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Price Effects of Minimum Wages: Evidence from the Construction Sector in East and West Germany*

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Abstract

In this paper, the authors present a new approach to estimate the impact of a minimum wage on the labor market of the construction sector in Germany. Instead of estimating the effect on employment, the authors focus on the change of prices on a firm level in order to differentiate between a competitive and a monopsonistic structured labor market. The composition of the sector-specific labor market serves again as a basis to evaluate whether the consequences of the minimum wage can be taken as economically advantageous or disadvantageous. Using firm data monthly conducted by the Ifo Institute for Economic Research, the estimations show that the minimum wage did have a different impact in East and West Germany. In East Germany, we find significant positive price effects of the minimum wage which exclude the possibility of positive employment effects due to monopsonistic structures. On the contrary, our results indicate a competitive sector-specific labor market and declining employment. In contrast, there was no significant price reaction observed for West Germany. The minimum wage seems too low compared to the wages paid in the West German construction sector. Therefore, the introduction of the minimum wage cannot be assumed to be binding.

JEL classification: J08, J38, J42, J48
Keywords: Labor market, minimum wage, employment effects, construction industry, difference-in-differences.

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1 Introduction and Motivation of the Paper

The literature on minimum wages is highly focused on the analysis of their impact on employment and usually evaluates the exogenous intervention in the labor market solely on the basis of this indicator. The former generalization, that a binding minimum wage always leads to less employment and to a rise of unemployment, has changed since the work of Card and Krueger (1994), who find a positive employment effect in the fast food branch after the introduction of a minimum wage. This surprising result is explained by the up to that point in time existence of a non-competitive labor market with monopsonistic or oligopolistic structures, respectively.[1]

One thing however should be clear and that is that employment is not the only indicator available for researchers when it comes to the purpose of an investigation as to whether the introduction of a minimum wage is advantageous or disadvantageous for the labor market. In addition, indicators of the goods market can deliver helpful interpretable information. When a minimum wage is introduced it should push the price level upwards when the labor market is competitive or downwards when monopsonistic structures are present. In our analysis, we benefit from this relationship, as it gives us the possibility to work with business survey data for the German construction sector, monthly conducted by the Ifo Institute for Economic Research. The extent of our data set is widespread and it contains 50,108 observations for East and 180,510 observations for West Germany. One important advantage of this dataset is that we can estimate the changes on the price level after the introduction of a minimum wage directly on a firm level. In order to generate consistent estimators, we are also able to control on a firm level for shifts in demand, the state of business and capacity utilization as well.

The paper is organized as follows: in the next section, we will give a brief overview of literature relating to key issues of the minimum wage debate. The third section presents the two major alternative views on the relevant market structure and the respective likely outcomes of minimum wage legislation: full competition vis-à-vis monopsonistic competition. In the fourth section, we present stylized facts of the construction sector in East and in West Germany. In addition, we put forward here our data set and the methodology chosen for the econometric estimations and present our own empirical findings. In the fifth section, we sum up our results and provide some tentative policy conclusions.

[1] To render the paper easier to read, the term "monopsonistic" is used hereafter to mean both "monopsonistic" and "oligopolistic".

2 Brief Review of the Literature

One of the most popular papers on the minimum wage issue stems from Card and Krueger (1994). The authors apply a difference-in-differences (DD) approach using firm data to find empirical evidence for positive, but minor employment effects of such a labor market regulation. The majority of quantitative studies focus on the labor market outcome triggered by a minimum wage legislation, where the achieved results differ widely (see e.g. Brown 1999, Metcalf 2008, Dickens et al. 1999). A well known example for the controversy in the literature is the paper of Neumark and Wascher (2000). They draw – in comparison to Card and Krueger – the opposite inference about employment effects on the same fast food market in New Jersey and Pennsylvania making use of a payroll dataset. For Germany, as one of the last countries in Europe without a general statutory minimum wage legislation, the number of quasi-experimental ex post studies is assessable. Ragnitz and Thum (2008) as well as Müller and Steiner (2008) figure ex ante simulation models to predict employment effects of a general statutory German minimum wage. Probably the most cited study on the impact of a sector-specific German minimum wage is König and Möller (2009). Essentially, their finding is that minimum wages introduced in 1997 in the construction sector harmed the branch-wide employment in East Germany, but did not affect employment in West Germany significantly. In a much more complete follow-up study, Möller et al. (2011) find supporting evidence for their earlier findings, but their results are not particularly robust. However, they are able show that the implementation of minimum wages led to a higher wage growth in East Germany's construction sector while such an observation could not be made in the case of West Germany. These results coincide with the conclusion of Rattenhuber (2011), who also detects sizeable growth of wages in East Germany and no impact in West Germany. Müller (2010) – who applies contra-factual semi-parametric approaches using payroll data – estimates crucial negative employment effects in East Germany (4-5%) and modest negative effects in West Germany (1-2%). For other East German sectors (electricians, roofers, painters and varnishers) with minimum wages, Kroeger (2010) finds no negative impact on employment and assigns this fact to monopsonistic competition structures.

However, none of the above-cited studies analyze the possible price effects which went along with the observed employment effects. We wish to fill this gap. A major goal of our study is therefore to present empirical evidence on the price effects which can be attributed to the introduction of minimum wages in the construction sector of West and East Germany. There are only a few papers around with a similar focus: Wadsworth (2010) finds that, for the UK that the aggregated inflation rates for take-away food, canteen meals, hotel services and domestic services grew significantly faster in the four years after implementation of the nationwide British minimum wage legislation. Lee and O'Roark (1999) test empirically a direct pass-through of higher wage costs on

