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Incentives for Schools, Educational Signals and Labour Market Outcomes

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Abstract

Central exams affect educational outcomes. In our paper we study the impact of central exams on labor market outcomes. We explain the quality choice of schools under central and non-central exams and model the resulting students' schooling decisions and employers' wage decisions. We use the German Abitur and the variation among the German federal states with respect to central exams as a quasi experimental design. We expect the ratio of Abitur holders to increase in states without central exams and their wage premiums to decrease at the same time. In states with central exams these effects should not occur. We test our implications with official statistics on education and with the GSOEP. The first two implications are born out in the data. Finally, explanations and policy recommendations are discussed.

Keywords: Educational Economics, School choice, Incentives for Schools, Central Exams, Economic impact, Labor Market Outcome

JEL Classification: M51, J31

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1. Introduction

Since TIMSS (Third International Mathematics and Science Study) and PISA (Programme for International Student Assessment) results were published, there has been an intensive debate about the factors determining the extreme variation in results. One of the policy instruments that has been extensively studied and discussed are central exams as a mean to ensure a high educational quality. Central exams are typically favored among economics of education specialists because they are perceived to set the right incentives and to be an appropriate instrument for monitoring educational quality. However, among teachers and pedagogical specialists, the efficacy of central exams is seriously questioned, because it is assumed that they undermine educational freedom and the pedagogical discretion that is supposed to be necessary to deal with heterogeneity among students. Teachers and pedagogical specialists therefore favor policies that increase school autonomy in order to allow teachers and schools to choose the optimal teaching goals and methods, given the unique circumstances they have to face. Recent empirical studies, however, show that the best educational outcome (as measured by TIMSS or PISA-scores) clearly evolves with a combination of central exams and school autonomy, and that the worst educational outcome evolves from autonomous schools without central exams. Central exams seem to have a positive effect on educational outcomes.

The aim of our paper is to analyze whether central exams not only have an impact on educational outcomes like the PISA or TIMSS results, but also on *labor market*

outcomes like wages. We introduce a model to explain the incentives within the school system and their impact on labor market outcomes. Firstly, we model the decision of students to acquire an educational signal, given expected earnings on the labor market and effort costs in the school system. Secondly, we model the decision of schools to maintain a high quality threshold, and therefore high students' effort costs, given the school internal incentive system. In our case we study the German high school diploma, the so called Abitur, which was acquired by less than 27 % of all school leavers in 2002 and which in general grants automatic entry into the German university system. And thirdly, we model employers' wage decisions given the value of the educational signal within a respective student population. We use a standard occupational choice model for the first part of our model, standard principal agency theory for the second part, and a standard signaling model for the third part.[1] We show that given the predominant incentive structure in the German school system, the absence of central exams for the Abitur should lead to ever decreasing quality standards, which in turn should make it rational for an increasing number of students to acquire the educational signal. If that is the case, more students with lower productivity will acquire the signal. This systematically lowers the value of the signal, which in turn should lead to a decreasing wage premium for the

[1] Thus, the school system is reduced to providing a labor market signal, i.e. no pedagogical issues are explicitly addressed. Schools are more or less limited to their information function, i.e. the Abitur is interpreted mainly as a separation signal for the labor market (Spence, 1973). A human capital perspective is not explicitly taken into account. Whereas the human capital perspective long dominated public discussion, more recently a signaling perspective has become increasingly recognized as an important aspect of an educational degree in the German speaking countries (NZZ, 2004; Die Zeit, 2004).

individuals holding the signal.[2] We test our hypotheses using official statistics on the Abitur and the German Socio-Economic Panel and find that most of our predictions are borne out in the data.

The paper is structured as follows. Section 2 gives a brief summary of the relevant literature, sketches our theoretical model and ends with a set of hypotheses. Section 3 introduces the data and presents our empirical results. Section 4 concludes with a summary of the main findings and offers tentative policy implications.

2 Incentives for school quality, student schooling choice and labor market outcomes: theoretical considerations

There are two strands of literature that are related to our topic. Firstly and very recently, there is an increasing number of papers focusing on quality incentives in schools and educational attainment, but these papers typically do not consider the interaction between the internal school system and the labor market. Effinger and Polborn (1999), for example, refer to TIMSS results and argue that a central exam is more difficult for students to pass because a central planner sets higher standards than autonomous schools. They find that students in states without central exams receive higher grades on their exams than those in states with central exams although their TIMSS results were similar. This so called grade inflation is also analyzed by Wikström and Wikström (2005). Effinger and Polborn (1999) find that on average the TIMSS test results were higher in states

[2] The theoretical model was first developed in Backes-Gellner and Weckmüller (1998).

with central exams (Effinger & Polborn, 1999:68). Bishop (1997, 1999) finds that central exams enhance students' performance by about the equivalent of one school year. Buechel, Juerges and Schneider (2003) also use the institutional variation of the German school system to estimate the effect of central exams on educational outcome. They apply a difference-in-differences estimator to exploit the quasi-experimental character of the TIMSS data. The estimated effect is the equivalent of about half a school year. An additional result is that when standards are centrally defined, grades correlate better with performance (Buechel et al., 2003:17). The authors conclude that central exams significantly enhance students' performance and that with central exams grades are better predictors for actual productivity. Closest to our analysis is a study by Gundlach and Woessmann (2003), who analyze not only the effects of central exams on educational outcomes but also the macroeconomic consequences of central exams. They conclude that "central exams are a requirement for decentralized school systems to function properly" (Gundlach & Woesmann, 2003:38). With regard to the educational outcomes their empirical evaluation of the TIMSS and TIMSS-Repeat studies reveals a positive central exam effect of about one school year. With respect to macroeconomic effects they show that growth rates are higher where educational outcomes are better. Accordingly, they conclude that central exams not only enhance students' performance, but also lead to equal opportunities independent of students' background (Gundlach & Woessmann, 2003: 36-38).

Secondly, there is a long tradition and a very large number of papers studying returns on education based on either human capital theory or - less frequently – on signaling theory. They focus on wages attached to various levels of educational

degrees, but usually do not study school-internal incentive systems and quality standards. Kroch and Sjoblom (1994) is one example of a study focusing on the signaling aspect of educational degrees. They define the essence of the signal value of a degree as the position of an individual in the educational distribution of a cohort. By using two separate panel datasets from the US, they find some evidence for a pure signaling value of education (Kroch & Sjoblom, 1994: 175). Tyler, Murnane and Willet (2000) use the differences in General Educational Development (GED) passing standards among US states to estimate the value of this signal. They compare persons with the same GED test score, who exogenously differ in signal status because of different passing standards. Since the data are quasi-experimental, they are able to use difference-in-differences estimators to separate the signaling effect of the GED. The impact of the signal GED on yearly earnings is estimated at about 10% to 19% (Tyler et al., 2000: 432f). However, even though there is empirical evidence for the labor market value of educational signals, the effect of incentive structures within schools on the value of this educational signal on the labor market has never been explicitly analyzed

In the following, we sketch our theoretical framework which we first introduced in Backes-Gellner/Weckmüller (1998) to explain why the German Hauptschule, which is the lowest quality level school in a three tier tracking system, is steadily loosing more and more students. The model explains the decrease in number of students by the incentives within the schooling system, labor market signaling and student reactions. In this paper we use the same model structure to explain the labor market effects of central exams in the highest quality level schools of the

three tier school system, i.e. the German Gymnasium granting the Abitur as the standard University entrance requirement. The Abitur is traditionally very selective; for example in 2002 more than 73% of an age cohort did not acquire the Abitur.

