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**The German minimum wage:
effects on business expectations,
profitability, and investments**

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The German minimum wage: effects on business expectations, profitability, and investments

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Abstract

In this article, we analyze the effects of the introduction of the German minimum wage using difference-in-differences estimations applied to the IAB Establishment Panel. The treatment effects on the treated establishments show a slight reduction in the employers' expected development of business volume. When we analyze the effects of the minimum wage on the net sales of intermediates and wages costs, we observe a reduction, which is fully explained by the increase in wage costs induced by the minimum wage. The results do not point to effects on establishment-level productivity or capital investments. Looking at investments in human capital, we do not observe any effects on apprenticeship offers or the placement of apprentices. If anything, the results point at a slight reduction in the provision of further training.

[128 words]

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1. Introduction

In 2015, the German labor market experienced the introduction of a statutory minimum wage, which became effective as of January 1st. Starting with initially €8.50, the minimum wage rose to €8.84 per hour in 2017 and 2018. The introduction of a nationwide statutory minimum wage was unprecedented in Germany as, prior to 2015, minimum wages had only been implemented in selected industries.

While in 2015 and 2016 a transitional exception applied to existing industry-specific minimum wages under the Posting of Workers Act (*Arbeitnehmerentsendegesetz*), the uniform minimum wage applied to all industries by 2017 at the latest. At the individual level, there are also specific groups – such as workers under the age of 18, apprentices, and the long-term unemployed – who are exempted from the minimum wage. However, despite these exceptions the statutory minimum wage is of major importance to the German labor market. Estimates from the Structure of Earnings Survey (*Verdienststrukturerhebung*) showed that in 2014 about 4 million employees received an hourly wage below €8.50 (Minimum Wage Commission, 2016). According to the 2014 IAB Establishment Panel, about 12 percent of all establishments were affected by the introduction of the minimum wage, which implies that in 2014 they employed at least one worker who was remunerated below the minimum wage (Bellmann et al., 2015).

The goal of this article is to provide empirical findings addressing the establishment-level effects of the statutory uniform minimum wage. Apart from adjusting their employment level, establishments might react to the minimum wage by compensating for the minimum wage-induced increase in labor costs by raising the productivity of their workers. This may be achieved, for instance, by altering investments in physical and human capital. The question of how establishments respond to the introduction of the minimum wage in terms of factor inputs, productivity and profitability is crucial to an understanding of the effects of the minimum wage on establishments' long-term capability to compete and survive in their product markets. With regards to establishment-level outcomes, we therefore aim to shed light on short-run establishment-level adjustments in the aftermath of the introduction of the minimum wage, while at the same time disregarding the distributional effects of the minimum wage at the individual level.

The empirical analysis on which this article is based relies on a difference-in-differences approach which compares differences in outcomes between establishments that were affected by the introduction of the minimum wage and those that were not affected. The primary source of data is the IAB Establishment Panel. This dataset is based on an annual survey of German establishments, whose sampling frame encompasses all German establishments that employ at least one employee subject to social security contributions. The panel data provide an ideal basis for estimating the effects of the introduction of the uniform minimum wage on establishment-level outcomes for several reasons: First and most importantly, the data permit us to assign an establishment-level treatment with respect to affected and unaffected establishments, as they contain information on whether establishments employed workers

below the minimum wage in 2014. Second, the data allow us to track affected and unaffected establishments after 2015 and enable us to retrieve a variety of establishment-level outcomes of interest, such as employment and turnover, as well as productivity and profitability.

In addressing the effects of the recent introduction of a uniform minimum wage on establishment-level outcomes, our article is related to the empirical literature on the labor market effects of minimum wages in Germany. While much of this literature initially dealt with the ex-post evaluation of industry-specific minimum wages, there are meanwhile a few studies that address the statutory minimum wage. Studies exploiting regional variation in the bite of the minimum wage are those by Garloff (2017), Caliendo et al. (2018) and Bonin et al. (2018). Ex-post establishment-level studies on employment outcomes include the analyses by Bossler and Gerner (2016) and by Bossler (2017). Our article first provides a brief overview of this recent literature, including the results of the short-run employment effects obtained by Bossler and Gerner (2016). In addition, and most importantly, we proceed to provide evidence on a variety of further establishment-level outcomes such as investment in physical and human capital as well as productivity and profitability, which so far have not yet been addressed in the most recent literature.

The remainder of this article is laid out as follows: Section 2 deals with the empirical identification strategy and Section 3 provides a description of the main source of data. While Section 4 presents the empirical results of the employment effects, Section 5 focusses on business expectations and competitive pressure as the main outcome variables. Section 6 and 7, in turn, look at investments in physical and human capital. Section 8 deals with effects on profitability and productivity. The final Section concludes.

2. Empirical identification strategy

To identify the various effects of the introduction of the minimum wage, we exploit treatment variation at the establishment level while tracking treated and untreated establishments over time, that is, we apply a fairly standard difference-in-differences approach, where the observations and the treatment variation are on the establishment level.¹ Hence, we estimate the following regression specification:

$$y_{it} = treated_i * post_t * \delta + x_{it} * \beta + \theta_i + \tau_i + \varepsilon_{it} \quad (1),$$

where y_{it} is the outcome variable of interest, such as the firm-level productivity in establishment i at time t . $treated_i$ is a dummy variable that indicates treated plants, which captures time-constant information measured before the minimum wage introduction. $post_t$ is a dummy variable that indicates all observations of the years 2015 and 2016, that is, after introduction of the minimum wage. x_{it} captures control variables including institutions such as collective bargaining and works councils, as these

¹ For a precise definition of treatment, see Section 3.

variables are known to impact on wage levels independently of minimum wages. Control variables also include the share of female and highly qualified employees. Finally, ε_{it} is an error term that is uncorrelated with all covariates in the model. For the calculation of statistical inference, we calculate cluster-robust standard errors, where clusters are defined at the level of establishments.

δ captures the treatment time interaction, which is the treatment effect on the treated establishments, that is, it captures changes in the outcome variable of the treatment group compared to the control group after the minimum wage was introduced. Establishment-level fixed effects impose a time-constant intercept for each establishment, which captures any time constant differences between establishments. It controls for differences that were already in place before the minimum wage was introduced, commonly known as group effects. Time fixed effects estimate separate effects for each time period in the data and capture any time-specific effects that are common to all plants in the data, such as macroeconomic shocks.

In our analysis, we also identify separate effects for the years 2015 and 2016. Some outcome variables, such as employer expectations, might already have been especially affected in 2015 when the minimum wage had just been introduced, while other outcomes might only react with a certain time lag. To identify separate effects over time, we expand equation (1) by including separate treatment effect interactions for both years:

$$y_{it} = treated_i * post2015_t * \delta_{2015} + treated_i * post2016_t * \delta_{2016} + x_{it} * \beta + \theta_i + \tau_i + \varepsilon_{it} \quad (2).$$

Here $post2015_t$ is a dummy variable indicating observations in 2015, which is the first year after introduction of the minimum wage, and $post2016_t$ is a dummy variable for 2016.

The identifying assumptions of the difference-in-differences approach are the *parallel trends assumption* and the *SUTVA assumption*. We check the parallel trends assumption visually, by conducting a graphical description and a regression-based placebo test. For the regression-based test, the post-treatment time is excluded and the treatment year is artificially assigned to the year 2014. If the parallel trends assumption is violated and if trend differences can be parametrized by linear or quadratic treatment group-specific trends, we follow the existing literature (Addison et al., 2015; Allegretto et al., 2011; Neumark et al., 2014b) and add treatment group and trend interactions to the regression specifications:

$$y_{it} = treated_i * post_t * \delta + x_{it} * \beta + treated_i * trend_t * \gamma + \theta_i + \tau_i + \varepsilon_{it} \quad (3).$$

If $treated_i * trend_t$ is capable of capturing the correct parametric form of the initial trend difference, δ captures the (trend-adjusted) treatment effect of interest.

The *stable unit treatment value-assumption* (SUTVA) states that the control group should be unaffected by the treatment intervention; that is, the control group should not react to the minimum wage introduction. If instead, the control group is likely to be affected by the minimum wage, we are able to

identify *indirectly* affected control group establishments, by using information on the indirect effects of the minimum wage which were included directly in the survey. However, even in the presence of a reaction of the control group, the treatment effect would still capture differences between the treatment group and the control group. Hence, the treatment effect could be a lower boundary of the true effect if the control group is influenced in the same direction as the treatment group, and it is an upper boundary if the control group is influenced in the opposite direction.

3. Dataset and sample description

The core of this analysis is based on the IAB Establishment Panel, a representative survey of workplaces located in Germany. The survey is conducted annually between June and September, involving between 15,000 and 16,000 entities. All establishments included in the survey have at least one employee subject to social security contributions, which excludes both the self-employed as well as establishments employing only marginal part-time employees or civil servants. The survey has been conducted in western Germany since 1993 and in eastern Germany since 1996 (Ellguth et al., 2014, Fischer et al., 2009). In order to ensure the representativeness of the survey, the sample was stratified by 10 establishment-size classes, 19 sectors, and the 16 German Federal States (*Bundesländer*). Analyses of potential selectivity of participation in the survey show that, controlling for the stratification variables, there is no meaningful difference to administrative data covering German establishments as a whole (Bossler et al., 2018). Employers are visited and interviewed by trained interviewers from the survey institute Kantar Public. This ensures a relatively high response rate of first-time respondents (27-29 percent of the gross sample in the years 2011 to 2015) as well as panel respondents (82-84 percent), pointing to a high panel stability.²

The dataset is particularly suitable to analyze the effects of the introduction of the minimum wage in Germany at the level of establishments: already in 2014, the questionnaire included a delimiting question about minimum wage affectedness, measuring whether a plant was affected by having at least one employee paid below €8.50 per hour. This extensive margin of affectedness is used as the treatment variable in the difference-in-differences analyses. Note that, hereafter, the notions “treatment and control group” and “affected and unaffected” establishments will be used as synonyms. To identify anticipating employers (that is, employers who anticipated the introduction of the minimum wage), the 2014 wave also polls whether any hourly wages were already adapted in the course of the debate around the introduction of the minimum wage.

Implemented after the law came into force, the 2015 survey wave measures the number of employees whose wages were increased to at least €8.50 due to the new wage floor. However, the variable is not

² A fraction of roughly 5 percent of establishments is not surveyed face-to-face but is exclusively contacted in writing. The response rates of these interviewees lie below the rates mentioned above.

suitable to measuring affectedness, as it already measures an endogenous consequence of the minimum wage. Such an endogenous consequence might, for instance, be potential non-compliance, spillovers to higher-paid employees, or the possible exclusion of employees who were laid off as a result of the legislation, blurring the line between affected and unaffected establishments. Affectedness is thus determined on the basis of the 2014 question. Nonetheless, two additional questions were included: first, to measure the extent of spillovers to lower as well as higher wage levels; and second, whether employees were still paid below €8.50 due to an exemption rule. As the latter group of workplaces only comprised about 2 percent of the sample, it is excluded from the analysis.