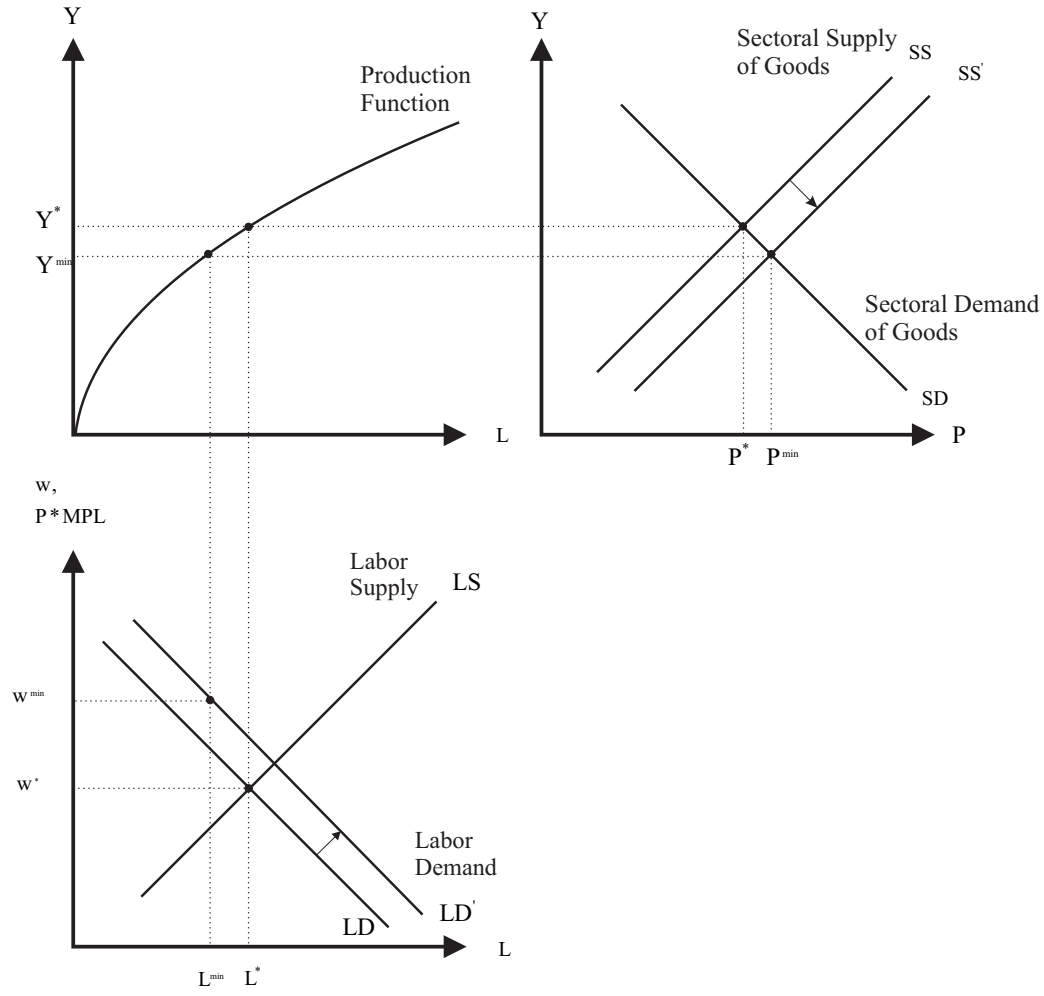
the prices of food and kindred products with a Input-output model. Their empirical findings suggest that a 10% minimum wage increase raises prices of industries with a high share of minimum wage workers by 0.75%. A crucial assumption made by these authors, however, is that the number of workers and hours is fixed in the short run. Price increases then reflect the aim of the firms to maintain their earlier profit level. In addition, the authors exclude spillover effects. Accordingly, Lemos (2006, 19) criticizes that "these underlying assumptions produce a highly stylized and unrealistic model and cast doubts on the results". In the above-mentioned studies the Consumer Price Index (CPI) is generally applied as the dependent variable. By contrast, Aaronson et al. (2008) use store-level data and find price increases in response to minimum wage shocks in the restaurant sector. As a matter of fact, the authors could not consider control variables at the firm level. To our knowledge, no approach with non-aggregated firm data exists, which considers other immediate influences – particularly demand shifts – on pricing behavior at the firm level.

However, the subject of firm profitability as a function of minimum wages is of greater interest in literature. Draca et al. (2011) find a significant reduction of the firm's profitability after the implementation of a statutory minimum wage in the UK and thereby they can explain the absence of negative employment effects in other empirical studies (see Metcalf 2008). A recent German study covers a segment of the construction sector, the roofing business (Kraft et al. 2012). These authors estimate the effects of the minimum wage on firms profitability and firm entry and exit rates. Only in the case of East Germany, do they find significant positive effects on the profitability and lower market entry rates. The rationale behind these effects, according to the authors, should be "negative causal impact of the minimum wage on the degree of competition in the East German roofer sector". Minimum wages would hence work as a device for raising rivals' costs (more precisely the costs of market entry) and could thereby reduce the degree of competition in the relevant market. However, Möller et al. (2011, 411) already analyzed the influence of the minimum wage on market entry/exits and the profitability in the for this purpose relevant main construction sector and found no significant effects.

3 A simple, but not simplistic theory

Amongst others, Barr and Roy (2008) have shown us, how it is possible and plausible to integrate the issue of minimum wage legislation into the context of modern growth theory in the vein of Lucas (1976), Rebelo (1992), etc. Their approach is important because, unlike many other studies, it departs from the narrow framework of partial analysis of the effects of minimum wages on the labor market in favor of a much broader endeavor. In our much simpler, but hopefully not simplistic model, we combine, in a

Figure 1: Price effects in a competitive labor market after an introduction of a minimum wage