The model consists of three interdependent decisions of schools, students and employers. Firstly, we model the schooling decision of the students, given expected earnings on the labor market and given the quality regime within the school system. Secondly, we model the decision of schools to maintain a certain quality standard for a particular educational degree, given the school internal incentive system created by the criteria used in the budget process. Thirdly, we model the wage decision of employers given the value of the educational signal of a student population.

1. Students' schooling choice

- We assume a population of students with i=1,..n students differing in individual ability a_i. To keep matters simple, we assume two types of students: Students with high productivity $a_{\max}$ and students with low productivity $a_{\min}$.
- The school system consists of two types of schools with school type 2 being more difficult than school type 1. The average expected income after leaving school type 1 and receiving a diploma type 1 is assumed to be V_1, which is lower than the average expected income V_2 after leaving school type 2. We think of school type 2 as the German Gymnasium where students receive the Abitur, and school type 1 as the German Realschule or Hauptschule (lower secondary education) where they cannot receive the Abitur.

- Students pass the test in school type 2 if the achieved test result q_i is above a minimum threshold $Q_{\min}$.[3]

$$p_i = p(q_i \geq Q_{\min})$$

- A student's test results are influenced by ability and luck, so individual test results q_i depend on individual ability a_i and a random, standard normally distributed error term ε.

$$q_i = a_i + \varepsilon \qquad \text{with } \mathrm{E}(q_i) = a_i \text{ and } \mathrm{Var}(q_i) = \sigma_\varepsilon^2$$

The error term includes all noise which biases the measurement of the true ability a_i in a school test. For example the result of a test may be biased by unclear questioning, fitness of the student on the test day or inaccurate assessment by the teacher. The error term includes all types of good or bad luck determining test results. The error term may also be thought of as imprecise self-evaluations, i.e. if students or their parents are not fully informed about their individual ability, their individual believes about the probability distribution of their passing the exam (given a minimum standard of school type 2) may also be described by the stochastic error term ε. For our model either interpretation is possible because both induce the same effect, i.e. students with abilities below the minimum standard enter school type 2 because they hope to be able to meet the quality hurdle. For simplicity we assume in the following that the error term represents the impreciseness of school internal testing procedures.

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[3] See also Costrell (1994: 959).

- Thus, q_i depends on a_i, the passing probability p_i of a more talented student is higher than that of a less talented student for a given threshold $Q_{\min}$. But it is also biased by the error term[4] ε, which becomes even more obvious when p_i is transformed into the standard normally distributed probability distribution:

$$p(q_i \geq Q_{\min}) = F_N\left(\frac{a_i - Q_{\min}}{\sigma_\varepsilon} / 0{,}1\right)$$

- Students maximize their lifetime income. Therefore, a school type 2 education is chosen if the expected income minus the individual cost is greater for school type 2 than for school type 1.[5] The expected income of a type 2 diploma is the higher income V_2 attached to a type 2 diploma weighted with the individual passing probability plus the alternative income V_1 weighted with the counter probability:[6]

$$E(V \mid Typ2) = p_i V_2 + (1 - p_i)V_1$$

If expected income minus individual costs is higher for school type 2 than for type 1, a student chooses to go to school type 2, i.e. if

$$E(V \mid Typ2) - C_2 > E(V \mid Typ1) - C_1$$ [7]

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4 An illustration can be found in Figure 1.

5 Empirical evidence on the determination of educational attainment by expected earnings can be found in Brunello et al (2004). Also Botelho & Pinto (2004) find that students are aware of the economic returns to a college education and Webbink & Hartog (2004) confirm that students can predict starting salary.

6 V_1 is assumed to be a risk free alternative income.

7 Costs in school type 2 are assumed to be higher than in school type 1, since school type 2 requires more effort in the form of attainment, learning and time.

This can be transformed into the following:

$$p(q_i \geq Q_{\min}) > \frac{C_2 - C_1}{V_2 - V_1},$$

with $\frac{C_2 - C_1}{V_2 - V_1}$ being the critical cost-return-relation.

Inserting the standard normally distributed probability distribution for the term on the left results in the following condition for the choice of school type 2:

$$F_N\left(\frac{a_i - Q_{\min}}{\sigma_\varepsilon} / 0,1\right) > \frac{C_2 - C_1}{V_2 - V_1}$$

Students with individual ability a_i choose a school type 2 education if their passing probability is higher than the critical cost-return relation, i.e. students use information both from within the school system, $Q_{\min}$ and σ_ε, and from the labor market, V_1 and V_2, for their optimal schooling decision.

Accordingly we can derive the following implications for individual schooling decisions:

1. An individual's probability of choosing school type 2 depends on the individual ability a_i. The higher a_i the higher is the passing probability p_i and therefore the higher is $E(V \mid Typ2)$. Better students are more likely to choose school type 2 than type 1.[8] This is not surprising, but it emphasizes the plausibility of the model.

[8] For a similar argument see also Effinger and Polborn (1998: 57).

2. The probability of choosing school type 2 depends on the minimum standards $Q_{\min}$ for passing school type 2. If $Q_{\min}$ is reduced, the passing probability p_i rises[9] and therefore $E(V \mid Typ2)$ also rises in the short term. So, the lower $Q_{\min}$, the more students will choose school type 2. In the long run declining standards will lower the premium which is paid for the diploma 2 signal. We will return to this in the next section.

3. The probability that students choose school type 2 also depends on the luck component σ_ε. The greater the role played by luck, the greater is the probability that even a student from the lower end of the ability distribution will be able to cross the threshold. The more accurate the tests are, the lower the chance of a low-end student passing the exam, which means they are less likely to choose type 2 in the latter case. Since we have no data on this component we will not go into more detail at this point.

4. Choice of school type 2 also depends on the individual cost relation C_2-C_1. However, we assume that these costs, consisting of attainment, learning and time, remain relatively unchanged over time and that there is no comparable influence like the income effect on the income relation V_2-V_1.

