017)	(0.003)	(0.037)
FA×Export share	0.024	-0.178***	-0.169**	-0.263***	-0.275***	-0.020**	-0.007
	(0.044)	(0.056)	(0.076)	(0.063)	(0.065)	(0.009)	(0.133)
FA×Labor share	-0.188***	-0.189***	-0.451***	0.186**	0.113	0.007	-0.632***
	(0.062)	(0.072)	(0.098)	(0.089)	(0.092)	(0.014)	(0.184)
FA×Profit share	-0.218**	0.020	0.223*	0.086	0.081	-0.083***	0.007
	(0.092)	(0.099)	(0.133)	(0.122)	(0.117)	(0.023)	(0.215)
FA×log(Employment)	-0.012	-0.029**	-0.043***	-0.028**	-0.033**	0.002	0.123***
	(0.009)	(0.012)	(0.017)	(0.014)	(0.014)	(0.002)	(0.029)
FA×Market Herfindahl	-0.049	0.204	0.141	-0.022	-0.044	-0.053*	0.256
	(0.148)	(0.163)	(0.225)	(0.195)	(0.195)	(0.029)	(0.404)
Panel C: Change between 1998 and 2000 (Placebo test)							
Fraction Affected (FA)	-0.048***	-0.002	-0.044***	-0.020*	-0.014	0.004**	-0.003
	(0.006)	(0.009)	(0.009)	(0.012)	(0.013)	(0.002)	(0.010)
FA×Export share	-0.043*	0.049	-0.003	0.002	-0.011	0.010	0.007
	(0.023)	(0.034)	(0.035)	(0.043)	(0.048)	(0.008)	(0.037)
FA×Labor share	0.004	0.152***	0.143***	0.254***	0.250***	0.056***	0.190***
	(0.032)	(0.050)	(0.054)	(0.068)	(0.082)	(0.014)	(0.059)
FA×Profit share	-0.033	0.013	-0.037	-0.119	-0.053	0.034	0.120
	(0.045)	(0.073)	(0.079)	(0.102)	(0.121)	(0.023)	(0.085)
FA×log(Employment)	0.010**	-0.016**	0.001	0.001	0.001	-0.003*	-0.031***
	(0.004)	(0.007)	(0.007)	(0.009)	(0.010)	(0.001)	(0.008)
FA×Market Herfindahl	0.037	0.003	0.030	0.013	-0.111	0.001	-0.134
	(0.064)	(0.100)	(0.097)	(0.116)	(0.133)	(0.021)	(0.114)

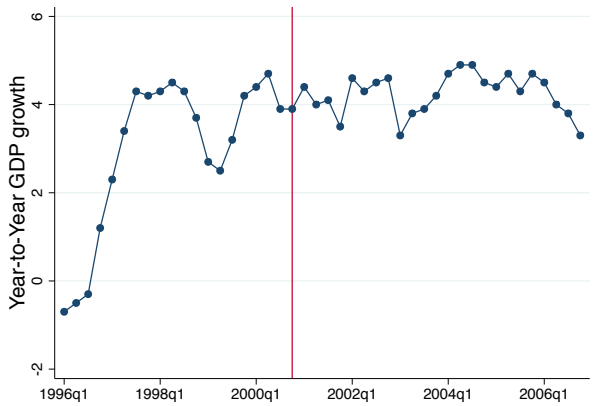
Note: We estimate equation 1 with the interaction terms of FA and various firm-level characteristics (in 2000). In each regression we control for all observable characteristics and **industry fixed effects**. Regressions are weighted by the logarithm of revenue in 2000. Robust standard errors are in parentheses.

Table A-7: Estimating the moments of the neoclassical model

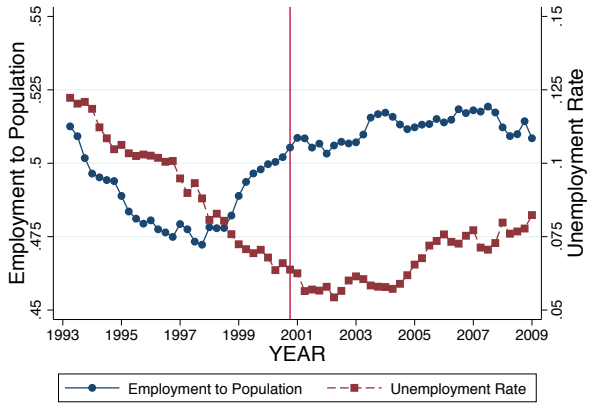
	All Firms		Manuf		Service		Trade		Non-Trade		Export	
	2002	2004	2002	2004	2002	2004	2002	2004	2002	2004	2002	2004
	(1)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Panel A: Estimated Parameters												
Output Demand, μ	-0.14	0.06	0.02	0.4	-0.21	-0.11	0.14	0.53	-0.8	-0.46	1.52	3.67
	0.13	0.19	0.2	0.29	0.2	0.28	0.24	0.33	0.3	0.43	0.59	0.81
Capital-Labor Substitution, σ_{KL}	1.18	2.23	1.03	1.74	1.48	3.25	0.68	1.23	1.97	4.53	3.87	5.21
	0.23	0.36	0.3	0.53	0.37	0.64	0.36	0.58	0.56	0.92	1.01	1.45
Material-Labor Substitution, σ_{ML}	0.14	0.06	0.12	0.1	0.1	-0.04	0.19	0.19	0.08	-0.16	-0.18	-0.38
	0.03	0.04	0.05	0.07	0.05	0.07	0.06	0.08	0.06	0.08	0.15	0.18
Panel B: Empirical Moments												
Labor Demand Elasticity	-0.15	-0.20	-0.14	-0.26	-0.14	-0.17	-0.19	-0.31	-0.09	-0.09	-0.34	-0.6
Revenue Elasticity	0.15	0.09	0.14	0.06	0.13	0.09	0.12	0.04	0.19	0.13	-0.07	-0.43
Materials Elasticity	0.09	0.06	0.08	-0.01	0.08	0.06	0.07	-0.03	0.13	0.08	-0.20	-0.50
Capital Elasticity	0.25	0.41	0.24	0.33	0.26	0.52	0.14	0.19	0.34	0.62	0.47	0.4
Price Elasticity			0.10	0.33								
Panel C: Moments Predicted by the Estimated Parameters												
Labor Demand Elasticity	-0.16	-0.21	-0.15	-0.27	-0.15	-0.17	-0.2	-0.33	-0.09	-0.1	-0.35	-0.61
Revenue Elasticity	0.2	0.16	0.22	0.13	0.17	0.15	0.21	0.11	0.21	0.16	-0.04	-0.36
Materials Elasticity	0.05	0.01	0.02	-0.06	0.05	0.02	0.01	-0.08	0.11	0.05	-0.22	-0.56
Capital Elasticity	0.24	0.4	0.23	0.31	0.25	0.51	0.14	0.18	0.34	0.62	0.47	0.39
Price Elasticity			0.23	0.23								
Share of Labor, s_L	0.18		0.23		0.15		0.25		0.12		0.18	
Share of Capital, s_K	0.07		0.06		0.07		0.05		0.06		0.07	
Share of Materials, s_M	0.76		0.71		0.79		0.70		0.82		0.76	
No of Moments Used	4		4		4		4		4		4	
No of Estimated Parameters	3		3		3		3		3		3	
Goodness of fit statistics	8.39	7.15	4.16	1.95	3.79	4.23	3.01	1.27	0.88	1.56	0.38	0.78

Note: We estimate the parameters of the neoclassical model presented in Section 6 with a minimum-distance estimator. We estimate the empirical moments by including **industry fixed effects** in the regressions.