Table 1: Sample size across years

Year (panel wave)	Number of observations	Information on affectedness	Establishments affected by the minimum wage	Unaffected	Don't know
2011	15,283	9,191	1,399 (15.22)	7,687 (83.64)	105 (1.14)
2012	15,556	10,691	1,636 (15.30)	8,925 (83.48)	130 (1.22)
2013	15,725	12,430	1,946 (15.66)	10,333 (83.13)	151 (1.21)
2014	15,577	15,521	2,394 (15.42)	12,927 (83.29)	200 (1.29)
2015	15,500	12,367	1,944 (15.72)	10,275 (83.08)	148 (1.20)
2016	15,341	10,838	1,699 (15.68)	9,020 (83.23)	119 (1.10)

Notes: Absolute number of observations and shares in parentheses.

Source: IAB Establishment Panel 2011-2016

The dependent variables used in this article, including business expectations, competitive pressure, investments in human and physical capital, and profitability, cover the survey waves of the years 2011 to 2016. The inclusion of years prior to the introduction of the minimum wage helps to distinguish general developments from those stemming from the minimum wage legislation. The number of establishments in the sample fluctuates only slightly between 15,000 and 16,000 over this time period (see Table 1). However, since affectedness is captured in 2014, only establishments that responded in 2014 are included in the analysis in the remaining years, leading to an analysis sample of plants that already existed in 2014.

Table 1 shows that the lowest share of establishments that existed in 2014 is observed in 2011 (60.14 percent, which results from 9,191/15,283). For the other waves, the common share is in the range between 68 percent and almost 80 percent. In spite of these limitations, the share of establishments affected by the wage floor is above 15 percent within each wave. Still, the limited number of observations for affected businesses does not allow for further division into subgroups such as industries

or Federal States (*Bundesländer*) when it comes to the difference-in-differences-based estimation of adjustments of the treated establishments.

4. Employment adjustments

Typically, the employment effects of minimum wages are very controversially discussed. Before the minimum wage was introduced in Germany, theory-based predictions expected an employment loss in the range of 400,000 to 900,000 jobs across Germany (Knabe et al., 2014). The most pessimistic scenario of these predictions draws on the neoclassical paradigm, which predicts an employment loss when minimum wages are binding. Assuming that workers are paid according to their marginal productivity, a binding minimum wage would raise wages above worker productivity, leading to a decline in the demand for labor. The reduction of labor demand could be due to a scale and/or a substitution effect. A substitution effect would be explained by a reduction in the demand for labor of the affected workers, whose input prices increase in relative terms. At the same time, input demand for other input factors also increases, as these became relatively cheaper. By contrast, a scale effect of labor demand would be due to the reduction of the production volume as a result of increased overall costs induced by a minimum wage.

While the neoclassical theory is fairly pessimistic as regards the employment effects of minimum wages, predictions have to be modified in a situation in which employers have market power in wage setting which results in a monopsonistic labor market, in which wages are paid below the workers' productivity. The minimum wage could work as an instrument to force employers to pay wages according to actual productivity levels, that is, competitive wages. However, if the minimum wage is set *above* productivity levels, it could still cause employment to fall.

To address this theoretical ambivalence, we surveyed existing studies that analyze the employment effects of the new statutory minimum wage in Germany, including results that are based on the difference-in-differences approach applied to the IAB Establishment Panel as described above. Before turning to the new statutory minimum wage, we will briefly review the research that has evaluated industry-specific minimum wages in Germany empirically. Such industry-specific minimum wages were introduced in the late 1990s and 2000s through agreements of the collective bargaining partners (unions and employers' associations) together with the Federal Ministry of Labor and Social Affairs. For instance, industry-specific minimum wages were introduced and analyzed in the construction sector (König and Möller, 2009; Berge and Frings, 2017), for electricians (Boockmann et al., 2013), roofers (Aretz et al., 2013), and painters (Frings, 2013). Most of these studies did not detect any substantial adverse employment effects. If anything, detrimental effects were observed for eastern Germany, where the "bite" of the minimum wage was particularly pronounced.

Table 2 provides a summary of studies relating to the introduction of the new statutory minimum wage that apply some kind of difference-in-differences approach as well as their respective results. The study

by Garloff (2017) exploits variation at the level of gender-age-region cells (=1,410 cells) and calculates the bite on the basis of the monthly wages of full-time employees.³ His results point to a very modest reduction in the growth rate of total employment of 0.1 to 1.1 percent (Garloff, 2017), which amounts to a total employment loss of between 4,000 and 43,000 jobs (own calculations). Caliendo et al. (2017) use a very similar approach where the bite is calculated at the level of labor market regions and from the hourly wage information of the Structure of Earnings Survey 2014. Their results show somewhat stronger adverse employment effects. A similar study by Bonin et al. (2018) exploits variation in the average absolute wage gap between the minimum wage and individual hourly wages at the level of labor market regions from the Structure of Earnings Survey 2014. They estimate a treatment effect on the treated regions (regions split at the median) and observe a disemployment effect in the range of 0.5 to 0.8 percent. Since the effect is identified from half of the German labor market regions, it amounts to roughly 75,000 jobs (own calculation⁴).

Finally, Bossler and Gerner (2016) exploit variation at the establishment level as described in Sections 2 and 3 of this article. They estimate an effect on treated establishments defined as “at least one employee paid below €8.50 per hour of work in 2014”. Their results show a disemployment effect of about 1.7 percent at treated establishments, which amounts to roughly 45,000 to 68,000 jobs throughout Germany. We replicate their results and show that the treatment effect is constant for the years 2015 and 2016 (Bossler et al., 2018). Since, employment follows an upward trend during the period of analysis in both the treated and control establishments – that is, in the economy as a whole – such relatively small disemployment effects imply negative deviations from a counterfactual employment increase. Hence, the employment effects should be interpreted as employment increases that have not taken place rather than a loss of existing jobs.

Table 2: Studies addressing the employment effects of the introduction of the German minimum wage in ex-post evaluations

Study	Methodology and treatment variation	Data	Size of effect
Garloff (2017)	Difference-in-differences based on variation across gender-age-region cells	Bite: Federal Employment Agency, fraction of full-time employees paid below €1,450 in 2014 Dependent variable: Federal Employment	Treatment effect on the fraction of affected workers' growth rate: -0.1% to -1.1%

³ Ahlfeld et al. (2018) and Schmitz (2017) present very similar analyses that use regional variation to identify employment effects of the minimum wage. While Ahlfeld et al. (2018) do not detect a significant disemployment effect, employment effects in Schmitz (2017) are in the range of Garloff (2017) and Caliendo et al. (2018).

⁴ For simplicity, our calculation assumes 32,000,000 employees in total and an equal split of the population share across treated and untreated labor market regions, resulting in 16,000,000 employees in treated labor market regions, of which 0.5 to 0.8 percent are lost due to introduction of the minimum wage.

		Agency, growth rate of total employment	Amounts to roughly 4,000 to 43,000 jobs (own calculations)
Caliendo et al. (2018)	Difference-in-differences based on variation across planning regions	Bite: Structure of Earnings Survey 2014, fraction of affected workers and Kaitz index Dependent variable: Federal Employment Agency, Log total employment	Treatment effect on the fraction of affected workers: -2.5% Amounts to roughly 140,000 jobs
Bonin et al. (2018)	Difference-in-differences based on variation in the average absolute gap between the minimum wage and individual hourly wages across labor market regions	Bite: Structure of Earnings Survey 2014, average absolute gap between the minimum wage and individual hourly wages in a labor market region Dependent variable: Federal Employment Agency, Log total employment	Treatment effect in more severely affected labor market regions compared with less affected labor market regions (split at the median): -0.5% Amounts to roughly 75,000 jobs (own calculation)
Bosler and Gerner (2018)	Difference-in-differences based on variation in the establishment-level bite	IAB Establishment Panel Bite: Establishments with at least one employee paid an hourly wage below €8.50 in 2014. Dependent variable: Log of establishment-level employment	Treatment effect on the affected establishments: 1.7% Amounts to roughly 45,000 to 68,000 jobs

Source: Own summary of the literature

All these employment effects presented in the literature are fairly small in size, especially compared to the pessimistic predictions ahead of the introduction of the minimum wage. While employment effects are probably the most heavily debated topic within the scientific discussions on minimum wages, they may not be the most prominent channel of adjustment for affected employers. In a descriptive report, Bellmann et al. (2016) show that adjustments in prices are much more likely to take place than employment adjustments in the number of heads. In our analyses below, we will address such alternative effects of the minimum wage at the establishment level.

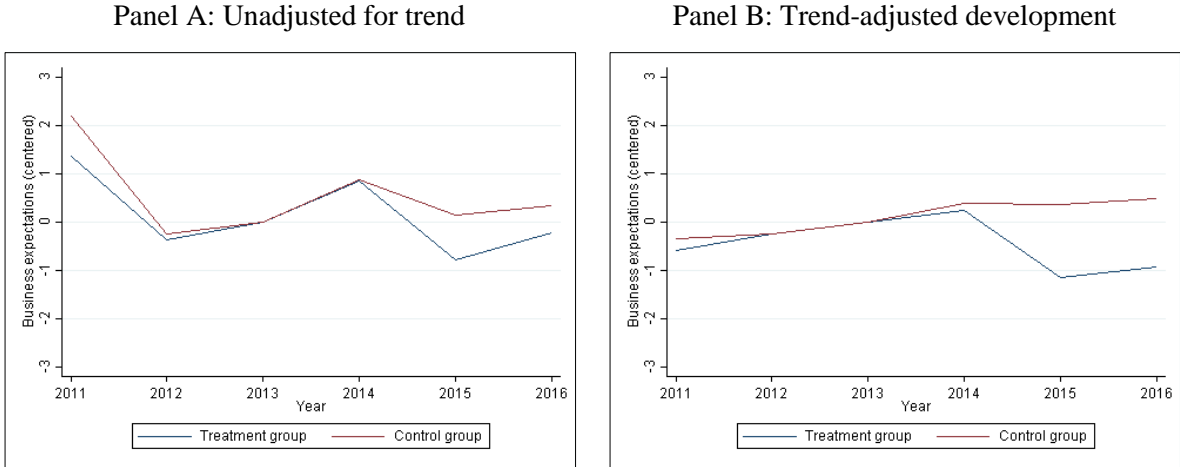
5. Business expectations and competitive pressure

5.1. Business expectations

As a first indicator of the potential impacts of the minimum wage on establishments' profitability, we analyze expected business turnover (for the following fiscal year). Business turnover may rise or fall with changes in output levels and/or prices. Establishments might expect business turnover to fall as a result of a decreasing demand if minimum wages cause product prices to increase (Link, 2018). A lower demand from business partners who are affected by the minimum wage, or a general climate of cautiousness among clients may also result in lower generated revenues.

The corresponding survey question asks whether establishments expect their business volume to rise or fall. If they report that they expect a change, they are then asked to state by how much they expect their business volume will change.

Figure 1: Graphical analysis of business expectations of current year



Notes: Expected development of business volume (in percent) 2011-2016 for the treatment and control group. Time series are centered around 2013.