5. Last but not least, the choice depends on the income relation V_2-V_1, which is generated through employers' wage decisions on the labor market and

[9] A decline in minimum passing standards moves $Q_{\min}$ to the left in Figure 1. In that case, low productivity students have a higher probability of passing and will more likely choose school type 2.

will be discussed in more detail in the next section. An increase in V_1 raises the critical cost-return relation and reduces the probability of a school type 2 choice and vice versa.[10]

2. Incentives in Schools and Minimum Quality Requirements

Concerning the quality regime within the school system, two kinds of regulation should be distinguished, particularly in the German case. On the one hand, tests and minimum passing standards are exogenous to the school because they are given by an autonomous authority, as for example in the case of the Zentralabitur (central school-leaving exam), where the tests and standards are set by the department of education. On the other hand, we have autonomous schools which not only design their tests internally but also decide on the passing standards themselves.[11] However, in both quality regimes school budgets are heavily dependent on the number of students a school serves, so schools have an incentive to have a high number of students.

Using standard principal agent theory[12] for a multi-tasking situation, it is common knowledge that an incentive system favouring just one task (by using just one indicator, like number of students) will induce the agent to neglect the other tasks,

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[10] Skill biased technological change may lead to a higher demand for Abitur-holders and thus to a higher V_2, which in turn may lead to an increased choice of school type 2. This relation can explain a rising Abitur-ratio. However, only an over proportional increase in Abitur-holders compared to increasing demand for qualification, can explain the shrinking wage premium for the credential "Abitur", which we observe in the data.

[11] Costrell (1994) also distinguishes between centralized and decentralized standard setting, and Effinger and Polborn (1998) describe centralized and decentralized standard setting as two different regimes that have different incentives for schools as regards their choice of quality.

[12] The school is seen as an agent for fulfilling a task assigned by the principal, i.e. the department of education or ultimately the society (see also Woesmann, 2004: 5 and Klieme et al, 2003: 47).

like quality of exams, in order to maximize their revenues (cf. Milgrom &, Roberts, 2002: 228 – 232). Thus, in the absence of exogenously set quality standards, we expect the schools to steadily reduce their quality threshold in order to gain more students to boost their budget. However, with exogenously set quality standards, reducing standards is not an option, so the school can only increase the number of students by offering a better educational program – which can be assumed to be in the interest of the principal, i.e. the department of education or society in general. This case, however, is unlikely, because costs for better education will rise dramatically when more students with lower abilities are attracted.

In considering student decisions and quality incentives of schools we are able to derive two empirically testable hypotheses. On the one hand, we have students pushing towards a higher educational degree in order to achieve the higher income V_2. And on the other hand, we have two types of school systems. We have schools without exogenous quality standards (in Germany these are schools in federal states without central exams), which can maximize their budget by taking in and allowing an increasing number of students to pass. As a result, in such a school system, all incentives work towards a reduction of the quality thresholds in school type 2 and an increasing number of students. Thus, in federal states without central exams (Zentralabitur) we expect a continuously increasing ratio of Abitur-holders **(Hypothesis 1)**. On the other hand, in we have schools with quality standards that are set exogenously (in Germany these are schools in federal states with central exams). These schools do not have the option to lower their standards independently for budget reasons. Therefore, in federal states with central exams

we expect the quality standards in school type 2 to remain more or less constant and the number of students to grow much more slowly, i.e. the ratio of Abitur holders remains more or less constant over time **(Hypothesis 2)**.

Given the schools' and students' decisions under the two different quality regimes, we will now look at the consequences on the labor market.

3. Labor Market Outcomes: Signaling Value and Wages

Signaling is used by asymmetrically informed employers who search for signals that reveal the true productivity of their potential employees (Spence, 1973: 356). Employers cannot directly observe the productivity a_i of potential employees i, so according to the signaling approach (Spence, 1973) they look for signals which reliably reveal the unobserved productivity.[13] The Abitur can be used as such a signal as long as students with higher productivity are the only ones who acquire the signal. Employers observe the signal status of the worker and accordingly offer a wage: $V_i \mid Signal$. The wage offered depends on the employers' expectations about the productivity of the group of signal holders: $E(a_i \mid Signal) = V_i \mid Signal$. Their expectations depend on past experience with the productivity of signal holders vs. productivity of workers without a signal (Spence, 1973: 359). After a worker has been employed, the employer receives feedback on his expectations and adjusts them if necessary, which in turn leads to

[13] Game theoretical modelling can be found in Gibbons (1992), Mas-Colell (1995) or Borjas (2002).

an adjusted wage offer to the next generation of signal holders.[14] According to Spence (1973) two different equilibria may occur.

Firstly, in a separating equilibrium the schools' minimum passing standards $Q_{\min}$ are high enough to separate the groups. They motivate high ability students to choose school type 2, but low ability students to self select into school type 1. Since only highly productive students obtain the costly type 2 signal, employers accordingly expect a higher average productivity of type 2 signal holders and offer the higher wages V_2. In a separating equilibrium the expectations of the employers are confirmed in every cycle, which means $E(a_i \mid Signal) = a_i$. If $Q_{\min}$ is stable over time, the wage offers will also be stable over time, and students' decisions will remain unchanged (ceteris paribus). Accordingly, the proportion of students entering school type 2 will also remain unchanged.[15]

With respect to the different school quality regimes, we expect the quality standards to be stable only in a school system with exogenously determined quality standards, like centralized exams.[16] Therefore, we expect a stable separating equilibrium in a school system with quality standards set exogenously by the principal or an independent agency setting standards for a principal[17] (with respect to Germany, we consider a central Abitur to be such an exogenous quality

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[14] Miller, Mulvey & Martin (2004) test a similar information gathering and wage adjustment process.

[15] For a similar argument see also Mas-Colell (1995: 455).

[16] It can also be assumed that a central authority not only keeps the standards fixed, but also sets higher standards than autonomous schools (Effinger & Polborn, 1998: 66,68), but we do not use this assumption in our analysis.

[17] An implicit assumption at this point is that the principal does not have an incentive to lower the standard.

regime). Accordingly, we expect the wage premium for central Abitur-holders to be constant over time **(Hypothesis 3)**.

Secondly, as shown above, we expect steadily declining quality standards in a quality regime without exogenous standards. That is why more and worse students choose to acquire the signal. Therefore, employers constantly have to adjust their productivity expectations and their wage offers downward, which in the long run results in a pooling equilibrium, where the signal does not clearly differentiate anymore between high and low quality students. In the middle or long run, we expect a shrinking wage premium for Abitur-holders who passed their Abitur in states without central exams **(Hypothesis 4)**.

To sum up, we have four hypotheses that we will test in the following section.

1. In a school system where schools are not subject to exogenous quality standards but are able to maximize their budget by taking in (and graduating) an increasing number of students, we expect an increasing number of students to choose school type 2 due to lowered passing standards.

