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State-level heterogeneity in returns to secondary schooling in West Germany

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Abstract

This study focuses on the determinants of regional heterogeneity in returns to schooling. School quality, labor market characteristics, and amenities are potential determinants of regional differences. In contrast to previous research, this study jointly evaluates the contribution of the different mechanisms. I find that returns to schooling differ substantially across the West German states, and correlate mainly with institutional features of the school system. A strong positive association between qualitative differences (e.g., curricula contents or teachers' training) and returns to schooling shows that these qualitative aspects may be powerful policy instruments.

Keywords: Returns to schooling, state-level heterogeneity, school quality
JEL: I21, H52, J24

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1 Introduction

The return to education is the percentage wage increase resulting from investments in education (Becker; 1964; Mincer; 1974). International comparisons show that the rate of return to schooling correlates, e.g., with the level of economic development, average income, and the supply of education (see, e.g., Psacharopoulos and Patrinos; 2004). Consequently, returns to schooling are important indicators in international comparisons of school systems, education policies, and labor market characteristics (see, e.g., OECD; 2012). Also, returns to schooling are subject to remarkable regional heterogeneity: in 2008, the rate of the return to upper secondary education for men was 20.2% in the U.S. and 12.2% in the U.K.. In Germany, the rate was one of the lowest among OECD countries with 6.8% (OECD; 2012).

Interestingly, determinants of regional heterogeneity in returns to schooling are hardly studied even though they are of major economic relevance. Understanding mechanisms behind regional differences enhances transparency and thereby promotes government productivity, for example, by more targeted programs. A number of studies compare returns to schooling across countries, states or regions and draw conclusions about potential determinants of regional differences (see, e.g., Psacharopoulos and Patrinos; 2004; OECD; 2012). Previous literature finds that returns to education correlate, e.g., with school quality (Card and Krueger; 1992), unemployment rates (Ammermueller et al.; 2009), and labor market characteristics and regional amenities (Beeson; 1991). Overall, the literature distinguishes the effect of school quality, labor market characteristics, and regional amenities on returns to education. However, so far no study evaluates these potential determinants jointly and no study focuses on their relative contribution to regional differences in returns to schooling.

This paper contributes to the literature in two important ways: first, it is the first study that evaluates the relative contribution of different determinants (labor market characteristics, regional amenities, institutional features of school systems) to regional heterogeneity in returns to secondary schooling in Germany. Second, so far no other study investigates the school quality-earnings relationship in Germany. I exploit variation in returns to schooling, institutional features of school systems, and labor market characteristics across federal states but within the country. This mitigates the influence of confounding unobserved regional characteristics. I use five representative cross sections of the German work force for the empirical analysis.

The empirical strategy extends the two stage approach of Card and Krueger (1992): the first stage represents a Mincer wage equation estimated by ordinary least squares (OLS). The second stage of the estimation strategy uses estimated returns to schooling clustered by state, year of birth, and survey year as dependent variable. Independent variables comprise labor market characteristics, amenities and institutional features of the school system. Here, OLS estimates give correlations between returns to schooling and state characteristics. Cross-state variation in returns to schooling identifies the estimates, which are likely to understate the underlying relationship.

I find substantial variation in state-level returns to schooling. Estimates range from 6.7% in North Rhine-Westphalia to 8.5% in Bavaria. Also, mainly institutional features of the school system contribute to these differences (e.g., pupil-teacher ratios), whereas labor market characteristics and regional amenities correlate weakly with returns to schooling. Traditional school quality measures such as pupil-teacher ratios or spending per pupil measure financial differences between states. However, the states' school systems also differ in qualitative aspect (e.g., curricula contents, training of teachers). PISA test scores are likely to capture these qualitative differences. I consider individuals born between 1940 and 1980 in the main sample and relate their returns to schooling to PISA results of pupils born in the late 1980s. A robust positive relationship between PISA 2003 test scores and returns to schooling affirms an association between school quality and returns to schooling. The results show that the design of school systems (e.g., curricula contents) may be an even more powerful instrument to guide incentives for educational investments and enhance students achievement than are financial investments. Thus, the evaluation of state differences in returns to schooling and potential determinants provides insights to the efficient allocation of resources. However, the analysis also reveals the lack of high quality information on school performance and school quality in Germany.

2 Theory and literature

2.1 Potential mechanisms

At the individual level, education represents an investment in human capital and the human capital approach views those investments as enhancements of individual productivity (Becker; 1964; Mincer; 1974). In perfect labor markets improved productivity will result in higher wages.[1] In fact, most empirical studies show a strong positive correlation between formal education and wages.[2] Overall, correlation studies by, for example, Lauer and Steiner (2001) and Boockmann and Steiner (2006) show that the average return to an additional year of education ranges between 6 and 8% for Germany.

Regional heterogeneity in returns to schooling may arise through different mechanisms. One potential determinant is school quality. The individual stock of human capital comprises educational attainment, its quality, and other components (Heckman et al.; 1996b). If educational attainment itself affects the productivity of individuals, we expect that the quality of the acquired education affects earnings as well (Burtless; 1996). If higher school quality raises productivity of workers we expect higher returns to schooling. Thus, high school quality in the region where individuals were educated in the past, translates into high returns to schooling.

[1] This holds true in a labor market with perfect competition and without barriers. In contrast to human capital theory, the theories of signaling (Spence; 1973) and screening (Thurow; 1970) both assume that education does not necessarily increase individual productivity. Following this theory, formal education is a signal for inherent ability and productivity. Bedard (2001), Layard and Psacharopoulos (1974) or Jaeger and Page (1996) suggest that both theories are relevant. In line with the main literature on returns to education the human capital approach is the basis for interpretation in my study.

[2] The main issue discussed in the international literature is whether education itself causes the observed positive correlation between education and wages, or whether instead individuals with greater ability choose to acquire higher levels of education. The main focus lies on the estimation of the causal effect of education on individual wages. Ashenfelter et al. (1999) review the literature on (causal) returns to education. The authors find in line with economic theory that controlling for ability lowers the OLS estimates for the returns to education for studies in the United States. However, an upward bias of OLS results does not hold for studies using non-US data (Ashenfelter et al.; 1999).

Present characteristics of the region of residence affect returns to schooling as well. Here, the literature differentiates between a labor demand effect (e.g., high unemployment) and the effect of regional amenities (e.g., crime rate, child care institutions) (Roback; 1982).