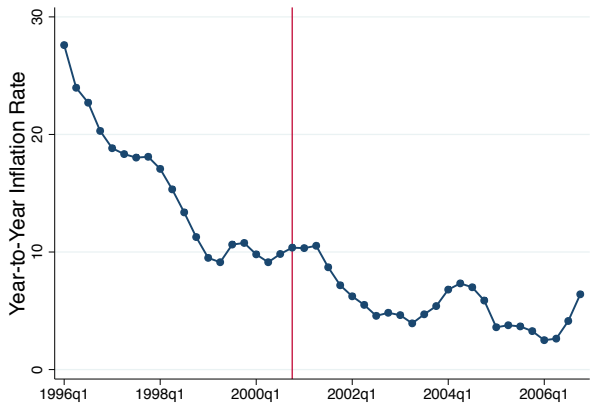
Figure A-1: Macroeconomic Trends



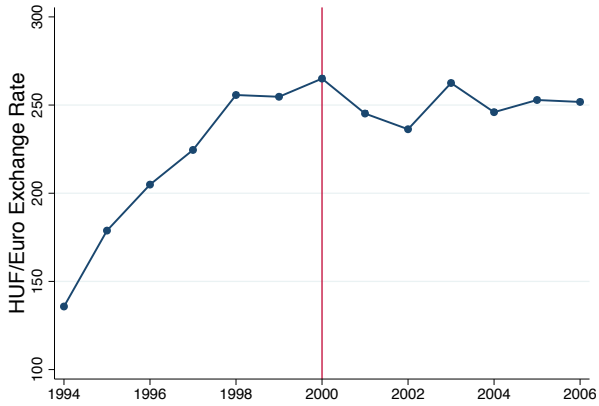
(a) GDP growth



(b) Employment and Unemployment trends



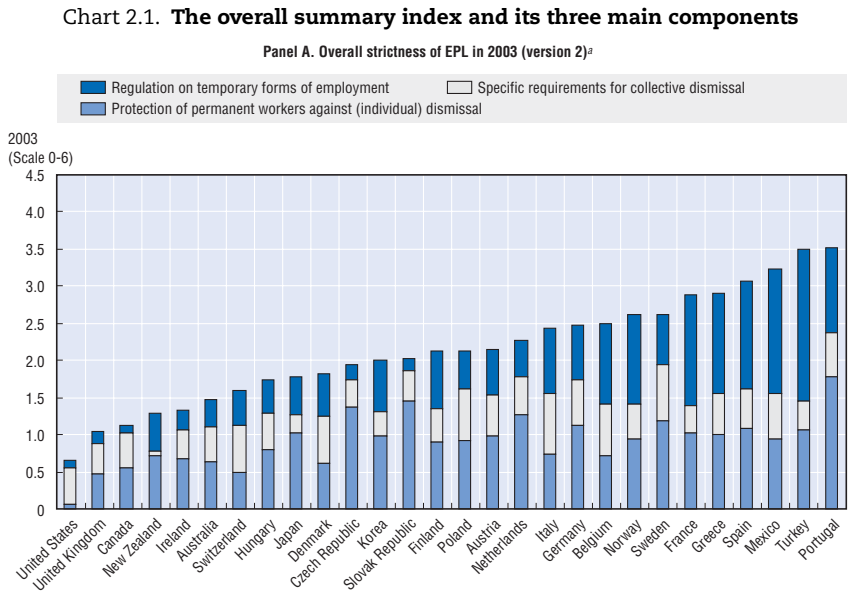
(c) Inflation Rate



(d) EUR/HUF Exchange Rate

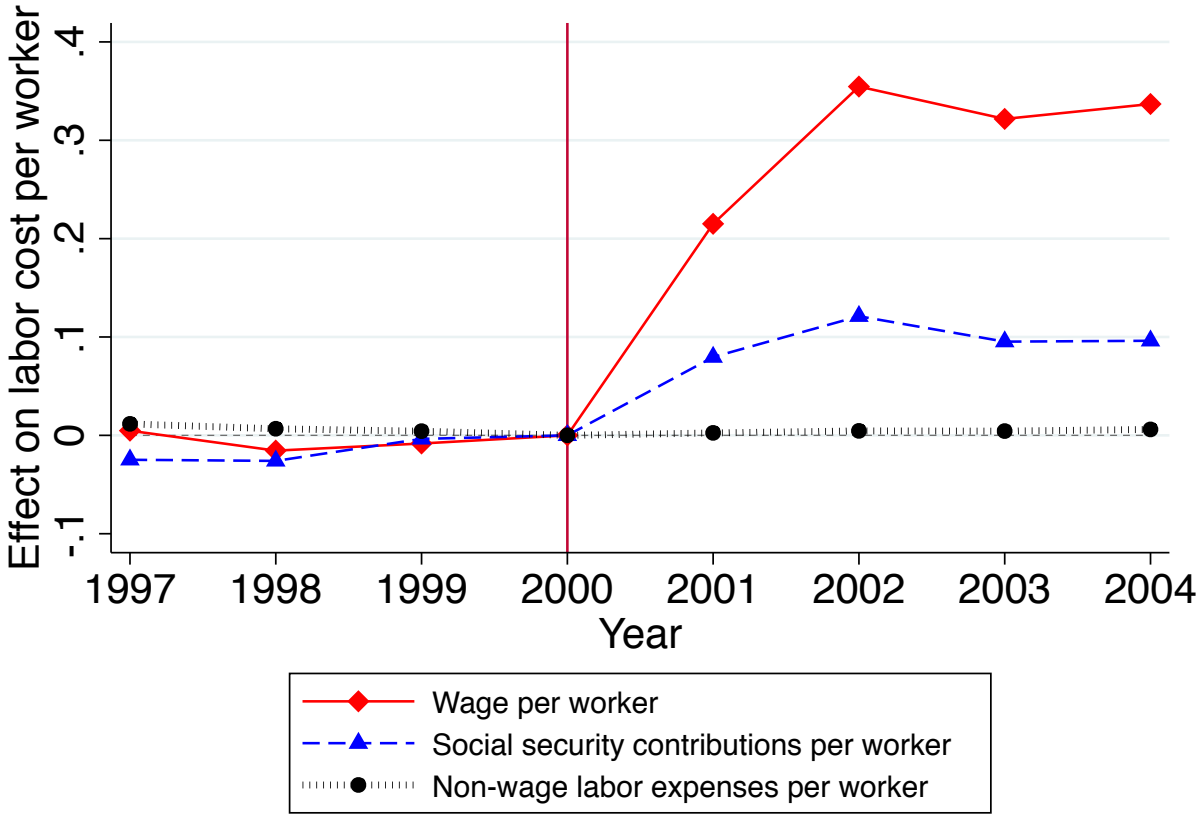
Notes: Panel (a) shows the seasonally adjusted, year to year real GDP growth rate between 1996 and 2006 in Hungary; panel (b) shows the evolution of employment to population rate and the unemployment rate between 1993 and 2009; panel (c) the year-to-year inflation rate (consumer price index), while panel (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-2: Employment Protection Legislation in OECD Countries