2. In a school system with exogenous quality standards where schools can only increase the number of graduates if they improve their educational program, we expect the number of students to remain constant (or grow much more slowly) over time, because passing standards remain stable.

3. With respect to the labor market outcome we expect the wage premium for school type 2 to be constant over time only in a school system with exogenously

determined quality standards, because the expected productivity of signal holders remains stable.

4. We expect a constantly shrinking wage premium for type 2 degrees in a school system without external quality standards, because the expected productivity of the increasing ratio of signal holders decreases.

3 Data, Measurement Issues, Methodology and Results

In order to test our hypotheses we continue in two steps. First we use official statistics from the Federal Office of Statistics (Bundesamt für Statistik 2000) to test hypotheses 1 and 2. We then apply data from the Socio-economic panel to test hypotheses 3 and 4.

Variables and Results for public data

Our *major explanatory variable*, i.e. the different school quality regimes, is operationalized by two types of federal states: the ones with and the ones without central exams (Zentralabitur)[18], and states without central exams. The so-called Zentralabitur is an exogenously fixed standard for school type 2 final exams, i.e. the Abitur which can be acquired at the Gymnasium or Gesamtschule. For the Zentralabitur the minimum level $Q_{\min}$ for a student to pass the exam is basically determined by the department of education (Klieme et al, 2003: 9,19,27,131). In contrast, in states without a Zentralabitur, the standards of the final exams are set autonomously by individual schools.

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[18] Central exams are common in other European countries as well (Arbeitsgruppe internationale Vergleichsstudie, 2003: 87) and are often seen as the functional complements to school autonomy (Woesmann, 2004: 5; Klemm, 1998: 275; Avenarius et al, 2003: 109).

However, all schools receive a major part of their budget according to the number of students in their school (Gemeindefinanzierungsgesetz 2004/2005: § 18 Art 2). Thus, according to the model, in states without a Zentralabitur we expect declining standards to attract an increasing number of students into the Gymnasium. Therefore, we expect an increasing portion of Abitur-holders in these states.

Figure 2 presents the results which are calculated from the official statistics on educational degrees. It shows the ratio of Abitur-holders to Non-Abitur-holders in the respective birth cohort in central exam states and non-central exam states.[19] We find that the Abitur-ratio is always lower in central exam states.[20]

----------Figure 2 here----------

Pooled over all years and also for the observation years 1984, 1993 and 2002 alone, which we use in the wage regression, the difference between central and non central Abitur-ratios is statistically significant. In 2002 for example the ratio of Abitur-holders in central exam states was 25.5% and in non-central exam states 31.6%. The difference is significant at the 5% level with a t-value of 2.21. Pooled over all years the Abitur-ratio in central exams states is 17.3% compared to 22.4% in non-central states, which is significantly higher at the 1% level.

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[19] States with central exams for the period analyzed in our paper are: Baden-Württemberg, Bayern, Mecklenburg-Vorpommern, Sachsen, Sachsen-Anhalt und Thüringen (Klemm, 1998: 279; Buechel et al., 2003: 5). For the majority of analyses the eastern states are dropped due to lacking data.

[20] The drop in the data in 1980 is due to a switch in school policy. Some states changed their school system from short term school years to normal school years. Therefore the number of school-leavers dropped in that year.

However, although we expect the ratio of Abitur holders to be constant in states with central exams, we observe that the Abitur-ratio steadily increases in both groups. But it rises faster in states without central exams, which partly supports our hypothesis because minimum standards are less stable without central exams than with central exams. Therefore, over time the difference in Abitur-ratios between non-central exam states and central exams states increases, which is shown by the line at the bottom of the diagram. This result is also supported by an estimation which regresses the difference in Abitur-ratios on a time variable to catch a general time trend. The regression indicates a significant positive time trend for the difference in the Abitur-ratios (t-ratios in parenthesis):

$$\underset{\quad}{Differenz} = \underset{(-20.35)}{-232.6} + \underset{(20.82)}{0.1198} * Jahr$$

The difference increases by about 0,12 percentage points per year.

A regression analysis with the Abitur-ratio as the dependent variable and year and state dummies as explanatory variables reveals a significant negative central exam effect, as well as a positive city-state effect. The results can be seen in Table 1. So the higher Abitur-ratio in non central states is partly driven by the city states, but none the less does the central exam have a significant decreasing effect on the Abitur-ratio. The Abitur-ratio in central exams states is significantly lower than in non-central exams states. Furthermore the regression indicates a positive time trend, i.e. the Abitur-ratio increases over time as can be seen in Table 1. Base year is 1985. The Abitur-ratio was always lower in the years before that and always higher in the years afterwards.

----------Table 1 here----------

Thus, the results clearly support hypothesis 1 (increase in Abitur-ratio in states without central exams), but only partly support hypothesis 2 (constant ratio in states with central exams): the ratio of Abitur-holders is not constant in central exam states but it grows significantly slower. Thus, the increasing difference of the Abitur-ratios points to systematically differing schooling behaviour due to different exams regulation.

To empirically evaluate the interactions of different school systems and the labor market we need a long term sequence of individual data on income and schooling. One such source is the German socio-economic panel (SOEP), which we will use in the following to test the impact of schooling decisions on the labor market. Unfortunately data for East Germany is rare and only partially available. Therefore the results of our analysis mainly refer to West Germany.

Measurement Issues, Data selection and descriptive results of the SOEP sample

Regarding our additional *explanatory variables* in our SOEP dataset, we have a dummy variable ABITUR for each individual indicating whether the person has an Abitur or not. We further refine this information to see whether the Abitur-holders did their exam in a school system with or without exogenously fixed passing standards. For all persons with Abitur the dummy variable CENTRAL indicates whether the person passed the Abitur in states with or without central exams.[21]

[21] Current state of residence is used to proxy state of school. A correlation of 0.78 between both variables in 2002 justifies this approach (Wooldridge, 2003: 295-297).

Our *dependent variable* for the wage regression are the wages V_2 and V_1 that the students with or without Abitur earn on the labor market after finishing their education. As acquiring a signal has to be seen as a long-term investment, the income V_2 should not only include income earned on the first job, but should also include income options which may arise from educational or labor market tracks that are only open to students with Abitur. According to the German regulation of admission to universities, students with Abitur are automatically given permission to enter the university system, which in turn opens the way to most of the better paid jobs in the economy (Avenarius et al, 2003: 178,180; Klemm, 1998: 272; Die Zeit, 17.04.2004: 61). In order to capture more than the wage on the very first job, which might be more or less arbitrary, we decided to look at wages of individuals aged 30 to 38. This age group should have completely finished their educational career and should have entered a regular employment relationship. Thus, the earnings of these employees explicitly include further education options and better jobs which are accessible with the Abitur.[22] We use log monthly wages as the dependent variable. Additionally, in our multivariate analyses we use common control variables for earning functions, such as gender, tenure and industry.

