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Educational Attainment and Returns to Education in Germany

– An Analysis by Subject of Degree, Gender and Region –

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Nontechnical Summary

This paper presents evidence on the development of educational attainment and its returns on the labor market in Germany in the period 1985-2002. Both the German micro-census (*Mikrozensus*) data and the German Socio-Economic Panel Study (GSOEP) are analyzed and the results are compared. Moreover, the returns to tertiary education are estimated separately by subject of degree. Further emphasis is placed on differences in gender and region.

As a general description of the status quo, the distribution of qualification levels in Germany differs by gender and region in a cross-section of the population: On average, men attain a higher qualification level than women, who more often have no vocational degree. In West Germany the share of persons with low degrees is higher than in East Germany, while persons living in East Germany more often have an apprenticeship or high secondary school degree. The differences between men and women are greater in West than in East Germany. The distributions of educational attainment are roughly comparable between the GSOEP and micro-census data but the share of people with no vocational education is higher while the share of academic degrees is slightly lower in the micro-census.

Concerning development over time, an educational expansion is apparent. The differences between men and women become less pronounced over time as well. The educational expansion was especially strong for women in West Germany in the period 1985-2002 and is coherent with the higher estimated returns to education for women in this time period. Women had a higher incentive to invest in education in these years because their investment led to higher returns on the labor market. The qualification level in East Germany stayed relatively constant at a high level, which West Germany has approached over the last decades.

The distribution of the subjects of tertiary degrees shows that the largest share of graduates (almost one quarter) studied subjects related to engineering. Similarly, relatively high shares of students graduated with degrees in languages and in cultural studies. The latter are the most prominent degrees for women, followed by studies to become teacher. The main difference between West and East Germany is their share of graduates in engineering, which is higher in East Germany for both men and women.

The returns to education range from 8 to 10 percent in West Germany and from 7 to 8 percent in East Germany during the time span 1985-2002. While the returns for women in West Germany were above those for men in most years, returns to education were higher for men around the year 2000. For 2002, the returns are higher for women again. Comparing the returns in West and East Germany shows higher returns in West Germany. The estimates based on the micro-census are comparable to those returns estimated from the GSOEP for Germany. When we distinguish by region and gender, the estimates differ slightly.

The returns are highest for the fields of law and medicine. The lowest returns can be observed for theology, agricultural science and arts and music. For men, also the studies of business and economics, natural sciences and some engineering degrees yield high returns of over nine percent. For women instead, returns to engineering degrees are rather low, especially in East Germany, while the returns for studies to become teacher are highest. It is obvious that each gender reaches higher returns relative to the other gender in those subjects, where its share of degrees is relatively high. The prime examples are engineering studies for men and studies to become teacher for women. This could be due to gender-related comparative advantages and would imply that it is not worthwhile for either men or women to choose a field of study which is dominated by the opposite gender.

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- An analysis by subject of degree, gender and region -

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Abstract: This paper presents evidence on the development of educational attainment and its returns on the labor market in Germany in the time period 1985-2002. Returns to education are estimated using Mincer equations. We analyze micro-census data in addition to GSOEP data, which allows estimating returns to tertiary education separately by subject of degree for the first time for Germany in such detail. The data indicate an educational expansion, especially for women in West Germany, which is coherent with the relatively high returns to this group. One interesting finding is that each gender reaches the highest returns in those fields of study where its shares are relatively high. For women this is in the fields of studies to become teacher, while men lead in law, business and economics and engineering. Additionally, the returns are higher for most degree subjects in West than in East Germany, especially for women.

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1 Introduction

This paper presents evidence on the distribution of educational attainment in Germany and the returns to education in the labor market. The rewards to education on the labor market are examined using estimations based on standard Mincer wage equations. In all analyses, emphasis is placed on differences in gender and differences between East and West Germany.[1] Our study complements the existing literature on returns to education in Germany (e.g. Bellmann et al., 1994; Dustmann and van Soest, 1998; Franz and Steiner, 2000; Lauer and Steiner, 1999, 2000) in three ways. First, we analyze the link between education and wages over the entire period from 1985 to 2002 for West Germany and from 1991 onward for East Germany and present the latest available evidence. Second, we present and compare the results based on two representative data-sets, the German Socio-Economic Panel study (GSOEP) and the micro-census *(Mikrozensus)*. Third and most important, we distinguish not only by the educational level when estimating the returns to education, but also by the field of study. With the exception of Pfeiffer (1999) regarding engineers and scientists, this is the first time subject specific returns to tertiary education are estimated for Germany to our knowledge.

Comparing the distribution of degree subjects by gender and the related returns to education may help our understanding of existing patterns of subject of degree choice. One interesting finding is that each gender reaches its highest returns in those fields of study where its presence is relatively strong. This could be interpreted as indicating that each gender focuses on the degree subjects in which there are gender-related comparative advantages. For women we find the highest shares in fields of studies to become teacher; men seem to have an edge in law, business and economics and engineering. Additionally, especially for women the returns are higher in most subjects in West than in East Germany.