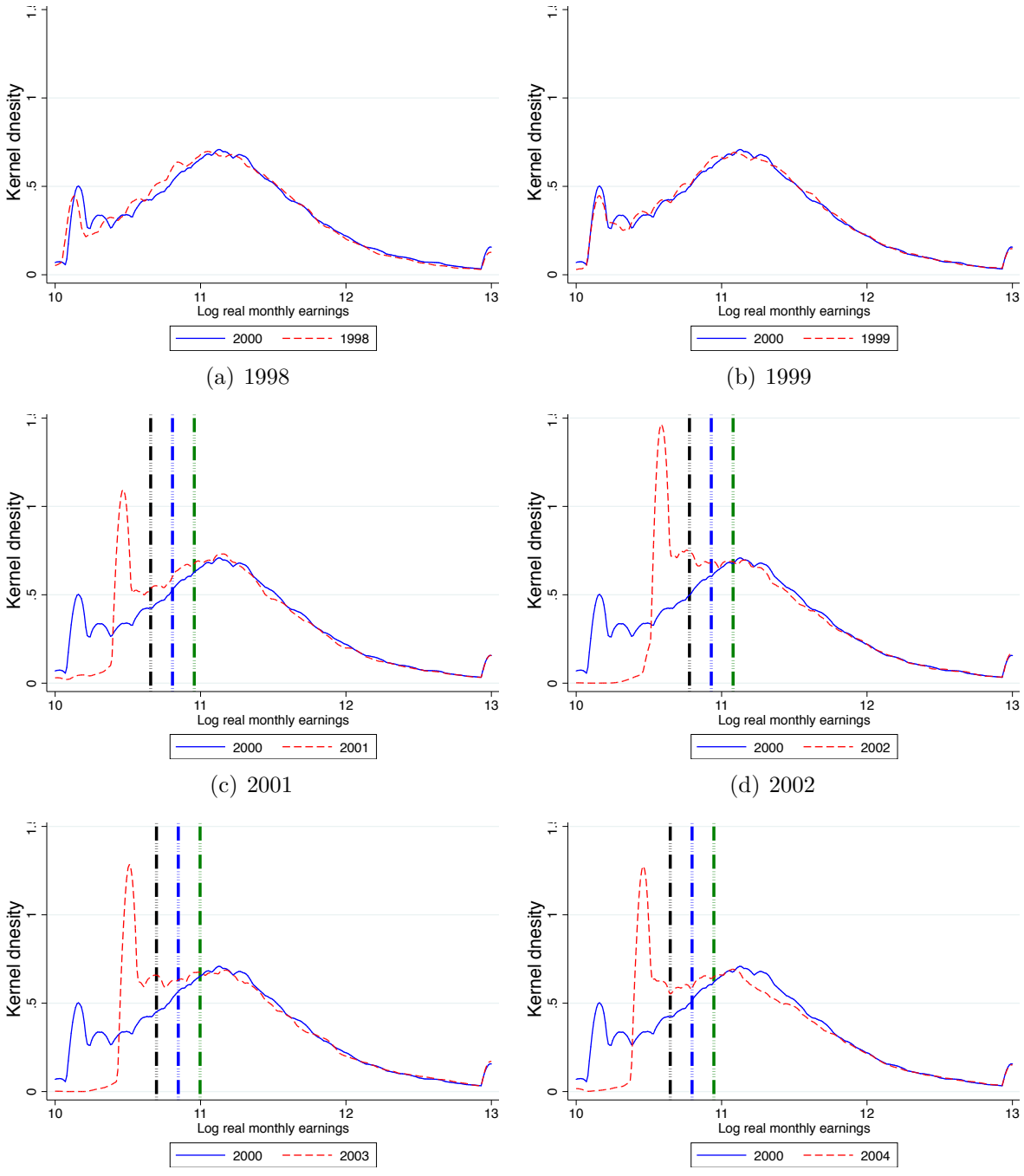
Notes: Source: OECD Employment Outlook in 2004. This figure shows the strictness of employment protection legislation in various OECD countries including Hungary. The data is from 2003, but the ranking was very similar in 1999. The strictness of employment protection is in the bottom third of the OECD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

Figure A-3: Effect of the Minimum Wage on Wages, Non-Wage Benefits, and Social Security Contributions



