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Abstract

This paper examines the impact of sector-specific minimum wages in Germany on the willingness of youths to undergo vocational training. The theoretical impact of wage floors on educational incentives is ambiguous: on the one hand, they raise the opportunity cost of education and prevent further skill accumulation. On the other hand, they lower the employment probability of unskilled workers which promotes additional training. We use a GSOEP-based sample of youths aged 17 to 24, covering a time period between 1994 and 2014 in order to estimate the probability of opting for an apprenticeship employing a mixed logit model. Contrasting with evidence from other countries, we find that increasing sectoral wage floors have a positive effect on already high training probabilities of youths. In case of binding minimum wages, demand for unskilled workers declines which lowers the opportunity cost of education. This effect is reinforced by high requirements concerning professional skills.

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1 Introduction

In times of globalization, economic flexibility and social security are constantly weighed against one another, especially when it comes to labor issues. Although Germany has traditionally been a country with a highly regulated and protective labor market (Organization for Economic Cooperation and Development, 2016a,b), there has been no statutory minimum wage until 2015. Its introduction caused an intense and controversial debate among politicians, scientists and labor market participants. Its proponents usually stress the argument of fairness since the number of *working poor* who have to rely on public support despite an employment has been observed to rise since the mid-2000s Eichhorst/Marx, 2011; Palier/Thelen, 2010). In contrast, the opponents of a statutory minimum wage worry about Germany's position in the global economy. Fixing a general minimum in a high-wage country might deal a death blow to Germany's competitiveness and destroy a large amount of flexible, low-wage job arrangements.

However, extensive wage floors are not unknown on the German labor market. For two decades, unions and employers associations have been fixing wage agreements on occupation level which are extendable to non-members by law. These *generally binding collective bargaining agreements* have originally been used in industry and manufacturing only. In the past ten years, the expansion of the service sector – which came along with an increasing number of low-wage jobs (Dustmann et al., 2009; Eichhorst/Marx, 2009; Palier/Thelen, 2010) – caused an increased usage of sectoral minima in services.

There is a vast literature on employment effects of minimum wages from all over the world whereas less empirical work has been dedicated to the analysis of other impacts. Following Becker's Human Capital Theory from 1964, the introduction of a statutory minimum wage increases the opportunity cost of education and thereby encourages individuals to enter the labor market (Becker, 1964; Neumark/Wascher, 2010). Yet, taking account of the probability to find an employment, the argumentation can also be reversed. Since employers only want to hire workers whose productivity corresponds to the statutory minimum, the employment prospects of low-skilled workers decline. Thus, additional skill formation pays off in terms of a larger job finding probability and a higher wage exceeding the general minimum. Given this trade-off, the educational effect of minimum wages is theoretically indeterminate (Checchi, 2006; Neumark/Wascher, 2010). Previous studies find strong evidence of a negative impact implying positive incentives to work at a minimum wage level instead of accumulating further human capital.

This paper sheds light on the educational effect of sectoral minimum wages in Germany. Primarily, we examine the effect on vocational training. The dual apprenticeship system in Germany is reputed to be an ideal form of school-to-work transition as it offers both formal professional schooling and on-the-job training and leads to a state-approved degree. The system covers a majority of occupations in all economic sectors and represents the standard type of non-academic vocational education in Germany (Büchel, 2002; Franz/Soskice, 1995; Thelen, 2004). Therefore, we do not expect training incentives to be negatively affected by higher wage prospects. By combining data from the *German Socio-economic Panel* (GSOEP) and administrative data on sectoral minimum wage levels, we estimate a mixed logit model in order to analyze the probability of being an apprentice for a sample of youths aged 17 to 24 covering the years 1994-2014.

The remainder of this paper is organized as follows. Section 2 is concerned with theoretical foundations and the previous empirical evidence. Section 3 provides a brief overview on wage floor arrangements in Germany with special emphasis on sectoral agreements. Section 4 introduces the methodological setup and the data base. Section 5 presents the estimation results. Section 6 discusses them and concludes.

2 Theoretical Foundations and Previous Evidence

The basic approach to illustrate the relation of wages and beyond-compulsory skill formation, is Becker's *Human Capital Theory* from 1964. In simplified terms, all individuals are on a low skill level $q = l$ at the beginning of their working life in $t = 0$. They can choose between spending their time on educational activities – in order to reach a high skill level $q = h$ – or on unskilled work.[1] Education involves cost in terms of training expenses[2] C and the foregone low-skilled wage W_t^l. Having finished their training, individuals receive the high-skilled wage $W_t^h > W_t^l$. The individual allocates the available amount of time so that the total cost of education equals the discounted future benefits of a higher skill level (Becker, 1964; Kellermann, 2017)

[1] Becker assumes that the total amount of time available cannot be split up in order to work and be trained in part-time.

[2] Since training is assumed to be general here, the individual has to bear the cost, e. g. for courses or material.

$$\sum_{t=1}^{T} \beta^t \frac{W_t^h}{(1+r)^t} = C + W_0^l. \tag{1}$$

Extending the model with regard to minimum wages, we assume that a statutory minimum wage is binding for low-skilled workers only, $W_0^h > MW > W_0^l$. Thus, the opportunity cost of education rises for this group (Neumark/Wascher, 2010). Individuals are encouraged to spend time on full-time work which causes labor supply to increase. Depending on the overall labor market situation, a potential consequence is an excess supply implying that individuals queue for a limited number of jobs. Therefore the literature refers to this outcome as the *Queuing Hypothesis* (Kellermann, 2017; Neumark/Wascher, 2010).

The argumentation points at the fact that the job finding probability ρ_i may generally be lower than 1, though Becker (1964) does not explicitly discuss this aspect. Taking account of how prospects of employment are affected by minimum wages, the educational impact can also be positive. Following basic labor market theory, workers are paid according to their level of productivity whereas highly qualified workers are assumed to be preferred and thus have a larger employment probability $\rho_h > \rho_l$. A minimum wage which is binding for the low-skilled only fosters a demand shift towards more qualified workers whose marginal product of labor at least equals the wage floor level. Thus, the employment probability rises for the high-skilled, $\rho_h^{MW} > \rho_h$ but declines for the low-skilled, $\rho_l > \rho_l^{MW}$. The minimum wage effect on employment probabilities outweighs the effect on income as such so that individuals have a larger incentive to participate in educational activities. This is labeled the *Substitution Hypothesis* (Agell/Lommerud, 1997; Kellermann, 2017; Neumark/Wascher, 2010).

$$\rho_h^{MW} \sum_{t=1}^{T} \beta^t \frac{W_t^h}{(1+r)^t} > \rho_l^{MW}(C + MW_t). \tag{2}$$

Conclusively, the direction of the minimum wage impact depends on the relation of employment probabilities of low-skilled and high-skilled workers. If public intervention is strong, demand for low-skilled labor sharply falls. Thereby, the opportunity cost of education is considerably lowered and skill accumulation is promoted. If minimum wages exceed market wages to only a slight extend, changes in employment prospects for the low-skilled are small which might not affect the individual calculus.

In line with the Queuing Hypothesis, previous research mostly finds decouraging educational impacts of minimum wages. Ehrenberg and Marcus (1982) observe a negative effect on the individual enrollment probability in school for US teenagers from poor family backgrounds. The opposite effect is observed for youths from wealthier families (Ehrenberg/Marcus, 1982). Conducting several studies for the US, Neumark and Wascher (1995a, 1995b, 2003) confirm these observations. Given a 10% increase in the relative state minimum wage, the schooling probability of teenagers declines by 3.4%. In addition, the probability to be neither in school nor employed rises by 6.7%. Thus, a rising minimum wage causes both educational disincentives and a lower demand for youth labor. Examining the effect on the aggregate level, Chaplin et al. (2003) show that the share of students who stay in school for post-compulsory education declines by about one percentage point in case of a minimum wage raise of 1.00 $.