Source: IAB Establishment Panel 2011-2016

To test the assumption of parallel trends, we graphically analyze the development of business expectations within both the treatment and the control group (Figure 1, Panel A). The differences in levels are centered around 2013, when the introduction of the minimum wage had not yet been planned, such that anticipation effects are ruled out. Expected business volume was lower in both groups in 2012 and recovered in a similar way until the year 2014. In 2015, treated establishments seemed to be more pessimistic about their future turnover than those in the control group, which might indicate that the minimum wage law has had an effect. Slight differences in trends already ahead of the introduction of the minimum wage led us to account for potential group-specific trends. Consistent with this idea, Figure 1, Panel B includes the corresponding trend-adjusted graphical development, which yields an improved treatment-control comparison. In fact, treated establishments show a sharp drop in business expectations, with negative expected growth rates throughout 2015 and 2016.

Table 3 shows via difference-in-differences estimations that after the introduction of the minimum wage, the expectations of the affected establishments decreased compared to those of unaffected establishments. The average effect was about -0.45 percentage points, which turns into a significant 1.24 percentage points decrease when controlling for group-specific trends (Panel A, column 2). To account for the possibility that the minimum wage had an effect on the trend itself, we estimate separate effects for the treatment years 2015 and 2016. Here, only the 2015 effect is significant, suggesting that affected establishments had significantly more pessimistic expectations during the first year of the law, while the expectations among employers in the treatment group were somewhat less pessimistic during 2016. However, this analysis does not tell us whether the negative expectations for 2015 had indeed materialized, and whether companies re-adjusted their expectations when they realized that the minimum wage has had a smaller impact on their business than originally expected. When controlling for group-specific trends, the treatment effect becomes larger and turns significant.

Table 3: Difference-in-differences effect on business expectations

	(1)	(2)	(3)
	Expected business turnover in percent	Expected business turnover in percent	Expected business turnover in percent
Panel A: Average effect for 2015 and 2016			
Treatment effect	-0.448 (0.296)	-1.243*** (0.456)	
Placebo effect			0.353 (0.334)
Panel B: Separate effects for 2015 and 2016			
Treatment effect 2015	-0.790** (0.355)	-1.341*** (0.462)	
Treatment effect 2016	-0.055 (0.376)	-0.856 (0.593)	
Linear trend	No	Yes	No
Observations	62,223	62,223	41,935
Average predicted growth, affected establishments (2014):		1.7	
Average predicted growth, unaffected establishments (2014):		1.6	

Notes: The coefficients are treatment effects on affected establishments from difference-in-differences specifications with fixed effects. The dependent variable is the expected change in business volume. Clustered standard errors are in parentheses (cluster=establishment). Stars indicate standard significance levels: *** 1%, ** 5% and * 10%. Control variables include dummies for works councils, collective agreements, and share of female employees.

Source: IAB Establishment Panel 2011-2016, analysis sample

It is sensible to assume that establishments may respond differently to the question at hand depending on whether they are located in eastern or western Germany, as the minimum wage bites harder in the East (Bossler and Gerner, 2016; Bellmann et al., 2015). Indeed, while both regions display a robust negative effect in 2015, the coefficient for western Germany turns positive for 2016 while eastern

German businesses continue to expect shrinking turnover for the subsequent year (Table 4). One possible explanation is a shift in attitudes towards the minimum wage in the West, where establishments were less affected than they had previously expected. Another possible interpretation is that their business volume indeed declined at first, and subsequently grew again. As for eastern Germany, establishments continued to expect negative business growth throughout 2015 and 2016.

Table 4: Difference-in-differences effect on business expectations, in eastern and western Germany

	Eastern Germany		Western Germany	
	(1)	(2)	(3)	(4)
	Expected business turnover in percent	Expected business turnover in percent	Expected business turnover in percent	Expected business turnover in percent
Panel A: Average effect for 2015 and 2016				
Treatment effect in 2015 and 2016	-0.804** (0.391)		-0.032 (0.455)	
Placebo effect		0.092 (0.440)		0.343 (0.539)
Panel B: Separate effects for 2015 and 2016				
Treatment effect in 2015	-0.813* (0.489)		-1.043** (0.483)	
Treatment effect in 2016	-0.795* (0.480)		1.167* (0.654)	
Observations	25,323	17,034	36,900	24,901

Notes: The coefficients are treatment effects on affected establishments from difference-in-differences specifications with fixed effects. The dependent variable is the expected change in business volume. Clustered standard errors are in parentheses (cluster=establishment). Stars indicate standard significance levels: *** 1%, ** 5% and * 10%. Control variables include dummies for works councils, collective agreements, and share of female employees.

Source: IAB Establishment Panel 2011-2016, analysis sample

5.2. Competitive Pressure

Competitive pressure may increase due to a minimum wage. Firms that face the obligation to increase wages face a corresponding increase in labor costs. Depending on the labor share of production costs, firms may have to increase their output prices. Such an increase makes it potentially harder for them to compete in the product market, especially with competitors located in countries with considerably lower wage levels who are able to offer their goods and services at a lower cost.

Competitive pressure could also decrease due to the introduction of a minimum wage when competitors have to pay higher wages and may even be forced to exit the market. Moreover, the minimum wage could serve as an entry barrier for potential low-wage – and hence low-price – entrants who would otherwise – that is, in the absence of the minimum wage – cause strong competitive pressure (Egelin et al., 2011). However, these mechanisms that potentially reduce competition would primarily concern our control group of unaffected establishments which did not pay wages below the minimum wage before its introduction, while their respective competitors were potentially restricted by the minimum wage.

Table 5: Assessment of change in competitive position due to the minimum wage

Due to the minimum wage, the competitive position has...	Full sample	Separate responses of affected and unaffected establishments	
		Unaffected	Affected
Improved	2.4%	2.6%	1.8%
Not changed	79.3%	82.3%	69.2%
Deteriorated	6.5%	3.0%	18.3%
Don't know	11.8%	12.1%	10.7%
Observations	1,435	1,107	328

Notes: Descriptive analysis of employers' responses to the respective survey question in the competitive position in the market, as in Bossler and Jaenichen (2017).

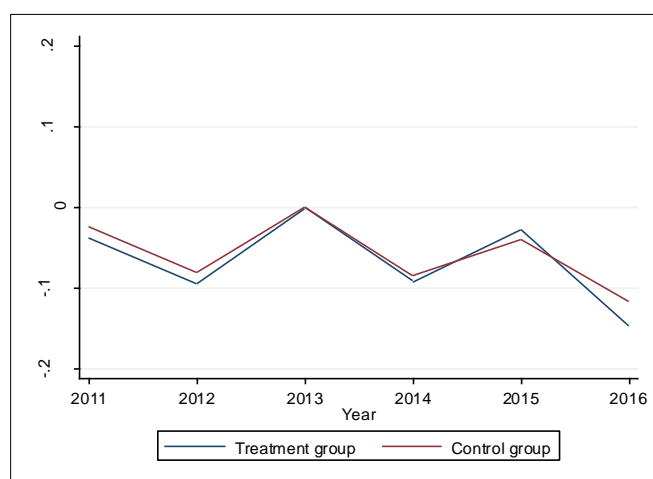
Source: IAB QUEST survey

Since the application of the difference-in-differences approach relies on an unaffected control group, we first address such potential effects that improve the competitive position of the control group. For this purpose, we use descriptive evidence from the IAB QUEST survey⁵, where employers were directly asked whether their competitive position improved or deteriorated in the course of the minimum wage introduction. Table 5 presents the responses for the full sample and separately for affected and unaffected establishments. Among the affected establishments, a significant fraction reported that their competitive position deteriorated. Since this self-reported pattern is merely descriptive, it should be interpreted with caution; we will address the potential effects on the affected treatment group in a difference-in-differences approach below. However, when looking at the group of unaffected establishments, Table 5 points neither to an improved nor to a deteriorated competitive position in the market. Hence, we reject the possibility that the minimum wage improves the competitive position of the control group, which in turns allows us to conduct a difference-in-differences analysis, where the control group is most likely unaffected.

For the difference-in-differences analysis, the questionnaire of the IAB Establishment Panel includes a subjective assessment of competitive pressure on a scale from 1 (“no competitive pressure”) to 4 (“high competitive pressure”). We operationalize this variable as a dummy that takes the value “1” for medium-to-high competitive pressure, and “0” if competitive pressure is low or nonexistent. Figure 2 depicts the development of the likelihood of being exposed to medium or high competitive pressure. The outcomes of both the treatment and control groups are subject to sizable fluctuations which were already in place prior to the introduction of the minimum wage. The trends do not seem to diverge more than slightly post-treatment.

⁵ The IAB QUEST dataset stems from a one-time cross-sectional survey conducted in 2016 (February to May) among 24,000 German establishments, and includes information on different topical subjects surrounding the labor market. The net sample with information on minimum wage affectedness consists of 1,525 establishments (Bossler and Jaenichen, 2017).

Figure 2: Graphical analysis of competitive pressure



Notes: Competitive pressure 2011-2016, by minimum wage affectedness. Time series are centered around 2013.

Source: IAB Establishment Panel 2011-2016

Table 6: Difference-in-differences effect on competitive pressure

	(1) Medium to high competitive pressure	(2) High competitive pressure, continuation of business at risk
Treatment effect	-0.000 (0.015)	0.012* (0.007)
Observations	68,670	68,483
Average level of competitive pressure, ... in unaffected establishments (2014)		3.053
... in affected establishments (2014)		2.880

Notes: The coefficients are treatment effects on affected establishments from difference-in-differences specifications with fixed effects. The dependent variable is perceived competitive pressure. Clustered standard errors are in parentheses (cluster=establishment). Stars indicate standard significance levels: *** 1%, ** 5% and * 10%. Control variables include dummies for works councils, collective agreements, and share of female employees.

Source: IAB Establishment Panel 2011-2016, analysis sample

The difference-in-differences analysis in Table 6 column (1) confirms the graphical analysis as it shows virtually no impact of the minimum wage on the perceived competitive pressure among affected establishments. The likelihood of being exposed to medium or high competitive pressure is not higher for establishments affected by the minimum wage. To uncover the possible impact on establishments specifically exposed to very high, compared to medium, low, or no pressure, we generate a dummy exclusively measuring the highest category of competitive pressure. We further narrow down the outcome variable to establishments stating that the continuation of their business is at risk due to high economic pressure. We thus measure the impact of the wage floor on businesses experiencing fierce rivalry on the edge of closing down. Indeed, affected establishments are 1.3 percentage points more likely to be in this narrower group of establishments after the minimum wage introduction. Thus there

seems to be a small fraction of market participants experiencing higher competition and the threat of closure in connection with their minimum wage affectedness.

Due to the higher bite of the minimum wage in eastern Germany, we also estimate the specification from column (2) in Table 6 broken down by region (western and eastern German establishments). The results indicate that treated establishments located in eastern Germany are significantly more often exposed to high competition and at risk of closure than establishments elsewhere in the Republic. These findings suggest that the results from Table 7 are mainly driven by establishments located in eastern Germany.