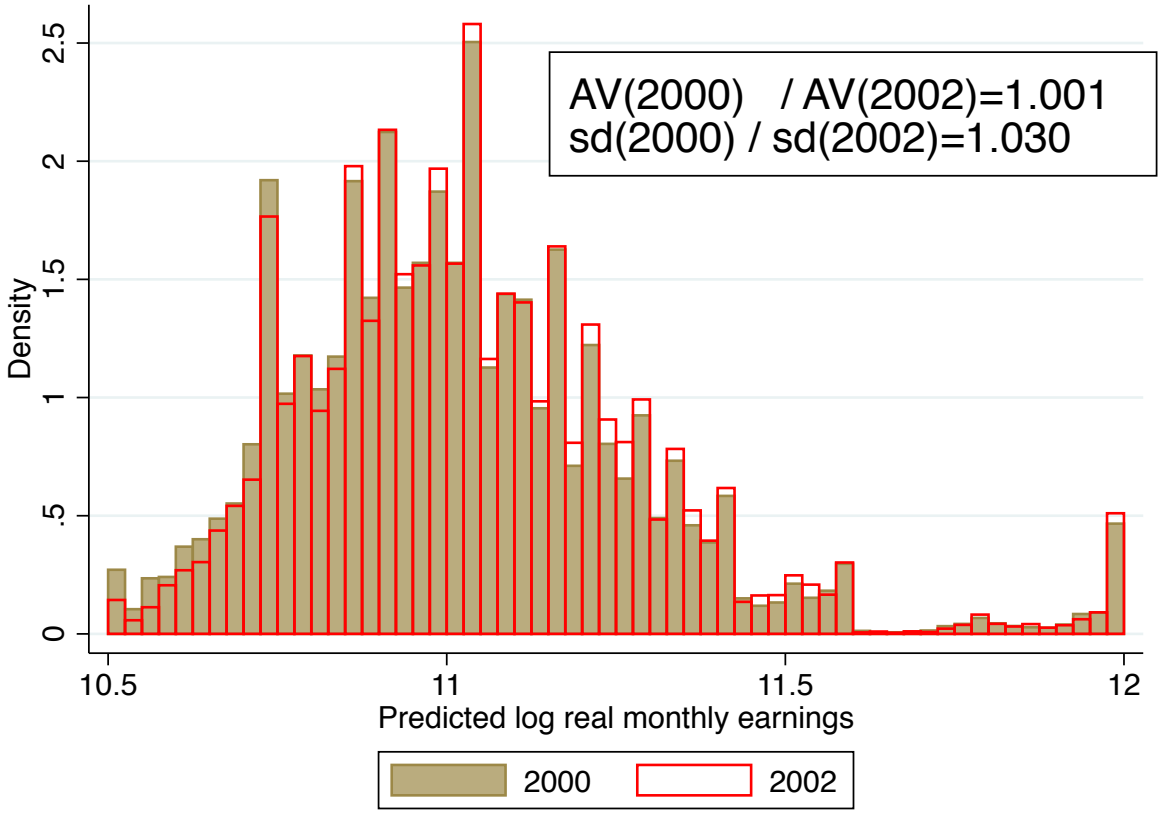
Notes: This figure shows firm-level regressions of percentage change in wage compensation (relative to 2000) on fraction affected by the minimum wage (beta coefficients with its confidence intervals from equation (1) over time. The red solid line show the effect on wage per worker, the blue dashed line 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-4: Evolution of kernel densities over time



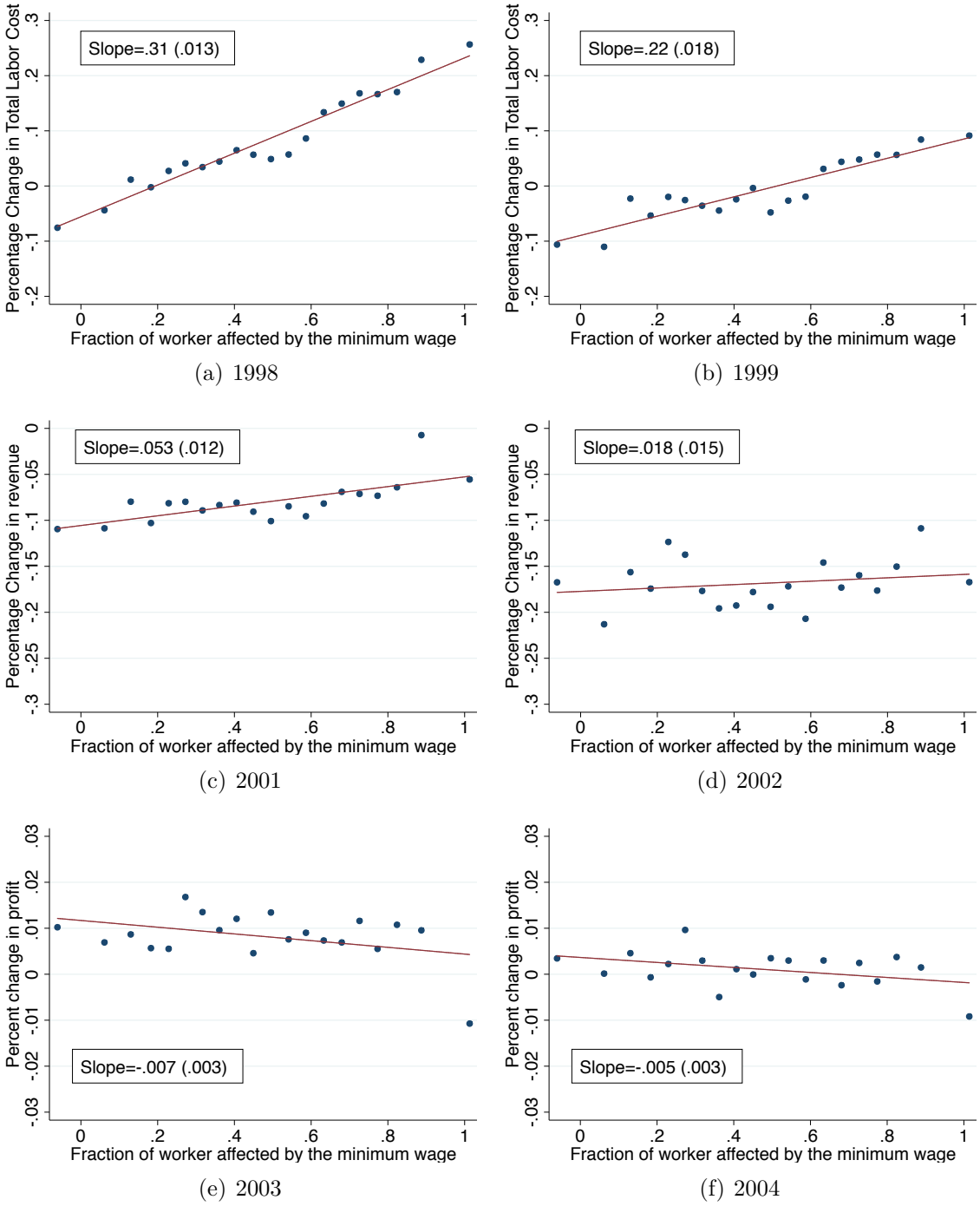
Notes: The kernel density of monthly log earnings over time are shown between 1998 and 2004 (red dashed line) relative to 2000 (blue line). Various thresholds ($\bar{W}$): 20% (black), 35% (blue),50% (green) above the new minimum wage shown in Panel (c)-(f).

Figure A-5: Predicted Earnings Distribution in 2002 and 2000



Notes: This figure shows the (density) earning distributions predicted by observables (age, age square, sex, education, region) in 2000 (brown solid bars) and in 2002 (red solid bars) for jobs that earned less than 150% of the new minimum wage. In both years we use the relationship between observables and the earnings in 2000. The differences between the 2002 predicted value and the 2000 predicted value uncovers the effect of changes in observables on the earnings distribution. The ratio of means (first line) and the standard deviation (second line) between 2002 and 2000 is reported in the top right corner. This ratio is close to one indicating that the two earnings distributions are very similar and so the worker's observables characteristics in jobs that earned less than 150% of the new minimum wage in 2002 and in 2000 are very similar.