The impacts of labor demand and regional amenities are closely related. Both work through the labor supply of skill groups. One can interpret the return to education as the price individuals get for their qualification. The higher the excess labor supply of a certain skill group, the lower the price this skill group receives (holding labor demand constant). Unfavorable labor market conditions such as high unemployment, i.e., excess labor supply, translate into lower skill prices (labor demand effect). Amenities affect the labor supply of skill groups in a certain region. Favorable conditions such as good infrastructure affect labor supply through a pull effect (see, e.g., Beeson; 1991). Especially the well educated, with high disposable incomes move to these regions and increase labor supply of this skill group and thereby lower skill prices for this skill group if labor demand remains constant (see, e.g., Beeson; 1991; Graves et al.; 1999; Black et al.; 2009; Krupka; 2009; Lee; 2010). In sum, we expect that state-level returns to schooling correlate with local labor market conditions. We expect that returns to schooling are low in desirable regions and in regions with excess labor supply.

2.2 Previous empirical findings

Empirical evidence on determinants of differences in returns to schooling by country, state, or region mainly concentrates on the U.S. with a few exceptions.

Findings for the school quality-earnings relationship are mixed (see Heckman et al.; 1996a; Card and Krueger; 1996). Omitted variables, misspecification of the underlying relationship, or the level of aggregation bias the results (Hanushek; 1997).[3] Card and Krueger (1992) study U.S. data and find a positive association of school quality (measured by pupil-teacher ratio, term length, relative teacher wage) and returns to schooling.

[3] See Card and Krueger (1996) for a detailed summary of previous findings.

The authors identify the correlations based on variation between the state of school attendance and the state of residence. Contradictory, Betts (1995) finds hardly any impact of school quality measures (e.g., percentage of teachers with master's degree) on returns to schooling using a similar identification strategy (see also Hanushek; 1997). Heckman et al. (1996b) affirm the impact of school quality (pupil-teacher ratio, term length, relative teacher wage) mainly for the return to college education. In line, Altonji and Dunn (1996) show a positive association of school quality (e.g., pupil-teacher ratio, expenditures per student) and wages in the U.S. using siblings correlation for identification. Harmon and Walker (2000) exploit a schooling reform in England and Wales and find only small effects of school quality on wages. For Germany, no study so far analyses the classical school quality measures. A related study of Baumgartner (2004) focuses on the relationship between class size and early career earnings and uses German district data. The author finds only a weak association.

Research on the relationship between labor market characteristics and returns to schooling usually finds the expected patterns. Beeson (1991) shows, based on OLS results, that amenities and labor demand are important but cannot fully account for regional differences in returns to schooling across U.S. metropolitan statistical areas (SMSA). Ammermueller et al. (2009) find a significant negative association between returns to schooling and aggregated unemployment rates in Germany. In contrast, Reilich (2013) finds predominantly homogeneous returns to schooling by German state which correlate positively with unemployment rates. Also, results of Reilich (2013) underpin the role of regional amenities as she finds a negative relationship between returns to schooling and land costs. Psacharopoulos and Patrinos (2004) survey estimated returns to schooling for about 70 countries and investigate potential patterns. The authors show that returns to schooling decrease with increasing average income. Overall, measures of labor demand conditions comprise, e.g., unemployment rates, shares of workers in a specific industry, or population density (see Hanushek; 1981). Some indicators, e.g., population density, alternatively constitute indicators for amenities (Beeson; 1991). Crime rates, recreational and health facilities, or the number of heating or cloudy days exemplify other typical measures for local amenities (see, e.g., Roback; 1982; Beeson; 1991).

3 Institutional background and school quality

The German secondary school system is a tripartite system that sorts students at the age of 10 into three school tracks: basic school (*Hauptschule*), middle school (*Realschule*), and high school (*Gymnasium*). These tracks prepare for different occupational careers. Basic school lasts for 5-6 years (depending on the state) and prepares for apprenticeship training and vocational schools. Middle school lasts 6 years and prepares for training in white-collar jobs. High school lasts 8-9 years and prepares for university attendance and academic careers.[4]

Because each German state governs its school system independently, substantial differences between state school systems arise and contribute to differences, for example, in school quality (Pluennecke et al.; 2007). Examination modes in high school (centralized exams at state level vs. school level exams)(van Ackeren and Klemm; 2009), the supply of comprehensive schools (Woessmann; 2010), and curricula contents (Rösner; 1999) exemplify differences between school systems. Here, qualitative differences such as curricula contents or the training of teachers may be of importance for labor market outcomes, but are difficult to quantify.

Another important difference between school systems is the organization of tracking. In general, student ability determines tracking after primary school. However, the organization of the transition to secondary school tracks differs between states (KMK; 2010a). Some states (e.g., Bavaria) rest on primary school grades to screen students' ability and require specific grade averages for the access to middle and high school. In other states, regulations are more flexible and parents decide on track choice (e.g., in Bremen) or the

[4]Additionally, students in all states can attend comprehensive schools without any tracking. Comprehensive schools are not very common in West Germany. In fact, in 1996/97 the share of students attending comprehensive schools reached only 8.7% in West Germany (Rösner; 1999). See Ertl and Phillips (2000) for further discussion.

decision lies with the parents but teachers give a recommendation (KMK; 2010b). Overall, different requirements for the transition to secondary school tracks may have different potential consequences for the distribution of students across and within states: first, selective states may exhibit low shares of high school students if we assume that ability is uniformly distributed across states. Second, high school students in selective states may have higher average ability. Third, labor supply of high school graduates may be lower in selective states if individuals work in the state where they are educated.

4 Empirical approach

4.1 Method

I examine potential determinants of regional heterogeneity in returns to schooling following the two step procedure of Card and Krueger (1992). In the first step, the authors estimate returns to schooling by U.S. state and birth cohort by OLS. In a second OLS estimation the authors explain differences in returns to education by school quality measures. Thus, instead of including interactions of schooling and state characteristics in one equation, they prefer two steps. Card and Krueger (1992) argue that the two step procedure has important advantages: first, it simplifies the interpretation of patterns in returns to schooling. Second, the two step estimation allows them to exploit the contribution of state characteristics to differences in state-level returns to schooling (see also Beeson; 1991). In the approach of Card and Krueger (1992), individuals who are born in a specific state and moved to another state identify the impact of school quality. I cannot follow their strategy because of low regional mobility among German workers (Harhoff and Kane; 1997; Huber; 2004; Machin et al.; 2012). Instead, I assume that individuals still live where they went to school. Thus, cross-state variation in returns to schooling identifies the determinants of regional differences. Section 4.2 discusses potential consequences of the modification of the approach of Card and Krueger (1992).