The outline of the paper is as follows. First, we describe the data-sets underlying the empirical analysis together with the educational categories we aggregated to define educational attainment and the methodology that will be used later on. In Section 3 we present descriptive statistics for the distribution of education by gender, region and subject of degree (3.1) and average wages by educational level (3.2). Section 4 presents the results of the estimated returns to education, where we also address the possible problem of selectivity with respect to labor market participation. Section 5 concludes.

2 Data, Variables and Methodology

The analyses are based on the German Socio-Economic Panel study (GSOEP) and micro-census (*Mikrozensus*) data, where we use the years 1985-2002 of the GSOEP and data on the year 2000 of the micro-census. The GSOEP collects representative micro-data on persons, households and families, where central areas of interest are (among others) labor market and occupational dynamics, earnings, income and education (Haisken-DeNew and Frock, 2003, p. 14 f.). The results of the GSOEP are always weighted by the sampling probability of individuals. The micro-census contains data collected in annual household surveys which are regulated by law. The sample size corresponds to one percent of the population size. We use an available sub-sample, where 70 % of the individuals of the original micro-census are sampled.

[1] "West Germany" refers to the old German *Laender* (before unification).

In order to analyze the development of the educational distribution and the returns to education, we define four major educational categories.[2] The four categories are: (1) No vocational qualification, (2) basic vocational qualification, (3) intermediate qualification, and (4) tertiary level qualification. The first category covers all persons not holding any educational degree or only holding a lower or intermediate level secondary degree corresponding to the German *Hauptschule* and *Realschule* degrees. The second category contains those degrees comparable to a basic vocational degree like the German *Lehre* or *Berufsfachschule*, where the graduates also hold a *Hauptschule* or *Realschule* degree. The third category includes all individuals having attained a higher vocational degree (comparable to the *Fachschule*, *Fachoberschule* or the East German *Ingenieurschule*) or a maturity degree (*Abitur* or *Fachhochschulreife*). Finally, we aggregate tertiary level degrees like university degrees and degrees from the universities of applied sciences (*Fachhochschule*) in the fourth category.

The returns to education are estimated by a Mincer (1974) wage equation using OLS. Most of the previous empirical evidence for Germany also relies on this method or slightly modified wage equations (e.g. Franz and Steiner, 2000; Lauer and Steiner, 1999, 2000). The different qualification levels available in the data are transformed into years of schooling that are needed to accomplish the given qualification. Hence, it is assumed that each year of schooling yields the same return to education, irrespective of the level of education. In addition, returns to educational degrees are calculated. This approach considers the highest degree attained, where the estimated returns to each level are divided by the number of years it takes to reach the respective qualification level. Thereby comparable yearly returns to education are calculated which may differ by degree. Hence, it is assumed that the acquired human capital depends on the level and the subject of the degree.

The described method for estimating returns to education is prone to both an endogeneity bias and a measurement error. Reproducing the huge literature in the field of estimating returns to education (e.g. Ashenfelter and Rouse, 1998; Ashenfelter et al., 1999; Card, 1995, 1999; Harmon et al. 2000; Heckman et al., 2003) would go beyond the scope of this paper, which foremost intends to present new and updated empirical evidence. The absolute magnitude of the presented estimates of returns to education should be interpreted cautiously, however (cf. Jochmann and Pohlmeier, 2004).

3 Descriptive Statistics

3.1 Distribution of education and its development

There are various ways to measure education and to analyze its distribution. In this paper we examine educational attainment defined as the highest educational degree an individual holds. Table 1 presents the status quo of the resulting educational distribution based on the GSOEP data for 2002. The sample is restricted to individuals aged between 30 and 60, i.e. individuals considered not to attain higher educational degrees and potentially belonging to the working population. The numbers are given separately by gender and region within Germany.

[2] The educational categories are defined according to Lauer (2003).