Similar decreases in enrollment rates or schooling probabilities are observed on the Canadian, British and New Zealand labor market (Hyslop/Stillman, 2007; Landon, 1997; Pacheco/Cruickshank, 2007; Rice, 2010). In a few cases, that is for single demographic groups, studies find no educational effect of minimum wages at all (Campolieti et al., 2005; Ehrenberg/Marcus, 1982; Landon, 1997). Thus, the negative impact dominates at least for Anglo-Saxon countries which are characterized by rather liberal labor markets and welfare regimes (Organization for Economic Cooperation and Development, 2016a,b). Contrastingly, the evidence suggests that legal interventions such as minimum wage exemptions or youth subminima effectively counteract the reduction in educational participation. In a cross-country analysis, Neumark and Wascher (2004) observe that legal subminima increase the employment probability of affected youths by 1 up to 9 percentage points given a rise in the adult minimum. Accordingly, Pacheco and Cruickshank (2007) show that a raise in the legal teenage subminimum in New Zealand causes school enrollment rates to increase. As argued by the authors, the cost advantage over adult workers shrinks which reduces the demand for teenage labor and raises enrollment. This observation will be referred to lateron.

3 Minimum Wages in Germany

Compared to other countries, the history of minimum wages in Germany is quickly recounted. Until the end of the 1990s, wage agreements that implied public involvement were unusual. Unions and employers' associations fixed payment standards in a bar-

gaining process on occupation level or even firm level from which only union members originally benefited (Dustmann et al., 2009). However, the German *Collective Agreement Act* allows to extend collective bargaining agreements to all workers in an occupational group or economic sector[3] and they are then referred to as *generally binding agreements* (Antonczyk et al., 2010; Fitzenberger et al., 2011). In case, they fix a payment standard, this can be considered the introduction of a sectoral minimum wage.

The first general minimum, introduced in 1997, covered workers in main construction trades[4]. Other sectors followed, e. g. the electrical trades and the painting sector. Since the process of collective bargaining was mainly prevalent in industrial sectors, the application of sectoral wage floors was limited to this part of the economy at first. However, from the beginning of the 2000s, there is a switch from industries to service sectors (see table 1). Promoted by the 2002 to 2006 labor market reform (*Hartz-Reform*), the growing number of flexible, atypical working contracts led to a higher wage inequality and a rising number of *working poor* (Dustmann et al., 2009; Eichhorst/Marx, 2011; Palier/Thelen, 2010). Thus, wage floors in low-payment service sectors, such as care nursing, building cleaning or security services, have been used to address this issue. Since the economic performance of federal states in the former German Democratic Republic[5] still falls behind in terms of lower average wages and higher unemployment rates (see appendix figure B.2), the majority of wage floors is adapted to the respective region. Strikingly, sectoral wage floors are not found to cause significant job losses among affected workers in West Germany. In East Germany moderate drops in employment are reported for painters and workers in electrical industries (Boockmann et al., 2013; Frings, 2013; Möller, 2012; Rattenhuber, 2014).

Since January 1, 2015, the first statutory minimum wage in Germany is in use. The vast majority of workers has been declared eligible for a gross hourly minimum of 8.50 € according to the *Minimum Wage Law*. As of January 1, 2017, the statutory minimum has been raised to 8.84 €. Despite the lack of scientific investigation of country-specific educational effects of minimum wages, protective measures have been adopted. The legislation implies – among some others – an exemption of under-agers without a professional degree. According to official information, this declaration of ineligibility intends to

[3]This measure is bound to some preconditions. According to the Collective Agreement Act, the respective agreements must apply to a (non-defined) majority of workers even before the extension.

[4]The information on sectoral minimum wages is taken from the respective legal regulations published in the German Federal Gazette.

[5]These include Berlin (East), Brandenburg, Mecklenburg-Vorpommern, Saxony, Saxony-Anhalt and Thuringia.

Table 1: Sectoral Minimum Wages in Germany

Occupational Group	Year of Introduction	Current Level in €[a]
Agriculture, Gardening & Forestry	2015	8.60
Billboard Manufacturing	2015	12.94[b]
Building Cleaning	2007	10.00 (West), 9.05 (East)[c]
Butchery	2014	8.75
Care Nursing	2009	10.20 (West), 9.50 (East)
Cash & Guarding Services	2015	varies by federal state
Chimney Sweep Trades	2014	12.95
Electrical Trades	1997	10.65 (West), 10.40 (East)
Hair Dressing	2013	8.84 (statutory minimum)[d]
Hard Coal Mining	2009	8.84 (statutory minimum)[d]
Main Construction Trades	1997	11.30
Laundry Services	2009	8.75
Painting & Varnishing	2003	13.10[b] (West), 11.30[b] (East)
Postal Services	2007	abolished in 2010
Professional Education	2012	14.60
Roofing	1997	12.25
Scaffolding	2013	10.70
Security Services	2011	8.84 (statutory minimum)[d]
Stone Cutting	2013	11.35 (West), 11.00 (East)
Subcontracted Work	2012	8.84 (statutory minimum)[d]
Textile Industry	2015	8.84 (statutory minimum)[d]
Waste Management	2010	9.10

[a] January 1, 2017

[b] For skilled workers

[c] Higher wage levels of 13.25 (West) and 11.53 (East) for specialists in window cleaning

[d] No sectoral minimum wage in use at the moment, negotations might still continue

preserve both training incentives and training opportunities. School-leavers should not feel encouraged to leave the educational path and enter the labor market in order to earn the minimum wage. At the same time, employers should have no incentive to abstain from hiring still unskilled youths and from offering them vocational training[6]. However, considering the institutional setting of the German labor market, the resulting question is whether incentives for professional education really have to be protected from a min-

[6]The Federal Ministry of Labor and Social Affairs published a respective statement referring on its official webpage, see Federal Ministry of Labor and Social Affairs (2014).

imum wage distortion. The German apprenticeship system is widely used and accepted over the entire economy as the standard option to obtain non-academic occupational skills. The system is often referred to as the ideal prototype of a smooth transition from school to work. Comprising of both vocational schooling and employer-financed job training, it produces qualified professionals facing good job prospects. Skills acquired during an apprenticeship are firm-specific to only a limited extent so that they can be applied in several employments at least in the same occupational group. This transferability positively stimulates the readiness to be trained (Eichhorst/Marx, 2009).

Associated with that, the apprenticeship system shapes the general skill level in an occupational group. Due to the common use of training, a majority of workers is skilled and apprenticeship training is required for many professions to be carried out, especially in industries (Franz/Soskice, 1995). Hence, the employment probability of unskilled workers is relatively low because there is a sufficiently large skilled workforce to meet firms' labor demand. In case of an increasing minimum wage, firms can substitute unskilled with skilled workers or with apprentices who will obtain required professional qualifications (Acemoglu/Pischke, 1998; Eichhorst/Marx, 2009). Consequently, the Substitution Hypothesis is more likely to apply in this framework. Furthermore, apprentices in Germany are in fact paid a reward so that vocational training does not imply a complete loss of earned income which partially offsets the rising opportunity cost of education (Büchel, 2002; Franz/Soskice, 1995; Thelen, 2004).

Finally, it has to be clarified that there is and has been no exception of youth workers from sectoral minimum wages which indicates that, at least with respect to this kind of wage floor, no significant distortions of educational incentives have been expected. Thus, we suppose that increases in sectoral minimum wages do not discourage school-leavers from participating in the well-established and encompassing system of vocational training. This working hypothesis is to be investigated in the following.

4 Data and Methodological Approach

The empirical analysis is based on micro data from the *German Socio-economic Panel* (GSOEP). Since the first sectoral minimum was introduced in 1997 only, the dataset is restricted to the period from 1994[7] to 2014 which is the latest version of the GSOEP. We

[7]The starting year is 1994 because of lagged variables included, see below.

basically follow the structure of an earlier analysis we performed (Kellermann, 2017). Our sample refers to youths aged 17 to 24 excluding individuals who already completed professional training and those for which no information on occupational activities is available. Furthermore, observations for youths with a higher secondary degree are omitted. The German secondary school system consists of a higher, a medium and a lower secondary track whereas only graduating from the higher track qualifies for universities. Hence, it is assumed that the higher track is followed intending to undergo academic education rather than vocational training. Moreover, jobs for academics are unlikely to be affected by minimum wages. These eliminations leave us with a dataset of 8,977 observations in the baseline model.

Since the GSOEP does not provide data on sectoral minimum wages, the respective information is extracted from the official declarations of general application of collective bargaining agreements. The matching process of wage floors and individuals is based on the 1992 classification of occupations by the Federal Statistical Office (FSO). The current job title of an individual given by the GSOEP is compared to the job titles which are declared eligible for a sectoral minimum according to the legislations. If they correspond, the observation is matched with the respective minimum in use, see appendix table B.1.