The first stage estimates returns to schooling by OLS and uses the following earnings equation:

$$\ln w_{ijtc} = \delta_1\, \textit{state}_j + \delta_2\, \textit{cohort}_c + \beta_{jtc}\, S_i(\textit{state}_j, \textit{cohort}_c, \textit{year}_t) + \delta_3 Z_i + \epsilon_{ijtc}. \quad (1)$$

The dependent variable is the logarithm of the gross hourly wage w_{ijtc} of individual *i*, living in state *j*, surveyed at time *t*, and born in year *c*. Variables $\textit{state}_j$ and $\textit{cohort}_c$ represent state and cohort fixed effects. S_{ijtc} measures the individual's secondary schooling, for example, years of secondary schooling.[5] I assume the return to schooling β_{jtc} to consist of three components: a state effect, year of birth effect, and a survey year effect.[6] Z_i represents additional controls for age and gender. ϵ_{ijtc} is an error term.

From OLS results of equation (1) I calculate the marginal effect of schooling on wages for clusters of state, cohort, and survey year. Thus, I construct returns to schooling β_{jtc} for each group of individuals born in year *c*, living in state *j* at time *t*. In the second step of the analysis, I relate returns to schooling β_{jtc} to characteristics of German states:

$$\beta_{jtc} = \alpha_1 q_{jc} + \alpha_2 a_{jt} + \alpha_3 d_{jt} + \alpha_4\, year_j + \alpha_5\, cohort_c + u_{jtc}. \quad (2)$$

The vector q_{jc} contains controls for institutional features of the school system and school quality that affected birth cohort *c* in state *j*. The vector a_{jt} controls for amenities and d_{jt} for labor market conditions in state *j* at time *t*. The estimates of α_1, α_2, and α_3 measure the correlations between school quality, labor market characteristics, amenities, and returns to schooling. u_{jtc} is an error term. Returns to schooling β_{jtc} vary by state, birth cohort, and survey year. As I aim to explain differences across states, I include cohort and survey year fixed effects in the second equation. These fixed effects capture cohort and time trends which may also correlate with state characteristics. Thus, the estimates α_1, α_2, and α_3 are identified by cross-state variation and show the contribution of state

[5] Because linearity may be an inappropriate assumption in a tracked school system, I also use a specification with indicator variables for school degrees.

[6] Using three components contrasts to Card and Krueger (1992) who concentrate only on state and cohorts effects. An additional survey year effect accounts, for example, for labor market conditions.

characteristics to state differences in returns to schooling.

4.2 Potential Biases

As I estimate equation (1) by OLS unobserved characteristics such as ability are likely to violate the conditional mean independence assumption and bias returns to schooling upwards.[7] Ability bias affects the estimates α_1, α_2, and α_3 in equation (2) if it varies systematically by state and correlates with state characteristics. As some states are more restrictive in the transition to secondary school tracks it is rather strong to assume that ability bias is regionally homogeneous. Further, control variables such as PISA scores may reflect regional differences in ability especially if I use track specific scores. However, an important advantage of the two step procedure is that I am able to control for selectivity of school tracks in the second stage of the estimation. The share of high school graduates potentially reflect average ability in high school and controlling for it mitigates biases because of omitted ability.

In equation (1), I assume that individuals are regionally immobile. Regional mobility may affect the results if mobility varies across states and mobility is correlated with state characteristics. Mobility across states is likely to be higher for smaller city states. Also, regional labor market characteristics are likely to be correlated with mobility and should even equalize regional returns to schooling in the long run. Consequently, results for regional amenities and labor market characteristics might be systematically biased. However, school quality characteristics are potentially not or only weakly correlated with mobility after graduation and lead to an attenuation bias.

Overall, regional mobility is on a such a low level in Germany that it potentially imposes minor consequences. In fact, Harhoff and Kane (1997) finds that 80% of West German workers never move within or across state during their working life. Also, Huber (2004) reports a gross mobility rate of 1.32. Thus, only 1.32% of the German population

[7] Card (1999) shows that returns to schooling are upward biased by omitting ability and individual heterogeneity. Nonetheless, no other method is applicable here: instrumental variable estimations require valid instruments, which are not available in my data.

moves across states within a year. Furthermore, the author finds that the rate decreased during the 1980s.[8] Given this low regional mobility, the mentioned biases should reveal minor consequences for the estimates. As a robustness check, I restrict the sample to men who are usually less regionally mobile, excluded all individuals who ever moved during their working life, and excluded city states with potentially higher mobility (Hunt; 2004).[9] The results underpin that regional mobility does not affect the results and main conclusions hold.

I am able to control for differences in ability bias across states and regional mobility is likely to lead to an attenuation bias. Thus, consequences from regional mobility and ability bias are very limited and estimates may represent a lower bound of the causal effect. Unfortunately, a threat to internal validity is the scarcity of high-quality state-level data and multicollinearity in the second stage of the estimation. Consequently, aggregated control variables such as unemployment rates may capture a whole set of business cycle characteristics and estimates represent correlations. However, as the main aim of the paper is the evaluation of the contribution of variable sets (labor demand, regional amenities, school quality) omitted variables do not weaken the main conclusions.

5 Data and variables

This analysis exploits five repeated cross sections of the Qualification and Career Survey (QaC), which provides large sample sizes in total and for each federal (West) German state. Each wave is a 0.1% representative cross section of the German labor force (i.e., blue and white-collar workers, civil servants, self employed) and covers the entire income distribution (Dostal and Jansen; 2002). The data provide detailed information about individuals' socio economic background and formal education. Each of the five waves of years 1979, 1985/86, 1991/92, 1998/99, and 2005/06 contains up to 35,000 observations.

[8] I also analyzed official statistics on across state migration from the federal statistical office. The statistics support that since the 1950s constantly only about 3% of individuals move across states.

[9] Results without individuals who ever moved during working life and results without city states are available upon request.

I pool all cross sections and restrict the sample to employed West German natives born between 1940 and 1980 and aged between 16 and 60 years at the time of the interview.[10] I drop observations with missing values in the schooling or in the income variable (13%).[11] The final sample comprises 70,474 observations.

I construct the hourly wage using information about monthly labor earnings.[12] The QaC provides detailed information about the acquired secondary and post-secondary degrees. I build the variable "Years of Schooling" using standard durations for graduation in secondary school tracks (Krueger and Pischke; 1995). In a tracked system years of schooling may differently affect wages depending on the attended track. In a second, more flexible specification, I replace the variable "Years of Schooling" by indicators for the highest secondary degree achieved. The three categories are: basic degree (reference)[13], middle degree, and high school degree.