Table 1: Status quo of the distribution of qualification levels, 2002, by sex and region (in percent)									
Highest degree obtained	Germany			Old Laender			New Laender		
	Overall	Men	Women	**Overall**	Men	Women	**Overall**	Men	Women
No vocational qualification									
No degree	**1.81**	1.96	1.67	**2.16**	2.31	2.02	**0.27**	0.42	0.12
Lower secondary education	**7.80**	5.59	9.95	**8.95**	6.40	11.42	**2.77**	2.08	3.45
Intermediate secondary education	**2.32**	1.51	3.11	**2.40**	1.36	3.40	**1.98**	2.16	1.80
Summation	***11.93***	*9.06*	*14.72*	***13.51***	*10.07*	*16.84*	***5.02***	*4.66*	*5.37*
Basic vocational education									
Lower secondary education + basic vocational degree	**25.60**	27.60	23.66	**28.41**	30.46	26.41	**13.33**	15.19	11.48
Intermediate secondary education + basic vocational degree	**22.35**	18.31	26.28	**17.90**	13.06	22.59	**41.79**	41.01	42.57
Summation	***47.95***	*45.90*	*49.94*	***46.31***	*43.53*	*49.01*	***55.12***	*56.20*	*54.05*
Intermediate qualification									
Intermediate vocational degree	**8.71**	10.76	6.72	**8.69**	10.98	6.46	**8.84**	9.82	7.87
Vocational maturity certificate	**3.11**	3.62	2.62	**3.65**	4.20	3.13	**0.75**	1.11	0.40
General maturity certificate	**0.97**	1.10	0.85	**1.14**	1.25	1.03	**0.26**	0.47	0.05
General maturity certificate + vocational degree	**4.71**	4.14	5.26	**5.12**	4.15	6.05	**2.93**	4.10	1.77
Intermediate vocational degree (East Germany), school of engineering	**1.39**	0.84	1.92	**0.24**	0.11	0.36	**6.42**	4.02	8.79
Summation	***18.90***	*20.46*	*17.38*	***18.83***	*20.68*	*17.04*	***19.20***	*19.51*	*18.88*
Tertiary level qualification									
Lower tertiary education	**7.09**	8.78	5.44	**7.11**	9.54	4.76	**6.98**	5.51	8.44
Upper tertiary education	**14.14**	15.80	12.52	**14.24**	16.19	12.36	**13.69**	14.12	13.26
Summation	***21.23***	*24.58*	*17.97*	***21.36***	*25.72*	*17.12*	***20.67***	*19.62*	*21.70*

Source: SOEP 2002, own computations.
Note: The calculations refer to the population aged between 30 and 60 years.

The educational degree which is attained the most often corresponds to the lower or intermediate secondary degree (Haupt- or Realschule) combined with the apprenticeship degree, which is attained by nearly half of the population. This fact emphasizes the importance of the system of vocational education in Germany. About 21 percent of the individuals in the representative sample of the GSOEP hold an academic degree, where the proportion of university graduates is higher than the proportion of graduates from the so-called "Universities of Applied Sciences" (Fachhochschule). Further widespread degrees correspond to the lower level

secondary (Hauptschule) degree (seven percent) and to the Fach(ober)schule degree (twelve percent). The proportion of individuals without educational degree is relatively small and amounts to two percent.

Comparing the findings for male and female individuals shows that there are a relatively high proportion of women holding a lower secondary *Hauptschule* degree but not attaining a higher level vocational degree. Among those individuals holding an apprenticeship degree (*Lehre*), women more often graduated from intermediate level secondary schools (*Realschule*) and men more often graduated from lower level secondary schools (*Hauptschule*). Furthermore male individuals more often hold an academic degree.

The proportion of individuals holding low level degrees only is smaller in East than in West Germany. Only five percent do not hold a vocational degree while 14 percent of the West Germans belong to this category. In East Germany, the proportion of individuals holding an intermediate secondary degree (*Realschule*) combined with an apprenticeship degree is especially high.

The distribution of educational attainment is also shown for the alternative data-source, the micro-census, for the year 2000 in Table A in the appendix. The figures are roughly comparable to those from the GSOEP. However, in the micro-census data the share of people with no vocational education is higher while the share of academic degrees is lower. The sampling years can explain part of the difference. Further differences are caused by differing definitions of the educational categories in both data-sets.[3] A higher proportion of university graduates in East Germany using the micro-census data stems from the fact that we cannot distinguish between East and West Berlin using this data-set. The proportions of higher educational degrees are higher in West Germany and lower in East Germany if we do not include Berlin in the East German sample. This is probably due to the high density of higher educational institutions in Berlin.