Figure A-6: Non-parametric relationship between revenue/profit/total labor cost change and fraction affected by the minimum wage



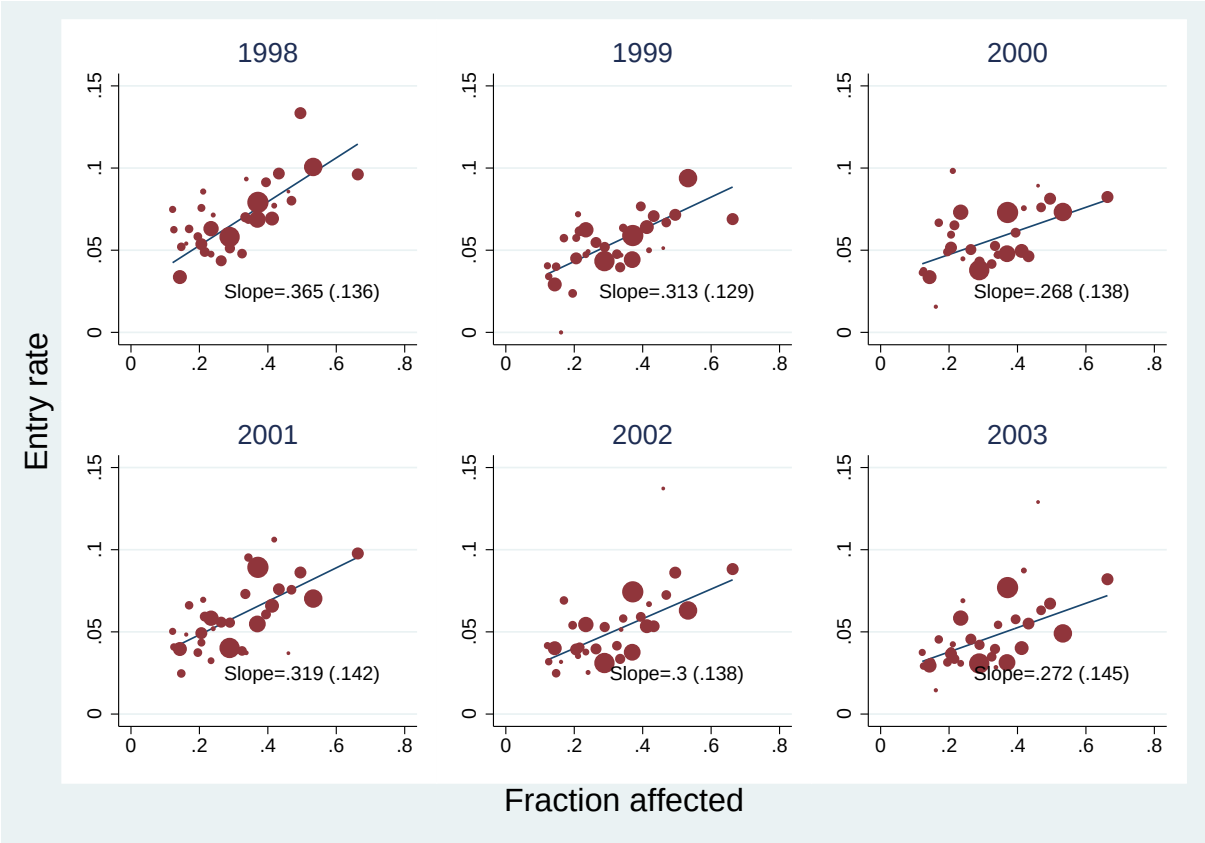
(a) 1998 (b) 1999

(c) 2001 (d) 2002

(e) 2003 (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). Panel (a),(c),(e) show the effect on employment in the short term (changes between 2002 and 2000) while panel (b),(d),(f) show the medium term effects (change between 2004 and 2000). The red line represent the best linear fit, while in the box we report the slope of that line.

Figure A-7: Effect on Firms Entry



Notes: This figure shows the relationship between exposure to the minimum wage and firms entry at two digit industry level. Each scatterplot relates the share of new firms 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 weighted by the number if firms in the sector. The regression slope along with the standard errors are indicated in the right bottom corner of each year from 1998 to 2003.

Web Appendix

1. Employment Elasticity with respect to the Wage

In Figure 4 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), Columbia	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	0.82 (0.67)	Table 4, Column 6	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	0.085 (0.52)	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
	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 4 we report only studies with at least 50 citations as of 2000 and where the standard error on the employment elasticity is less than one.

2. Description of the main data sets and the main variables

2.1. 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-8: 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 .
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.
Miscellaneous items:	This item includes depreciation and 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). Investment is calculated as the change in fixed assets plus depreciation deflated by two-digit sectoral level investment indices. Investment indices are obtained from the Central Statistical Office of Hungary.

2.2. 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 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% for larger firms and 50% 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 3. 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 that time-series because this is what the Hungarian Statistical Office has been consistently reporting since 1998.

2.3. 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 the 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 the following regression for the subset of firms where at least 5 employees are observed in the SES data:

$$FA_{it}^{Measured} = \alpha_t + \beta_{1t} AvCostLabor_{it} + \beta_{2t} AvCostLabor_{it}^2 + \varepsilon_{it} \tag{11}$$

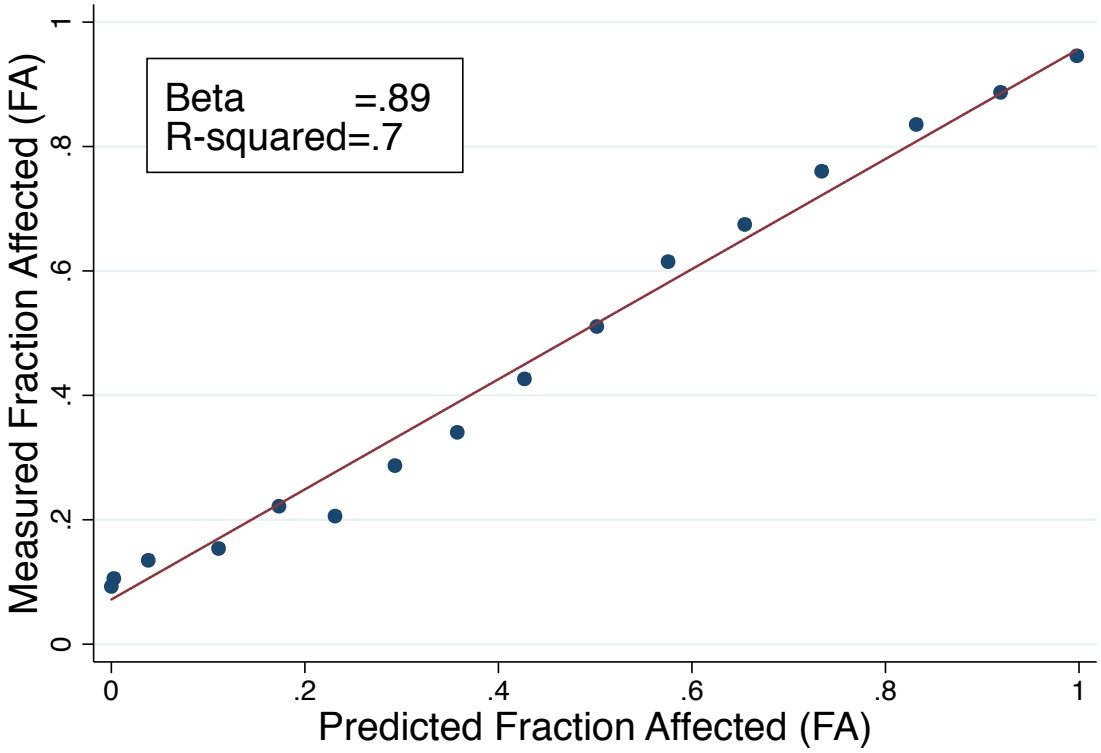
where $FA_{it}^{Measured}$ uses the SES data to measure the fraction of workers affected by the 2002