Table 7: Difference-in-differences effect on high competitive pressure and risk of closure in eastern and western Germany

	Western Germany	Eastern Germany
	(1)	(2)
	High competitive pressure	High competitive pressure
Treatment effect	0.000	0.0198**
	(0.011)	(0.008)
Observations	40,918	27,885
Mean, affected establishments (2014)	0.148	0.138
Mean, unaffected establishments (2014)	0.117	0.103

Notes: The coefficients are treatment effects on affected establishments from difference-in-differences specifications with fixed effects. The dependent variable is the exposure to high competitive pressure while the business is at risk. The mean corresponds to the share of establishments among affected (unaffected) establishments from eastern (western) Germany that are exposed to high pressure and the risk of closure. Clustered standard errors are in parentheses (cluster=establishment). Stars indicate standard significance levels: *** 1%, ** 5% and * 10%. Control variables include dummies for works councils, collective agreements, and share of female employees.

Source: IAB Establishment Panel 2011-2016, analysis sample

6. Investment in Physical Capital

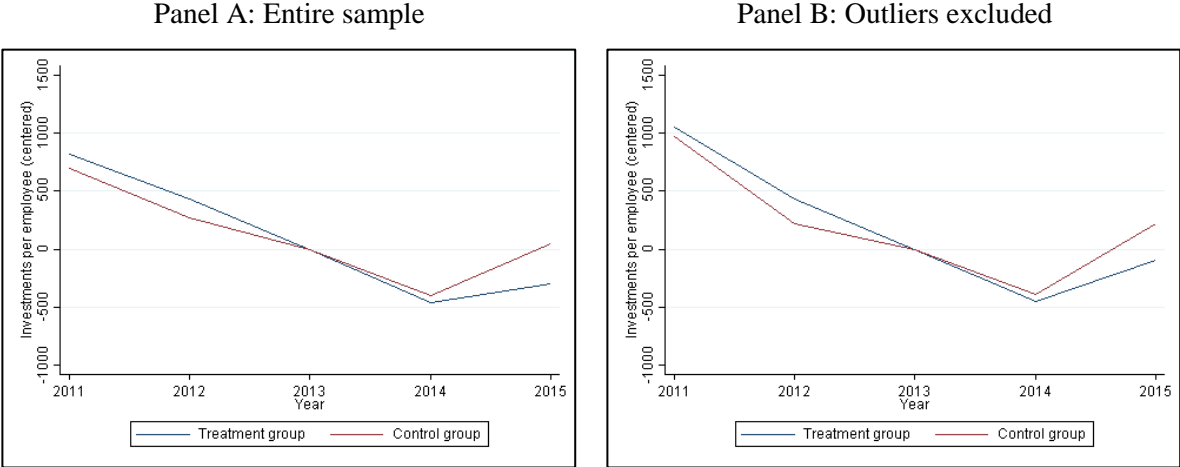
From a theoretical perspective, the effect of the minimum wage on establishments' investment in physical capital is *a priori* ambiguous. On the one hand, due to higher personnel costs, establishments could be forced to reduce their investments. This might be especially the case in the short run, if establishments cannot adjust inputs such as labor and capital. On the other hand, especially in the long run, the minimum wage might create incentives to substitute labor by capital.

The results from previous empirical literature that analyzed the effect of minimum wages on investment in physical capital are ambiguous. Apel et al. (2012) find no significant effect on investment, studying the introduction of various sectoral minimum wages. Bellmann et al. (2016) find that only a small proportion of German establishments (6.2 percent), which are affected by the national minimum wage, have decreased investments in physical capital.

To identify the effects of the minimum wage on investments in physical capital, we rely on two measures: investments in physical capital per employee and expansion investments per employee. We

normalize both measures by the number of employees in order to cope with heterogeneous effects due to establishment size. Again we estimate a difference-in-differences approach.

Figure 3: Graphical analysis of investments in physical capital



Notes: Investments in physical capital in 2011-2016, by minimum wage affectedness. Time series are centered around 2013.
 Source: IAB Establishment Panel 2011-2016

Figure 3 shows the trends in the mean investments in physical capital per employee for establishments in the treatment and control groups. Panel B plots these trends from a sample in which outliers (upper 0.1 percent) were excluded. From 2011 to 2014, we can observe that investments in physical capital per employee decreased over time, relatively parallel for both the treatment as well as the control group. However, from 2014 onwards, investments increased for both groups.

Table 8 shows some descriptive statistics as well as the results from the difference-in-differences regressions. In 2014, affected establishments invested €2,778 on average, while unaffected establishments invested €5,644. The coefficient, representing the placebo effect, is statistically insignificant, which may be interpreted in favor of the parallel trend assumption. The coefficient, representing the treatment effect, is negative, albeit statistically insignificant. Hence, the treated establishments did not alter their investment strategy after the introduction of the minimum wage. Note that these results neither change qualitatively when excluding outliers nor when including more control variables.

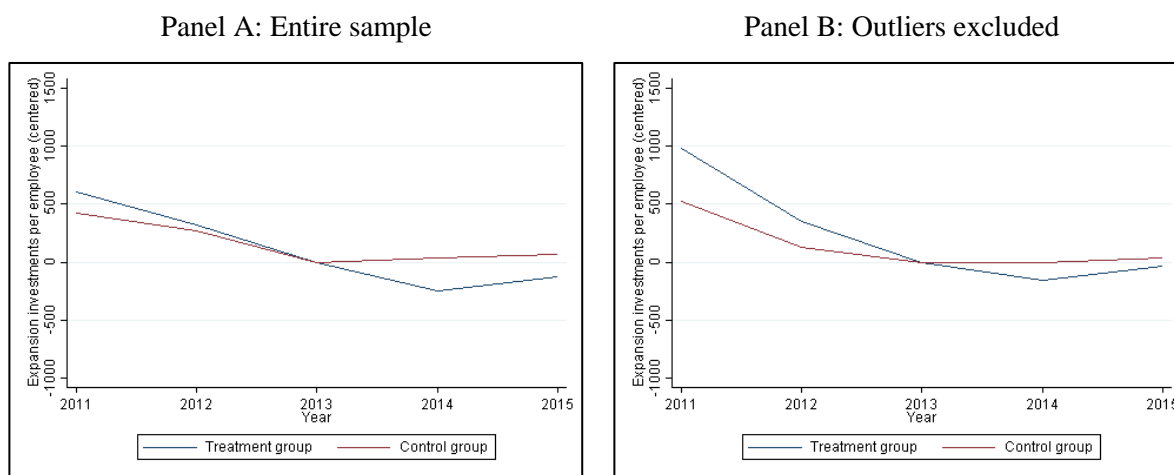
Table 8: Difference-in-differences regression results – investments in physical capital

	(1)	(2)
	Investments per employee	Investments per employee
Treatment effect	-352.64 (387.93)	
Placebo effect		-211.03 (320.83)
Number of observations	50,705	40,989
Investments of affected establishments (2014)		2777,89
Investments of unaffected establishments (2014)		5643,86

Notes: The coefficients are treatment effects on affected establishments from difference-in-differences specifications with fixed effects. The dependent variable is the investment in physical capital per employee in €. Clustered standard errors are in parentheses (cluster=establishment). Stars indicate standard significance levels: *** 1%, ** 5% and * 10%. Control variables include dummies for works councils, collective agreements, and share of female employees.

Source: IAB Establishment Panel 2011-2016, analysis sample

Expansion investments are different from replacement investments since it might be easier for establishments to reduce them when other costs, such as wage costs, increase. Figure 4 shows the trends in the mean expansion investments per employee for establishments that are affected by the minimum wage (treatment group) and those not affected (control group). Panel B again plots the same trend from a sample in which outliers (upper 0.1 percent) were excluded. From 2011 to 2013, the expansion investments per employee decreased on average in both the treatment and the control group. However, from 2014 onwards, these investments remained fairly constant in the control group, whereas they decreased slightly in the treatment group. In 2015, establishments from the treatment group increased their investments again. Excluding outliers does not alter these results.

Figure 4: Graphical analysis of expansion investments

Notes: Expansion investments in 2011-2016, by minimum wage affectedness. Time series are centered around 2013.

Source: IAB Establishment Panel 2011-2016

Table 9 shows the results from the difference-in-differences regression as well as the magnitude of the mean expansion investments for both groups. In 2014, establishments in the treatment group spent on average €989 per employee on expansion investments while establishments in the control group spent more than twice that amount (€2,170 per employee).

Overall, the coefficients, representing the treatment effects, are negative while being statistically insignificant – as they were in the previous analysis. It seems that affected and unaffected establishments do not differ from each other with respect to expansion investments. It is worth noting that, in the sample in which outliers were excluded, the coefficients – representing the placebo effects – become statistically significant. This indicates that the regression results need to be interpreted with caution because it may be the case that, before the introduction of the minimum wage, affected establishments invested systematically in a different way from unaffected establishments.⁶

Table 9: Difference-in-differences regression results – investments in expansion capital

	(1)	(2)	(3)	(4)
	Investments per employee	Investments per employee	Investments per employee	Investments per employee
Treatment effect	-235.57 (226.43)	345.82 (324.20)	255.01 (509.52)	
Placebo effect				-330.29 (224.48)
Linear trend	No	Yes	Yes	No
Quadratic trend	No	No	Yes	No
Number of observations	49,382	49,382	49,382	39,915
Average investments of affected establishments (2014)		988.77		
Average investments of unaffected establishments (2014)		2,169.72		

Notes: The coefficients are treatment effects on affected establishments from difference-in-differences specifications with fixed effects. The dependent variable is the average expansion investment per employee in €. Clustered standard errors are in parentheses (cluster=establishment). Stars indicate standard significance levels; *** 1%, ** 5% and * 10%. Control variables include dummies for works councils, collective agreements, and share of female employees.