Development of the distribution of formal qualifications

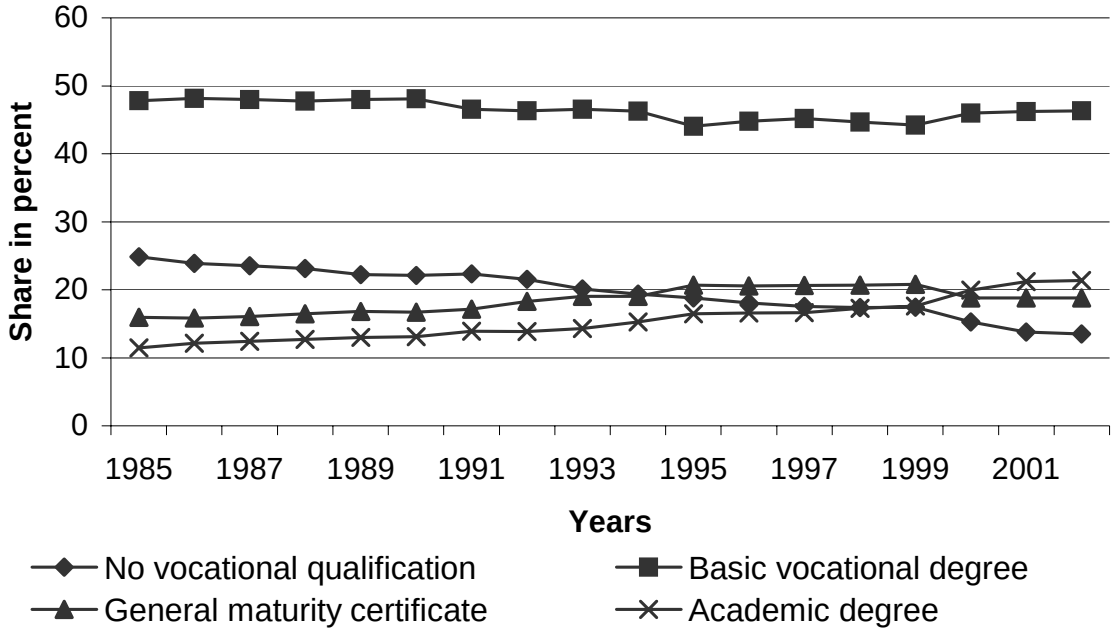
In the figures below, we consider the development of the distribution of educational degrees over time. Using the GSOEP data we examine a relatively long time span (1985 to 2002) for West Germany. For East Germany the data allow to look at the time period 1992 to 2002. Again, the sample includes persons aged 30 to 60. We show the developments using four aggregated educational categories (see the summation lines in Table 1). One obvious pattern reflects the educational expansion of higher degrees.

West Germany

Figure 1 shows that the share of individuals (approximately half of the West German population) holding a professional degree corresponding to the apprenticeship level as the highest educational degree hardly changes over time. While the second largest group used to consist of those individuals not having attained any vocational degree in the beginning of the sampling period, the size of this group has decreased over time and nowadays the smallest proportion of the West Germans belongs to this category. At the same time, the proportions related to higher secondary level degrees comparable to the *Abitur* level and academic degrees increased.

[3] Thus, in the GSOEP questions concerning educational degrees of the East German system are asked in addition to the categories defined for East Germany. However, e.g. the degree of the Fachschule is combined in one category together with the Ingenieurschule. Therefore, the GSOEP does not allow us to distinguish between more detailed categories.

Figure 1: Development of the distribution of qualification levels in the former federal territory (West Germany)



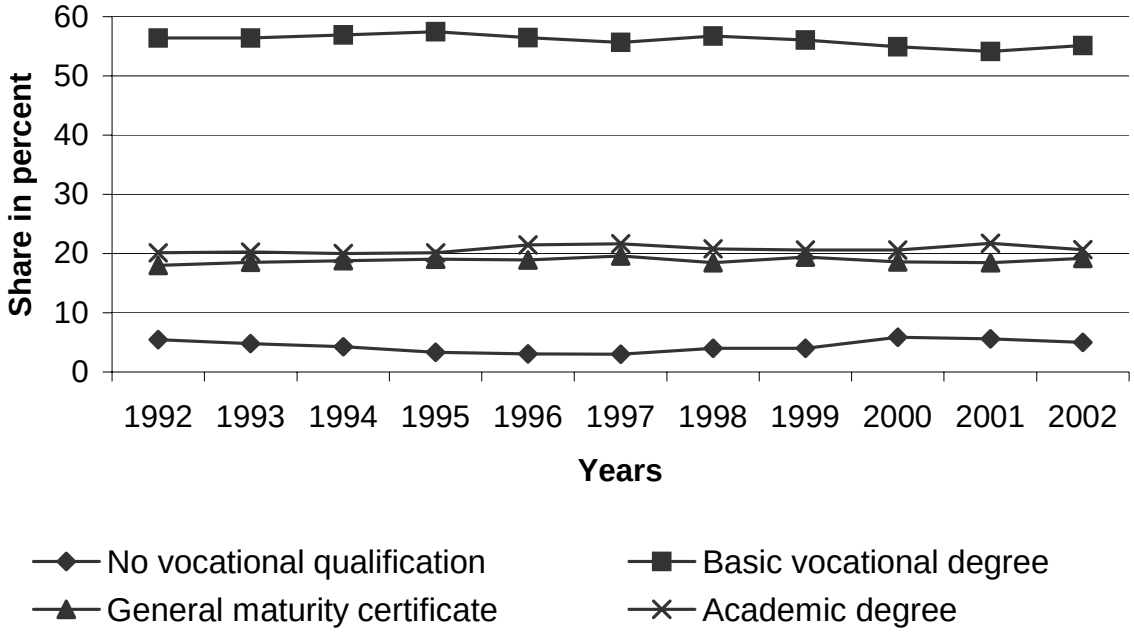
Source: SOEP, waves 1985 to 2002, own calculations.
Note: Share in the four aggregated educational categories of West Germans aged between 30 and 60 years.