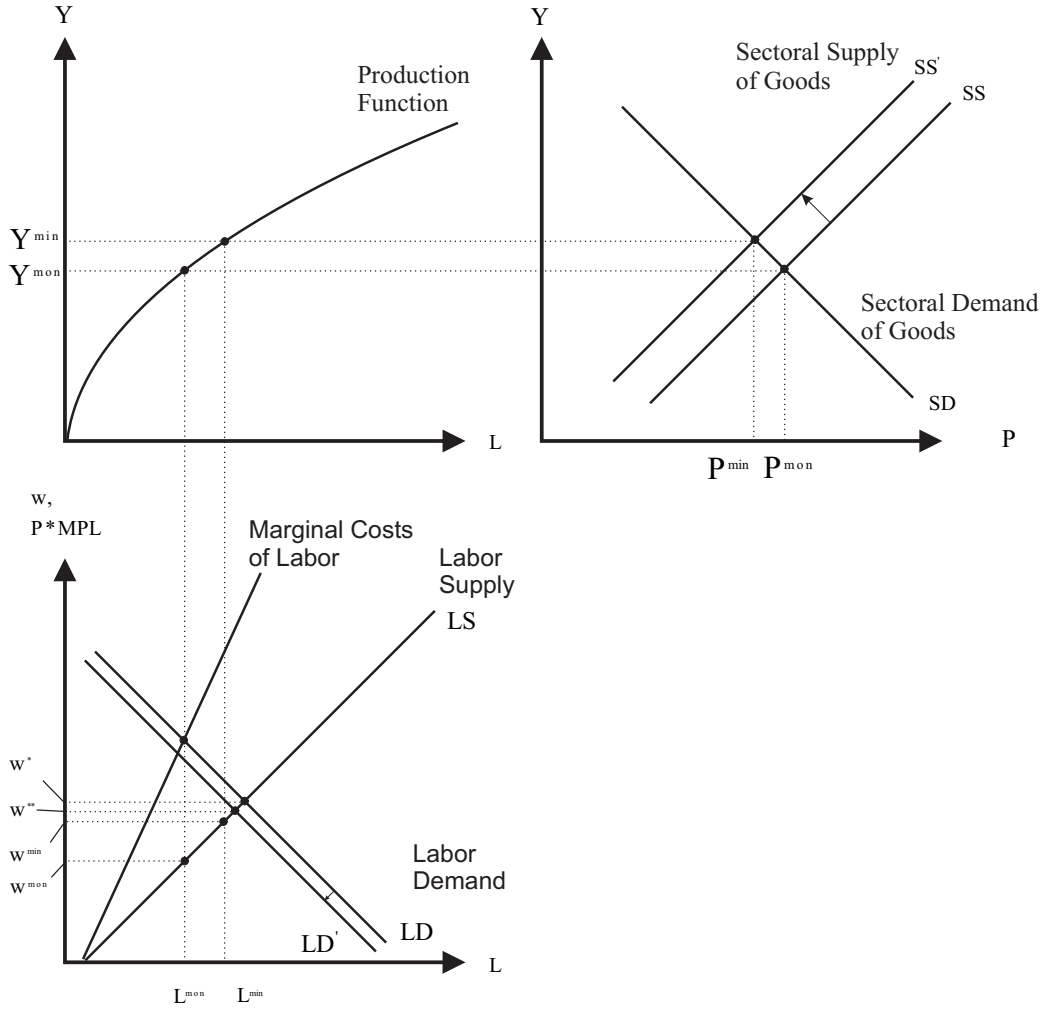
short-term perspective, the (perfectly competitive) labor market with the respective (perfectly competitive) goods market and a very fundamental production function in a scheme of three quadrants. We do this without using any algebraic exposition. The details can be found in Figure 1. In the upper left diagram, we have depicted a traditional production function (with decreasing marginal returns) in a sector which is eligible for a minimum wage legislation. In the "base run" of Figure 1, we assume perfect competition in the concomitant goods market. The respective supply and demand curves are "well behaved" (see upper right diagram). Their intersection explains the equilibrium output Y^* and price level P^* in the initial situation. Equilibrium output, which is shown in the upper left quadrant, goes along with equilibrium employment L^*, the latter is the result of the intersection of labor demand and labor supply in the lower quadrant. Notice that due to the short run perspective, physical capital and all

other relevant factors of production are taken as given and constant.
In the second scenario, we now introduce a binding minimum wage w^{min} rate into the labor market. Employers will reduce employment accordingly, production will shrink and the sectorial supply SS curve will be shifted to the right. The resulting excess demand on the goods market will lead to a new and higher price P^{min}. Notice that the higher price will now increase the marginal product of labor in terms of value (i.e. labor demand) and will shift the respective curve LD in the lower quadrant to the right LD' with the result that we achieved the level of employment L^{min} and the new output level Y^{min}. Without this effect (as a matter of fact neglected by many studies on the issue), the negative employment and hence production effect of minimum wages would be stronger, other conditions remaining the same.
Some qualifications however have to be made, we are interested in the impact this type of regulation has on labor cost and hence on labor demand (see Ragnitz and Thum 2008, Knabe and Schöb 2008, etc.), but also on the prices of goods and hence the demand and supply curves for these goods (Müller and Steiner 2008). Let us inspect the role of price elasticity in more detail: Rising prices and a lower output and employment level can be expected ceteris paribus – in the absence of monopsonistic market structures – if the demand curve on the relevant market for goods of the respective sector is not one of the special cases (perfect price elasticity or perfect price inelasticity).
There is also an additional point: When firms generate profits because of imperfect competition on the goods market, they can reduce their margins and do not inevitably adjust employment and output. Draca et al. (2011, 3) argues that as long as "profits do not fall below the exit threshold, the firm will remain in the market with lower profitability". In the following, we exclude monopolistic competition on the goods market and abstract from any endogenization of the demand elasticity triggered by the minimum wage legislation (as did Draca et al., who constructed this special case theoretically).[2]
What about the supply schedule? Two remarks can be made: one applies to the shift, the other to the curvature. Firstly, the shift toward the right of the supply curve is not a must. At first glance, economic theory predicts higher marginal labor costs as a response to a binding minimum wage if there is no compensating increase in the marginal productivity of labor. One has to be cautious, however: In principle, effective wages may rise much less than minimum wages would make one expect. Whenever there is a considerable sectoral and overall unemployment rate, employers are potentially able to force their employees to work extra hours for free. Secondly, the less elastic the supply curve on the goods market is, the higher the accompanying price effects will be.

[2]Below, we show that the German construction sector is very far from a monopolistic goods market (see section 4.1)

The Figure 2 should reflect the impact of minimum wages when market imperfections prevail, such as a monopsonistic competition in the labor market (see Card and Krueger 1994, etc.). We want to show why a monopsonistic or likewise oligopsonistic competition on the labor market in conjunction with a traditional (full competitive) goods market is able to explain, why minimum wages can go along with an increase in employment and production and, at the same time, with a decrease of prices in the relevant sector.