Source: IAB Establishment Panel 2011-2016, analysis sample

7. Investment in Human Capital

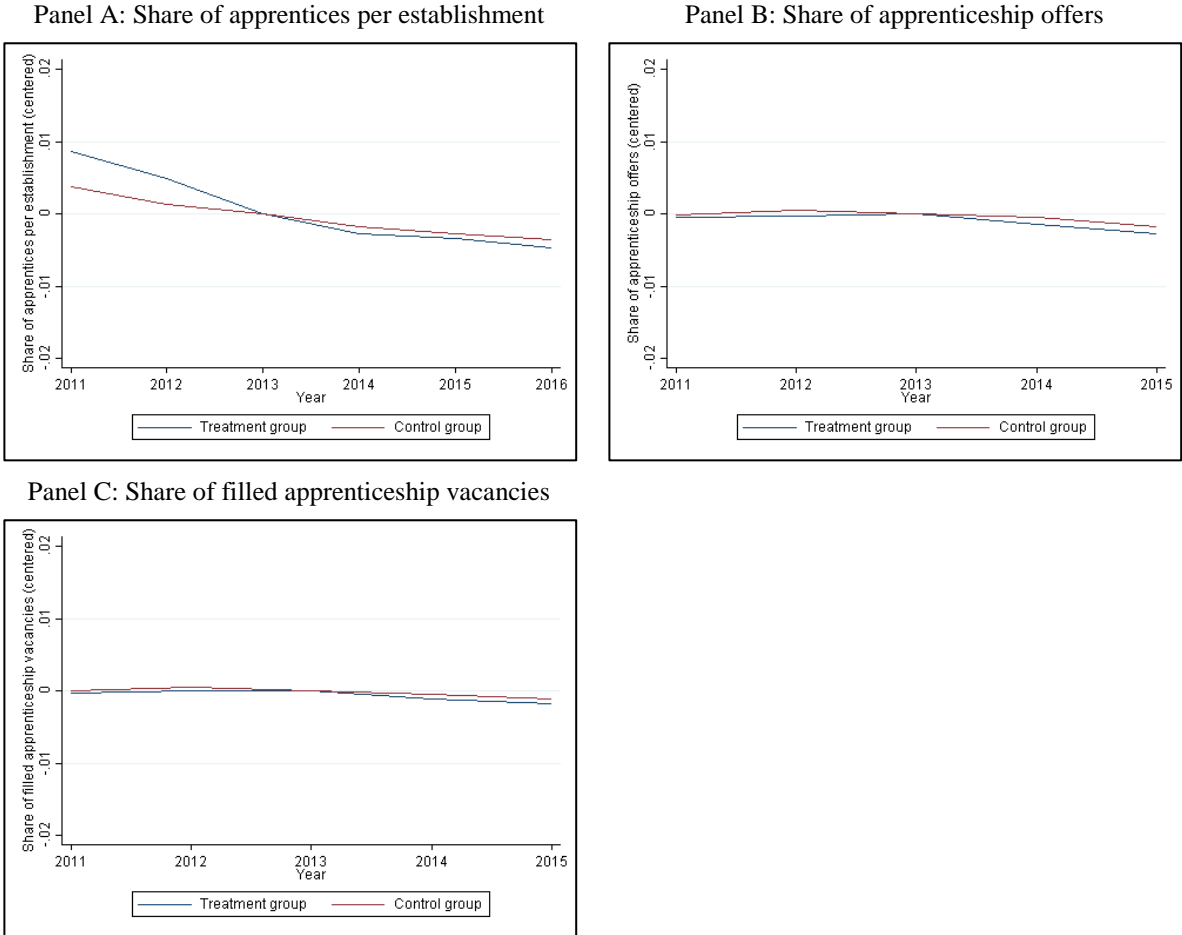
7.1. Apprenticeship Training

Apprentices are exempted from the new German minimum wage. Thus, establishments could have an incentive to reduce labor costs by hiring more apprentices for tasks that would otherwise be executed

⁶ In Bossler et al. (2018), we also explore the effects in a sample in which we exclude establishments that anticipated the introduction of the minimum wage. Using this sample, we again find significant placebo effects, which might confirm this observation.

by regular workers. However, minimum wage-induced increases in overall labor costs could also lead to a reduction in hiring new apprentices, for example, due to a shrinking productive output (scale effect). Moreover, establishments could reduce the number of apprentices as establishments typically retain apprentices and cannot recuperate the apprentice’s training costs after training completion due to the exogenous wage increase (Schumann, 2017).

Figure 5: Apprenticeship training



Notes: Time series are centered on 2013 values.
 Source: IAB Establishment Panel 2012-2016

For Germany, the current state of research is restricted to the effects of sectoral minimum wages. Kellermann (2017) finds that sectoral minimum wages have a positive effect on the probability of undergoing vocational training. Schumann (2017) shows that the minimum wage in the construction sector negatively affected the number of new apprentices at the establishment level in Eastern Germany. Boockmann et al. (2011) do not detect effects of the minimum wage on apprenticeship training in the electrical trade sector, and Aretz et al. (2011) observe negative effects for Eastern Germany but positive effects for western Germany in the roofing sector.

Figure 5 illustrates descriptive averages by treatment status for the outcome variables of interest. Panel A shows that, in 2011 and 2012, the fraction of apprentices per establishment decreased more rapidly in treated establishments than in control establishments. This difference largely disappeared from 2013

onwards, thus indicating no treatment effect in 2015 or 2016. Panels B and C illustrate that the share of apprenticeship offers and the share of filled apprenticeship vacancies evolved similarly in the treatment and control group before and after the introduction of the minimum wage.

Table 10: Difference-in-differences estimates on apprenticeship training

	(1)	(2)	(3)	(4)	(5)	(6)
	Share of apprentices per establishment		Share of offers of apprenticeships		Share of filled apprenticeship vacancies	
Treatment effect for 2015 and 2016	-0.001	(0.001)				
Treatment effect 2015			-0.000	(0.001)	-0.000	(0.001)
Placebo effect		-0.003**		0.000		-0.000
		(0.001)		(0.001)		(0.001)
Observations	68,803	46,350	52,582	42,481	52,523	42,420
Mean of dependent variable affected establishments (2014)		0.030		0.020		0.013
Mean of dependent variable unaffected establishments (2014)		0.035		0.019		0.015

Notes: The coefficients are treatment effects on affected establishments from difference-in-differences specifications with fixed effects. Dependent variables indicated by column titles. Clustered standard errors are in parentheses (cluster=establishment). Stars indicate standard significance levels: *** 1%, ** 5% and * 10%. Control variables include dummies for works councils, collective agreements, and share of female employees.

Source: IAB Establishment Panel 2011-2016, analysis sample.

Turning to the difference-in-differences estimates, the results in column (1) of Table 10 demonstrate that the introduction of the minimum wage did not have any effect on the share of apprentices per establishment. The estimated effects are close to zero and statistically insignificant⁷. According to these estimates, the minimum wage has no effect on the share of offers of apprenticeships and the share of filled apprenticeship vacancies in 2015, either⁸: both effects are small and insignificantly different from zero, see columns (3) and (5).

In Table 11, the effect on the share of offers of apprenticeships is estimated separately for establishments that retain some of their apprentices after completion of training and those that do not retain apprentices. While the first group of employers may be viewed as using apprenticeship training as a strategy to invest in human capital, the latter group is more likely to employ apprentices as productive workers. Thus, for

⁷ The placebo regression in column (2) is significantly different from zero but the effect is small and an entropy balancing supports the validity of the result.

⁸ Effects are only estimated for 2015 because the IAB Establishment Panel surveys the information on offers of apprenticeships and filled posts from the previous training year.

the first group, one may expect negative effects if the minimum wage prevents employers from recuperating their training costs after training completion.

Table 11: Difference-in-differences estimates on apprenticeship training

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Share of apprenticeship offers				Share of filled apprenticeship vacancies			
Treatment effect	0.002 (0.008)		-0.003* (0.001)		0.003 (0.009)		-0.001 (0.001)	
Placebo effect		-0.000 (0.008)		-0.001 (0.002)		-0.011 (0.009)		0.001 (0.002)
<i>Sample:</i>								
Not hiring former apprentices	X	X			X	X		
Hiring former apprentices			X	X			X	X
Observations	2,738	2,209	22,021	17,879	2,737	2,208	21,968	17,823
Mean of dependent variable, affected establishments (2014)		0.050		0.035		0.034		0.025
Mean of dependent variable unaffected establishments (2014)		0.048		0.031		0.047		0.026

Notes: The coefficients are treatment effects on affected establishments from difference-in-differences specifications with fixed effects. Dependent variables indicated by column titles. Split samples are indicated in the respective rows. Clustered standard errors are in parentheses (cluster=establishment). Stars indicate standard significance levels: *** 1%, ** 5% and * 10%. Control variables include dummies for works councils, collective agreements, and share of female employees.

Source: IAB Establishment Panel 2011-2016, analysis sample

Looking at the share of occupied apprenticeship positions (columns (5)-(8)), the introduction of the minimum wage had no effect on either of the two groups. However, the minimum wage reduced the share of apprenticeships offered by 0.3 percentage points in treated establishments that typically retained former apprentices (column (3)). However, the magnitude of this effect is small in absolute terms, as only about 1,200 additional apprenticeship positions could have been offered in these establishments in the absence of the minimum wage.

7.2. Further Training

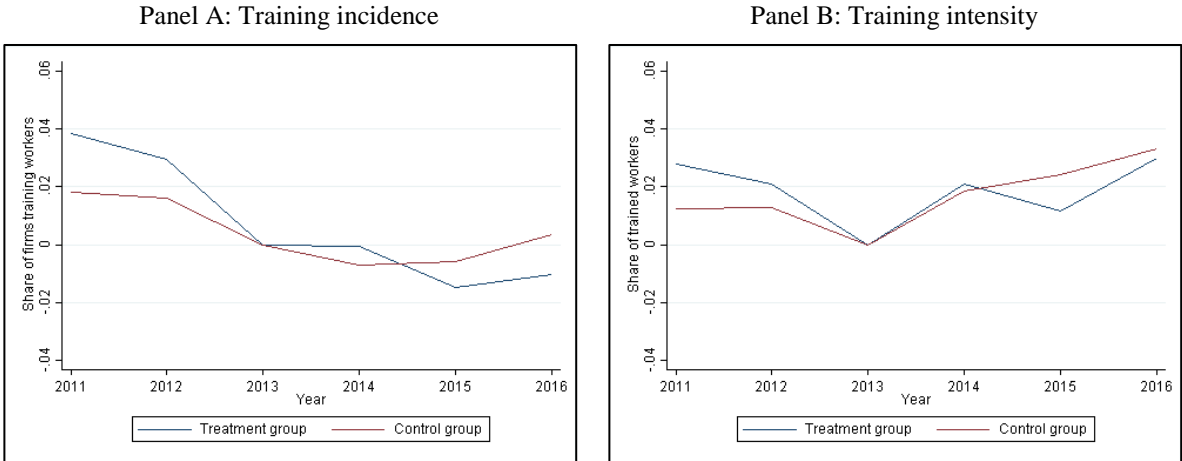
Another possibility to invest in human capital is further training. As mentioned above, the minimum wage effect on training is in general ambiguous. On the one hand, the minimum wage may reduce the ability of employers to finance such investments through wage cuts and, thus, may reduce training (Acemoglu and Pischke, 2003; Bellmann et al., 2017). On the other hand, with a binding minimum

wage, an increase in training will raise workers' productivity while not raising wages, thereby increasing employers' incentives for training (Acemoglu and Pischke, 2003). Moreover, the introduction of a minimum wage generally raises the wages of low-skilled relative to high-skilled workers. The resulting shift in relative labor demand towards high-skilled workers (substitution effect) might, in turn, induce low-skilled workers to invest further in training (Cahuc and Michel, 1996)⁹.

Existing results concerning the impact of minimum wages on training differ across studies. Acemoglu and Pischke (2003), Arulampalam et al. (2004), and Riley and Bondibene (2017) find an increase in training activities. Lechthaler and Snower (2008) and Leighton and Mincer (1981) find that the minimum wage has a negative effect on the training activity of low-skilled workers and a positive effect on that of medium-skilled and high-skilled employees. For Germany, Bellmann et al. (2017) find a slight reduction in the training intensity at establishments with at least one employee paid the minimum wage.

The minimum wage could affect training at the extensive and intensive margin, that is, (a) the incidence of training, and (b) the fraction of employees undergoing training. Figure 6 shows the development of training incidence and training intensity for treated and control establishments. The evolution of the training incidence of treated establishments differs from that of unaffected establishments in 2012 and 2014 (Panel A). The evolution of the share of trained workers also diverges for both groups before introduction of the minimum wage (Panel B), albeit to a somewhat lower extent.

Figure 6: Training incidence and training intensity



Notes: Time series are centered on 2013 values.