Figure A in the appendix distinguishes between male and female individuals. Women are catching up so that the female educational distribution becomes more and more similar to the male distribution. While the proportion of academic degrees increased and the proportion of degrees comparable to the apprenticeship level decreased in the male sample, in the female sample the proportion of academic degrees has risen strongly while the proportion of women holding *Abitur* level degrees increased, too. Thus, the educational expansion is mainly due to the higher educational attainment of women.

East Germany

In East Germany the development of the highest attained educational degrees looks quite stable over time (Figure 2). While academic degrees made up the smallest educational category in West Germany in the beginning of the nineties, already a significant proportion of the East Germans held such a degree during this time (approximately 20 percent). Figure B in the appendix distinguishes between the male and female sub-samples. We do not observe a stronger educational expansion together with a catching-up process of females comparable to the developments in West Germany. In East Germany, the educational distributions of men and women used to be relatively similar in the beginning of the nineties already.

Figure 2: Development of the distribution of qualification levels in the New Laender (East Germany)



Source: SOEP, waves 1992 to 2002, own calculations.
Note: Share in the four aggregated educational categories of East Germans aged between 30 and 60 years.

Distribution of the fields of university degrees

Apart from the formal educational level there is also variation in the subjects of study. The micro-census data allow distinguishing between different subjects of study when looking at academic degrees. Table 2 shows the distribution of major subjects of study based on the sample of individuals holding an academic degree.

Table 2: Distribution of university degrees by field (in 2000)

Field of study	Germany			Old Laender			New Laender		
	Overall	Men	Women	**Overall**	Men	Women	**Overall**	Men	Women
Philology and cultural studies	**13.08**	8.00	21.30	**12.90**	7.87	21.46	**13.69**	8.46	20.85
Studies for teachers	**10.68**	6.07	18.13	**12.16**	6.97	21.00	**5.86**	2.88	9.95
Humanitarian sciences	**18.62**	19.75	16.78	**18.93**	20.86	15.63	**17.60**	15.81	20.05
Natural sciences	**10.03**	11.05	8.39	**10.11**	11.12	8.39	**9.78**	10.80	8.37
Medical science	**6.99**	6.45	7.86	**7.13**	6.76	7.75	**6.54**	5.34	8.18
Engineering science	**23.65**	33.13	8.32	**21.55**	30.80	5.79	**30.50**	41.41	15.56
Arts and music	**3.16**	2.37	4.43	**3.16**	2.30	4.61	**3.15**	2.60	3.91
Other/n.s.	**13.79**	13.18	14.79	**14.06**	13.32	15.37	**12.88**	12.70	13.13
Sum	***100***	*100*	*100*	***100***	*100*	*100*	***100***	*100*	*100*

Source: Micro-census 2000, own computations.
Note: Data for all persons aged between 30 and 60 years. Measured as share of persons who named their field of study or answered „Other/not specified". New Laender include Berlin.

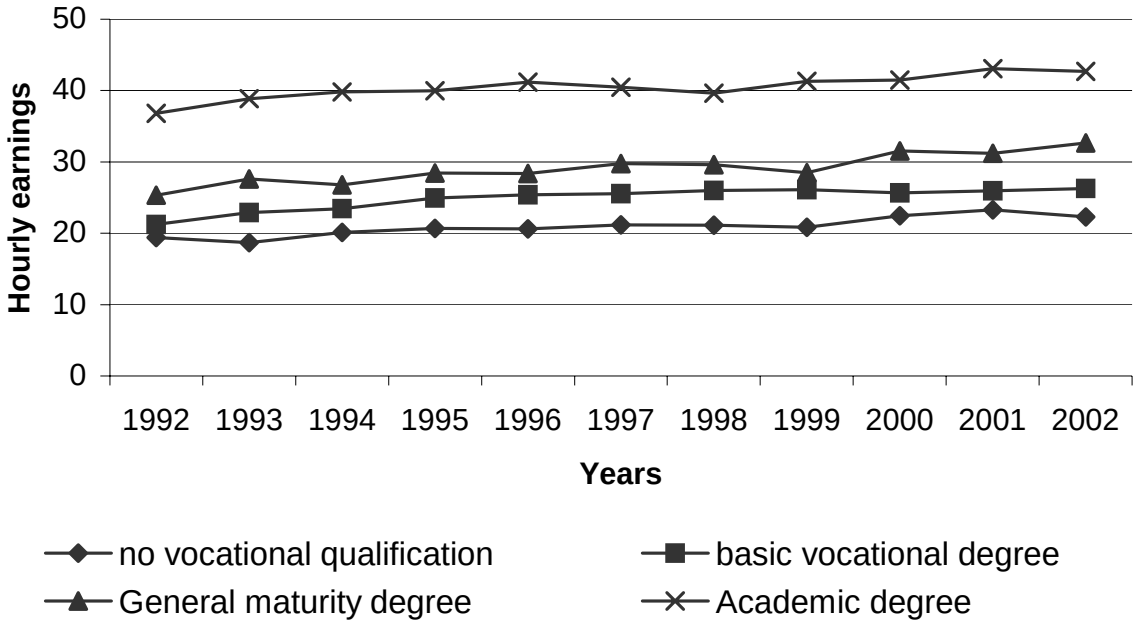
The largest group consists of graduates in engineering sciences (especially if we look at the sample of male graduates) and social sciences. Women most often hold academic degrees in languages and cultural studies as well as teaching. In East Germany the proportion of academics holding an engineering degree is even higher than in West Germany, especially for women.