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.
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 relationship between the measured fraction affected and its prediction in 2000 is shown in the following figure:

Figure A-8: Relationship Between the Predicted and the Measured Fraction Affected in 2000

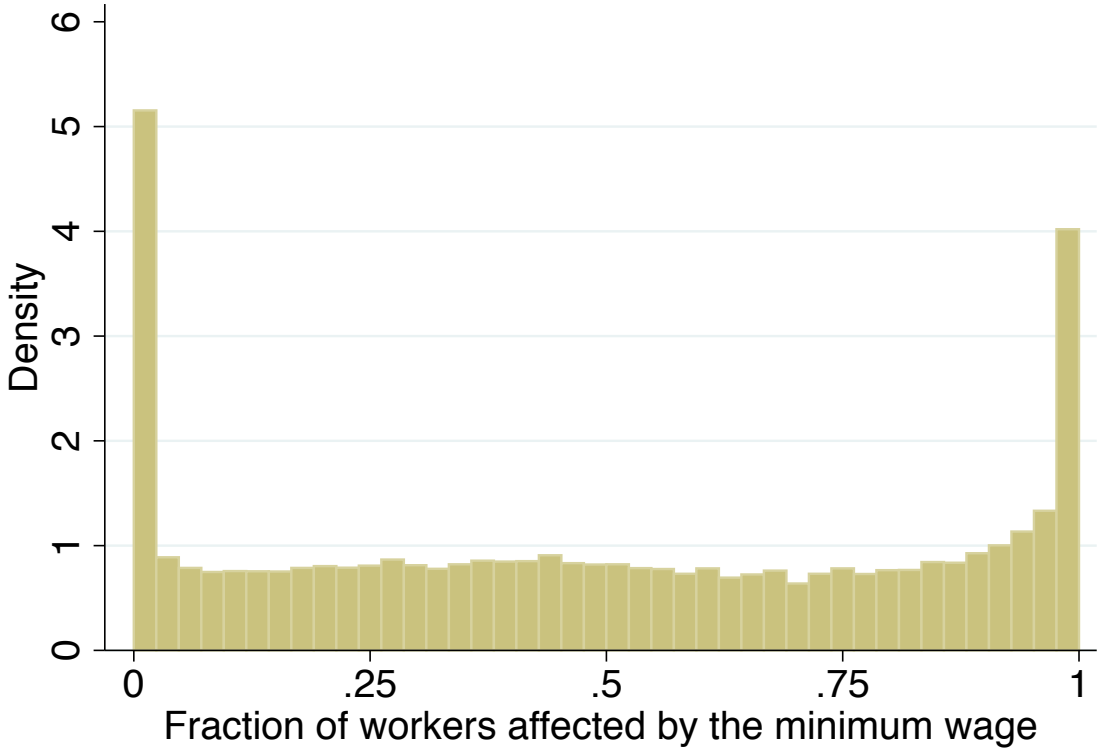


Finally, to reduce noise in the measure of fraction of affected workers we take the average between 1997 and 2000. Formally,

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

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

Figure A-9: Relationship Between the Predicted and the Measured Fraction Affected in 2000



In addition, we also explored alternative prediction models to equation 11, including estimating equation 11 with a tobit model, including higher order terms for average cost of labor, and using control variables besides average cost of labor. Our prediction model performed better than the tobit model in terms of R-squared. 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.

2.4. 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 fora 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 by 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.

2.5. 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 worker's 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.

2.6. Hungarian Household Budget Survey (HBS)

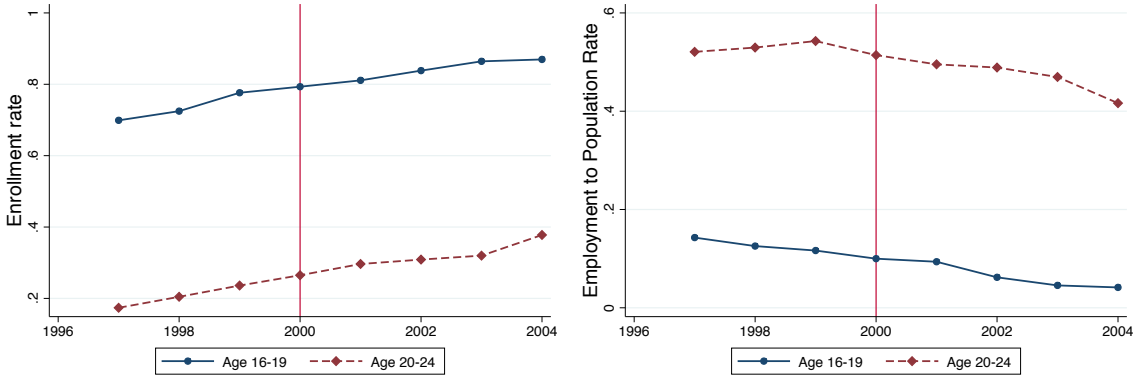
To assess the distributional consequences of the minimum wage in Section 5 of the Appendix we exploit the Hungarian Household Budget Survey. This dataset contains detailed income and consumption measures of broadly 10,000 households per year.

3. Institutional Context and Policy Changes

3.1. Expansion of Higher Education

Between 1990 and 2001, the number of students in higher education in Hungary increased threefold, 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-10: 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 Section 3.1.

3.2. Large pay raise 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 2014). 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 (2014) estimates that the effect of public sector wage increase had a small effect on private sector wages. (Telegdy 2014)

3.3. 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 attract more workers and increase the number of workers searching for jobs. To test for this, we report the effect of the minimum wage on inactivity rate in the following table.