Source: IAB Establishment Panel 2011-2016

⁹ For an extensive discussion of the potential effects, see, for example, Bellmann et al. (2017).

Table 12: Difference-in-differences estimates on further training

	(1)	(2)	(3)	(4)	(5)	(6)
	Establishment provides training at all			Share of trained employees		
Treatment effect for 2015 and 2016	-0.004 (0.008)			-0.011* (0.006)		
Treatment effect for 2015		-0.001 (0.010)			-0.014** (0.007)	
Treatment effect for 2016		-0.008 (0.011)			-0.008 (0.008)	
Placebo effect			0.006 (0.009)			-0.002 (0.007)
Observations	68,733	68,733	46,326	67,298	67,298	45,269
Mean of dependent variable affected establishments (2014)		0.593			0.252	
Mean of dependent variable unaffected establishments (2014)		0.703			0.336	

Notes: The coefficients are treatment effects on affected establishments from difference-in-differences specifications with fixed effects. Dependent variables are indicated by column titles. Clustered standard errors are in parentheses (cluster=establishment). Stars indicate standard significance levels: *** 1%, ** 5% and * 10%. Control variables include dummies for works councils, collective agreements, and share of female employees.

Source: IAB Establishment Panel 2011-2016, analysis sample

The difference-in-differences estimates in Table 12 indicate no minimum wage-induced effect on the incidence of training. Despite the trend divergence in Figure 6, the placebo effect in column (2) turns out to be insignificant. The effect of the minimum wage on training intensity is displayed in columns (4) and (5) of Table 12. In 2015, the point estimate is negative and significantly different from zero. The share of trained employees in treated establishments is 1.4 percentage points lower than in non-treated establishments. Applying a back-of-the-envelope calculation suggests that about 64,300 additional employees would have been trained in the absence of the minimum wage. This result is in line with Bellmann et al. (2017). However, the treatment effect becomes insignificant in 2016. Hence, the negative effect on training intensity might be only temporary.

To further validate our findings, we also conducted an entropy balancing, which confirmed the baseline results (see Appendix A). The entropy balancing creates a weighted control group, which aligns with the pre-treatment trend of the treatment group. We apply the entropy balancing as described in Hainmueller (2012) and as implemented in Stata by Hainmueller and Xu (2013), and we use lagged outcomes for the years 2011-2014 as covariates to ensure that the balancing is based on the trend-determining variables. We use the entropy balancing weights to construct an improved control group in both the graphical analysis and the difference-in-differences estimation of Appendix A.

8. Productivity and Profitability

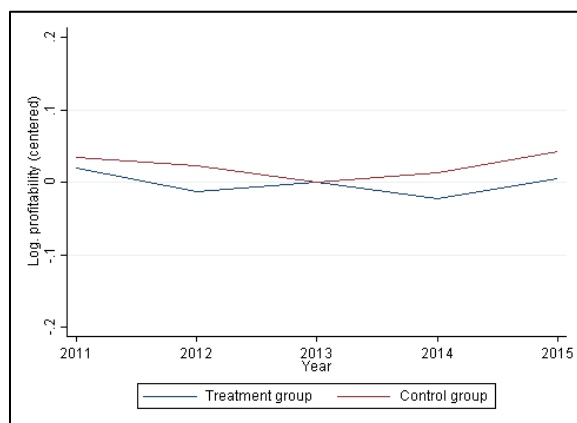
8.1. Productivity

In response to the minimum wage, firms may try to compensate their higher personnel costs by increasing their labor productivity. This could be achieved, for example, by intensifying their capital usage, by higher investments in human capital (see Riley and Bondibene, 2017), by improving organizational procedures (see Riley and Bondibene, 2017), and by selecting their hires more carefully (see Gürtzgen et al., 2016). Using German survey data (from the Linked Personnel Panel (LPP)), Bossler and Broszeit (2017) analyzed whether the work engagement of affected workers changed after the German minimum wage introduction. They found a strong correlation between introduction of the minimum wage and wage satisfaction and also between work engagement and wage satisfaction. However, they did not find any measurable evidence that the minimum wage directly affected work engagement. Pusch and Rehm (2017) use individual survey data (the German *Panel "Arbeitsmarkt und soziale Sicherheit"* (PASS), that is, the "Labour Market and Social Security" Panel Study) and found that workers who were affected by the German minimum wage reported more frequently that their workload had increased during the last two years. This latter result could be interpreted as evidence of increasing labor productivity. Additionally, Falk et al. (2006) found evidence that the minimum wage could increase worker motivation, fairness valuation of wage payments, and work effort. Results from Bossler and Jaenichen (2017) and Bossler and Broszeit (2017), however, cast some doubts on the latter evidence as these authors cannot confirm such an effect using data for Germany.

It is worth noting that the minimum wage itself can reduce employment and therefore increase labor productivity without firms actively reacting, that is, by increasing the capital devoted to each employee. This latter channel is disregarded in the analyses by Bossler and Broszeit (2017) or Pusch and Rehm (2017). Hence, it remains an empirical question whether or not the minimum wage has direct effects on the productivity of establishments.

In the following analysis, labor productivity at the establishment level is proxied by the log of average sales per employee. Figure 7 shows the development of this variable between 2011 and 2015 for both the treatment and the control groups. It can be easily seen that sales per employee evolved relatively parallel for both groups. However, we find a small upward kink between 2012 and 2014 for the treatment group, which is not reflected by the development of the control group.

Figure 7: Log sales per worker by treatment status



Notes: Time series are centered on 2013 values.

Source: IAB Establishment Panel 2012-2016

Table 13 shows the results of the difference-in-differences analysis. These regressions deliver insignificant results, both statistically and economically. It seems that the affected establishments did not develop systematically differently in terms of sales per employee as compared to unaffected establishments. The coefficients representing the placebo effect are insignificant as well and close to zero. Further robustness checks, such as restricting the definitions of control and treatment groups, splitting the sample into eastern and western Germany, or including more controls do not alter these results. However, it is worth noting that, in the absence of detailed data on prices and quantities, our regression results could potentially mask effects on either outcome, as – by construction – sales are a combination of prices and quantities.

Table 13: Difference-in-differences estimates on labor productivity

	(1)	(2)	(3)	(4)
	Log sales per worker	Log sales per worker	Log sales per worker	Log sales per worker
Treatment effect	0.000 (0.009)		0.000 (0.009)	
Placebo effect		0.008 (0.009)		0.009 (0.009)
Additional control variables	No	No	Yes	Yes
Number of observations	34,359	27,806	34,359	27,806
Mean log sales per employee in affected establishment (2014)			11.01	
Mean log sales per employee in unaffected establishment (2014)			11.42	

Notes: The coefficients are treatment effects on affected establishments from difference-in-differences specifications with fixed effects. The dependent variable is the log of sales per employee in €. Clustered standard errors are in parentheses (cluster=establishment). Stars indicate standard significance levels: *** 1%, ** 5% and * 10%. Control variables include dummies for works councils, collective agreements, and share of female employees.

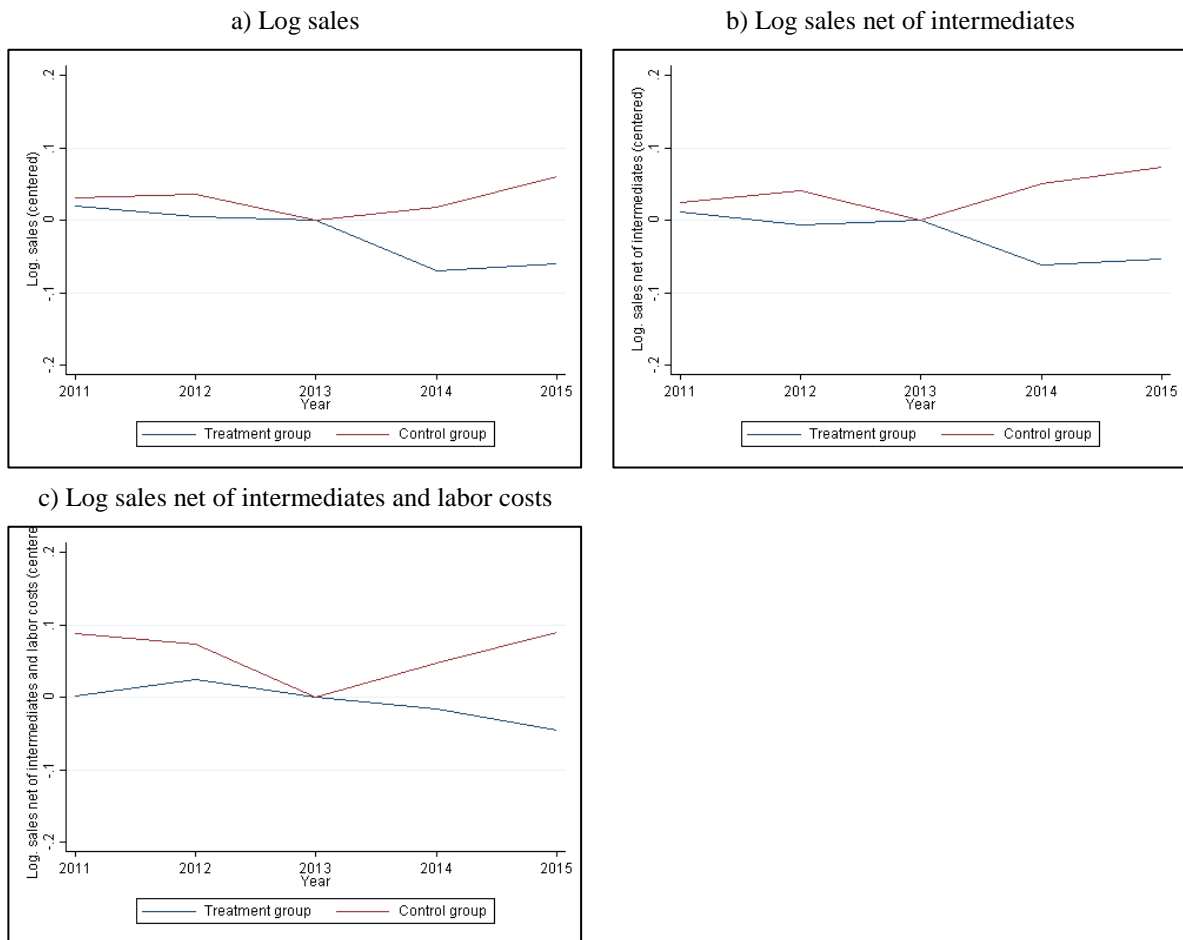
Source: IAB Establishment Panel 2011-2016, analysis sample

8.2. Profitability

From a theoretical perspective, the national minimum wage could directly affect the profitability of establishments as it increases personnel costs. This applies in particular if establishments cannot pass these costs on to their customers through higher prices or if the cost increase cannot be compensated by higher labor productivity, as previous results indicate. Previous results from empirical literature are ambiguous. Using British FAME data, Draca et al. (2011) find almost a one-to-one relationship between profits and wage increases due to the minimum wage, that is, profits decreased almost as much as wage costs increased. Bell and Machin (2018) explore the effect of the announcement of an increase of the British minimum wage on companies' stock prices. These authors show that, at the time of the announcement as well as over the next days, expected profits decreased for firms that were affected by the British minimum wage.