Figure 2: Price effects in a monopsony labor market after an introduction of a minimum wage



As is well known from textbooks (see e.g. Borjas 2007), the monopsonist equates the marginal costs of labor with the marginal revenue (i.e. labor demand) and finds the optimal employment as well as the optimal wage rate on the labor supply curve (see lower diagram in Figure 2). As a result, the monopsonistic employer will choose the wage rate w^{mon} and the employment level L^{mon} which is lower than the hypothetical

competitive wage rate w^* and the equilibrium employment L^*, respectively. The introduction of a minimum wage w^{min} which is set in-between the competitive and the monopsonistic wage rate has a double effect: The monopsonist now acts as a (factor) price taker, he raises employment, and hence production and shifts the supply curve on the goods market leftwards from SS to SS'. As a consequence, an excess supply on the goods market will emerge which can be removed by a price decrease from P^{mon} to P^{min}. Once the minimum wage rate is set, the price decrease on the goods market (which, under normal circumstances, should not be foreseeable to the government) leads to an inward shift of the labor demand to LD' curve to its new position. Theoretically, one could derive from the new labor demand schedule a new monopsonistic and a new hypothetical competitive wage rate w^{**} in the lower diagram. In the short run, this new information should be irrelevant, as all involved parties will stick to the existing minimum wage rate for a while. In the medium term, this new scenario may become interesting as any higher minimum wage rate will have analogous effects on employment, prices and production and hence (the falling) hypothetical competitive wage rate comes quite close to the (new) minimum wage rate. Notice that, once the competitive equilibrium level of the wage rate is reached, our monopsonist will mutate into a "classical" employer. From now on, he is no longer interested in the labor supply curve, but merely in labor demand (Borjas, 2007, 203).
In Table 1, we have put together our theoretical findings: When we detect positive price effects after the introduction of a minimum wage rate in conjunction with a competitive labor market, we expect negative employment, negative production of goods effects and an overall negative evaluation of this policy instrument. If, on the other hand, we come across with negative price affects going along with a monopsonistic labor market, we expect positive employment, positive production of goods effects and an overall positive evaluation of the introduction of a minimum wage rate.

Table 1: From price effects to an economic evaluation of the minimum wage

labor market structure	employment	production of goods	price effect	overall economic evaluation
competitive labor market	−	−	+	−
monopsonistic labor market	+	+	−	+

In the following empirical part of the paper, we check for the price effects after an introduction of a sectoral minimum wage for construction sector workers as an indicator for labor market structures and economic consequences in the German construction sector.

4 Empirical Evidence

4.1 Stylized facts on German construction sector

There are a number of stylized facts which characterize the German construction sector: production is organized "on demand" which implies the insignificance of storage or inventory accumulation (Bosch and Zühlke-Robinet 1999, 240). Demand for goods and services of the construction sector itself is highly volatile being a function of the business cycle and of seasonal cycles. There are a large number of medium and small-sized enterprises with small financial reserves. This fact makes employment highly insecure (ibid.). Foreign firms achieved a strong influence over labor supply during the 1990's as they sent up to 185,000 workers legally from abroad. In addition there is a large illegal workforce. The economic impact on the sector-specific labor market was a race to the bottom with regard to wage rates (and partly also to prices), because the foreign firms applied the "law of origin" (*"Ursprungslandprinzip"*), and paid wages according to the conditions prevailing in their home country.
Therefore, in 1997, a very "German form" of minimum wage legislation was introduced with the so-called (*"Entsendegesetz"*). The law aimed directly at stopping a bid-down process of wages. Union agreements which introduced minimum wages were declared to be binding (*"allgemeinverbindlich"*) for all employees in the sector (Bosch et al. 2011, 50). To this day, the level of minimum wage has been changed several times as is shown in Table 2. The economic conditions accompanying this regulation in the construction sector could not have been worse: due to idle capacities, a weakening of (overall and sector-specific) demand and intensive competition, prices began to fall in 1996 and continued to do so in 1997 (Bosch and Zühlke-Robinet 1999, 254). As a consequence, the German market for housing and construction changed in the late 1990's from a seller‘s market into a buyer‘s market. This structural change limited the possibility of setting mark-ups and reduced the number of large enterprises in favor of medium and small sized firms significantly. Competition functioned between a higher number of (on average) smaller firms, as larger and medium-sized firms were particularly hit by the down-swing: as opposed to the smaller companies, they had to sustain larger equipment and staff (Bosch et al. 2011, 29).
However, there are considerable structural differences between the construction sector in West and in East Germany. In West Germany, firms profited indirectly from the *"Entsendegesetz"*: Before this minimum wage legislation of 1997, East German firms in the construction sector had a comparative advantage with regard to labor costs. This comparative advantage was eliminated to a large extent, as from then on effective labor costs rose much more in East Germany than in West Germany: when introduced on January 1, 1997, the minimum wage represented 64% of the average wage in West Germany's construction sector, but was equivalent to 85% of the average wage in the

case of East Germany (Apel et al. 2012, 3). Möller et al. (2011, 202) calculated that only 3% percent of the employees in the West and at least 17% of the employees in East Germany were affected by the minimum wage of 1997. In addition, East Germany's construction sector's labor intensity of production is more pronounced than in West Germany. Hence, any kind of labor market regulation which increases labor costs will have stronger repercussions on total costs, ceteris paribus. Moreover, East German firms still have disadvantages in the field of labor productivity (Loose and Ludwig 2006).

Table 2: Minimum Wage Development

	East		West	
date	w^{min}	Δw^{min}	w^{min}	Δw^{min}
01/97	8.00		8.69	
09/97	7.74	−0.033	8.18	−0.059
09/99	8.32	0.075	9.46	0.157
09/00	8.49	0.020	9.65	0.020
09/01	8.63	0.016	9.80	0.016
09/02	8.75	0.014	10.12	0.033
09/03	8.95	0.023	10.36	0.024
09/05	8.80	−0.017	10.20	−0.015
09/06	8.90	0.011	10.30	0.010
09/07	9.00	0.011	10.40	0.010
09/08	9.00	0.000	10.70	0.029
09/09	9.25	0.028	10.80	0.009
09/10	9.50	0.027	10.90	0.009
07/11	9.75	0.026	11.00	0.009
01/12	10.00	0.133	11.05	0.005
01/13	10.25	0.000	11.05	0.000

Source: Möller et al. (2011, 152) and several wage agreements.

4.2 Data Description and Descriptive Statistics

The data-set is based on business survey data for the German construction sector conducted monthly by the Ifo Institute for Economic Research.[3] Our sample runs from January 1991 to December 2007 and encompasses 50,108 observations for East and 180,510 observations for West Germany. Firms are asked whether they changed the prices of their products in comparison to the previous month and the answers are coded as 1 ("increased"), 0 ("unchanged") and -1 ("decreased"). The same applies

[3]See Seiler (2012) for further details on the dataset.