As mentioned we use monthly wages of 30 to 38 year old employees at a given point in time (observation year). In order to acquire independent cross section samples, we use three different observation years, namely 1984, 1993 and 2002. Since these observation points are nine years apart, the cross sections consisting of 30 to 38 year old individuals do not overlap. The three samples reflect three

[22] Career effects should be relatively small at that age of 30 to 38, because this is at the beginning of the career. Therefore the signalling value of the Abitur may be underestimated.

cycles in the signaling feedback mechanism described in the previous section. In total, we have N= 3734 employees in our sample, with 602 persons in 1984, 1,237 in 1993 and 1,895 in the 2002 cross section.[23]

A summary of descriptive statistics for the pooled dataset can be found in Table 2.

----------Table 2 here----------

Just as observed in the official statistics, in the Socio Economic Panel we also find that in both regimes the portion of Abitur-holders increases over time, and the ratio of students acquiring the Abitur is always significantly lower in central exam states. Looking at real wages, we find that Abitur-holders in all three observation years earn significantly more than non-holders.

Multivariate Model

In our multivariate analyses we apply a log linear OLS estimation model to estimate a Mincer wage equation, in which our main explanatory variable, the effect of holding an Abitur (ABI) with or without centralized standards (CENTRAL) on wages, is estimated by an interaction term (Wooldridge, 2003: 232):[24]

$$\ln(wage) = \beta_0 + \beta_1 DY + \beta_2 Abi + \beta_3 Abi*DY + \beta_4 Central + \beta_5 Abi*Central + \beta X' + e$$

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[23] Summary descriptive statistics for the pooled dataset can be found in Table 2.

[24] Unfortunately, given our research question and our estimation method we cannot really take advantage of the panel structure of the data, as difference-in-differences methods for natural experiments (Buechel et al., 2003; Tyler et al., 2000) or fixed-effect or fixed-growth estimator do (Juerges & Schneider, 2004). Since "ABITUR" is a time invariant characteristic and a natural experiment structure does not apply, we are restricted to the estimation method described.

The interaction term ABI*CENTRAL indicates that an individual not only holds an Abitur, but also acquired it in a state with central exams. We include a vector of year dummies (DY) to control for year specific effects like inflation or economic conditions (Wooldridge, 2003: 427). The effect of a year on the log wage is captured in β_1.

The coefficient β_2 estimates the pure effect of the signal Abitur on log wages, β_4 is the pure effect of living in a central exam state on log wages, and the coefficients of the interaction term ABI*DY or ABI*CENTR show additional effects of having acquired an Abitur in a particular year or in a central exam regime. β_3 captures the additional effect of an Abitur in a particular year, and β_5 the additional effect of an Abitur in a central exam regime, a so called Zentralabitur. X' is a vector with common control variables.[25]

β_2 is expected to be greater than zero, i.e. in the short-run, an Abitur in general is expected to have a positive impact on earnings. β_5 is also expected to be positive because acquiring an Abitur in a central exam regime is assumed to guarantee higher quality standards and thereby higher wages than in a non-central exam regime. Furthermore, β_3 is expected to decrease over the years. Because of reduced standards in non-central exam states, an Abitur today has a lower market-value than an Abitur twenty years ago, when all Abitur-holders are pooled on the labor market.

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[25] These are: Dummies for Gender, German nationality, employment status, West Germany, education of father and mother, job training of father and mother, occupation of father, 10 industry dummies. Also included are: tenure and tenure squared, age and age squared and daily work hours.

Results

Table 3 summarizes the main results of the OLS regression. Model 1 uses a dummy variable CENTRAL for states with and without central exams as described above, plus a dummy variable WEST to distinguish former GDR (East German) states from the states in West Germany (former FRG). Model 2 uses a complete set of state dummies to see whether there are state-specific effects that are independent of central exams or East-West differences.[26] The F-tests and the R-squared values are high for both models. The coefficient of the variable ABITUR is positive in both models, but statistically significant at 1% level only in the first model. In 1984 a person with the Abitur received a 36% wage premium in model 1 (without Bundesland-Dummies) and a 22% premium in model 2 (with Bundesland-Dummies).

----------Table 3 here----------

The coefficients on the interaction terms of the year dummies with ABITUR (β_3) estimate an additional effect of an Abitur in the corresponding year, which is significantly negative in both models. The effect on wages of holding an Abitur in 1993 as compared to 1984 is -0.099. The effect of holding an Abitur in 2002 as compared to 1984 is -0.17. Hence, there is a positive wage premium on an Abitur, but this premium was considerably higher in 1984, and has continually decreased since that year. There is, then, some evidence to support hypothesis 4. The coefficient on the interaction term ABITUR*CENTRAL (β_5) estimates the

[26] Unfortunately with this approach the numbers of observation in the cells are getting very small which badly affects the significance of the results of Model 2.

additional effect of having an Abitur with exogenous quality standards. β_5 is not significant and neither are all the coefficients on Abitur and all the single state interaction terms (ABITUR*STATE).

We apply different specifications to check the robustness and sensitivity of our results. A summary of the regression results can be found in Table 4.

----------Table 4 here----------

A separate estimation of East- and West-Germany yields similar results as the baseline estimation introduced in Table 3. Since data in observation year 1993 is rare for East-Germany and in 1984 there is no data at all, the results for only East-Germany should not be taken into account. Estimating separately for men and women also leads to similar results as in Table 3. As a last modification we drop the controls for branch and employment status since the fact of entry into a specific branch or employment status may already be the result of the signaling value of the Abitur.[27] The results are again basically the same as in Table 3. The Abitur has a significant signaling value and this value decreases over time.

The results indicate that acquiring a Zentralabitur does not guarantee a wage premium. The value of the signal decreases similarly for all signal holders. The result is also consistent with the descriptive results on the ratio of students holding an Abitur over the last decades. The ratio of Abitur-holders increases regardless of the quality regime, albeit starting from different levels.

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[27] We thank Christoph Lechner for this interesting extension of our basic argument.

Our explanation is that even though there is a school system separated into states, there is only one national labor market, especially for highly skilled employees like Abitur-holders. This in turn means that even though more students are discouraged from acquiring type 2 degrees in states with central exams than in states without central exams, because of higher costs associated with harder, exogenously set tests, they do not earn the wage premium they deserve. The reason is that on the labor market they are pooled together with the larger number of type 2 degree holders from non-central exam states with lower quality standards and thereby lower productivity. This in turn means that students from states with central exams receive systematically downward biased wages given the signal they acquired.[28] To avoid such an unfavorable pooling of students from states with and without central exams on the labor market, it would be helpful to have institutions that guarantee uniform quality regimes on a national level.