Table A-9: Unemployment Effect of the Minimum Wage, Grouping Estimator

	(1)	(2)	(3)	(4)	(5)
Panel A: Effect on Inactivity Rate					
After 2000 × FA_g	-0.08**	-0.03	-0.01	-0.01	0.01
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
After 2002 × 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

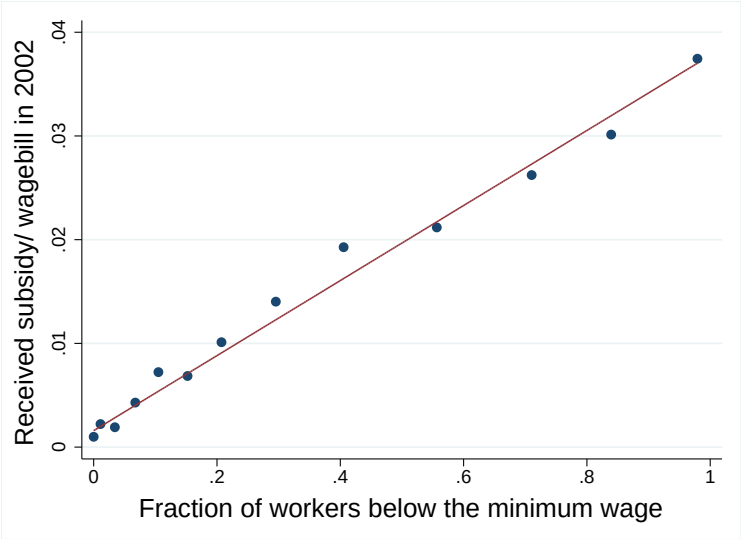
Note: *** p<0.01, ** p<0.05, * p<0.1. Table shows the group level relationship between group-level exposure to the minimum wage (FA_g) and inactivity rate. Groups are created based on demographics, age, education and the region where the workers live. The coefficient on the variable After 2000 × FA_g estimates the short term effect of the minimum wage, while the After 2002 × FA_g estimate 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.

3.4. Small subsidies in 2001 and 2002

The Hungarian government introduced small compensation schemes in 2001 and 2002 to help firms absorbing 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-11: The relationship between the subsidy and exposure to the minimum wage



We draw attention to two features of Figure A-11. 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% in 2002. If we subtract the 4% extra subsidy at highly exposed firms, then the wage bill still increases by 29%. 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.

3.5. Tax Evasion

There are two basic forms of evading taxes in our context: (1) not registering employment and (2) registering employment, but under-reporting actual earnings. These two modes of tax evasion 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% in Hungary (Elek, Scharle, Szabó and Szabó 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 does 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 overestimates the total employment effects (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 et al. 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 usually comes with over-reporting of cost items either by reporting personal consumption as company cost items, or by securing additional invoices (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 the effect 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 (see. Aaronson et al., 2012 for recent evidence on that) then food consumption could fall even in the absence of any tax evasion.(Aaronson, Agarwal and French 2012) 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 5). 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 et. al. (2011) which identifies cheaters and non-cheaters by estimating a structural model (double hurdle model) using data from 2006. Elek et. al. (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 et. al. (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 5 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 5 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, as we demonstrated in Figure **??** we do not find evidence for that the composition at the bottom of the wage distribution changed in response to the minimum wage.

4. Non-Competitive Market with Three Inputs

We derive here the key empirical moments shown in Section 6. First we derive the output demand elasticity given consumer's preferences. Then we show that consumer's 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).

4.1 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 the 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

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

Take the FOCs:

$$\frac{\partial L}{\partial q(\omega)} = \left(a \left(Q^{\frac{\kappa}{\kappa-1}} \right)^{\frac{\theta-1}{\theta}} + (1-a) X^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}-1} a \left(Q^{\frac{\kappa}{\kappa-1}} \right)^{\frac{\theta-1}{\theta}-1} Q^{\frac{\kappa}{\kappa-1}-1} q(w)^{\frac{\kappa-1}{\kappa}-1} - \lambda p(\omega) = 0 \tag{12}$$

$$\frac{\partial L}{\partial X} = \left(a \left(Q^{\frac{\kappa}{\kappa-1}} \right)^{\frac{\theta-1}{\theta}} + (1-a) X^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}-1} (1-a) X^{\frac{\theta-1}{\theta}-1} - \lambda = 0 \tag{13}$$

Taking the ratio of equation 12 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 the consumer's 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 13 and 12:

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

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.

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

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

$$\frac{\partial \log q(\omega)}{\partial \log p(\omega)} = -\kappa \tag{14}$$

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

$$\frac{\partial \log q(\omega)}{\partial \log P} = -1 - \frac{\left(\frac{1-a}{a}\right)^{\theta} (\theta - 1) P^{\theta-1}}{1 + \left(\frac{1-a}{a}\right)^{\theta} P^{\theta-1}} \tag{15}$$

4.2. 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

$$p(\omega) = \frac{c(w, r, p_m)}{1 + \mu}. \tag{16}$$

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 remain the same.[55] And, in particular, the price

[55] Remember that we are in a partial equilibrium framework and so we treat the wages of the high-skilled

charged by a minimum wage firm producing variety ω is given by

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

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, $\frac{\partial \log(1+\mu)}{\partial MW} = 0$, 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.

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

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 7 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 depend on the extent 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, then every firm raises prices by s_L and so the relevant demand elasticity is determined by equation 15.

Now we turn to derive 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 lead us to the following equation:

$$\frac{\partial \log l(\omega)}{\partial MW} = \frac{c_{ww}}{c_w} + \frac{\partial \log q(\omega)}{\partial MW} \tag{17}$$

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

$$\frac{\partial \log l(\omega)}{\partial \log MW} = MW \frac{c_{ww}}{c_w} - \eta s_L. \tag{18}$$

workers, interest rates and the price of materials as fixed. In a general equilibrium framework, where these prices can also change and may be affected by the minimum wage . In that case, the all firms may change their prices.

Now we turn to 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

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

By Shephard's lemma:

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

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 18 leads to equation 8 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 $\sigma_{kl} = \frac{cc_{rw}}{c_r c_w}$ 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 9 in the paper:

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

5. 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
3. low-wage workers remain employed at the same number of hours after the minimum wage increases.

Our results show that these assumptions approximately hold , since we have shown that (1) consumer demand is very inelastic (see Table 8); (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 1 and Table 2).[56]

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 fraction of workers who earn below the 2002 minimum wage, fa_s at the industry-level. This 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 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 by $(I - BU)^{-1} B \cdot fa_s$. Table A-10 shows the fraction affected workers in the industry, the direct exposure to the minimum wage $B \cdot fa_s$, 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 her spending on goods produced in each industry. The minimum wage content of total consumption measures the spending weighted

[56] 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.

total exposure for each individual. Figure A-12 shows the non-parametric relationship between household income and the minimum wage content of the consumption bundle. The figure highlights that richer households spend slightly more of their income on goods produced by minimum wage workers.