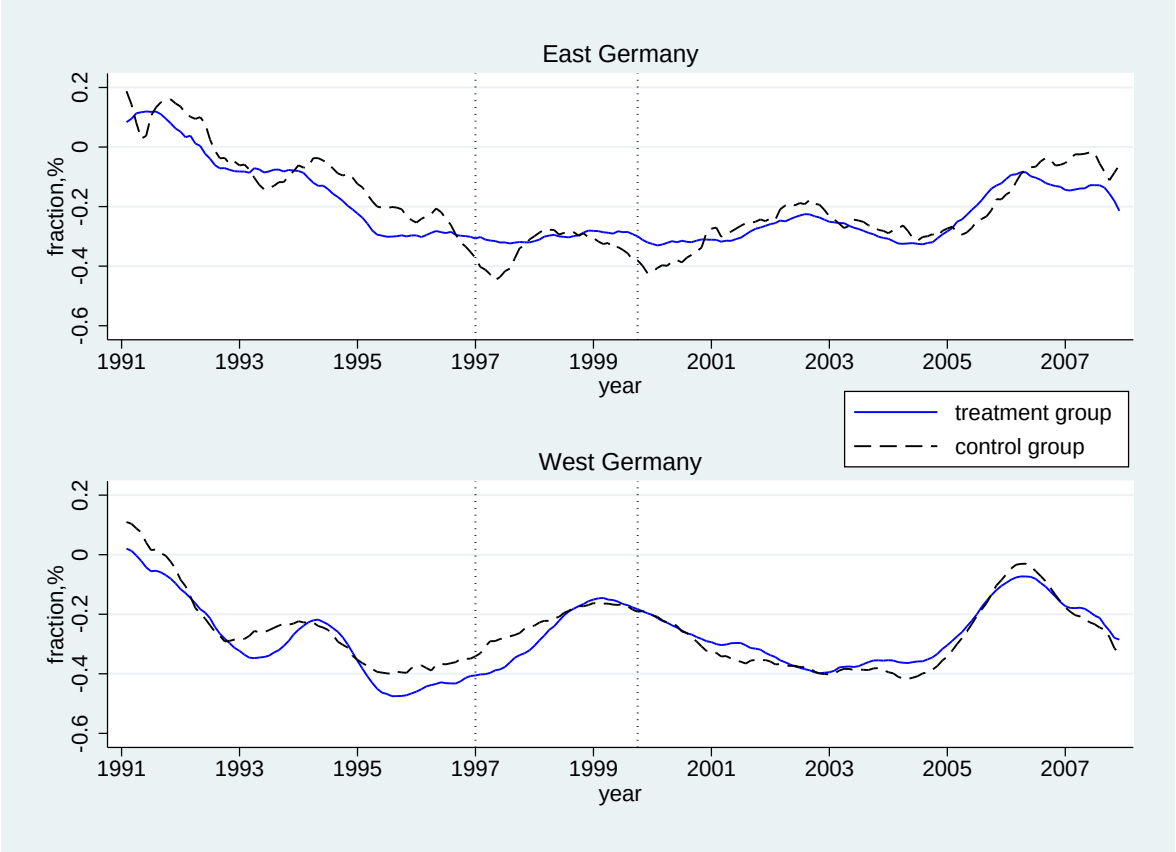
to questions about the development of demand (*demand*) and the state of business (*statebus*). In addition, firms are asked about the rate of capacity utilization (*capacity*). Finally, we use the monthly aggregated price data of upstream industry which produces construction materials (*material price*). For that purpose, we deduct the share of price decreases from the fraction of price increases. A summary of all used variables and their descriptive characteristics is given in Table 3.

Table 3: Descriptive Statistics: Price and explanatory variables

		East		West			
	variable	mean	sd	mean	sd	min	max
price		−0.227	0.495	−0.264	0.506	-1.0	+1.0
1 (increase)	*demand*	0.224	0.731	0.291	0.694	-1.0	+1.0
	statebus	0.215	0.677	0.275	0.704	-1.0	+1.0
	capacity	75.168	19.638	74.211	18.001	0.0	+150
	material price	0.006	0.186	0.068	0.194	-0.5	+0.4
0 (constant)	*demand*	−0.139	0.667	−0.173	0.647	-1.0	+1.0
	statebus	−0.240	0.605	−0.354	0.605	-1.0	+1.0
	capacity	71.924	20.647	65.171	18.408	0.0	+150
	material price	−0.049	0.192	−0.043	0.191	-0.5	+0.4
-1 (decrease)	*demand*	−0.514	0.640	−0.605	0.589	-1.0	+1.0
	statebus	−0.611	0.537	−0.770	0.442	-1.0	+1.0
	capacity	61.451	21.691	55.354	18.044	0.0	+150
	material price	−0.077	0.185	−0.078	0.182	-0.5	+0.4

The qualitative nature of the data is manifested in the trichotomic shape of most variables. This means that, the variables can be ordered, but the distance between the different categories are unknown and therefore, an examination of the extent of the price changes is not feasible. The crucial advantage of the utilized panel data set is the capability to control the immediate influences of the current business situation on pricing at the firm level. As Ifo survey data considers not only data on price development, but further variables, especially demand information, determined on an individual basis. Moreover, we can distinguish between firms directly and not directly affected by the minimum wage legislation using the five-digit industry classification WZ03.
Figure 3 plots the trends in the accumulated price development of companies directly affected by the minimum wage against the accumulated price development of not directly affected companies in East and West German firms, respectively. We extract the underlying data by subtracting the share of firms which reported price decreases from the share of firms which reported price increases. We smooth the time series by using a one-month running mean. As expected, the market trends in the two regions

Figure 3: Price development in East and West Germany



Source: Own estimation.

are non-synchronous. Accordingly, in the following we have to consider East and West Germany separately. We can also detect a slight drifting apart of the price trends after the implementation of the minimum wage in 1997 and its crucial enhancement at the end of 1999 (depicted by the dotted vertical lines) in East Germany contrary to West Germany, where no significant deviation is observed. These price developments and their causal link to the minimum wage legislation need therefore to be investigated econometrically in the next subsection.