4 Conclusion

Many research papers on policy implications of the TIMSS and PISA results have focused on central exams as one important instrument for stabilizing or improving educational outcomes. Here, we extend the focus beyond the educational system and study the impact of central exams on labor market outcomes. We introduce a model of three steps. Firstly, we model the decision of schools to keep a certain quality level given their school internal incentive system. Secondly, we model students' decision to acquire an educational signal, given the quality regime

[28] Light and Strayer (2004) also introduce a signaling mechanism and find similar „indirect" wage benefits for college transfer students.

within the school system. And thirdly, we model employers' decisions to pay a premium for signal-holders given the value of the educational signal of a respective student population. We use standard principal agent arguments for the first part of our model, a typical occupational choice model for the second part, and a basic signaling model for the third part. Our model has four implications: Firstly, in a school system in which schools maximize their budget by taking in an increasing number of students who are not faced with central exams, we expect over time an increasing number of students to acquire the Abitur. Secondly, in a school system with central exams, schools cannot increase the number of students, resp. graduates, by lowering their standards. Here they can only increase the number of graduates if they improve their educational program, so we expect the number of students acquiring the Abitur to remain constant (or grow significantly slower) over time. Thirdly, we only expect the wage premium for Abitur-holders to be constant over time in a school system with central exams, and fourthly, we expect a constantly shrinking wage premium for Abitur-holders in a school system without central exams.

Our empirical analysis shows that the ratio of Abitur-holders continually increases over time and that the value of the signal decreases accordingly. However, contrary to our hypotheses, the ratio of Abitur-holders in central exam states also rises, but on a lower absolute level and with a slower rate. Thus, the gap between the Abitur-ratio in central and non-central exams states is increasing. On average the ratio of Abitur-holders is about 4 percentage points lower than in central exam states, which should result in a wage premium for Abitur holders in a labor market with a separating signaling equilibrium. However, we do not observe a significant

wage premium in our data. There is a wage premium for the Abitur, but not an additional premium for a Zentralabitur. In 1984, wages of Abitur-holders were 36% higher than wages of non-Abitur-holders, so the credential "Abitur" does have a significant signaling value on the labor market. The wage premium for Abitur-holders decreased as the ratio of Abitur-holders increased. In 1993 this wage differential decreased to 26% and in 2002 to 19%. Contrary to what we expected, the wage premium for Abitur-holders from central exam states is not significantly higher than that for Abitur-holders from states without central exams. This points to an inconsistency between the school system and the labor market for highly skilled employees. Whereas the school system in Germany is separated by state, the labor market is obviously not separated. There is just one national labor market in which Abitur-holders from all states and school systems are pooled together. On such a national labor market the Zentralabitur as opposed to a non-Zentralabitur is not or cannot be used as a signal. Therefore, students from states with central exams are faced with systematically downward biased wages, because they only receive a wage which corresponds with the mean productivity of the pooled central and non-central Abitur-holder population. Given the signal they acquired, they could earn a higher wage premium than the pooled wage premium they get. This kind of unfavorable pooling for students from states with central exams could be avoided if standards were to be fixed on a national level. However, this does not necessarily mean that a state agency is required to set the standards; that function could just as well be performed by independent institutions who serve as agents to the public (similarly to the institutions overseeing the SAT or GMAT exams). What is most important is that

standards are exogenously fixed and not set within individual schools, which have the incentive to adjust standards downwards due to their budget incentives. Additionally, in a federal educational system, a uniform quality regime is helpful to guarantee the efficiency of educational signals. It is important that external institutions set the quality standards and that these educational standards are valid within the boarders of the respective labor market.

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6 References

Arbeitsgruppe internationale Vergleichsstudie (Hrsg.) (2003). Vertiefender Vergleich der Schulsysteme ausgewählter PISA-Teilnehmerstaaten. (Berlin, BMBF).

Avenarius, H. et al. (2003). Bildungsbericht für Deutschland. Erste Befunde. (Opladen, Leske und Bruderich).

Backes-Gellner, U., & Weckmüller, H. (1998). Ist das Ende der Hauptschule aufzuhalten? Ein informationsökonomischer Beitrag zur Wirkung alternativer Schulregulierungsstrategien auf das Schulnachfrageverhalten. In: von Weizsäcker, & Robert K. (Hrsg.): Deregulierung und Finanzierung des Bildungswesens. (Berlin, Duncker & Humblot: pp 49-77).

Bishop, J.H. (1997). The Effect of National Standards and Curriculum-Based Exams on Achievement. American Economic Review Vol. 87, pp. 260-264.

Bishop, J.H. (1999). Are National Exit Examinations Important for Educational Efficiency? Swedish Economic Policy Review Vol. 6, pp. 349-401.

Borjas, J. (2002), Labor Economics. (McGraw Hill International).

Botelho, A., & Pinto, L.C. (2004). Students' expectations of the economic returns to college education: results of a controlled experiment. Economics of Education Review 23, pp. 645-653.

Büchel, F. , Jürges, H. , & Schneider, K. (2003). Leistungs- und Signaleffekte zentraler Abschlussprüfungen - Eine TIMSS-Auswertung bei deutschen Haupt- und Realschülern. Beitrag für den Tagungsband der Zürcher Tagung des Bildungsökonomischen Ausschusses des VfS. Überarbeitete Fassung.

Brunello, G., Lucifora, C., & Winter-Ebmer, R. (2004). The Wage Expectations of Euopean Business and Economics Students. Journal of Human Resources Vol. 39 No. 4, pp. 1116-1142(27).

Costrell, R.M. (1994). A simple model of educational standards. The American Economic Review Vol. 84 No. 4, pp. 959-971.

Die Zeit Nr.17 / 2004. Andreas Molitor. Wohin mit dem Kind? www.zeit.de/2004/17/Titel_2fSchule vom 28.06.2004.

Die Zeit Nr 22 / 1998. Thomas Kerstan. Der Kreml läßt schön grüßen. www.zeit.de/archiv/1998/22/public_files vom 28.06.2004.

Effinger, M.R., & Polborn, M.K. (1999). A Model of Vertically Differentiated Education. Journal of Economics Vol. 69 No 1, pp. 53-69.

Gemeindefinanzierungsgesetz – GFG 2004/2005.

Gibbons, R. (1992). A Primer in Game Theory. (Prentice Hall).

Gundlach, E., & Wößmann, L (2003). Bildungsressourcen, Bildungsinvestitionen und Bildungsqualität: Makroökonomische Relevanz und mikroökonomische Evidenz. Revidierte Fassung.

Jürges, H., & Schneider K. (2004). Dynamische Effekte beruflicher Weiterbildung: Eine Längsschnittanalyse mit den Daten des SOEP. Beitrag für die Jahrestagung des Bildungsökonomischen Ausschusses des VfS. Frankfurt a. M 25.-26.3.2004. Vorläufige Fassung.