The question of interest is whether an individual hinges her decision to undergo professional training on the sectoral wage floor. The set of alternatives comprises of two options since a school-leaver without permission to follow an academic track can voluntarily choose between apprenticeship training and unskilled employment. This is identical to a choice between a below-market and below-minimum training reward or a reward according to the sectoral minimum wage. Hence, the resulting dependent variable capturing the educational status is binary and takes up a value of 1 if an individual is currently doing an apprenticeship and 0 if an individual is an unskilled full-time or part-time worker. This approach only examines the vertical occupational decision, that is whether accredited professional skills are accumulated, but no horizontal choice regarding the occupational field itself which is assumed to depend on other factors, e. g. personal interests or talents.

The explanatory variable is the gross hourly sectoral minimum wage in € valid on January 1 of the year under observation.[8] To measure the degree of affection, we follow

[8]Minimum wages prior to the introduction of the € in 2002 are converted at the official rate fixed by the European Council.

previous studies, in particular those by Neumark and Wascher (1995a, 1995b, 2003). The sectoral minimum is set into relation to the gross hourly median wage of all workers in the federal state an individual lives in. This relative minimum wage is the so-called *Kaitz index* (Landon, 1997; Neumark/Wascher, 1995a,b, 2003; Rice, 2010). Pre-analysis shows that the series of relative minimum wages mostly contain a unit root.[9] In order to perform an unbiased estimation, the Kaitz index is thus replaced by its first difference. This procedure is preferred over taking logs so that observations with a zero minimum wage do not get lost. Finally, for the purpose of modeling a certain delay in reactions to minimum wages, the one-, two- and three-period lags of the Kaitz difference are included.

The estimation is conducted employing a mixed logit model. Compared to a standard panel logit model, the mixed logit estimation allows for any correlation between the error terms as well as for dependence of irrelevant alternatives (Hensher/Greene, 2003; Revelt/Train, 1998). Although the observed group of school-leavers does not face other choices than apprenticeship training or unskilled work, a dependence on academic training cannot completely be excluded.[10] The mixed logit model is preferable to obtain unbiased estimates. It splits up the error term into an independently and identically distributed component ϵ_{it} and an individual-specific random component η_{it} which is allowed to be serially correlated. The model setup used here requires to maximize the apprenticeship probability (Hensher/Greene, 2003; Kellermann, 2017)

$$P_{it} = \int L_{it} f(\eta|\Omega) d\eta \tag{3}$$

with the likelihood function

$$L_{it}(\eta) = \frac{exp(\alpha + \sum_{k=0}^{3} \beta_k \Delta Kaitz_{it-k} + \gamma \boldsymbol{X_i} + \delta \Delta \boldsymbol{Z_{t-1}} + \lambda_t + \eta_{it})}{1 + exp(\alpha + \sum_{k=0}^{3} \beta_k \Delta Kaitz_{it-k} + \gamma \boldsymbol{X_i} + \delta \Delta \boldsymbol{Z_{t-1}} + \lambda_t + \eta_{it})}. \tag{4}$$

The variable $\Delta Kaitz_{it-k}$ refers to the first differences of relative sectoral minimum wages as described above. We control for several personal, social and economic characteristics. Among these is a vector of common demographics $\boldsymbol{X_i}$, namely sex and nationality (Campolieti et al., 2005; Chaplin et al., 2003; Neumark/Wascher, 1995a,b, 2003) as

[9] See appendix figure B.3

[10] For example, a general shift towards a higher skill level caused by increasing public support of academic education could encourage school-leavers with lower secondary degrees to do an apprenticeship in order to keep up with the overall trend.

Table 2: Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Survey Year	8,977	2003.723	6.083	1994	2014
Educational Status	8,977	0.81	0.392	0	1
in Minimum Wage Groups	1,022	0.854	0.353	0	1
in Other Occupational Groups	7,955	0.805	0.397	0	1
Δ Minimum Wage	8,977	0.523	2.488	-11.05	11.55
Δ State Median Wage	7,813	0.279	0.554	-3.895	7.446
Δ Kaitz Index	8,977	0.037	0.176	-0.83	0.9
Sex	8,977	0.433	0.496	0	1
Nationality	8,063	0.125	0.331	0	1
Age	8,977	20.196	1.925	17	24
Secondary School Degree	8,977	1.555	0.59	0	2
Required Education for Occupation	7,569	4.327	1.196	1	6
Region of Residence	8,977	0.253	0.435	0	1
Δ State Unemployment Rate	7,813	-0.057	1.139	-13.1	11.7
Δ Number of Apprenticeship Places	7,279	-0.377	29.591	-37.764	93.848
Δ Relative Youth Cohort Size	8,977	0.158	0.351	-0.156	0.961
Time	8,977	2003.723	6.083	1994	2014

well as secondary school degree measured as medium, lower or no degree (Kellermann, 2017). Furthermore, in order to illustrate the competitive situation on the labor market, we use a vector of macro-level controls $\Delta \boldsymbol{Z_{t-1}}$. These are the size of the youth cohort in percent of the entire population (on national level), the state unemployment rate in percent of civil employees and the absolute number of apprenticeship places offered by firms in thousands (on national level) all of which are also included as one-period lagged first differences. In addition, time effects are controlled for (Kellermann, 2017; Neumark/Wascher, 1995a,b; Pacheco/Cruickshank, 2007).

Descriptive statistics are displayed in table 2.[11] Notably, the fraction of apprentices among youths is higher than 0.85 in both minimum and non-minimum sectors and thus more than five times larger than the fraction of unskilled workers, indicating that professional training is by far the likelier choice.

[11]For correlation and collinearity diagnostics, see appendix tables B.2 and B.3.

Figure 1 presents the shares of apprentices in minimum and non-minimum sectors over time. No clear difference can be determined by means of visual inspection. In figure 2, the educational status is plotted against the lags of the first Kaitz index difference. Looking at the first three subplots in particular, a small positive link between the educational status and minimum increases is suggested.