3.2 Human capital and labor market earnings

In this section, we describe the relationship between labor market earnings and educational attainment using GSOEP data. Figure 3 shows the development of real hourly earnings which are used for the estimation of returns to education in section 4. Hourly earnings are based on total annual income including (Christmas) bonuses and further compensations.[4]

Figure 3 clearly shows that investing in human capital through attaining higher educational degrees is connected to higher labor market incomes. There is a general trend of higher earnings for all educational groups but no larger change between educational groups in the considered time span.

Figure 3: Real hourly earnings by level of qualification



Source: SOEP, waves 1992 to 2002, own computations.
Note: In German Mark, deflated (base year: 1991). Aggregated educational categories. The computations refer to employed persons (without self-employed persons) aged between 30 and 60 years.

Figure C in the appendix presents the real hourly earnings separately for men and women. Women have on average lower earnings at each qualification level than men. A closing of the earnings gap over time is not apparent. A comparison between the hourly earnings in East and West Germany shows that employees in West Germany earn more at each qualification level than in East Germany. The earnings have risen strongly over the observed period in East Germany, while they stayed relatively constant in West Germany.

[4] When looking at East Germany one needs to consider that earnings are observed for a relatively small number of observations especially in the lower educational categories. This yields less precise results.

4 Returns to education

Returns to education measure the value of an investment in education by indicating the yearly returns that are additionally earned through higher labor market earnings as a result of a higher qualificational level. One can distinguish between the average yearly returns of an additional year of schooling and the returns of a specific qualification level. We will further investigate how the subject of study affects the returns to tertiary education.

Using years of education

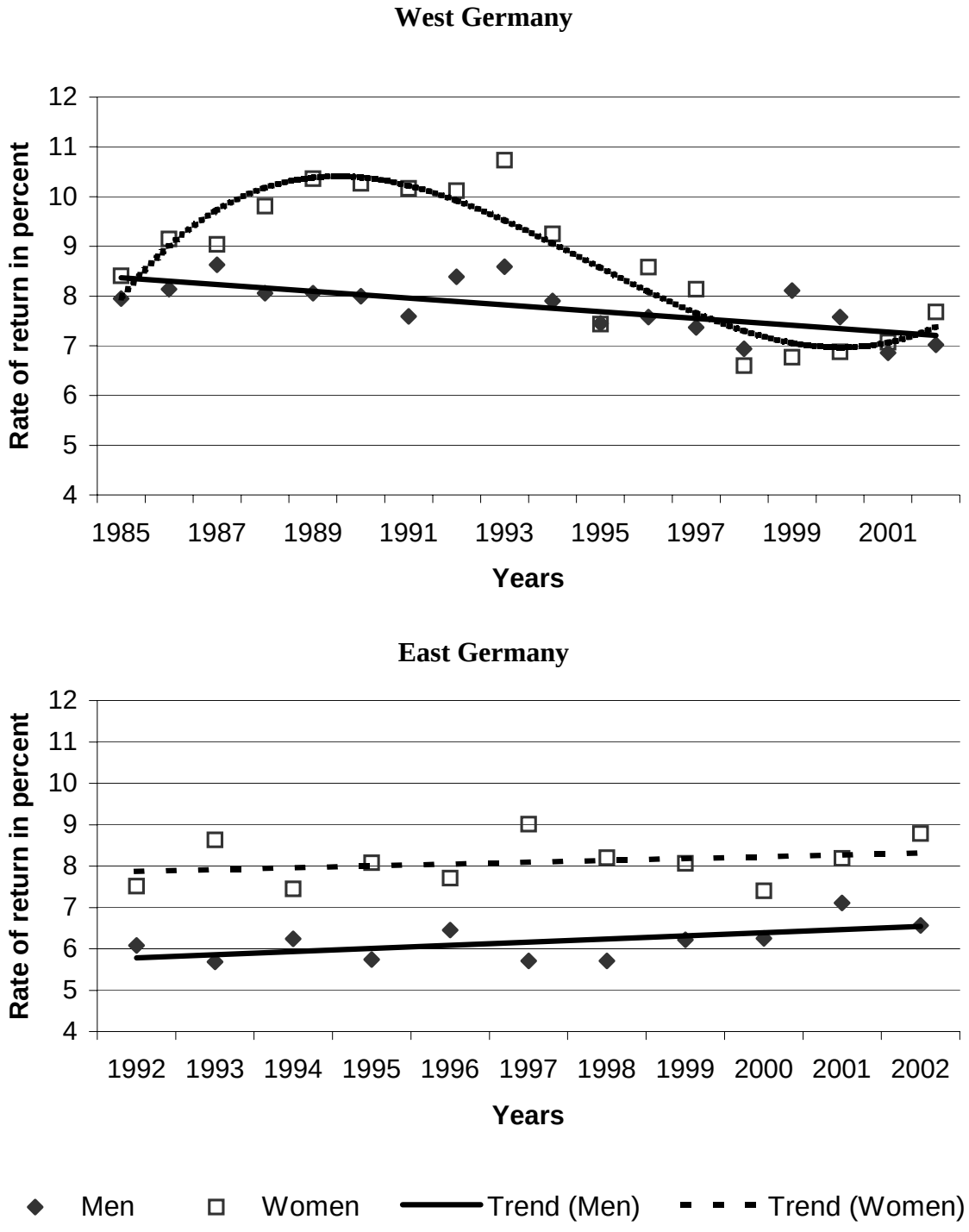
Figure 4 depicts the development of the yearly returns to education separately for West and East German employees and by gender. The values of the returns to education including the values for the whole of Germany are also presented in Table B in the appendix. The coefficients for the years of education in the wage equation, from which the returns to education are calculated, are all highly significant. Table C in the appendix presents an example of the estimates of the wage equation for the year 2002.