The data used for control variables in the second stage are provided mainly by the Federal Bureau of Statistics (1952-2006). Table 1 describes control variables included in the second stage of the estimation. The first part shows controls capturing institutional features of the school system. One of the *traditional* measures for school quality is the pupil-teacher ratio by state and *year of birth+10* (see, e.g., Card and Krueger; 1992).[14] Thus, I assume that the pupil-teacher ratio matters for the quality of education of 10 years old pupils. Additionally, I use spending per pupil (see, e.g., Altonji and Dunn; 1996) and include the share of high school students to control for the selectivity of transition mechanisms to secondary school tracks. All school quality measures are aggregated at the state and year of birth level and capture mainly financial differences between states. As pointed out in Section 3, other factors such as the training of teachers or curricula contents differ

[10]East Germany is of interest as well. However, the East German school system differed during the communist regime and one cannot easily compare school degrees (Riphahn and Trübswetter; 2013).

[11]In the distribution of qualifications of the dropped individuals, high and low educated individuals are over represented. Missing values are uniformly distributed across the federal states.

[12]The earnings variable is measured in classes. Following Pischke and von Wachter (2008) I set earnings to the class midpoints (see details in their discussion paper version).

[13]The reference category also entails drop-outs (1.5% of individuals in the data set). Excluding them from the analysis gives the same results.

[14]Pupil-teacher ratios entail primary and secondary school pupils and teacher.

across states. As these are difficult to quantify I include test results of the *Programme for International Student Assessment* (PISA) by state in a second specification.[15] I use PISA math scores from 2003, so the underlying population of the PISA tests and the main sample is different with respect to year of birth. The main sample entails individuals born 1940-1980. Pupils participating in PISA 2003 are born in the late 1980s.[16] PISA test scores capture qualitative differences in school systems across states and reflect school quality for individuals in the main sample if older cohorts faced similar conditions. As PISA results may also be an outcome of returns to education of the students' parents or a measure of average state ability, PISA scores suffer from reverse causality. However, no better measure for qualitative differences in school quality is available so far.

The second part of Table 1 displays means of variables capturing cultural and labor market conditions in the state of residence at the time of the interview. Whereas crime rate and GDP per capita control for local amenities, population density reflects both, labor demand conditions and amenities (see, e.g., Beeson; 1991). The share of workers in the manufacturing sector and the unemployment rate control for labor demand differences between states (see, e.g., Hanushek; 1981).

6 Empirical results

6.1 Descriptive evidence and first stage results

Table 2 shows state averages and standard deviations of log wage and years of secondary schooling. Additionally, I calculate the share of graduates by school leaving certificate, unemployment rates, and pupil-teacher ratios. Shaded cells represent minimum and maximum values within one column. The differences in years of schooling and shares of

[15] The OECD conducts PISA and provides representative and comparable data about basic competences of students from the OECD countries (PISA-Konsortium Deutschland; 2002). An extension of the international survey, the PISA-E survey, ensures representative sampling also within each German state.

[16] PISA tests always put special attention on one subject (reading, science, or mathematics). Whereas PISA 2000 focused on reading scores, the main focus of PISA 2003 was mathematics (PISA-Konsortium Deutschland; 2005).

graduates are most striking. Differences in years of schooling (column 2) reach 0.57 years with 10.5 years (highest) in Hamburg and 9.73 years (lowest) in Bavaria. The share of basic school graduates varies between 36% (Hamburg) and 55% (Saarland); the shares of middle school (column 4) and high school graduates (column 5) vary as well. However, variation in schooling and differences in log wages are not obviously related (column 1). As previously mentioned, selective transitions to high school translate into low shares of high school graduate and vise versa. The descriptive evidence supports this pattern as Bavaria is most restrictive in the transition to secondary school tracks and has lowest shares of high school graduates. The last columns provide average unemployment rates, population densities, and pupil-teacher ratios.

Table A.1 in the Appendix presents the results of two first stage estimations where I regress log wages on interactions between state and schooling and a rich set of covariates. To measure schooling, I use years of schooling in the first estimation (column 1) and more flexible indicators for school leaving certificates in the second estimation (column 2). The statistical significance of the state and schooling interactions in Table A.1 already show state-level heterogeneity in returns to schooling. Based on the first stage regression I calculate returns to schooling for 1,685 cluster of *state* $\times$ *year of birth* $\times$ *year of survey*. Table 3 shows state-level average returns to schooling of these clusters and the corresponding ranks.[17] The average return to an additional year of schooling in West Germany (column 1) ranges between 6.7 (North Rhine-Westphalia) and 8.5% (Bavaria) and is comparable to previous findings (e.g., Lauer and Steiner; 2001; Boockmann and Steiner; 2006). As the assumption of a linear relationship between schooling and wages is restrictive, especially in a tripartite school system, the model specification in columns 2 and 3 use an indicator-based definition of schooling. Table 3 gives the percentage wage increase after graduation from middle (column 2) or high school (column 3) compared to basic school graduates. The average return to middle degree compared to basic degree (column 2) ranges between 11.4 and 21.1% and the return to high school degree (column

[17] In order to save space I do not present average returns to schooling by state, cohort, and year of survey. Results are available upon request.

3) lies between 33.1 and 43.6% (see Dustmann (2004) for comparable results). The last columns gives the number of clusters of survey year and cohort in each state and again the share of high school graduates.

The estimates vary across German states. Whereas Bavaria is in the upper third of the ranking regardless of the education variable, Saarland consistently ranks 9th. For the other states the results are mixed. If the return to one of the degrees is high, also returns to years of schooling are in an upper range (see, e.g., Bremen). Interestingly, the return to high school degree and the corresponding shares of graduates are related. I observe high shares of high school graduates in Hamburg and low returns to high school degrees. In Bavaria I find the reversed pattern. Apparently, the share of high school graduates captures differences in transition mechanisms to high school and reflects the selectivity of school systems and ability in high school. The lower the share of high school students, the higher is average ability, and ability bias in returns to schooling. Thus, the negative relationship of returns to schooling and the share of graduates underpins an upward bias in returns to schooling. Also, it supports that the share of graduates captures ability bias. Consequently, controlling for the share of high school graduates in the second stage of the estimation limits potential consequences of ability bias for second stage estimates.

6.2 Second stage results

The second stage of the estimation relates returns to schooling to measures for the states' labor market conditions and institutional features. Table 4 presents the key results for the second stage of the estimation. The columns present results from regressions where the dependent variables are returns to years of schooling (columns 1 and 2), middle degree with reference basic degree (columns 3 and 4), and high school degree with reference basic degree (columns 5 and 6). For each dependent variable, I estimate two specifications: one controlling for labor market characteristics (estimates given in panel A) only and one where I also include institutional features (panel B). Each specification also comprises cohort fixed effects and year of survey fixed effects to capture cohort trends (e.g., educational expansion) and year effects (e.g., inflation). Thus, only cross-state variation in returns to schooling identifies estimates in the second stage. As the estimation procedure involves two estimation steps, I calculate standard errors by a bootstrap algorithm that estimates first and second stage jointly (200 replications).