Figure 1: Apprenticeship Probability by Year and Occupational Group

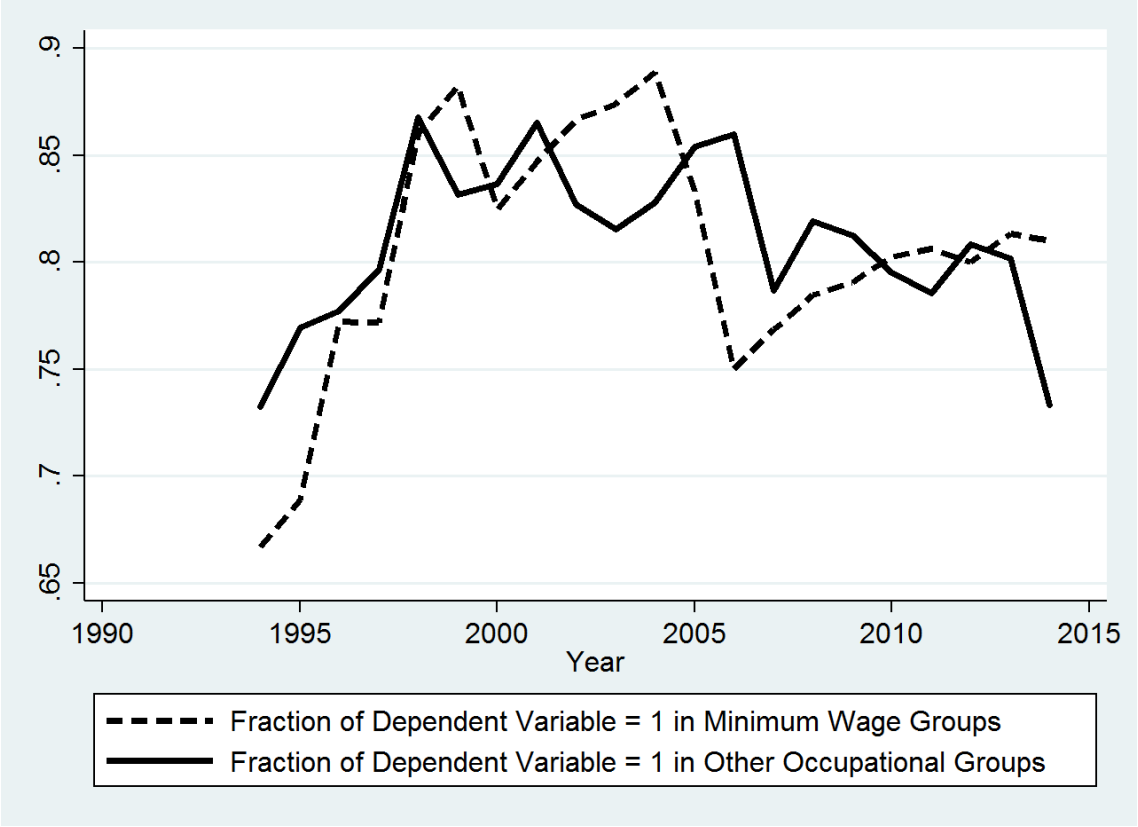
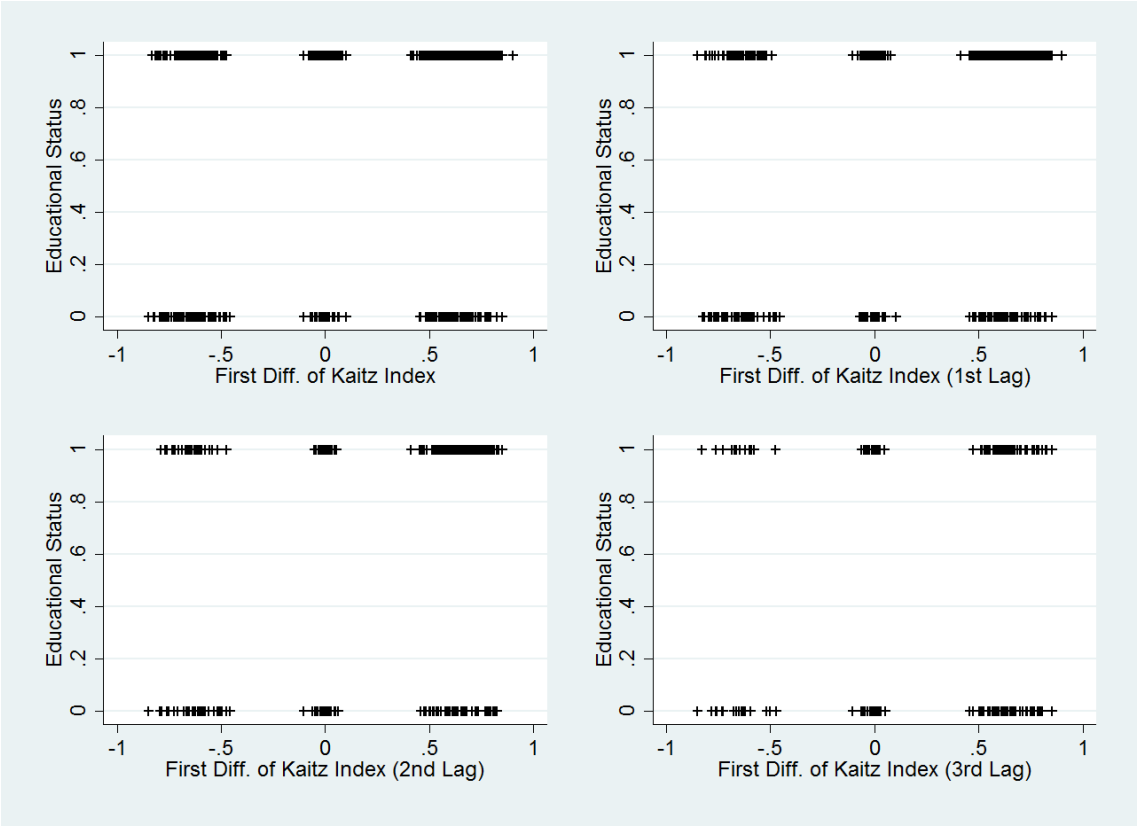


Figure 2: Plot of Educational Status against Explanatory Variables



5 Empirical Results

Baseline Regression Baseline regression results are illustrated in table 3. In line with previous expectations, the minimum wage impact is positive and significant on a 1% level up to the second lag. Both the one- and two-period lagged Kaitz differences yield larger estimates than the Kaitz difference in t which is plausible considering the fact that educational decisions as a reaction to minimum changes can only be realized with a certain delay. The three-period lagged Kaitz difference produces no significant coefficients. Adding control variables, the estimates remain significantly positive showing the same time pattern. Thus, an increase in sectoral minimum wages induces a higher probability of training in affected ocupations. This corresponds to our previous results (Kellermann, 2017).

Another suitable approach is to specify a multinomial probit model which also allows for correlation between the error terms but without calculating a person-specific component. The respective estimation results are displayed in columns (3) and (4) of table 3.

Consistent with the mixed logit results, the minimum wage impact is again significantly positive. Moreover, the same time pattern can be observed as the one-period lagged Kaitz difference yields the largest coefficient and the two-period lagged Kaitz difference the second largest. For the three-period lagged Kaitz differences, coefficients are again insignificant.

Table 3: Baseline Regression Results

Dep. Variable: Educational Status	(1)	(2)	(3)	(4)
	Mixed Logit		Multinomial Probit	
Δ Kaitz Index	1.294***	1.019***	0.439***	0.590***
	(0.313)	(0.293)	(0.133)	(0.189)
$(\Delta$ Kaitz Index$)_{t-1}$	2.050***	1.748***	1.023***	1.112***
	(0.436)	(0.409)	(0.190)	(0.233)
$(\Delta$ Kaitz Index$)_{t-2}$	1.827***	1.616***	0.980***	0.894***
	(0.540)	(0.504)	(0.251)	(0.268)
$(\Delta$ Kaitz Index$)_{t-3}$	0.336	0.304	-0.0253	-0.101
	(0.652)	(0.605)	(0.322)	(0.337)
Sex: Female		-0.355**		-0.146**
		(0.145)		(0.0624)
Nationality: Non-German		-1.398***		-0.570***
		(0.201)		(0.0975)
Secondary Degree: Lower		1.769***		0.719***
		(0.330)		(0.178)
Secondary Degree: Medium		3.161***		1.301***
		(0.331)		(0.176)
$(\Delta$ State Unemployment Rate$)_{t-1}$				0.0172
				(0.0368)
$(\Delta$ Number of Apprenticeship Places$)_{t-1}$		0.0577***		-0.000860
		(0.0168)		(0.00983)
$(\Delta$ Relative Youth Cohort Size$)_{t-1}$		-0.121		-0.636**
		(0.415)		(0.304)
Constant	3.268***	0.488	0.821***	0.701***
	(0.266)	(0.374)	(0.0876)	(0.214)
Random Individ. Error (Std. Dev.)	1.229***	0.935***		
	(0.0351)	(0.0352)		
Observations	8,977	6,877	8,977	5,056
Year Effects	Yes	Yes	Yes	Yes

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Since the estimates of a mixed logit model are not intuitively interpretable, table 4 gives the average marginal effects of a minimum wage increase on the training probability. Person-specific errors are excluded here in order to calculate a sample average. If, for

instance, all other variables are held constant at their mean values, an increase in the one-period lagged Kaitz difference by one unit raises the apprenticeship probability by 7 percentage points in the model with control variables and by 10 percentage points in the model without controls. Recall that the Kaitz difference takes up a sample mean of about 0.04 (see table 2). Multiplying this value with the marginal effects computed here, the apprenticeship probability rises between 0.16 and 0.38 percentage points depending on the considered lag of the Kaitz difference.

Table 4: Marginal Effects, Baseline Regression (Rounded Values)

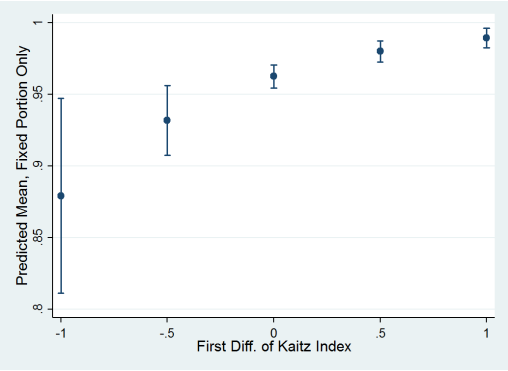
Variable	Marginal Effect	Std. Err.	P-Value
	Without Controls (N=8,977)		
$(\Delta$ Kaitz Index$)_t$	0.044	0.012	0.000
$(\Delta$ Kaitz Index$)_{t-1}$	0.070	0.017	0.000
$(\Delta$ Kaitz Index$)_{t-2}$	0.062	0.020	0.001
	With Controls (N=6,877)		
$(\Delta$ Kaitz Index$)_t$	0.059	0.017	0.001
$(\Delta$ Kaitz Index$)_{t-1}$	0.101	0.024	0.000
$(\Delta$ Kaitz Index$)_{t-2}$	0.093	0.030	0.002

Figure 3 shows the average predicted apprenticeship probabilities at the indicated values of first Kaitz differences.[12] All other exogenous variables are again at their mean values. The predicted values strongly exceed 0.5 so that on average all observed individuals are more likely to do an apprenticeship than to be an unskilled worker.[13] A strong decline of the minimum wage lowers the apprenticeship probability, yet the predicted value still exceeds 0.75 in all cases. Thus, the apprenticeship decision is affected but not altered by changing wage prospects.