The returns to education vary between 8 and 10 percent in West Germany as well as 7 and 8 percent in East Germany. The returns to education for women in West Germany are higher than the returns for men, only around the year 2000 the returns are higher for men. The estimates are comparable to results from previous studies (cf. Lauer and Steiner (2000), who consider the development for West Germany up to 1997).[5]

The returns to education for women in East Germany were higher than for men for the whole period of observation. The returns increased slightly over time for both men and women, while the returns in West Germany fell slightly in the nineties. The returns for West German men were generally higher than the returns for East German men. West German women had higher returns than East German women at the beginning of the observation period, while East German women have higher returns since 1997.

[5] Lauer and Steiner (2000) estimate an average return of 8.3 percent for West German men and 10.5 percent for women over the period 1984-1997 using GSOEP data.

Figure 4: Development of the returns to education by sex and region



***Source**:* SOEP, waves 1992 to 2002, own computations.

Table 3 presents the estimated returns to education for the year 2000, based on the micro-census, which provides only information on net earnings reported in brackets. For Germany, the results are comparable to those from the GSOEP. When we distinguish by region and sex however, the returns differ by about one percentage point between the two data source and men have significantly higher returns than women in East Germany.

Table 3: Annual private returns to education, by sex and region			
	Germany	**Old Laender**	**New Laender**
Male	7.14	7.48	7.48
Female	7.04	7.64	6.57

Source: Micro-census 2000, own calculations.
Note: Rate of return based on classified net income in percent for employed persons aged between 30 and 60 years. New Laender include Berlin.

Using formal qualification levels

This approach accounts for the German educational system, in which formal qualification levels and degrees are of great importance. As indicated above, it considers the highest degree attained instead of the years of schooling. The wage equation now comprises dummies for the different degrees. The estimated returns to each level are divided by the number of years it takes to reach the respective qualification level. Thereby comparable yearly returns to education are calculated which may differ by degree. Hence, it is assumed that the acquired human capital depends on the level and the content of the degree.

Table 4: Annual average returns to level of qualification (in 2002)						
Highest degree obtained	Germany		Old Laender		New Laender	
	Men	Women	Men	Women	Men	Women
Basic vocational degree and comparable	5.33	7.06	7.16	9.09	6.37	4.42
General maturity certificate and comparable	8.28	10.08	8.84	11.43	9.55	10.22
Academic degree	9.67	10.44	10.45	11.31	9.20	10.88

Source: SOEP 2002, own computations.
Note: Returns in percent. The comparison group comprises the categories no degree and lower or intermediate secondary education. The returns to education by degree are divided by the average supplementary years required for the degree compared to the comparison group. The calculations refer to the working population (without self-employed persons) aged between 30 and 60 years.

As can be seen in Table 4, an additional year of education at the tertiary level yields a return of about 10 percent, while an additional year of apprenticeship or maturity degree yields lower returns. The yearly returns to education increase with the level of qualification. The findings are similar to those in Lauer and Steiner (2000). The returns for each category of gender and region can only be compared with caution because the returns to education may differ among the respective reference groups. It seems that female employees benefited more from a higher degree than men. Moreover, the investment in a higher degree yields higher returns in West than in East Germany, relative to the respective reference group of no vocational degree. It should be noted that the share of persons with no vocational degree is lower in East than in West Germany. Generally, the share of persons with an apprenticeship or comparable qualification level is highest in Germany with about 48 percent, followed by tertiary degrees and the maturity degree (see Table 1).