Jürges, H., & Schneider K. (2004). International Differences in Student Achievement: An Economic Perspective. German Economic Review Vol.5, Issue 3, pp. 357-380.

Klemm, K. (1998). Steuerung der Schulentwicklung durch zentrale Leistungskontrollen? Jahrbuch der Schulentwicklung: Daten, Beispiele und Perspektiven Band 10, pp. 271-294. (Weinheim).

Klieme, E. et al. (2003). Expertise zur Entwicklung nationaler Bildungsstandards. (Berlin, BMBF).

Kroch, E. A., & Sjoblom, K. (1994). Schooling as Human Capital or a Signal: Some Evidence. Journal of Human Resources Vol. 29 No. 1, pp. 156-180.

Light, A., & Strayer, W. (2004). Who receives the College Wage Premium?-Assessing the Labor Market Return to Degrees and College Transfer Patterns. Journal of Human Resources Vol. 39 No. 3, pp. 746-773(28).

Mas-Colell, A., Whinston, M.D., & Green, J.R. (1995). Microeconomic Theory. (New York/Oxford, Oxford University Press).

Miller, P.W., Mulvey, C., & Martin, N. (2004). A test of the sorting model of education in Australia. Economics of Education Review Vol. 23 Issue 5, pp. 473-482.

NZZ Nr. 226/2004. Jürg Schweri und Stefan Wolter. Was bringen gute Noten im Studium? vom 28.09.2004.

NZZ am Sonntag. Interview mit Prof. Jürgen Oelkers: Kompetenzen statt Noten vom 12.12.2004.

Spence, M. (1973). Job Market Signaling. Quarterly Journal of Economics Vol. 87, pp. 355-374.

Statistisches Bundesamt (2000). Bildung und Kultur. Fachserie 11 Reihe S.2: Allgemeinbildende und berufliche Schulen 1950 bis 1999, (Wiesbaden 2000).

Tyler, J. H., Murnane, R. J., & Willett, J. B. (2000). Estimating the Labor Market Signaling Value of the GED. Quarterly Journal of Economics Vol. 115 (2), pp. 431-468.

Webbink, D., & Hartog, J. (2004). Can students predict starting salaries? Yes. Economics of Education Review 23 Issue 2, pp. 103-113.

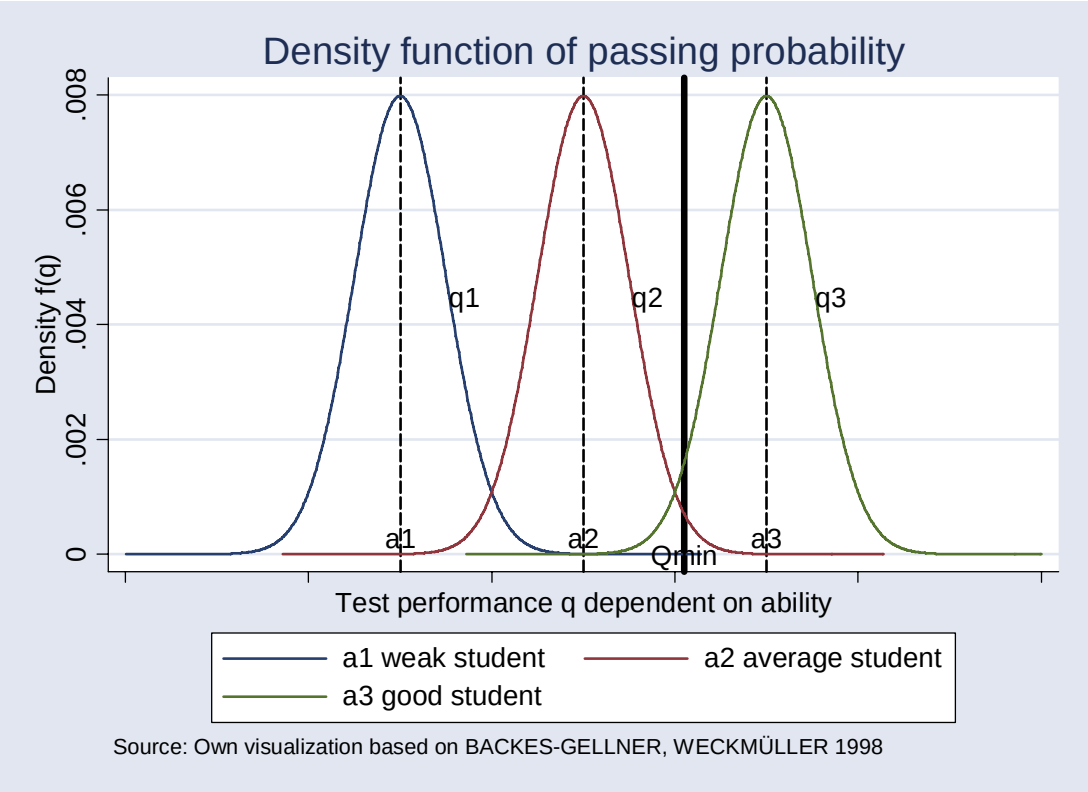
Weiss, A. (1995). Human Capital vs. Signaling Explanation of Wages. Journal of Economic Perspective Vol. 9 No. 4, pp. 133-154.

Wikström, C., & Wikström, M. (2005). Grade inflation and school competition: an empirical analysis based on Swedish upper secondary schools. Economics of Education Review 24, pp. 309-322.

Woessmann, L. (2004). The Effect Heterogenity of Central Exams: Evidence from TIMSS, TIMSS-Repeat and Pisa. CESifo Working Paper No. 1330.