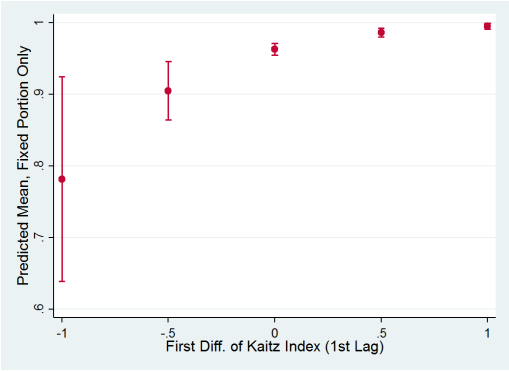
[12]Since the Kaitz index is the minimum-to-median ratio, its first differences can only take up values between -1 and 1. The predictions refer to models (1) and (2) in table 3 only.

[13]For the exact values of average predictions, see appendix table B.4

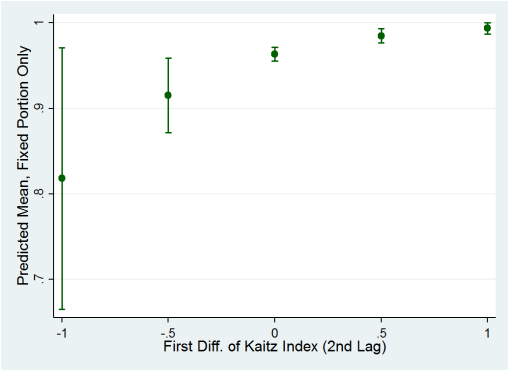
Figure 3: Average Predicted Probabilities



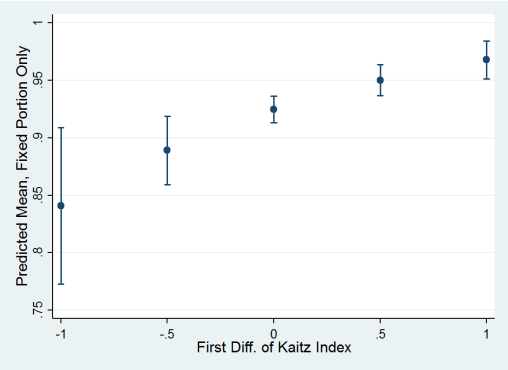
(a) Δ Kaitz$_t$, Without Controls



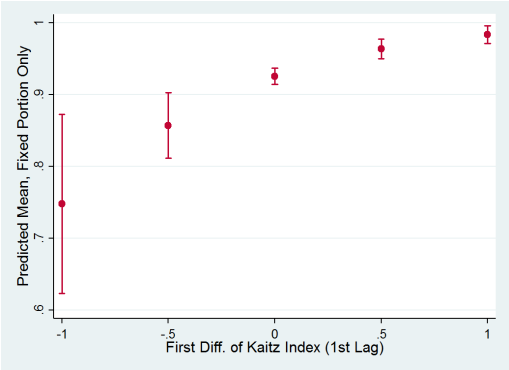
(b) $(\Delta$ Kaitz$)_{t-1}$, Without Controls



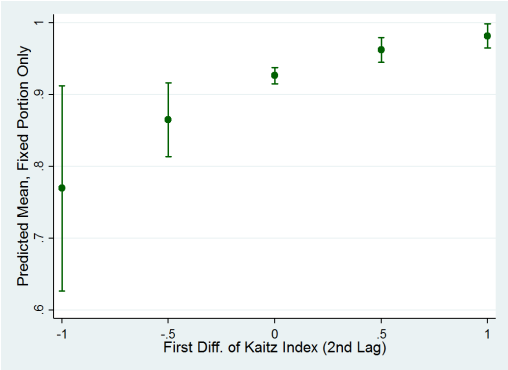
(c) $(\Delta$ Kaitz$)_{t-2}$, Without Controls



(d) Δ Kaitz$_t$, With Controls



(e) $(\Delta$ Kaitz$)_{t-1}$, With Controls



(f) $(\Delta$ Kaitz$)_{t-2}$, With Controls

Robustness Checks In order to check whether the observed impact is stable, several robustness tests are conducted. Columns (1) and (2) in table 5 show the estimates for the baseline model including the one-period lagged value of the dependent variable.

Table 5: Alternative Specifications

Dep. Variable: Educational Status	(1)	(2)	(3)	(4)
	Lagged Dep. Variable		Required Education	
Educational Status$_{t-1}$	4.056***	3.684***		
	(0.115)	(0.146)		
Δ Kaitz Index	0.798**	0.820**	1.081***	1.077***
	(0.319)	(0.380)	(0.388)	(0.387)
(Δ Kaitz Index)$_{t-1}$	0.798**	0.879**	1.916***	1.942***
	(0.370)	(0.441)	(0.530)	(0.540)
(Δ Kaitz Index)$_{t-2}$	0.802	0.947*	0.835	0.984*
	(0.507)	(0.532)	(0.601)	(0.590)
(Δ Kaitz Index)$_{t-3}$	-0.621	-0.405	-0.775	-0.655
	(0.621)	(0.647)	(0.803)	(0.775)
Sex: Female		-0.121		-0.238
		(0.136)		(0.178)
Nationality: Non-German		-0.634***		-1.054***
		(0.208)		(0.253)
Secondary Degree: Lower		0.510		1.602***
		(0.361)		(0.438)
Secondary Degree: Medium		1.173***		2.861***
		(0.365)		(0.443)
(Δ State Unemployment Rate)$_{t-1}$		0.00472		
		(0.0743)		
(Δ Number of Apprenticeship Places)$_{t-1}$		-0.0418**		-0.00463**
		(0.0199)		(0.00223)
(Δ Relative Youth Cohort Size)$_{t-1}$		-2.246***		0.496***
		(0.618)		(0.149)
Required Education: Orientation		-3.505***	-4.265***	
		(0.513)	(0.698)	
Required Education: Introduction		-0.664	-1.719**	
		(0.516)	(0.692)	
Required Education: Course Training		1.003*	-0.451	
		(0.543)	(0.711)	
Required Education: Professional Training		2.105***	0.847	
		(0.476)	(0.659)	
Constant	-1.448***	-0.406	-2.959***	1.389*
	(0.183)	(0.441)	(0.578)	(0.749)
Random Individ. Error (Std. Dev.)	-0.201	0.138	1.100***	0.993***
	(0.148)	(0.125)	(0.0546)	(0.0621)
Observations	6,299	4,111	6,683	5,793
Year Effects	Yes	Yes	Yes	Yes

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

When deciding to undergo professional training, new apprentices sign a respective contract with a firm which usually implies a training duration of three years. Thus, once the decision has been made, individuals are likely to keep their status for more than one period for what reason it appears logical to include the lagged dependent variable as explanatory.

The resulting coefficients are positive, strongly significant and relatively large. Hence, having been an apprentice in $t-1$ is a good predictor for being one in t. However, the impact of the current and one-period lagged Kaitz differences are still significantly positive. Adding controls, only the one-period lagged Kaitz difference yields a significant coefficient on a significance level of 10%. Moreover, the size of coefficients is more than halved compared to the baseline regression. Thus, although the minimum wage effect is statistically observable and mainly stable, it is weak in reality.

Models (3) and (4) present the estimation results of the baseline regression including the required skill level to carry out an individual's current occupation. Unsurprisingly, the apprenticeship probability is significantly lowered if no approved qualifications are necessary whereas high qualification requirements promote vocational training.[14] With respect to Kaitz differences, the estimates decrease compared to the baseline model but remain positive and mostly significant. Interaction effects of required education and minimum wage increases have also been checked, however these did not produce significant coefficients.