Since we have no direct information about profits from the IAB Establishment Panel, we had to construct an approximation. We did this by subtracting costs for intermediates and labor costs from sales in a given year. As we subsequently analyzed each component of this measure, we were able to disentangle potential effects on profits.

Figure 8: Log sales net of intermediates by treatment status



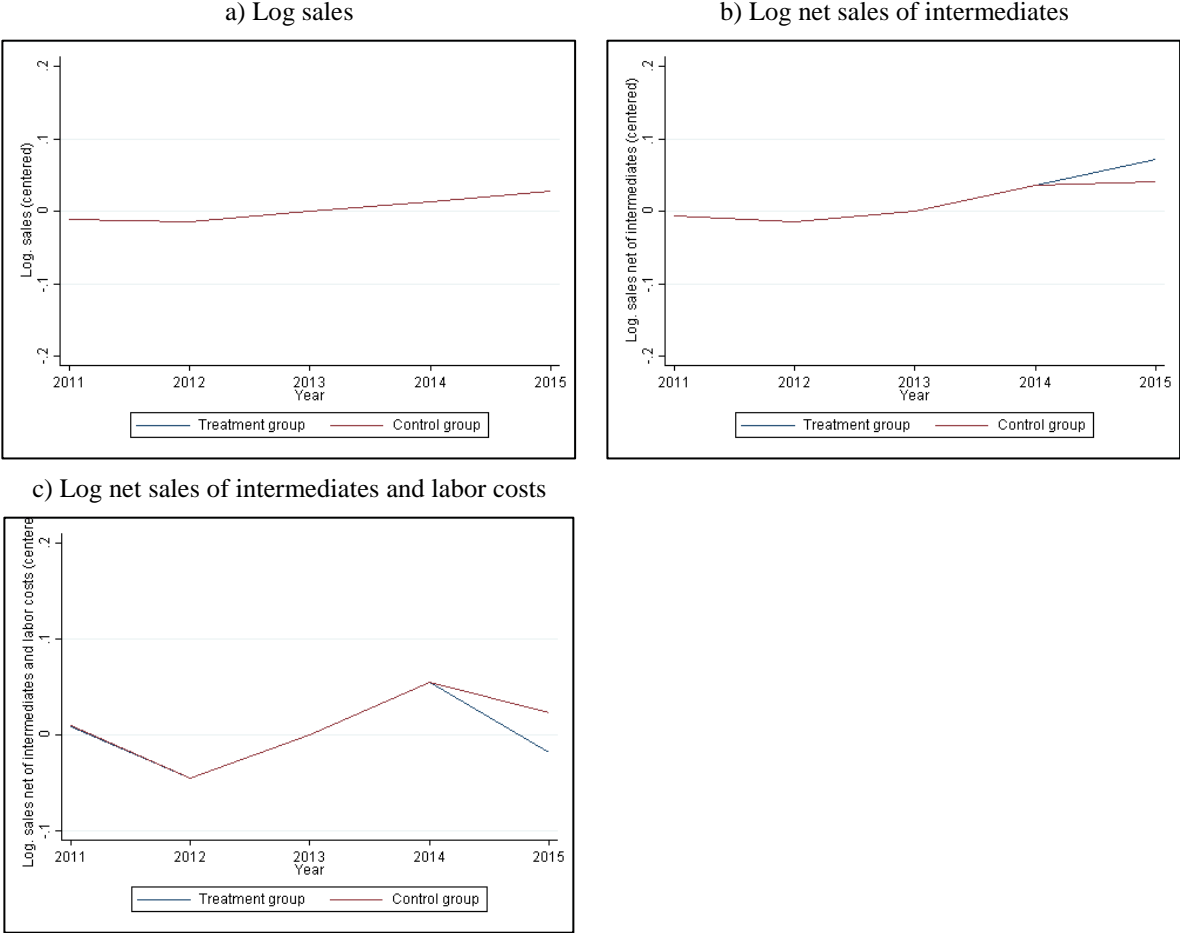
Notes: Time series are centered on 2013 values.

Source: IAB Establishment Panel 2011-2016

Figure 8 shows the trends in our first measure – log sales – from 2011 to 2016. Between 2011 and 2013, log sales evolved relatively in parallel for the treatment as well the control group. After 2013 however, sales increased for the control group while they decreased and then flattened out for the treatment group. The same is true for the second measure – net sales of intermediates. The third measure – net sales of intermediates and labor costs – increased in 2012 and fell afterwards for the treatment group while it decreased until 2013 and increased afterwards for the control group.

Since, for all three measures, the parallel trend assumption cannot be confirmed, we use an entropy balancing procedure as described in subsection 7.2 to construct a weighted control group that aligns with the pre-treatment trend of the treatment group. Unsurprisingly, after balancing, all three measures evolve in parallel for both groups as Figure 9 depicts.

Figure 9: Log sales net of intermediates by treatment status after entropy balancing



Notes: Weighted time series centered on 2013 values.
 Source: IAB Establishment Panel 2011-2016

Table 14: Difference-in-differences estimates on sales and profitability

	(1)	(2)	(3)	(4)
Panel A: Log of sales				
Treatment effect	-0.012 (0.017)		-0.012 (0.017)	
Placebo effect		-0.000 (0.013)		-0.001 (0.012)
Additional control variables	No	No	Yes	Yes
Number of observations	12,337	10,263	12,337	10,263
Mean of dependent variable affected establishments (2014)		14.238		
Mean of dependent variable unaffected establishments (2014)		14.244		
Panel B: Log of sales net intermediates				
Treatment effect	-0.008 (0.020)		-0.008 (0.021)	
Placebo effect		-0.000 (0.017)		-0.002 (0.017)
Additional control variables	No	No	Yes	Yes
Number of observations	12,337	10,263	12,337	10,263
Mean of dependent variable affected establishments (2014)		13.471		
Mean of dependent variable unaffected establishments (2014)		13.477		
Panel C: Log of sales net intermediates and labor costs				
Treatment effect	-0.089* (0.046)		-0.088* (0.046)	
Placebo effect		-0.001 (0.039)		-0.000 (0.039)
Additional control variables	No	No	Yes	Yes
Number of observations	12,337	10,263	12,337	10,263
Mean of dependent variable affected establishments (2014)		12.729		
Mean of dependent variable unaffected establishments (2014)		12.734		

Notes: The coefficients are treatment effects on affected establishments from weighted difference-in-differences specifications with fixed effects, where weights are calculated in an entropy balancing algorithm that conditions on past outcomes of the years 2011-2014. The dependent variable is the log of sales/net sales of intermediates/ net sales of intermediates and labor costs in €. Clustered standard errors are in parentheses (cluster=establishment). Stars indicate standard significance levels: *** 1%, ** 5% and * 10%. Additional control variables include dummies for works councils, collective agreements, and share of female employees. *Source:* IAB Establishment Panel 2011-2016, analysis sample

Table 14 shows the results from the respective weighted difference-in-differences regressions. Using the log of mean sales as well the log of mean net sales as the dependent variables delivers negative, albeit statistically insignificant coefficients throughout all regressions. These results indicate that affected and unaffected establishments did not evolve differently in terms of sales and net sales of intermediates after the introduction of the German minimum wage. Accounting for labor costs, however, increases both the economical and statistical significance of the coefficients, representing a negative treatment effect. This result indicates that the German minimum wage affected establishments' profits via the labor cost channel. All these results are robust to including more controls, restricting the control group definition, and excluding those establishments which were indirectly affected by the minimum wage.

9. Conclusions

In this article, we provide empirical evidence of the establishment-level effects of the German statutory minimum wage. In doing so, we shed light on the short-term establishment-level adjustments in the aftermath of the introduction of the minimum wage, while at the same time disregarding the distributional effects of the minimum wage at the individual level.

The main results – which are based on the IAB Establishment Panel – rely on a difference-in-differences approach and can be summarized as follows: In surveying the most recent literature dealing with the minimum wage, we first document that, according to the establishment-level analysis by Bossler and Gerner (2016), about 45,000 to 68,000 additional jobs would have been created in the absence of the statutory minimum wage. We then proceed to provide initial evidence on a variety of further establishment-level outcomes, such as business expectations, investment in physical and human capital, and productivity and profitability, which so far have not been addressed in the most recent literature.

Our empirical findings show that the minimum wage exerted an adverse effect on establishments' business expectations. These effects are derived from establishments' self-assessment and are found to be particularly pronounced for the year 2015, while becoming insignificant for 2016. Moreover, while our estimates fail to detect any significant effects on competitive pressure in general, they suggest that treated establishments in Eastern Germany more often perceive their businesses to be at risk in comparison to the control group.

As it might be conceivable that – apart from adjusting their employment level – establishments aim at compensating the minimum wage-induced increase in labor costs by raising the productivity of their workers, we explicitly looked at investment into physical and human capital. The difference-in-differences results do not indicate that the introduction of the minimum wage resulted in any major short-term adjustments in investments either in physical or human capital. The latter is operationalized by apprenticeship or further training, with the estimates pointing to a slight negative effect on further

training for 2015 only. Consistent with the absence of any major effects on labor upgrading, the analyses provide no evidence of a significant minimum wage-induced effect on labor productivity. The effects on establishment profitability, defined as the difference between value added and labor costs, are shown to be weakly significantly negative and primarily arise from the minimum wage-induced increase in labor costs. These latter results are robust to the exclusion of establishments which report that they are indirectly affected by the introduction of the minimum wage. Thus, based on these findings, there appears to be no evidence for major spill-over effects and a potential violation of the SUTVA assumption underlying the difference-in-differences approach.

An important caveat is that the analyses are restricted to the very short-run effects of the minimum wage introduction up to the year 2016. This shortcoming is particularly relevant for outcomes such as investments in physical and human capital, whose adjustments typically require a longer-term horizon. The question of whether the minimum wage has any long-run effects on the outcomes of interest not only requires tracking treatment and control group establishments over a longer time-period, but it is also subject to stronger identifying assumptions. This is because the parallel trends assumption of treatment and control group underlying the difference-in-differences approach is more likely to be violated, the longer the time horizon after the policy change.

References

- Acemoglu, D. and J.S. Pischke (2003). Minimum Wages and On-the-job Training. *Research in Labor Economics*, Vol. 22: 159-202.
- Addison, J. T., M. L. Blackburn and C. D. Cotti (2015). On the robustness of minimum wage effects: geographically-disparate trends and job growth equations. *IZA Journal of Labor Economics*, Vol. 4, No. 1.
- Ahlfeldt, G., Roth, D. and T. Seidel (2018). The regional effects of Germany's national minimum wage. *Economics Letters*, Vol. 172: 127-130.
- Allegretto S. A., A. Dube and M. Reich (2011). Do minimum wages really reduce teen employment? Accounting for heterogeneity and selectivity in state panel data. *Industrial Relations*, Vol. 50, No. 2: 205-240.
- Apel, H., R. Bachmann, S. Bender, P. vom Berge, M. Fertig, H. Fings, M. König, J. Möller, A. Paloyo, S. Schaffner, M. Tamm, M. Umkehrer and S. Wolter (2012). Arbeitsmarktwirkungen der Mindestlohn-einführung im Baugewerbe. *Journal for Labour Market Research*, Vol. 45, Nr. 3: 257–277.
- Aretz, B., M. Arntz, S. Gottschalk, T. Gregory, M. Niefert, C. Rammer, H. Schröder, H. Schütz, J. Goedecke and C. Skripalle (2011). Evaluation bestehender gesetzlicher Mindestlohnregelungen-Branche: Dachdeckerhandwerk. Abschlussbericht an das Bundesministerium für Arbeit und Soziales (BMAS).