Panel A shows correlations between labor market conditions and returns to schooling. The estimates for the share of workers in manufacturing and population density show the expected negative sign. Only for the population density the estimates are precisely estimated. The higher the population density, the lower the returns to schooling. This result underpins the hypothesis that higher labor supply leads to lower skill prices.[18] Surprisingly, I find a positive relationship between crime rates and returns to high school degree. However, one may attribute this finding to reverse causality. The other labor market characteristics are only weakly correlated with returns to schooling. Estimates are imprecise because state characteristics are highly collinear.[19]

Panel B in Table 4 gives the results when I add controls for institutional features of the school system. As expected, the number of pupils per teacher correlates negatively with returns to schooling. However, this relationship is significant only for returns to years of schooling. The size of the estimate is comparable to that in studies for the U.S. (e.g., Card and Krueger; 1992). Log spending per pupil is not significantly related to returns to schooling.

The share of high school students reflects regional labor supply of high qualified individuals and average ability in school tracks. The correlation between shares of high school graduates and returns to high school degree is significantly negative. This negative relationship suggests that omitted ability biases OLS estimates of returns to schooling upwards. Also, the negative relationship suggests that returns to high school degree are low where the labor supply of high qualified individuals is high.

In sum, state characteristics measuring labor supply (unemployment, share of work-

[18]Population density is especially high in the city states Hamburg and Bremen. The results are robust to the exclusion of the city states. Results are available upon request.

[19]Here, I use crime rate as a measure for regional amenities. In other specifications I also used spending for recreation and average rent. I did not find a significant relationship. Results are available upon request.

ers in manufacturing) are negatively correlated with returns to schooling. This negative relationship supports the labor demand hypothesis. The relationship between returns to schooling and regional amenities is inconclusive, for example, crime rates are positively related to returns to schooling. However, the correlation is hardly significant and reverse causality potentially causes the positive correlation. When I include measures for institutional features of the school system, I find evidence for a negative correlation of the pupil-teacher ratio (support for school quality hypothesis) and a negative relationship between the share of high school graduates and returns to schooling.

6.3 Qualitative differences across state school systems

The results in Table 4 show that especially institutional features of the school system correlate with state-level returns to schooling. As discussed earlier, the German school system differs also in qualitative aspects.

PISA results of German students vary substantially by state, correlate with institutional features of the school system (Woessmann; 2010), and may reflect differences in school quality (Pluennecke et al.; 2007). In Table 5 I include state-level PISA math results from 2003 in the second step regression (equation 2) to capture qualitative differences across state school systems.

The last line in panel B of Table 5 gives the relationship between PISA scores in math in 2003 and returns to schooling. I find a highly significant positive relationship especially between returns to high school degree and PISA. The significant relationship between the share of high school students and returns to schooling remains unchanged. The inclusion of PISA test scores decreases the coefficient of pupil-teacher ratios in magnitude and precision. Thus, PISA scores correlate with both, returns to schooling and traditional school quality measures.

The correlation of PISA scores and returns to schooling on the one hand, and the correlation with pupil-teacher ratio on the other support the argument that PISA scores measure school quality. However, the question remains whether PISA scores correlate with returns to schooling because of reverse causality (e.g., because students in PISA show more effort in certain states because they expect higher returns to schooling such as their parents). Unfortunately, because of a lack of detailed data I cannot test which mechanism lies behind the results.

7 Robustness

The basic sample uses men and women born between 1940 and 1980. The changing role of women in education and the labor market in this period may affect my results. Additionally, women are typically more regionally mobile then men (Hunt; 2006). As regional mobility potentially leads to an attenuation bias, I expect more pronounced estimates in a male subsample.

Table 6 gives results for men only. Here, I give one specification with and one without including PISA scores. The sample size reduces to 40,775 men in the first stage and remains at 1685 clusters in the second stage of the estimation. The results underpin my baseline results. Here, estimates for the relationship of amenities and labor demand and returns to schooling are no longer significant though similar in signs. The findings for institutional features are robust to the change in sample selection criteria. The correlation between pupil-teacher ratio and returns to schooling is significant at least at the 10% level for all schooling variables in a specification without PISA scores. The positive and significant correlation supports the school quality hypothesis. The inclusion of PISA test scores also affects the results in this subsample. The correlation with PISA scores is again especially pronounced for high school. The pupil-teacher ratio coefficient decreases and is no longer significant once I control for PISA scores.

Table 7 gives results when I use PISA 2000 reading scores instead of the 2003 math scores. Before PISA 2003 states had the opportunity to compare their performance in the 2000 tests to each other and react accordingly. Before 2000 such detailed information on student performance by state was not available. Thus, my results with 2003 scores might be downward biased if states with low school quality reacted to their bad results. For the 2000 scores we expect a more pronounced relationship between PISA and returns to schooling. Unfortunately, for 2000 PISA scores are not available for Hamburg and I have to exclude the state and reduce the sample size. However, Table 7 shows a more pronounced relationship between PISA scores and returns to schooling. Thus, the main results are robust to that change and the robustness check supports the hypothesis that PISA reflects school quality and that school quality affects individuals' labor market outcomes.

8 Conclusions

Returns to schooling constitute important indicators in the comparison of school systems and labor markets; they are systematically related to economic development, average income, and supply of education (Psacharopoulos and Patrinos; 2004). Many studies focus on cross-country differences in returns to education (see, e.g., OECD; 2012). However, because of unobserved country characteristics the analysis of potential determinants of regional heterogeneity in returns to schooling, for example, labor market characteristics and institutional features, is difficult. Following the strategy of Woessmann (2010) this paper uses Germany as a microcosm for regional differences in an international context. This paper studies determinants of state-level heterogeneity in returns to secondary schooling in Germany.

Institutional features of the school system, labor market characteristics such as unemployment rates, or regional amenities constitute potential determinants of differences in returns to schooling. Whereas institutions might affect returns to schooling through the quality of education (see, e.g., Card and Krueger; 1992), characteristics of the region of residence affect returns to schooling through regional amenities or through the labor supply/demand of/for certain skill groups (see, e.g., Beeson; 1991).

To evaluate potential determinants of state-level heterogeneity in returns to schooling, my empirical strategy extends the two step procedure of Card and Krueger (1992). In the first step, I estimate a Mincer wage regression where I assume the return to schooling to consist of a state, cohort, and a year of survey component. On the basis of this first regression I calculate returns to schooling for 1,685 clusters of state, survey year, and year of birth. In the second step I regress clustered returns to schooling on state characteristics.