4.3 Empirical Approach

In order to identify minimum wage effects on prices, we want to determine mutations in the pricing behavior of directly affected firms in comparison to not directly affected firms considering the current business situation on firm level. Thus, we use – quite in line with existing literature – a quasi-experimental difference-in-differences (DD)

setting. In this framework, the treatment effect (TE) can be defined by:

$$TE = (Y^{(G=1,T=1)} - Y^{(G=1,T=0)}) - (Y^{(G=0,T=1)} - Y^{(G=0,T=0)}) \quad (1)$$

where Y is the outcome and G and T are binary group and treatment indicators, respectively. The first difference is the change in pricing behavior before and after the introduction of the minimum wage within the treatment group. The second difference reflects the variation of prices in the control group. Accordingly, the DD shows the purely treatment effect only under the condition that the development of prices in the control and treatment group would have been the same if the minimum wage had not been introduced. To satisfy this so-called parallel trend assumption, we choose an intra-industrial control group. We identify the minimum wage affected firms on the basis of the five-digit industry classification WZ03 and compare the price trends of these firms with the price development in the remaining construction sector.[4] The choice of alternative control groups, i.e. upstream or downstream industries, leads to erroneous conclusions concerning the singularity of the construction sector. Because the collapse of prices (see again Figure 3), which started after a short upswing in the course of the German reunification, was considerably larger than in all comparable sectors, the DD analysis resulted in price cuts allegedly triggered by minimum wages. Due to the limitations of ordinal survey data we have to use a non-linear model. This means that we estimate the probabilities for price increases, price decreases and constant prices as a function of group affiliation, pre- and post-intervention periods as well as of several control variables. With ordinal outcome variables, it is common to use logistic or probabilistic versions of the ordinal regression model. However, the implicit parallel regression assumption of the ordinal models – where the relationship between each pair of outcome groups is the same – must be discarded with the help of the Brant-Test. In the existing literature, the multinomial model is often used as an alternative, but it treats the dependent variables as un-ordered and has to allow the coefficients to vary freely by every outcome. Based on the deficiencies of the multinomial and the ordinal approaches, the *stereotype ordered regression model* (SOR) developed by Anderson (1984) seems more adequate. On the one hand, the SOR does not require the parallel regression assumption, and on the other hand, it is possible to impose constraints so that a loss of efficiency by ignoring underlying orders of the outcomes can be avoided. The SOR – using the case of the probability estimation of price increases p^{in} which stands exemplarily for the other outcomes price decreases p^{de} and constant prices p^{co} – is defined as:

[4]For this purpose, we draw on the work of Möller et al. (2011), who already identified the minimum wage affected firms by the WZ03 classification (see p. 47-71).

$$Pr(y = p^{in}|\boldsymbol{x}) = \frac{exp(\theta^{in} - \phi^{in}\boldsymbol{\beta x})}{exp(\theta^{co} - \phi^{co}\boldsymbol{\beta x}) + exp(\theta^{de} - \phi^{de}\boldsymbol{\beta x})} \tag{2}$$

where $\boldsymbol{\beta}$ is a vector of coefficients associated with the corresponding independent variables of vector $\boldsymbol{x}$. The θs are intercepts and the only, but crucial difference in comparison to the multinomial model is the existence of the constraints ϕ, which ensures consideration of the order of origin. The ϕs force the ratio of coefficients to be equal across variables (see Long and Freese 2005, 279):

$$\frac{\phi^{in}\beta_1}{\phi^{de}\beta_1} = \frac{\phi^{in}\beta_2}{\phi^{de}\beta_2} = \frac{\phi^{in}}{\phi^{de}} \tag{3}$$

In order to identify our model, we determine the intercept θ^{co} of the base category "price is constant" as 0. Moreover, we impose the constraints $\phi^{co} = 0$, $\phi^{in} = 1$ and estimate ϕ^{de} by the data. Due to the fact that $\phi^{in} > \phi^{co} > \phi^{de}$, we retain the underlying order of the survey data.[5]

The application of the DD setting – usually used in linear regressions – on the SOR method leads to the following simplified regression equation:

$$\Pr(y = p_{it}|G, T, \boldsymbol{Z}) = F[\beta_1 G_i + \beta_2 T_t + \beta_3 (T_t{}^* G_i) + \boldsymbol{\psi Z_{it}} + \epsilon_{it}] \tag{4}$$

where p_{it} denotes the price development (*increased*, *constant* and *decreased*) of firm i in quarter t and the dummy variable G_i stands for the group status, i.e. G_i equals 1 if firm i is directly affected by minimum wage and 0 otherwise. The post-reform dummy variable T_t adopts the value 1 for 12 months after the implementation of the statutory minimum wage in January 1997 (and in the second estimation additionally for 12 months after the crucial minimum wage enhancement in September 1999) and 0 otherwise. Furthermore, $\boldsymbol{Z_{it}}$ labels a vector of control variables, whilst $\boldsymbol{\psi}$ is a vector of the associated unknown coefficients. The vector of control variables encompasses the development of demand, the state of business, the capacity utilization and the aggregated price data of the upstream industry, whereas the former trichotomic variables *demand* and *statebus* are recoded as four binary dummy variables ($statebus^+/statebus^-$ and $demand^+/demand^-$). The implementation of the DD estimator is achieved through the interaction of the variable treatment group G and the post-reform variable T. In contrast to linear regression models – where the treatment effect always equals the slope coefficients – the analysis in non-linear models is much more complicated. In the relevant literature, the method of Ai and Norton (2003) is very common (see e.g. König and Möller 2009, Boockmann et al. 2012, etc.). These authors demonstrate that the parameter of interest is not the cross difference or derivative (as in linear models),

[5]Equations (2) and (3) are derived from Long and Freese (2005, 280)

but the double discrete difference:

$$TE = \frac{\Delta^2 F(\cdot)}{\Delta T \Delta G} = [F(\beta_1 + \beta_2 + \beta_3 + \boldsymbol{\psi Z}) - F(\beta_1 + \boldsymbol{\psi Z})] - [F(\beta_2 + \boldsymbol{\psi Z}) - F(\boldsymbol{\psi Z})] \quad (5)$$

where $F(\cdot)$ is the conditional distribution function of the logistic distribution. This application is particularly suited to randomized treatment groups. In our case, we model a counterfactual scenario so that the approach initially developed by Puhani (2008) fits better. Puhani (2012, 87) states that the treatment effect in a potential outcome framework is equal to the difference of two differences between observed outcome in the treatment group and the counterfactual outcome in the control group:

$$TE = F(\beta_1 + \beta_2 + \beta_3 + \boldsymbol{\psi Z}) - F(\beta_1 + \beta_2 + \boldsymbol{\psi Z}) \quad (6)$$

This implies that we are able to compute the impact of the statutory minimum wage on prices by estimating the marginal effect of the coefficient of the interaction term, β_3.[6] We calculate the *average marginal effect* (AME) not only for the interaction term, but for all right hand side variables to improve the interpretability of the estimates. To obtain unbiased standard errors, we use the delta method and cluster standard errors on the firm level to account for serial correlation.