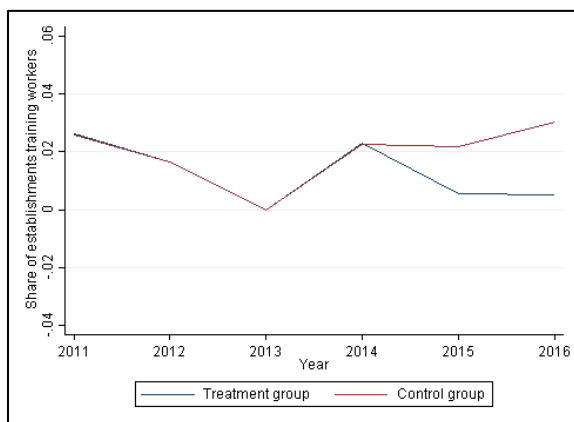
- Aretz, B., M. Arntz and T. Gregory (2013). The Minimum Wage Affects Them All: Evidence on Employment Spillovers in the Roofing Sector. *German Economic Review*, Vol. 14, No. 3: 282-315.
- Arulampalam, W., A.L. Booth and M.L. Bryan (2004). Training and the new minimum wage. *The Economic Journal*, Vol. 114: C87-C94.
- Bell, B. and S. Machin (2018). Minimum Wages and Firm Value. *Journal of Labor Economics*, Vol. 36, No. 1: 159-195.
- Bellmann, L., M. Bossler, M. Dütsch, H.-D. Gerner and C. Ohlert (2016). Folgen des Mindestlohns in Deutschland: Betriebe reagieren nur selten mit Entlassungen. IAB-Kurzbericht 18/2016, Nürnberg.
- Bellmann, L., M. Bossler, H.-D. Gerner and O. Hübler (2015). IAB-Betriebspanel: Reichweite des Mindestlohns in deutschen Betrieben. IAB-Kurzbericht 06/2015, Nürnberg.
- Bellmann, L., M. Bossler, H.-D. Gerner and O. Hübler (2017). Training and minimum wages: first evidence from the introduction of the minimum wage in Germany. *IZA Journal of Labor Economics*, Vol. 6: 1-22.
- Berge, P. vom and H. Frings (2017). High-Impact Minimum Wages and Heterogeneous Regions. IZA Discussion Paper 05/2017, Bonn.
- Bonin, H., I. Isphording, A. Krause, A. Lichter, N. Pestel, U. Rinne, M. Caliendo, C. Obst, M. Preuss, C. Schröder and M. Grabka (2018). Auswirkungen des gesetzlichen Mindestlohns auf Beschäftigung, Arbeitszeit und Arbeitslosigkeit. Studie im Auftrag der Mindestlohnkommission, Bonn/Potsdam/Berlin.
- Boockmann, B., K. Harsch, A. Kirchmann, G. Klee, R. Kleimann, C. Klempt, A. Koch, R. Krumm, M. Neumann, P. Rattenhuber, M. Rosemann, R. Sappl, J. Späth, H. Strotmann and H. Verbeek (2011). Evaluation bestehender gesetzlicher Mindestlohnregelungen Branche: Elektrohandwerk. Abschlussbericht an das Bundesministerium für Arbeit und Soziales (BMAS).
- Boockmann, B., R. Krumm, M. Neumann and P. Rattenhuber (2013). Turning the Switch: An Evaluation of the Minimum Wage in the German Electrical Trade Using Repeated Natural Experiments. *German Economic Review*, Vol. 14, No. 3: 316–348.
- Bossler, M. (2017). Employment expectations and uncertainties ahead of the new German minimum wage. *Scottish Journal of Political Economy*, Vol. 64, No. 4: 327-348.
- Bossler, M. and S. Broszeit (2017). Do minimum wages increase job satisfaction? Micro data evidence from the new German minimum wage, *Labour*, Vol. 31, No. 4: 480-493.
- Bossler, M., G. Geis and J. Stegmaier (2018). Comparing survey data with an official administrative population: Assessing sample-selectivity in the IAB Establishment Panel. *Quality and Quantity. International Journal of Methodology*, Vol. 52, No. 2: 899-920.

- Bossler, M. and H.-D. Gerner (2016). Employment effects of the new German minimum wage: evidence from establishment-level micro data. IAB Discussion Paper 10/2016, Nürnberg.
- Bossler, M., N. Gürtzgen, B. Lochner, U. Betzl, L. Feist and J. Wegmann (2018). Auswirkungen des gesetzlichen Mindestlohns auf Betriebe und Unternehmen. IAB-Forschungsbericht, 04/2018, Nürnberg.
- Bossler, M. and U. Jaenichen (2017). Der gesetzliche Mindestlohn aus betrieblicher Sicht. *WSI-Mitteilungen*, Vol. 70, No. 7: 482-490.
- Cahuc, P. and P. Michel (1996). Minimum wage unemployment and growth. *European Economic Review*, Vol. 40, No. 7: 1463-1482.
- Caliendo, M., A. Fedorets, M. Preuß, C. Schröder and L. Wittbrodt (2018). The Short-Run Employment Effects of the German Minimum Wage Reform. *Labour Economics*, Vol. 53, EALE-Conference Issue: 46-62.
- Draca, M., S. Machin and J. Van Reenen (2011). Minimum Wages and Firm Profitability. *American Economic Journal*, Vol. 3, Nr. 1: 129-151.
- Egeln, J., S. Gottschalk, N. Gürtzgen, M. Niefert, C. Rammer and M. Sprietsma (2011). Evaluation bestehender gesetzlicher Mindestlohnregelungen – Branche: Abfallwirtschaft. Endbericht für das Bundesministerium für Arbeit und Soziales, Mannheim.
- Ellguth, P., S. Kohaut and I. Möller (2014). The IAB Establishment Panel – methodological essentials and data quality. *Journal for Labour Market Research*, Vol. 47, No. 1-2: 27-41.
- Falk, A., E. Fehr and C. Zehnder (2006). Fairness Perceptions and Reservation Wages—the Behavioral Effects of Minimum Wage Laws. *The Quarterly Journal of Economics*, Vol. 121, Nr. 4: 1347–1381.
- Fischer, G., F. Janik, D. Müller and A. Schmucker (2009). The IAB Establishment Panel. Things users should know. *Schmollers Jahrbuch: Journal of Contextual Economics*, Vol. 129, No. 1: 133-148.
- Frings, H. (2013). The Employment Effect of Industry-Specific, Collectively Bargained Minimum Wages. *German Economic Review*, Vol. 14, No. 3: 258-281.
- Garloff, A. (2017): Side effects of the introduction of the German minimum wage on employment and unemployment * Evidence from regional data. Update. Bundesministerium für Wirtschaft und Energie. Diskussionspapier, No. 4, Berlin.
- Gürtzgen, N., A. Kubis, M. Rebien and E. Weber (2016). Neueinstellungen auf Mindestlohnniveau. Anforderungen und Besetzungsschwierigkeiten gestiegen. IAB Kurzbericht 12/2016, Nürnberg.
- Hainmueller, J. (2012). Entropy Balancing for Causal Effects: A Multivariate Reweighting Method to Produce Balanced Samples in Observational Studies. *Political Analysis*, Vol. 20: 25-46.
- Hainmueller, J. and Y. Xu (2013). ebalance: A Stata Package for Entropy Balancing. *Journal of Statistical Software*, Vol. 54, No. 7: 1–18.

- Kellermann, K.L. (2017). Minimum Wages and Vocational Training Incentives in Germany. IAAEU Discussion Paper Series in Economics 08/2017.
- Knabe, A., R. Schöb and M. Thum (2014). Der flächendeckende Mindestlohn. *Perspektiven der Wirtschaftspolitik*, Vol. 15, No. 2: 133-157.
- König, M. and J. Möller (2009). Impacts of minimum wages: a microdata analysis for the German construction sector. *International Journal of Manpower*, Vol. 30, No. 7: 716-741.
- Lechthaler, W. and D. Snower (2008). Minimum wages and training. *Labour Economics*, Vol. 15: 1223-1237.
- Leighton, L.S. and J. Mincer (1981). The effects of minimum wage on human capital formation. Pp. 155-173 in: S. Rottenberg (eds.), *The Economy of Legal Minimum Wages*, Washington D.C..
- Link, S. (2018). The Price and Employment Response of Firms to the Introduction of Minimum Wages. Mimeo.
- Minimum Wage Commission (2016). Erster Bericht zu den Auswirkungen des gesetzlichen Mindestlohns. Bericht der Mindestlohnkommission an die Bundesregierung nach § 9 Abs. 4 Mindestlohngesetz, Berlin.
- Neumark, D., I. Salas and W. Wascher (2014b). Revisiting the Minimum Wage-Employment Debate: Throwing Out the Baby with the Bathwater? *Industrial & Labor Relations Review*, Vol. 67, Supplement: 608-648.
- Pusch, T. and M. Rehm (2017). Mindestlohn, Arbeitsqualität und Arbeitszufriedenheit. *WSI-Mitteilungen*, Vol. 70, Nr. 7: 491-498.
- Riley, R. and C.R. Bondibene (2017). Raising the standard: Minimum wages and firm productivity. *Labour Economics*, Vol. 44: 27-50.
- Schmitz, S. (2017). The Effects of Germany's New Minimum Wage on Employment and Welfare Dependency. Mimeo.
- Schumann, M. (2017). The effects of minimum wages on firm-financed apprenticeship training. *Labour Economics*, Vol. 47: 163-181.

Appendix A

Figure A1: Share of establishments that train workers (weighted control group)



Notes: Weighted time series centered on 2013 values.

Source: IAB Establishment Panel 2011-2016

Table A1: Difference-in-differences estimates on further training activities in establishments (weighted)

	(1) Share of trained employees	(2) Share of trained employees	(3) Share of trained employees
Treatment effect in 2015 and 2016	-0.009 (0.010)		
Treatment effect in 2015		-0.006 (0.012)	
Treatment effect in 2016		-0.012 (0.013)	
Placebo effect			-0.000 (0.011)
Observations	47,537	47,537	33,748
Average share of trained employees, ... in unaffected establishments (2014)		0.63	
... in affected establishments (2014)		0.63	

Notes: The coefficients are treatment effects on affected establishments from weighted difference-in-differences specifications with fixed effects, where weights are calculated in an entropy balancing algorithm that conditions on past outcomes of the years 2011-2014. The dependent variable is the share of workers that participate in further training. Clustered standard errors are in parentheses (cluster=establishment). Stars indicate standard significance levels: *** 1%, ** 5% and * 10%. Control variables include dummies for works councils, collective agreements, and share of female employees.

Source: IAB Establishment Panel 2011-2016, analysis sample