Table A-10: Effect on Firm-level Outcomes by Sectors

		Fraction Affected	Direct Exposure	Total Exposure
AtB	Agriculture, Hunting, Forestry and Fishing	0.50	0.17	0.34
C	Mining and Quarrying	0.20	0.10	0.18
15t16	Food, Beverages and Tobacco	0.33	0.26	0.48
17t18	Textiles and Textile Products	0.59	0.14	0.22
19	Leather, Leather and Footwear	0.55	0.13	0.19
20	Wood and Products of Wood and Cork	0.59	0.19	0.28
21t22	Pulp, Paper, Paper , Printing and Publishing	0.34	0.15	0.27
23	Coke, Refined Petroleum and Nuclear Fuel	0.01	0.06	0.15
24	Chemicals and Chemical Products	0.06	0.09	0.19
25	Rubber and Plastics	0.28	0.10	0.18
26	Other Non-Metallic Mineral	0.28	0.11	0.18
27t28	Basic Metals and Fabricated Metal	0.26	0.11	0.21
29	Machinery, Nec	0.18	0.10	0.18
30t33	Electrical and Optical Equipment	0.18	0.06	0.12
34t35	Transport Equipment	0.12	0.07	0.12
36t37	Manufacturing, Nec; Recycling	0.52	0.15	0.24
E	Electricity, Gas and Water Supply	0.06	0.05	0.14
F	Construction	0.54	0.11	0.19
50	Sale, Maintenance and Repair of Motor Vehicles and Motorcyclel	0.57	0.12	0.23
51	Wholesale Trade and Commission Trade, Except of Motor Vehicle	0.43	0.16	0.28
52	Retail Trade, Except of Motor Vehicles and Motorcycles	0.58	0.13	0.24
H	Hotels and Restaurants	0.61	0.16	0.26
60	Inland Transport	0.20	0.07	0.18
61	Water Transport	0.34	0.11	0.14
62	Air Transport	0.01	0.20	0.24
63	Other Supporting and Auxiliary Transport Activities	0.32	0.12	0.22
64	Post and Telecommunications	0.14	0.08	0.20
J	Financial Intermediation	0.10	0.09	0.23
70	Real Estate Activities	0.37	0.06	0.18
71t74	Renting of M&Eq and Other Business Activities	0.44	0.10	0.23
75+	Public Sector	0.45	0.08	0.21
	Imports	0.00	0.00	0.00

Figure A-12: The relationship between household income and the minimum wage content of consumption

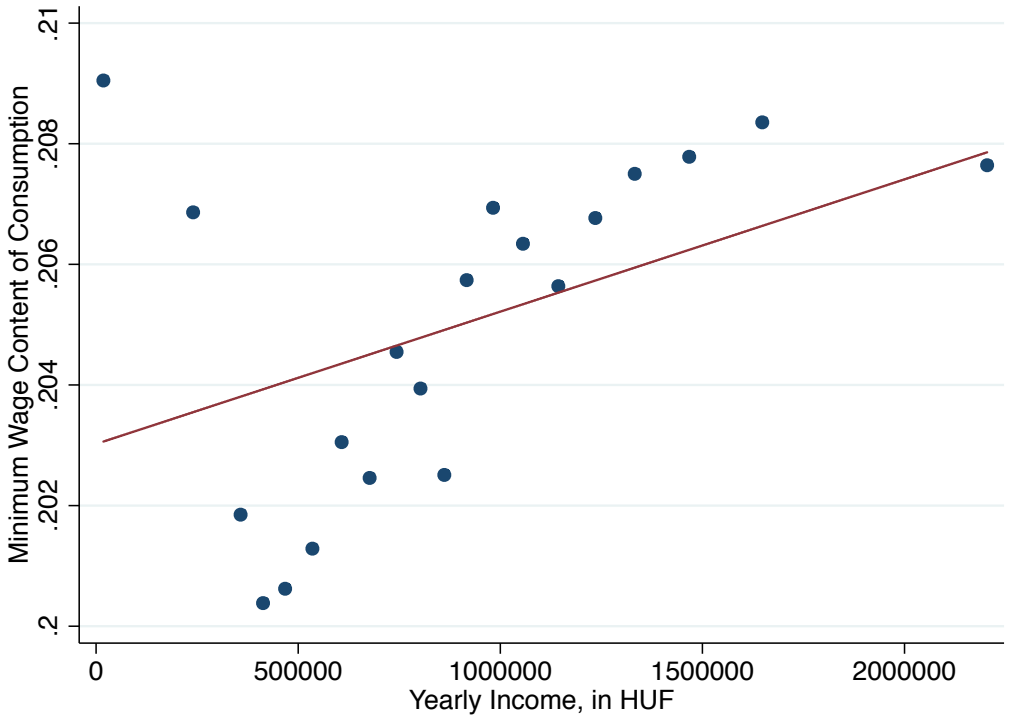


Table A-11: Classification of sectors and main characteristics

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 (2010) and classify tradability as follows. Tradable sectors are where 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 (%)	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

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Sector	Name	Classification	Employment (5+)	Fraction affected (%)	Geographical Herfindahl
1586	Processing of tea and coffee	Other	1540	13.7	54.3
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

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Sector	Name	Classification	Employment (5+)	Fraction affected (%)	Geographical Herfindahl
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
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

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Sector	Name	Classification	Employment (5+)	Fraction affected (%)	Geographical Herfindahl
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
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

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Sector	Name	Classification	Employment (5+)	Fraction affected (%)	Geographical Herfindahl
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	Aluminium production	Tradeable	4379	31.2	61.7
2751	Casting of iron	Non-tradeable	1757	22.2	28.9
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

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Sector	Name	Classification	Employment (5+)	Fraction affected (%)	Geographical Herfindahl
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
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

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Sector	Name	Classification	Employment (5+)	Fraction affected (%)	Geographical Herfindahl
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
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

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Sector	Name	Classification	Employment (5+)	Fraction affected (%)	Geographical Herfindahl
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
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

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Sector	Name	Classification	Employment (5+)	Fraction affected (%)	Geographical Herfindahl
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
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

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Sector	Name	Classification	Employment (5+)	Fraction affected (%)	Geographical Herfindahl
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
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

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Sector	Name	Classification	Employment (5+)	Fraction affected (%)	Geographical Herfindahl
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
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

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Sector	Name	Classification	Employment (5+)	Fraction affected (%)	Geographical Herfindahl
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
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

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Sector	Name	Classification	Employment (5+)	Fraction affected (%)	Geographical Herfindahl
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
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