My findings imply that institutional features of the school systems are more important in the explanation of differences in returns to schooling than labor market conditions. I find a positive relationship between school quality (measured by pupil-teacher ratios) and the selectivity of school systems and returns to schooling. Furthermore, returns to schooling of individuals born 1940-1980 are strongly positively related to PISA test scores of pupils born in the late 1980s. Although reverse causality might generate the positive correlation, it is also plausible that qualitative differences between school systems (e.g., curricula contents) affect returns to schooling.

Educational policy, education spending, and the design of the school system are important policy instruments. My findings show that characteristics of school systems are highly correlated with individuals' later labor market outcomes and suggest that qualitative inputs to the education system such as curricula contents may be more important than financial inputs.

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Table 1: Description, aggregation level, and source of aggregated control variables

	Variable (1)	**Mean (Sd.)** (2)	**Min.** (3)	**Max.** (4)	**Description** (5)	**Aggregation level** (6)	**Source** (7)
Institutional Features	Pupil-teacher ratio	0.28 (0.09)	0.11	0.61	Pupil-teacher Ratio ÷ 100	State × Birth cohort	Federal statistical office, *Statistische Jahrbücher*
	Log Spending / pupil	0.57 (0.87)	-1.55	2.33	Logarithm of educational spending per pupil	state × Birth cohort	Federal statistical office, *Statistische Jahrbücher*
	Share high school	0.23 (0.17)	0.00	1.00	Share of high school graduates	Survey year × state × Birth cohort	QaC
	PISA math 2003	4.96 (0.16)	4.71	5.33	State averages of PISA 2003 math scores ÷ 100	State	PISA-Konsortium Deutschland (2005)
	PISA reading 2000	4.82 (0.16)	4.48	5.10	State averages of PISA 2000 reading scores ÷ 100	State	PISA-Konsortium Deutschland (2002)
Amenities and Demand	Population Density	0.60 (0.69)	0.15	2.31	Number of inhabitants per square meter ÷ 1000	Survey year × state	Federal statistical office, *Statistische Jahrbücher*
	Share in manufacturing	0.32 (0.09)	0.15	0.52	Share of workers in sector manufacturing	Survey year × state	Federal statistical office, *Statistische Jahrbücher*
	Unemployment	9.12 (3.45)	2.10	16.60	Unemployment rate in percent	Survey year × state	Federal Employment Agency (2009)
	Crime rate	11.21 (1.54)	7.66	15.19	Number of convictions per capita × 1000	Survey year × state	Federal statistical office, *Statistische Jahrbücher*
	Log GDP	11.43 (1.04)	9.23	13.13	Logarithm of GDP per capita in EUR	Survey year × state	Federal statistical office, *Statistische Jahrbücher*

Note: Standard deviations in parentheses. Own calculations.

Table 2: Descriptive statistics for the German states

State	Log wage	Years of schooling	Share of graduates by degree: Basic degree	Middle degree	High school degree	Unemployment rate	Population Density	Pupil-teacher ratio /100	Observations
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Schleswig-Holstein	2.820	10.040	0.472	0.339	0.190	8.768	0.170	0.288	3160
	(0.563)	(1.434)	(0.499)	(0.473)	(0.392)	(2.763)	(0.006)	(0.083)	
Hamburg	2.839	10.517	0.366	0.325	0.309	9.923	2.206	0.256	1912
	(0.571)	(1.632)	(0.482)	(0.469)	(0.462)	(3.775)	(0.070)	(0.068)	
Lower Saxony	2.828	9.966	0.476	0.321	0.203	9.628	0.159	0.298	8623
	(0.585)	(1.577)	(0.499)	(0.467)	(0.402)	(2.982)	(0.007)	(0.101)	
Bremen	2.789	10.159	0.441	0.318	0.241	12.013	1.673	0.259	1031
	(0.551)	(1.573)	(0.497)	(0.466)	(0.428)	(4.838)	(0.036)	(0.069)	
North Rhine-Westphalia	2.877	10.039	0.468	0.265	0.266	9.689	0.511	0.322	20295
	(0.560)	(1.784)	(0.499)	(0.441)	(0.442)	(2.755)	(0.016)	(0.089)	
Hesse	2.856	9.970	0.443	0.327	0.229	6.859	0.274	0.295	6422
	(0.569)	(1.727)	(0.497)	(0.469)	(0.420)	(2.837)	(0.011)	(0.080)	
Rhineland-Palatinate	2.815	9.747	0.542	0.267	0.191	7.203	0.192	0.307	4464
	(0.593)	(1.646)	(0.498)	(0.442)	(0.393)	(2.270)	(0.009)	(0.082)	
Baden-Wurttemberg	2.898	9.950	0.473	0.301	0.226	6.035	0.278	0.289	10258
	(0.552)	(1.705)	(0.499)	(0.459)	(0.418)	(1.719)	(0.017)	(0.085)	
Bavaria	2.811	9.734	0.533	0.281	0.186	8.148	0.164	0.287	12937
	(0.580)	(1.638)	(0.499)	(0.450)	(0.389)	(2.900)	(0.009)	(0.069)	
Saarland	2.775	9.903	0.551	0.231	0.218	7.561	0.414	0.305	1347
	(0.609)	(1.614)	(0.498)	(0.422)	(0.413)	(3.954)	(0.005)	(0.071)	
West Germany	2.849	9.948	0.483	0.291	0.226	8.409	0.374	0.300	70449
	(0.571)	(1.689)	(0.500)	(0.454)	(0.418)	(3.122)	(0.376)	(0.086)	

Note: State specific means and standard deviations in parentheses. Hamburg is excluded, because average PISA scores in 2000 are not available. Shaded cells represent maximum and minimum values by column.
Source: Qualification and Career Survey waves 1979, 1985/86, 1991/92, 1998/99, 2005/06. Own calculation.

Table 3: OLS results: state averages of returns to years of schooling, middle degree, and high school degree

	Returns to							
	Years of schooling		Middle degree		High school degree		Number of Clusters	Share high school
	ME	Rank	ME	Rank	ME	Rank		
	(1)		(2)		(3)			
Schleswig-Holstein	8.456 ***	3	21.086 ***	1	38.273 ***	6	168	0.190
	(0.103)		(0.988)		(0.045)			
Hamburg	7.308 ***	8	11.443 ***	10	33.129 ***	10	169	0.309
	(0.663)		(2.111)		(3.699)			
Lower Saxony	7.930 ***	4	16.532 ***	7	38.336 ***	5	170	0.203
	(0.182)		(1.863)		(1.288)			
Bremen	8.504 ***	2	15.027 ***	8	40.140 ***	2	158	0.241
	(0.085)		(1.911)		(0.679)			
North Rhine-Westphalia	6.696 ***	10	17.520 ***	4	34.051 ***	8	172	0.266
	(0.085)		(0.405)		(0.338)			
Hesse	7.485 ***	6	17.955 ***	3	38.732 ***	4	172	0.229
	(0.067)		(1.224)		(0.059)			
Rhineland-Palatinate	7.693 ***	5	17.320 ***	5	39.526 ***	3	169	0.191
	(0.574)		(1.792)		(3.718)			
Baden-Wurttemberg	7.476 ***	7	16.917 ***	6	37.527 ***	7	172	0.226
	(0.211)		(0.074)		(1.155)			
Bavaria	8.505 ***	1	20.487 ***	2	43.659 ***	1	171	0.186
	(0.583)		(1.112)		(3.654)			
Saarland	6.964 ***	9	14.871 ***	9	33.336 ***	9	164	0.218
	(0.041)		(2.963)		(0.950)			