4.4 Empirical Results

Initially, we only consider the price development only immediately after the implementation of the statutory minimum wage in East and West Germany. For that purpose, the treatment variable *year 1997* equals 1 for the 12 month after January 1997 (and 0 otherwise). Table 4 reports that all control variables are highly significant and show the expected sign. For instance, a contraction in demand *(demand$^-$ = 1)* raises the probability for price decreases by 13% in East and by almost 16% in West Germany. The table also demonstrates the absence of a universal deviation between the price trends of the minimum wage affected and not directly affected firms, since the effect of the variable *treatment group* is insignificant for both the East and the West German panel. From first glance, the highly significant negative effect of the treatment period (*year 1997*) on prices in the East Germany is striking. This should be an outcome of the above mentioned economic condition in the mid and late 1990s, which considerably restricted the scope for price increases in the East German construction sector (see section 4.1). It also becomes apparent that the marginal treatment effect of the minimum wage implementation is only significant in East Germany. The treatment effect for West Germany is negligible because the effect is relatively small and not significant.

[6] We also estimate the treatment effect by the *"Ai-Norton method"* whereby the results are very similar to the findings gained by the *"Puhani approach"* and are available on request.

Table 4: Difference-in-differences estimation:
Treatment effect 1997

	East			West		
	p^{de}	p^{co}	p^{in}	p^{de}	p^{co}	p^{in}
treatment group	-0.001	0.001	0.000	0.010	-0.008	-0.002
	(0.031)	(0.025)	(0.006)	(0.019)	(0.015)	(0.004)
year 1997	0.136**	-0.117**	-0.019***	-0.001	0.001	0.000
	(0.053)	(0.048)	(0.006)	(0.025)	(0.020)	(0.005)
treatment effect	-0.076*	0.056**	0.020	0.043	-0.036	-0.007*
	(0.041)	(0.027)	(0.015)	(0.030)	(0.025)	(0.004)
$demand^{+}$	-0.036***	0.028***	0.007**	-0.055***	0.045***	0.010***
	(0.012)	(0.010)	(0.003)	(0.009)	(0.007)	(0.002)
$demand^{-}$	0.133***	-0.106***	-0.027***	0.165***	-0.135***	-0.030***
	(0.011)	(0.011)	(0.005)	(0.009)	(0.008)	(0.002)
$statebus^{+}$	-0.169***	0.135***	0.034***	-0.194***	0.158***	0.036***
	(0.027)	(0.025)	(0.006)	(0.017)	(0.015)	(0.003)
$statebus^{-}$	0.133***	-0.106***	-0.0267***	0.169***	-0.138***	-0.0311***
	(0.013)	(0.012)	(0.005)	(0.009)	(0.008)	(0.002)
capacity	-0.002***	0.002***	0.000***	-0.003***	0.002***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)
material price	-0.147***	0.118***	0.030***	-0.146***	0.119***	0.270***
	(0.027)	(0.021)	(0.009)	(0.018)	(0.014)	(0.004)
Log-Ps.Lik	-31,843.57			-109,023.32		
N	50,108			180,510		

Standard errors, reported in parentheses, are clustered at the firm level. Statistical significance of the coefficients at the 10%, 5% and 1% level are indicated by *, **, and ***.

Only the negative impact on the probability of price increases is slightly significant at the 10% level, whereas the marginal effect is below 1%. This is certainly not sufficient evidence for a negative causal price effect caused by the minimum wage legislation in West Germany.

The first three columns in the third row of Table 4 display the treatment effect of the minimum wage in East Germany. Here, the probability of price decreases declines by approximately 8% while the likelihood of unchanged prices increases by nearly 6%. However, only the effect on maintaining the prices constant is tolerably significant. The computed positive effect on price increases is quite small with 2% and, moreover, not even significant at the 10% level. Thus, this is only a slender indication rather than sufficient evidence for a positive pass-through of minimum wage on prices and the underlying market structure of the construction sector in East Germany. Nevertheless, the achieved weak results can be referred back to the circumstances of comparing the price development in the year 1997 with all other subsequent periods, so that we ignore

Table 5: Difference-in-differences estimation:
Treatment effect 1997 and September 1999 to August 2000

	East			West		
	p^{de}	p^{co}	p^{in}	p^{de}	p^{co}	p^{in}
treatment group	0.006	-0.005	-0.001	0.011	-0.009	-0.002
	(0.030)	(0.024)	(0.006)	(0.019)	(0.015)	(0.003)
year 1997/2000	0.121***	-0.103***	-0.019***	-0.038*	0.030**	0.008*
	(0.031)	(0.028)	(0.004)	(0.019)	(0.015)	(0.004)
treatment effect	-0.072***	0.054***	0.019**	0.020	-0.017	-0.004
	(0.027)	(0.020)	(0.009)	(0.023)	(0.020)	(0.004)
Log-Ps.Lik	-31,811.787			-111,599.990		
N	50,108			180,510		

Standard errors, reported in parentheses, are clustered at the firm level. Statistical significance of the coefficients at the 10%, 5% and 1% level are indicated by *, **, and ***.

all minimum wage enhancements and reductions thereafter. Table 2 shows the development of the minimum wage in the construction sector and indicates that the sole crucial alternation (during our observation period) took place in September 1999. The minimum wage rate rose by 15.7% in East and at least by 7.5% in West Germany. Table 5 reveals our most important results, where we use the year 1997 combined with the 12 months from September 1999 to August 2000 as the treatment period.[7] As anticipated, the significance level of the altered treatment effect improves substantially for the East German panel and rises to the 1% level for price decreases and constant prices and for price increases up to the 5% level, respectively. The marginal effects remain almost the same as in the previous estimation confirming the positive causal influence of the sectoral minimum wages on the construction sector prices in East Germany. In contrast, the significance levels of the West German treatment effect deteriorate sharply in comparison to the previous estimation. Accordingly, we cannot prove a causal relationship between the minimum wage rate and prices in West Germany. This fact can be ascribed to lessor minimum wage eligibility of the West German firms which can be attributed to the relatively higher wage level and to the lower labor intensity of production in West Germany, as already mentioned in section 4.1.