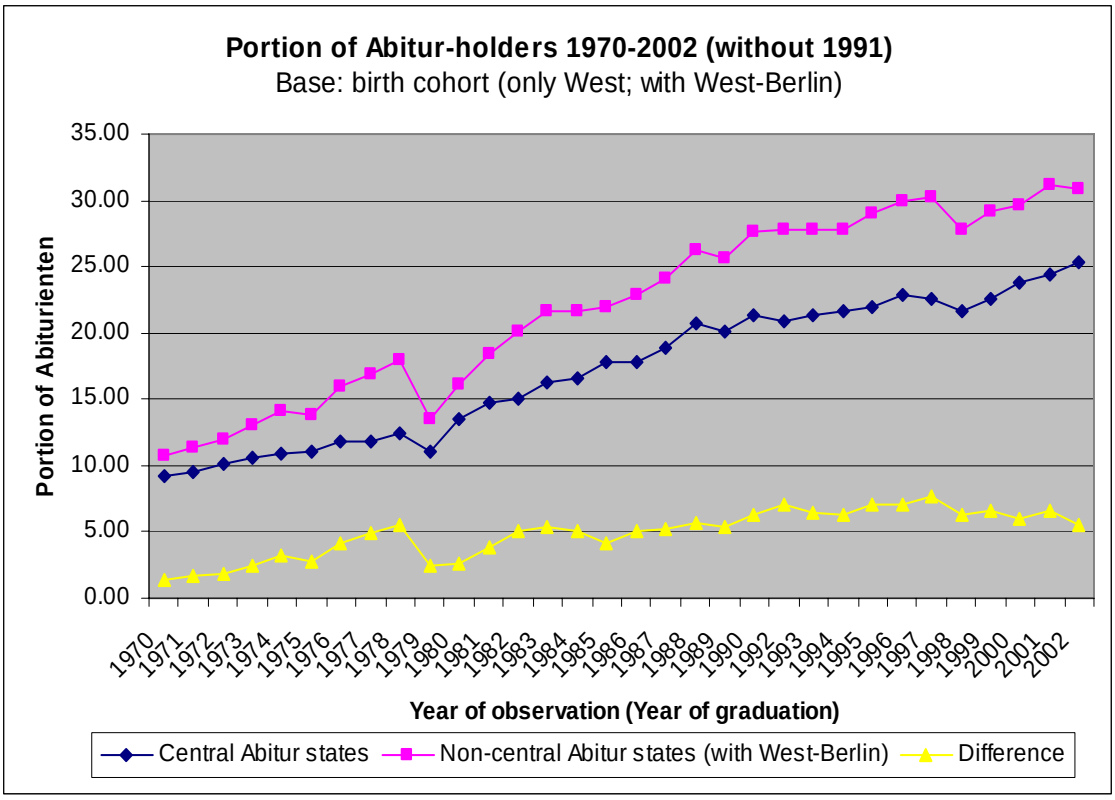
Wooldridge, J. M. (2003). Introductory Econometrics: A modern Approach 2e. (Thomson South Western).

Figure 1: Density function of passing probability



Source: Own illustration

Figure 2: Portion of Abitur-holders over time



Source: Own calculations based on official statistics from the federal office of statistics (Bundesamt für Statistik)

Table 1: Regression Results Abitur-ratio

Dependent Variable: Abitur-ratio
Base Year: 1985

Variables	Koeff	P-value
Central	-2.9267	0.000***
City-State	7.9078	0.000***
Year_1970	-9.8305	0.000***
Year_1971	-9.2540	0.000***
Year_1972	-8.7393	0.000***
Year_1973	-7.7477	0.000***
Year_1974	-6.2541	0.000***
Year_1975	-6.8577	0.000***
Year_1976	-4.3584	0.001***
Year_1977	-5.1219	0.000***
Year_1978	-3.8615	0.004***
Year_1979	-9.4312	0.000***
Year_1980	-4.9184	0.000***
Year_1981	-2.9734	0.027**
Year_1982	-1.9745	0.142
Year_1983	-0.9171	0.495
Year_1984	-0.4068	0.762
Year_1986	0.7195	0.592
Year_1987	2.3915	0.075*
Year_1988	4.2265	0.002***
Year_1989	3.5318	0.009***
Year_1990	5.5680	0.000***
Year_1991	5.8524	0.000***
Year_1992	5.9174	0.000***
Year_1993	6.0104	0.000***
Year_1994	7.1222	0.000***
Year_1995	7.8653	0.000***
Year_1996	8.2221	0.000***
Year_1997	5.9780	0.000***
Year_1998	7.1361	0.000***
Year_1999	7.9265	0.000***
Year_2001	9.0676	0.000***
Year_2002	9.6064	0.000***
N	341	
R ^ 2	0.8523	
F	53.7	
Prob > F	0.000***	

Source: Own calculations based on official statistics (Bundesamt für Statistik)

Table 2: Descriptive Statistics of the pooled SOEP sample

Table 2				
N = 3734				
Variable	**Mean**	**Std.Dev.**	**Min**	**Max**
Abitur	0.2223	0.4158	0	1
Central	0.4472	0.4973	0	1
Year 1984	0.1612	0.3678	0	1
Year 1993	0.3313	0.4707	0	1
Year 2002	0.5075	0.5000	0	1
West	0.7603	0.4270	0	1
Male	0.5686	0.4953	0	1
Tenure	6.5279	5.5367	0	23
Age	33.7108	2.2787	30	37
Monthly income	1871.5580	1098.4440	18	10000
German	0.9949	0.0712	0	1

Source: Own calculations based on SOEP, 30-38 data

Table 3: Wage Regression Results for SOEP Data

Table 3

Dependent Variable: Log Monthly Income
Base Year: 1984

	30-38 Year Olds			
	Model 1 without BundeslandDs		**Model 2** with BundeslandDs	
Variables	Koeff	P-value	Koeff	P-value
Abitur	0.3609	0.000***	0.2171	0.143
Year93	0.3266	0.000***	0.3283	0.000***
Year02	-0.1647	0.000***	-0.1616	0.000***
Abitur*Year93	-0.0989	0.089*	-0.0930	0.124
Abitur*Year02	-0.1705	0.001***	-0.1625	0.003***
Central	-0.0092	0.597		
Abitur*Central	-0.0251	0.480		
West	0.1811	0.000***		
Male	0.3690	0.000***	0.3723	0.017**
Tenure	0.0138	0.003***	0.0136	0.004***
Tenure quadr.	-0.0003	0.210	-0.0003	0.216
N	3734		3734	
R^2	0.5965		0.6000	
F	53.71		42.60	
Prob > F	0.000***		0.000***	

Controls: tenure, tenure^2, age, age^2, sex, German, branch, education of father and mother, job training of father and mother, occupation of father, work hours, employment status

Source: Own calculations based on SOEP, 30-38 data

Table 4: Sensitivity analysis of the Wage Regression

Table 4

Sensitivity Analysis

	Baseline Estimation of Table 3		Separat Estimation West-East			
			only West-Germany		only East-Germany	
Variable	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Abitur	0.3609***	0.2171	0.3773***	0.3873***	0.2296***	0.2427**
Abitur*Jahr93	-0.0989*	-0.0930	-0.1158*	-0.1087*	n.a	n.a.
Abitur*Jahr02	-0.1705***	-0.1625***	-0.1674***	-0.1602***	-0.0584	-0.0493
Central	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Abitur*Central	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

	Separat Estimation Male-Female				Without Controls for:	
	only Men		only Female		Branch, empl. status	
Variable	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Abitur	0.1840***	0.2968*	0.5016***	0.4025	0.3938***	0.2861*
Abitur*Jahr93	-0.0363	-0.0369	-0.1819*	-0.2025*	-0.1071*	-0.1053*
Abitur*Jahr02	-0.0513	-0.0479	-0.2893***	-0.2962***	-0.1686***	-0.1664***
Central	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Abitur*Central	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

***	significant at 1% level
**	significant at 5% level
*	significant at 10% level
n.s.	not significant
n.a.	not available

Source: Own calculations based on SOEP data