Notes: Returns to schooling by state (ME= marginal effect) calculated from year of birth, year of survey, and state specific returns to schooling. Standard errors are bootstrapped (200 replications). ***, ** and * indicate statistical significance at the 1%, 5% and 10% level.
Source: QaC 1979, 1985/86, 1991/92, 1998/99, 2005/06; own calculations.

Table 4: Relationship between state characteristics and returns to schooling

	Dependent variable: Returns to					
	Years of schooling		Middle degree		High school degree	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Amenities and labor demand						
Unemployment rate	0.02	0.025	0.123	0.129	0.079	0.106
	(0.062)	(0.062)	(0.223)	(0.224)	(0.320)	(0.321)
Share in manufacturing	-2.881	-2.227	-10.349	-9.184	0.689	4.564
	(4.143)	(4.045)	(13.869)	(13.415)	(20.279)	(19.516)
Population density	-0.899 **	-0.922 **	-4.151 ***	-4.155 ***	-4.546 **	-4.503 **
	(0.390)	(0.381)	(1.261)	(1.201)	(1.886)	(1.808)
Crime rate	0.167 *	0.15	0.011	-0.017	0.85	0.757
	(0.098)	(0.092)	(0.341)	(0.313)	(0.521)	(0.485)
Log of GDP per Capita	-0.274	-0.249	0.042	0.079	-0.573	-0.446
	(0.207)	(0.209)	(0.871)	(0.887)	(1.062)	(1.072)
Panel B: Institutional features and school quality						
Pupil-teacher ratio	-	-5.384 *	-	-8.527	-	-27.169
		(3.020)		(12.469)		(16.711)
Log of spending per pupil	-	-0.09	-	-0.294	-	-0.847
		(0.208)		(0.893)		(1.428)
Share of high school graduates	-	-0.281 ***	-	-0.443	-	-2.708 ***
		(0.085)		(0.336)		(0.512)
Number of clusters	1685	1685	1685	1685	1685	1685
Year of birth fixed effects	YES	YES	YES	YES	YES	YES
Survey year fixed effects	YES	YES	YES	YES	YES	YES

Notes: Correlations of state characteristics and returns to years of schooling, middle degree, and high school degree. Dependent variable: estimated returns to schooling (see Table A.1). First step of estimation based on 70449 observations. Each column represents a separate linear regression. Standard errors are bootstrapped (200 replications, first and second stage jointly). ***, ** and * indicate statistical significance at the 1%, 5% and 10% level.
Source: QaC 1979, 1985/86, 1991/92, 1998/99, 2005/06; own calculations.

Table 5: Qualitative differences in school systems

	Dependent variable: Returns to		
	Years of schooling (1)	Middle degree (2)	High school degree (3)
Panel A: Amenities and labor demand			
Unemployment rate	0.068	0.222	0.306
	(0.056)	(0.203)	(0.291)
Share in manufacturing	-3.289	-11.454	-0.347
	(4.110)	(13.352)	(19.821)
Population density	-0.579	-3.421 **	-2.915
	(0.422)	(1.399)	(2.004)
Crime rate	0.107	-0.11	0.556
	(0.100)	(0.342)	(0.526)
Log of GDP per Capita	-0.358 *	-0.153	-0.948
	(0.215)	(0.921)	(1.102)
Panel B: Institutional features and school quality			
Pupil-teacher ratio	-1.659	-0.572	-9.954
	(3.679)	(14.722)	(19.884)
Log of spending per pupil	-0.144	-0.41	-1.1
	(0.197)	(0.850)	(1.372)
Share of high school graduates	-0.215 **	-0.303	-2.405 ***
	(0.090)	(0.363)	(0.544)
PISA 2003 Math	2.678 ***	5.721	12.38 **
	(0.912)	(3.683)	(4.872)
Number of clusters	1685	1685	1685
Year of birth fixed effects	YES	YES	YES
Survey year fixed effects	YES	YES	YES

Notes: State characteristics and returns to years of schooling, middle degree, and high school degree only for men. Dependent variable: estimated returns to schooling (see Table A.1). First step of estimation based on 70449 observations. Each column represents a separate linear regression. Standard errors are bootstrapped (200 replications, first and second stage jointly). ***, ** and * indicate statistical significance at the 1%, 5% and 10% level.
Source: QaC 1979, 1985/86, 1991/92, 1998/99, 2005/06; own calculations.

Table 6: Robustness: relationship between state characteristics and returns to schooling - only men

	Dependent variable: Returns to					
	Years of schooling		Middle degree		High school degree	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Amenities and labor demand						
Unemployment rate	0.061	0.099	0.333	0.375	0.294	0.515
	(0.079)	(0.072)	(0.269)	(0.254)	(0.385)	(0.360)
Share in manufacturing	1.524	0.567	9.852	8.793	23.406	17.866
	(5.285)	(5.341)	(18.864)	(18.833)	(24.251)	(24.425)
Population density	-0.74	-0.428	-1.734	-1.39	-3.075	-1.274
	(0.598)	(0.657)	(1.485)	(1.655)	(2.658)	(2.893)
Crime rate	0.161	0.12	0.365	0.321	0.816	0.583
	(0.113)	(0.121)	(0.393)	(0.415)	(0.574)	(0.607)
Log of GDP per Capita	-0.217	-0.316	-0.251	-0.361	-0.404	-0.975
	(0.252)	(0.259)	(1.201)	(1.245)	(1.226)	(1.270)
Panel B: Institutional features and school quality						
Pupil-teacher ratio	-6.596 *	-3.086	-28.437 *	-24.555	-37.68 **	-17.379
	(3.543)	(4.209)	(14.530)	(16.815)	(18.986)	(21.629)
Log of spending per pupil	-0.11	-0.15	-0.886	-0.929	-0.394	-0.623
	(0.226)	(0.217)	(1.168)	(1.137)	(1.479)	(1.437)
Share of high school graduates	-0.211 **	-0.191 **	-0.882 **	-0.86 **	-1.977 ***	-1.861 ***
	(0.094)	(0.096)	(0.348)	(0.353)	(0.484)	(0.495)
PISA 2003 Math	-	2.377 **	-	2.629	-	13.749 **
		(1.115)		(3.993)		(5.803)
Number of clusters	1685	1685	1685	1685	1685	1685
Year of birth fixed effects	YES	YES	YES	YES	YES	YES
Survey year fixed effects	YES	YES	YES	YES	YES	YES

Notes: Correlations of state characteristics and returns to years of schooling, middle degree, and high school degree only for men. Dependent variables: estimated returns to schooling. First step of estimation based on 40775 observations. Each column represents a separate linear regression. Standard errors are bootstrapped (200 replications, first and second stage jointly). ***, ** and * indicate statistical significance at the 1%, 5% and 10% level.
Source: QaC 1979, 1985/86, 1991/92, 1998/99, 2005/06; own calculations.