As the distribution over occupational groups shows, a large share of observations is classified as workers in main construction trades (see appendix figure B.1). Not only have sectoral minimum wages been used for the longest period here, specific, technical skills are needed so that apprenticeship training is likely to be opted for (Eichhorst/Marx, 2009). Thus, a conceivable objection against the baseline results is that they are mainly driven by this dominant group. Addressing this issue, the estimation is repeated excluding workers in main construction trades and results are reported in table 6.

[14]The estimates for academic education as required are not shown here.

Table 6: Exclusion of Main Construction Trades

Dep. Variable: Educational Status	(1)	(2)
	Mixed Logit	Mixed Logit
Δ Kaitz Index	1.941***	2.087***
	(0.500)	(0.600)
$(\Delta \text{ Kaitz Index})_{t-1}$	2.121***	2.084***
	(0.620)	(0.683)
$(\Delta \text{ Kaitz Index})_{t-2}$	1.699**	1.822**
	(0.788)	(0.785)
$(\Delta \text{ Kaitz Index})_{t-3}$	0.526	0.654
	(0.870)	(0.875)
Sex: Female		-0.289
		(0.209)
Nationality: Non-German		-1.352***
		(0.319)
Secondary Degree: Lower		1.271**
		(0.505)
Secondary Degree: Medium		3.066***
		(0.509)
$(\Delta \text{ State Unemployment Rate})_{t-1}$		0.0129
		(0.0557)
$(\Delta \text{ Number of Apprenticeship Places})_{t-1}$		-0.00539**
		(0.00222)
$(\Delta \text{ Relative Youth Cohort Size})_{t-1}$		-0.368*
		(0.215)
Constant	3.470***	1.239***
	(0.285)	(0.0365)
Random Individ. Error (Std. Dev.)	1.526***	1.129***
	(0.497)	(0.0559)
Observations	8,270	4,687
Year Effects	Yes	No

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

The positive minimum wage impact is stable. The coefficients for Kaitz differences in t and $t-1$ are significant on a 1% level and for $t-2$ on a 5% level. Notably, the structural time pattern is slightly altered in model (2) as the Kaitz difference in t yields the largest estimate. Due to the shorter periods of minimum use in sectors other than construction, the effects might be shifted towards the present.

As mentioned earlier, many sectoral minimum regulations are adapted to regions in order to take account of their economic differences. Therefore, a final analysis checks for a region-specific educational impact. Kaitz differences are interacted with an indicator

variable that equals 1 if an individual reports to live in East Germany. As displayed, the positive educational impact is robust to this sample variation, at least regarding the Kaitz differences in t and $t-1$.

Table 7: Regional Separation

Dep. Variable: Educational Status	(1) Mixed Logit
Δ Kaitz Index	0.796**
	(0.375)
$(\Delta$ Kaitz Index$)_{t-1}$	1.326**
	(0.555)
$(\Delta$ Kaitz Index$)_{t-2}$	0.841
	(0.696)
$(\Delta$ Kaitz Index$)_{t-3}$	0.0421
	(0.833)
Region: East Germany	1.566***
	(0.217)
Region: East Germany * Δ Kaitz Index	1.323*
	(0.721)
Region: East Germany * $(\Delta$ Kaitz Index$)_{t-1}$	1.433
	(0.944)
Region: East Germany * $(\Delta$ Kaitz Index$)_{t-2}$	2.186*
	(1.185)
Region: East Germany * $(\Delta$ Kaitz Index$)_{t-3}$	-0.0761
	(1.385)
Constant	2.978***
	(0.268)
Random Individ. Error (Std. Dev.)	1.237***
	(0.0366)
Observations	8,977
Year Effects	Yes

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Furthermore, the regional analysis reveals two interesting aspects. First, the apprenticeship probability of youths in East Germany is significantly higher compared to their West German counterparts. Second, the interaction terms yield positive estimates which are significant on a 10% level. Thus, a positive minimum wage impact emerges in both parts of the country whereas it is stronger in East Germany which potentially results from the relatively weaker macroeconomic conditions. Even though wage floors are adapted to regions, they still might affect the East German economy to a greater extent, thereby leading to a stronger decline in employment probabilities of unskilled workers and to

further training incentives. A second explanation might be regional disparities of educational preferences. If more school-leavers in West Germany favor university education, for example due to the fact that it is easier affordable for families there, the share of East German youths among apprentices is larger. Both of these arguments require further investigation which is beyond the scope of this paper.

6 Discussion and Conclusion

Contrasting with the empirical evidence from other countries, the effect of minimum wages on educational incentives in Germany is positive. We thereby confirm the result found in Kellermann (2017). As relative sectoral wage floors increase from $t-1$ to t, youths in the affected occupational groups are encouraged to undergo vocational training rather than entering the labor market as formally unskilled workers. The impact is stable to several model variations. Yet, minimum wages do not represent a strongly influencing factor of educational decisions. Given an average increase of a sectoral wage floor, the apprenticeship probability is raised by less than 0.5 percentage points. Even in case of strong, hypothetical reductions of relative minimum wages, the predicted apprenticeship probability still exceeds a value of 0.75 so that training decisions are not altered but rather confirmed by rising minimum wages. Although youths take account of wage prospects, these are not a crucial determinant of occupational decisions.

To explain these observations, we follow the argumentation of the Substitution Hypothesis. The educational effect of a wage floor raise is positive if the associated demand reduction for affected low-skilled workers outweighs the income effect induced by the higher minimum. As shown in figure 3, the predicted apprenticeship probability is relatively large, even in case of a sharp minimum wage reduction. This fits with what Eichhorst/Marx (2009) call the *institutional complementarity* of the German labor market. The design of employment relationships aims at particularly employing skilled workers in standard, permanent and full-time contracts (Eichhorst/Marx, 2009). Thus, with respect to training choices, the effect of a minimum wage raise on changing employment prospects is likely to outweigh the direct effect on income. It can be inferred that preferring vocational training over unskilled employment depends on other determinants. In light of the highly institutionalized and publicly regulated apprenticeship system in Germany, occupational skill standards and qualification requirements serve as an explanation.

The argumentation is underpinned by taking account of the required level of education as a control variable. Not only that the computed estimates are highly significant, they also cause larger effects than minimum wages. Hence, apprenticeship decisions are rather driven by educational standards and resulting employment prospects than by wage prospects. Furthermore, the observed impact of previously obtained secondary education support this idea. Individuals who signal higher abilities by means of higher school degrees are likelier to do an apprenticeship, probably because they are preferred by employers (Acemoglu/Pischke, 1998). Since apprenticeship payments are usually exogenous, firms are interested in offering training to the most apt youths only. This exactly corresponds to the Substitution Hypothesis. The higher are skill requirements and average qualifications in an occupational group, the lower is the job finding probability for the unskilled and the costlier is it to forego the accumulation of these skills.

Finally, the question of necessity of a youth exemption from the statutory minimum wage, which was raised at the beginning of the paper, can be answered. In principle, the positive minimum impact suggests that there is no need to exempt younger workers. However, the Substitution Hypothesis can again be used to provide an argument in favor of an exception. In case of a binding minimum wage, employers are unwilling to hire the affected workers. Thus, in response to a minimum wage applicability of youths, employers reduce the number of apprenticeship places. Being non-eligible on the contrary, youths might even benefit. Apprentices can legally be paid a subminimum which makes them more favorable than unskilled adults. Hence, employers face incentives to offer more apprenticeship places instead of standard jobs. Here, we can refer to the previous evidence by Neumark and Wascher (2004) and Pacheco and Cruickshank (2007) who found that below-minimum wages for youths increase their employment rate. An exemption of apprentices promotes the substitution behavior and vocational training.

Consequently, a youth exemption from minimum wages can still be classified as reasonable from a point of view of education policy in order to protect or even enhance opportunities for vocational training. However, if employers substitute low-skilled adult workers with apprentices, the exemption implies job losses among the latter. To accept these or to even purposely use the competitive advantage as a device to promote skill acquisition among youths appears at least questionable. In the end, the loss of apprenticeship opportunities is weighed against the loss of low-skilled employment when implementing a youth subminimum wage (Kellermann, 2017).