[7]For reason of space and clarity, we do not reproduce here again the marginal effects of all control variables in Table 5.

4.5 Sensitivity and Robustness Checks

In order to find confirmation for our results, we ran several sensitivity analyzes and robustness validations. We exemplarily report the two most important checks below. Considering our control variables, the multicollinearity assumption can hardly be denied. However, moderate collinearity is fairly common and neither the standard errors nor the regression coefficients point toward severe collinearity problems. To face this issue, we use the *variance inflation factor* (VIF) as an indicator whether collinearity is a cause for concern or not (see Stevens 1992, 74). The VIFs for the East and West German sample are shown in Table 6 and it becomes apparent that all of them are far below the common critical benchmark of 10. Thus, the precision of our parameter estimations should not be restricted by the correlation between the right hand side variables.

Table 6: Vector Inflation Factor

	East	West
treatment group	1.050	1.063
year 1997/2000	8.156	5.038
treatment effect	8.196	5.061
$demand^{+}$	1.192	1.166
$demand^{-}$	1.228	1.240
$statebus^{+}$	1.141	1.142
$statebus^{-}$	1.244	1.307
capacity	1.106	1.156
material price	1.030	1.051

Furthermore, we conduct several *placebo tests* to provide evidence that the statutory minimum wage rate, rather then other unobserved differences between treatment and control group influences the prices of the considered firms. We run the same non-linear regression as before 16 times in each case setting the treatment effect 1 for one of the years from 1991 to 2007. It figures out that in addition to year 1997 in the year 2000, i.e. immediately after the crucial minimum wage enhancement at the end of 1999, that the market trend of the treatment group in East Germany deviates significantly from the development of the remaining construction sector (see Table 7[8]).
For the affected West German firms, we also observe negligible deviations of the price development from the rest of the sector for two years only. In addition to the mentioned trend deviation in the year 1997, the probabilities of price increases decline relatively in the year 1996. However, as well as in 1997, the marginal effect is smaller than 1%

[8]We show only the statistically significant *treatment effects*, but the complete results are available from the authors on request.

Table 7: Placebo Tests

	East *(year 2000)*			West *(year 1996)*		
	p^{de}	p^{co}	p^{in}	p^{de}	p^{co}	p^{in}
treatment effect	-0.066*	0.049**	0.017	0.050	-0.043	-0.008*
	(0.034)	(0.023)	(0.011)	(0.031)	(0.027)	(0.004)
Log-Ps.Lik	-31,847.739			-111,437.590		
N	50,108			180,510		

Standard errors, reported in parentheses, are clustered at the firm level. Statistical significance of the coefficients at the 10%, 5% and 1% level are indicated by *, **, and ***.

and only significant at the 10% level.
Hence, our findings of a positive minimum wage impact on construction prices in East Germany and unaffected pricing behavior in West Germany can be confirmed.

5 Conclusion

The pros and cons of the introduction of a minimum wage – both for a general one and for a sector-specific one – are based on the degree of competition in the labor market. In contrast to many other studies, we did not focus on the indicator "employment", but instead on the development of the price level. In our theoretical section, a positive price effect due to an introduction of a minimum wage indicates a competitive labor market causing decreasing employment and more unemployment in general (see Table 1). When the price change is negative instead, we suppose that a monopsonistic labor market is given, causing increasing employment if the minimum wage is set below the final equilibrium wage rate. In order to estimate these economic chain reactions, we utilized comprehensive business survey data on a firm level conducted by the Ifo Institute for Economic Research. With access to more than 230,000 relevant observations in total, our empirical results diverge for East and West Germany.
For West Germany, we did not find a causal inference between the minimum wage and the pricing behavior of firms. This result could be explained by the fact that the minimum wage only affected less than 3% of the construction sector workers in West Germany. For East Germany, we find a positive and significant effect on prices which suggests a binding minimum wage in a competitive labor market and decreasing employment. Finally, an alternative explanation of rising prices – in which a steady employment level is conceivable – should be mentioned: The minimum wage leads to a decreasing extent of competition and increasing mark-ups and prices, respectively (see Kraft et al. 2012). However, Möller et al. (2011) do not find any evidence for changes in

market competition. In fact, they find little evidence for negative employment effects of the minimum wage in East Germany and no indications for employment effects at all in West Germany. Thus, our results reinforce the relatively low robustness of the negative employment effect Möller et al. find for East Germany.

6 Policy Implications

Our findings are highly relevant for the ongoing discussion relating to the introduction of an overall statutory minimum wage in Germany. As with many earlier papers, we are unable to provide good arguments in favor of the introduction of minimum wage legislation. Based on our theoretical and empirical analysis of the German construction sector, the ex-ante probability of welfare losses – measured by the price effect as an indicator for the market structure – is higher than the probability of welfare gains.
This result could also be important for an ex-ante evaluation of uniform minimum wage legislation in Germany. As demonstrated in our paper, the evaluation of a minimum wage depends significantly on the question whether a monopsonistic or a competitive market is present. Therefore, further research should also investigate differences in sectoral market structures. If significant disparities of market power on the sector-specific labor markets where to arise – which does not seem to be unlikely – one could infer that sector-specific minimum wages compared to a uniform minimum wage across the country should be preferred with a view to efficiency considerations.
Beyond that, policy makers should acknowledge the existence of alternative instruments to raise the level of wages of the low and medium-qualified labor force. A couple of years ago, the Ifo Institute for Economic Research put forward the idea of wage subsidies, which could be paid to employers or to employees directly (see Sinn et al. 2006). Such a policy must be accompanied by programs dedicated to the enhancement of qualifications and, hence, of labor productivity. This would allow firms to raise market levels of wages in line with increasing productivity. .

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