Table 7: Robustness: qualitative differences in school systems - PISA 2000

	Dependent variable: Returns to		
	Years of schooling (1)	Middle degree (2)	High school degree (3)
Panel A: Amenities and labor demand			
Unemployment rate in percent	0.003	-0.159	-0.146
	(0.044)	(0.166)	(0.238)
Share of workers in manufacturing	-11.725 **	-47.148 ***	-43.053 *
	(5.256)	(18.125)	(25.347)
Population density	0.134	1.517	1.648
	(0.635)	(2.469)	(3.204)
Number of convictions / Inhabitants	0.119	-0.422	0.559
	(0.095)	(0.330)	(0.504)
Logarithm of GDP	-0.032	0.741	0.765
	(0.244)	(0.918)	(1.260)
Panel B: Institutional features and school quality			
Pupil-Teacher Ratio / 100	-8.095 ***	-4.306	-41.513 ***
	(2.509)	(10.857)	(14.601)
Log spending per pupil	-0.354 ***	-0.151	-2.771 ***
	(0.088)	(0.346)	(0.546)
Share of high school graduates	-0.280 *	-0.294	-2.213 *
	(0.151)	(0.772)	(1.151)
PISA 2000 reading	2.998 **	13.081 ***	13.942 *
	(1.401)	(4.640)	(7.294)
Number of clusters	1493	1493	1493
Year of birth fixed effects	YES	YES	YES
Survey year fixed effects	YES	YES	YES

Notes: Correlations of state characteristics and returns to years of schooling, middle degree, and high school degree. Dependent variables: estimated returns to schooling. First step of estimation based on 68537 observations. Each column represents a separate linear regression. State Hamburg is excluded because PISA 2000 scores are not available. Standard errors are bootstrapped (200 replications, first and second stage jointly). ***, ** and * indicate statistical significance at the 1%, 5% and 10% level.
Source: QaC 1979, 1985/86, 1991/92, 1998/99, 2005/06; own calculations.

Appendix

Table A.1: OLS results: returns to years of schooling, middle degree, and high school degree

Dependent Variable: Log hourly wage	(1) coef.		SE	(2) coef.		SE
Years of secondary schooling	0.099	***	0.009			
Basic degree					Reference	
Middle Degree				0.238	***	0.028
High School degree				0.432	***	0.043
Years of schooling interacted with						
Schleswig-Holstein		Reference				
Hamburg	-0.011		0.009			
Lower Saxony	-0.004		0.007			
Bremen	-0.003		0.01			
North Rhine-Westphalia	-0.013	**	0.006			
Hesse	-0.007		0.007			
Rhineland-Palatinate	-0.004		0.007			
Baden-Wurttemberg	-0.009		0.006			
Bavaria	0.003		0.006			
Saarland	-0.003		0.009			
Survey Year fixed effects						
1979		Reference				
1985/86	0.014	***	0.001			
1991/92	0.033	***	0.002			
1998/99	0.045	***	0.003			
2005	0.052	***	0.004			
Year of birth fixed effects (40)		YES				
Middle degree interacted with						
Schleswig-Holstein					Reference	
Hamburg				-0.088	***	0.026
Lower Saxony				-0.037	**	0.018
Bremen				-0.050	*	0.030
North Rhine-Westphalia				-0.027		0.017
Hesse				-0.023		0.019
Rhineland-Palatinate				-0.030		0.022
Baden-Wurttemberg				-0.037	**	0.018
Bavaria				-0.001		0.017
Saarland				-0.034		0.031
Survey Year fixed effects						
1979					Reference	
1985/86				0.013		0.009
1991/92				0.090	***	0.009
1998/99				0.082	***	0.011
2005				0.027	*	0.014
Year of birth fixed effects (40)					YES	

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Table A.1 - continued

High school degree interacted with						
Schleswig-Holstein				Reference		
Hamburg				-0.041		0.035
Lower Saxony				0.003		0.026
Bremen				0.002		0.038
North Rhine-Westphalia				-0.020		0.023
Hesse				0.011		0.027
Rhineland-Palatinate				0.014		0.028
Baden-Wurttemberg				-0.006		0.025
Bavaria				0.047	*	0.024
Saarland				0.003		0.036
Survey Year fixed effects						
1979				Reference		
1985/86				0.030	**	0.013
1991/92				0.181	***	0.014
1998/99				0.225	***	0.015
2005				0.218	***	0.019
Year of birth fixed effects (40)				YES		
Additional controls						
Female (0/1)	-0.215	***	0.003	-0.221	***	0.003
Age	0.427	***	0.037	0.455	***	0.037
Age^2	-1.431	***	0.157	-1.468	***	0.157
Age^3	2.202	***	0.284	2.262	***	0.285
Age^4	-1.262	***	0.187	-1.302	***	0.188
State fixed effects						
Schleswig-Holstein	Reference			Reference		
Hamburg	0.136		0.092	0.07	***	0.018
Lower Saxony	0.036		0.066	0.004		0.012
Bremen	0.024		0.097	0.011		0.02
North Rhine-Westphalia	0.173	***	0.061	0.045	***	0.011
Hesse	0.124	*	0.066	0.045	***	0.012
Rhineland-Palatinate	0.076		0.069	0.023	*	0.013
Baden-Wurttemberg	0.158	**	0.063	0.071	***	0.011
Bavaria	0.009		0.062	0.016		0.011
Saarland	0.016		0.091	-0.009		0.017
Year of birth fixed effects (40)	YES			YES		
Number of observations	70449			70449		

Note: OLS regressions of equation (1) with linear schooling (column 1) and degree indicators (column 2). Dependent variables is log hourly wage. Each column represents a separate linear regression. Standard errors are robust. ***, ** and * indicate statistical significance at the 1%, 5% and 10% level.
Source: QaC 1979, 1985/86, 1991/92, 1998/99, 2005/06; own calculations.