Yet, there are some shortcomings of our analysis that readers should be aware of. First, it refers to sectoral minimum wages which are specificly applied on the German labor market. It is still to prove whether the results can be generalized to all forms of wage floors. This point is of special importance since the youth exception discussed above is implemented for the new statutory minimum wage. Due to a higher degree of affection or spillover effects, educational incentives might be differently impacted by a general nation-wide minimum wage. In addition, as the observations are shaped by the idiosyncratic German system of vocational training, they might lack international generalizability. There is a need for internationally comparative research in order to verify our results.

Despite the contributions to the analysis of minimum wage analysis we made here, some questions are left unanswered. First, it might be worthwhile to investigate potential minimum wage impacts on the horizontal occupational decision, say, to answer the question whether youths prefer an occupation to which a sectoral wage floor applies over one that is unaffected by public intervention. Second, in order to give an appropriate recommendation concerning the question of necessity of a youth exemption, the impact of the statutory minimum wage on education decisions shall be scrutinized. If our result of a non-distorting educational effect is confirmed, a general eligibility would be preferable in order to avoid job losses among low-skilled adult workers. Yet, because of the short period of use, a qualitatively appropriate amount of data will only be available in a few years from now.

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A Dataset Description

Survey Year. Year under observation, 1994 to 2014.

Educational Status. Occupational alternatives for school-leavers aged 17 to 24 without higher secondary degrees or professional degrees, i. e. *Working Unskilled* (0), *Doing an Apprenticeship* (1).

Minimum Wage. Gross hourly generally binding sectoral or occupational minimum wage in € valid on January 1 of the respective year under observation.

State Median Wage. Median of gross hourly wages in € on federal state level. Represents the median of all workers' wages including part-time and marginally employed persons and apprentices.

Kaitz Index. Ratio of the sectoral minimum wage to the median wage in the individual's state of residence.

Sex. Indicator: Male (0), Female (1).

Nationality. Indicator: German (0), Non-German (1).

Secondary School Degree. Secondary school degree obtained by an individual excluding higher secondary degrees: No Degree (0), Lower Degree (1), Medium Degree or Other Degree (2).

Required Education for Occupation. Skill level required to carry out an individual's current occupation: *None* (1), *Orientation* (2), *Introduction* (3), *Course Training* (4), *Professional Training* (5), *Academic Training* (6).

Region of Residence. Indicator: West Germany (0), East Germany (1).

State Unemployment Rate. Number of registered unemployed persons in percent of civil employees on federal state level.

Number of Apprenticeship Places. Number of officially registered apprenticeship places in thousands on September 1 of the year under observation on national level.

Relative Youth Cohort Size. Number of youths aged 17 to 24 in percent of the population on national level.

B Addendum to the Regression Analysis

Table B.1: Association of Occupations with Minimum Wages

Label of Occupational Group	Codes FSO-1992-Classification
Agriculture, Gardening & Forestry	100-140, 200-243, 500-529, 600-629
Barbering	9010-9019
Building Cleaning	9340-9343, 9349
Butchery	400-4017
Care Nursing	8640-8657
Chimney Sweep Trades	8040-8042
Electrical Trades	3100-3152, 3157-3177, 3200-3229
Hard Coal Mining	700-727
Main Construction Trades	4000-4429, 4600-4889, 5440, 5446-5469
Laundry Services	9300-9359
Painting & Varnishing	5100-5149
Postal Services	7300-7354
Professional Education	8680-8682, 8769, 8855, 8856
Scaffolding	4430-4437
Security Services	7900-7912, 7920-7929
Stone Cutting	1000-1019
Textile Industry	3400-3619, 6733
Roofing	4880-4889
Waste Management	9350-9359

Table B.2: Baseline Collinearity Diagnostics

Variable	VIF	$\sqrt{VIF}$	Tolerance	R-squared
Educational Status	1.05	1.02	0.9542	0.0458
Δ Kaitz Index	1.08	1.04	0.9288	0.0712
Δ Kaitz Index$_{t-1}$	1.15	1.07	0.8707	0.1293
Δ Kaitz Index$_{t-2}$	1.14	1.07	0.8751	0.1249
Δ Kaitz Index$_{t-3}$	1.08	1.04	0.9254	0.0746
Sex	1.18	1.09	0.8455	0.1545
Nationality	1.06	1.03	0.9471	0.0529
Secondary School Degree	1.07	1.03	0.9343	0.0657
Δ State Unemployment Rate$_{t-1}$	1.03	1.02	0.9692	0.0308
Δ Number of Apprenticeship Places$_{t-1}$	1.12	1.06	0.8966	0.1034
Δ Relative Youth Cohort Size$_{t-1}$	1.04	1.02	0.9591	0.0409
Time	1.12	1.06	0.8928	0.1072
Economic Sector According to NACE	1.14	1.07	0.8747	0.1253
Mean VIF	1.10			

Table B.3: Cross-Correlation Diagnostics

Variables	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11
Educational Status (v1)	1.000										
(Δ Kaitz Index) (v2)	0.023	1.000									
(Δ Kaitz Index)$_{t-1}$ (v3)	0.046	-0.174	1.000								
(Δ Kaitz Index)$_{t-2}$(v4)	0.032	-0.053	-0.185	1.000							
(Δ Kaitz Index)$_{t-3}$(v5)	-0.019	-0.008	-0.075	-0.199	1.000						
Sex (v6)	-0.015	-0.095	-0.080	-0.059	-0.033	1.000					
Nationality (v7)	-0.159	-0.013	-0.024	-0.021	-0.002	-0.005	1.000				
Secondary School Degree (v8)	0.176	-0.030	0.009	0.012	-0.001	0.095	-0.149	1.000			
(Δ State Unemployment Rate)$_{t-1}$ (v9)	-0.028	-0.033	-0.016	-0.019	-0.010	0.002	0.021	-0.078	1.000		
(Δ Number of Apprenticeship Places)$_{t-1}$ (v10)	-0.023	0.023	0.016	-0.019	-0.001	-0.007	-0.006	-0.016	-0.161	1.000	
(Δ Relative Youth Cohort Size)$_{t-1}$ (v11)	0.003	0.004	0.114	-0.005	0.027	0.008	0.012	0.030	-0.192	0.098	1.000

Table B.4: Average Predicted Probabilities

Cut-Off Value	Average Prediction	
	Without Controls	With Controls
Δ Kaitz Index$_t$ = -1	0.8793018	0.8408154
Δ Kaitz Index$_t$ = -0.5	0.9317046	0.8890496
Δ Kaitz Index$_t$ = 0	0.962606	0.9246948
Δ Kaitz Index$_t$ = 0.5	0.9799292	0.9500976
Δ Kaitz Index$_t$ = 1	0.9893493	0.9676293
Δ Kaitz Index$_{t-1}$ = -1	0.781735	0.7480607
Δ Kaitz Index$_{t-1}$ = -0.5	0.9050284	0.8570644
Δ Kaitz Index$_{t-1}$ = 0	0.9628654	0.9253877
Δ Kaitz Index$_{t-1}$ = 0.5	0.9862093	0.9636856
Δ Kaitz Index$_{t-1}$ = 1	0.9949869	0.9832987
Δ Kaitz Index$_{t-2}$ = -1	0.8180558	0.769643
Δ Kaitz Index$_{t-2}$ = -0.5	0.9152427	0.8650432
Δ Kaitz Index$_{t-2}$ = 0	0.9634797	0.9263264
Δ Kaitz Index$_{t-2}$ = 0.5	0.9848813	0.9621259
Δ Kaitz Index$_{t-2}$ = 1	0.9938547	0.9814643

Figure B.1: Distribution of Occupations over Minimum Wage Sectors

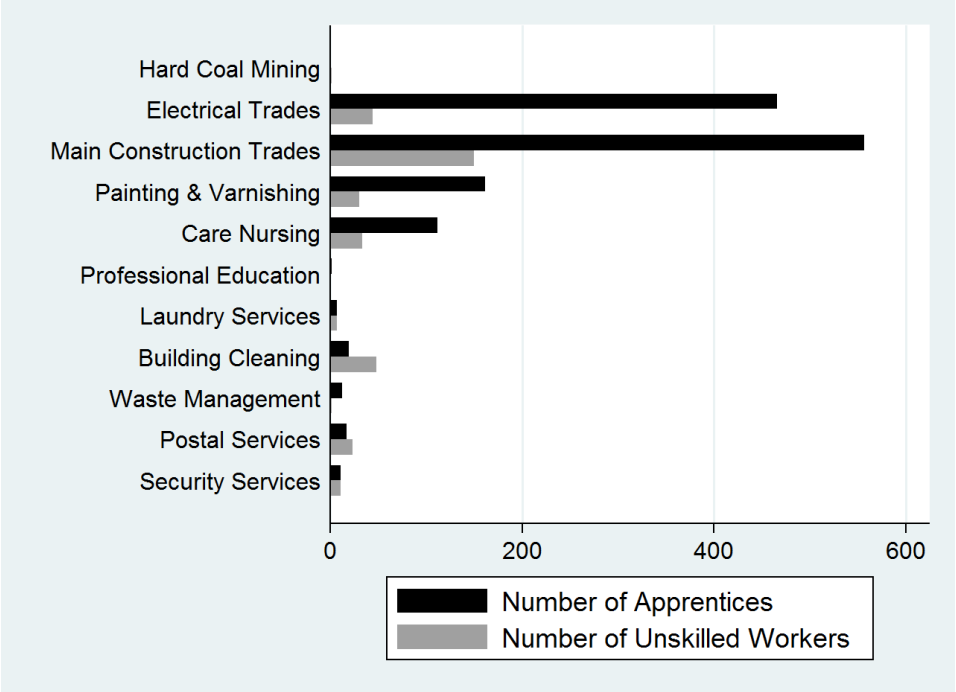


Figure B.2: Wages and Unemployment Rates over Federal States

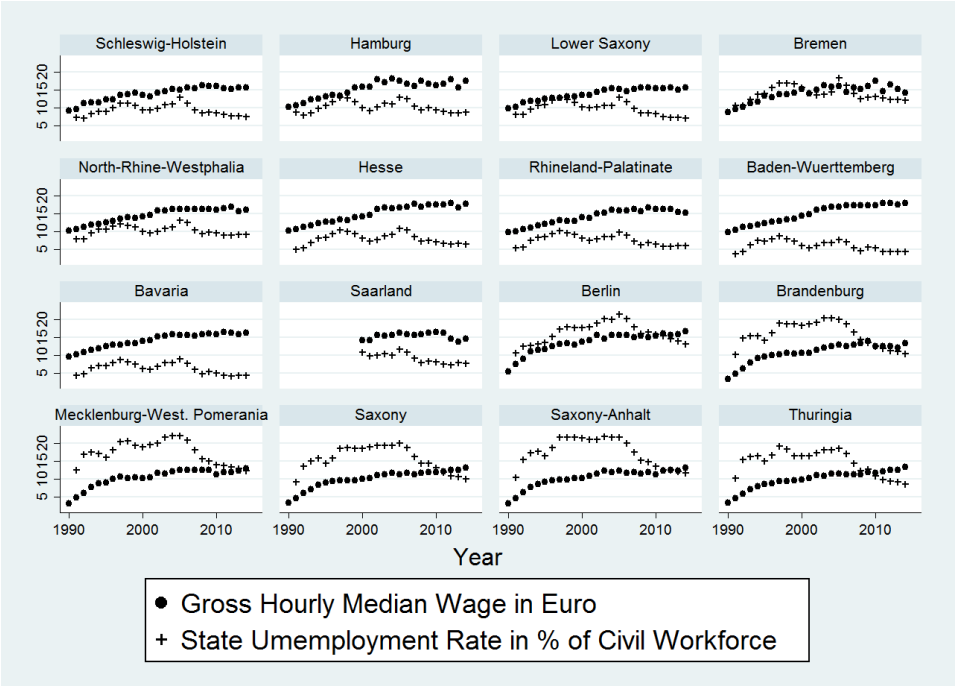
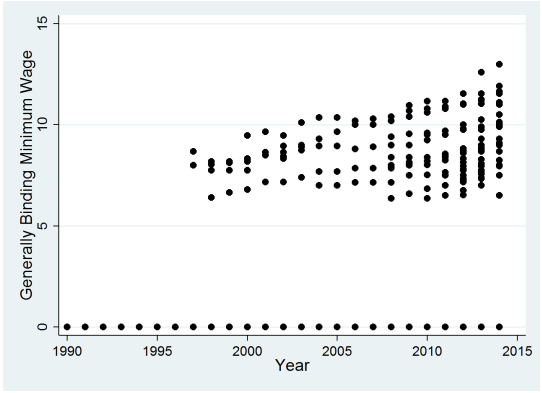
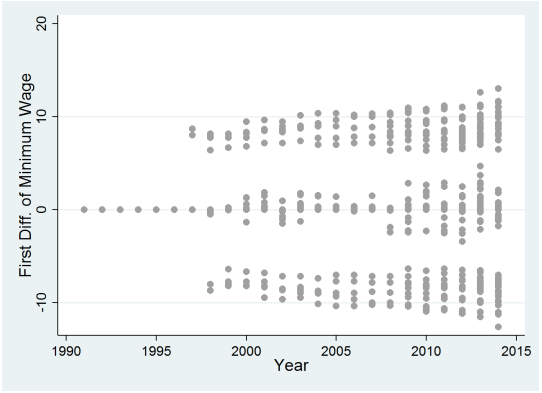


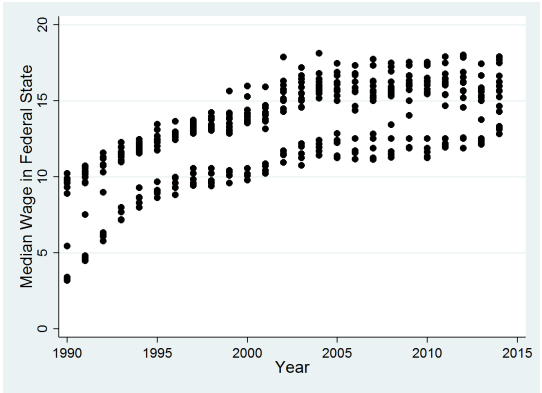
Figure B.3: Minimum Wages and State Median Wages, 1990-2014



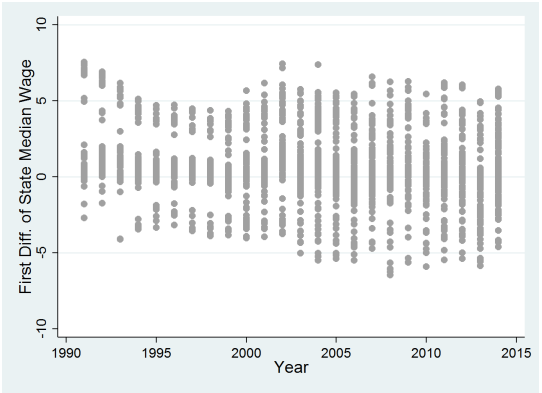
(a) Minimum Wage



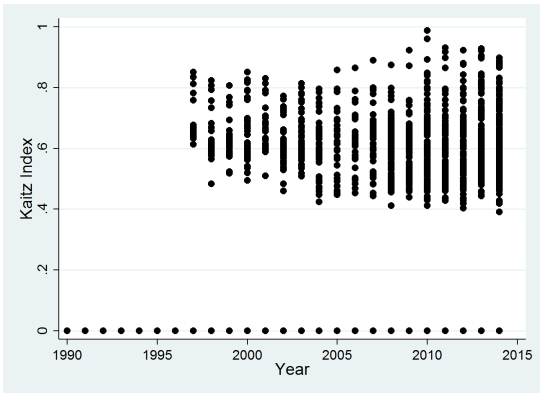
(b) Δ Minimum Wage



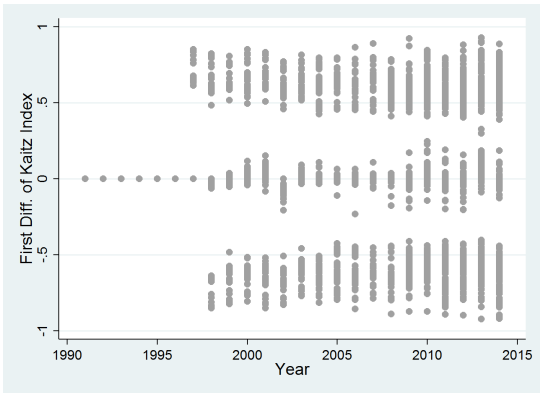
(c) State Median Wage



(d) Δ Median Wage



(e) Kaitz Index



(f) Δ Kaitz Index

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