Returns to education by subject of tertiary level degree

One feature of the micro-census 2000 is the information on the subject of tertiary level degree. Therefore, we can distinguish not only between the *levels* of qualification but also by the *subject* of study for the first time in such detail. This differentiation seems reasonable because graduates differ by their prospective earnings and the duration of their studies differs by the

field of study. Furthermore, it helps to compare the financial rewards for different fields of study and to assess the price for specific contents of higher education on the labor market.

Table 5: Annual returns to education by field of university degree (in 2000)

Field of study	Germany		Old Laender		New Laender	
	Men	Women	Men	Women	Men	Women
Education science	6.32*	7.32	7.21*	7.86	7.18	7.96*
Languages	8.23	8.63*	8.33	9.31*	11.22*	8.97*
Theology	4.13*	6.52	4.27*	6.97	6.60	7.56
Studies for teachers	9.73*	11.72*	9.82*	12.55*	9.93	9.88*
Law	11.96*	10.55*	12.46*	11.89*	15.41*	9.46*
Business & econom.	11.45*	7.59	12.66*	9.75	10.20	6.75
Social sciences	7.30*	8.61	8.54	8.90	9.16	10.88
Mathematics	9.60*	9.92*	11.11*	12.00*	10.17*	8.59*
Informatics	10.09*	7.99	11.77*	9.61	8.87	6.56
Physics	10.12*	5.64	11.82*	5.50	9.27	9.02
Biology	8.42	8.37	8.65	9.21	11.68*	8.40
Chemistry	11.06*	5.78	13.03*	7.90	8.55	5.33
Pharmacy	10.14*	6.92	10.47	8.17	13.37	6.23
Geology	8.14	7.74	9.13	8.82	9.65	8.04
Human medicine	11.07*	9.75*	12.17*	10.56*	11.48*	10.24*
Dentistry	6.85	10.51	7.15*	11.38	-	10.85
Veterinary medicine	10.05	7.30	12.71*	9.07	11.50	6.74
Agricultural science	5.96*	3.47*	8.94	6.37	5.13*	2.52*
Electrical engineering	8.99*	6.15	10.89*	8.86	7.35	5.48
Construction engineering.	7.52	4.29*	8.90	5.27*	8.29	4.76*
Transport engineering	7.32	4.81	9.68	4.10	8.64	6.64
Architecture	7.68	5.83	8.06	6.75	8.74	5.48
Machine engin.	8.91*	4.68*	10.99*	9.41	6.86*	3.89*
Other engineering science	7.55	4.93*	9.86*	8.44	6.96*	3.97*
Arts and Music	6.05*	6.46	6.91*	7.56	6.54	5.64

Source: Micro-census 2000, Statistisches Bundesamt (2003), own computations.

Note: Rate of return in percent. The comparison group comprises the categories no degree and lower or intermediate secondary education. The returns to education by degree are divided by the average supplementary years required for each degree compared to the comparison group, using subject-specific weighted averages of study time in technical colleges and universities (Statistisches Bundesamt, 2003). New Laender include Berlin. The calculations refer to the working population (without self-employed persons) aged between 30 and 60 years. A * indicates that the rate of return differs at the 5-percent-significance-level from the rate of return of residual university degrees, which amounts to 8.01 for men and 6.88 percent for women throughout Germany.

Table 5 presents the returns to education for various fields of study.[6] The yearly returns are highest for the fields of law and medicine. The lowest returns can be observed for theology, agricultural science and arts and music. For men, also the studies of business and economics, natural sciences and some engineering degrees yield high returns of over nine percent. For women instead, returns to engineering degrees are rather low, especially in East Germany, while the returns for studies to become teacher are highest. When we recall the distribution of university degrees (Table 2), it is obvious that each gender reaches higher returns relative to the other gender in those subjects, where its share of degrees is relatively high. The prime examples are engineering studies for men and studies to become teacher for women. This would imply that it is not worthwhile for either men or women to choose a field of study which is dominated by the opposite gender.[7]

The returns for men in West and East Germany are roughly comparable. Noteworthy is the high return of 15 percent for law in East Germany, which may be due to the high demand for lawyers and administrators with law degree after unification. Women have higher returns in most subjects in West than in East Germany, especially in engineering, in which women's share is three times higher in East than in West Germany.

Returns to education and selection into employment

Only the sample of employed persons, for which earnings are observable, has been used so far for estimating the returns to education. Returns to education can also be estimated for the entire population (including the non-employed) by accounting for the selection into employment. Therefor the selection into employment has to be modeled before estimating the returns to education including the probability to be employed in the wage equation (see Heckman, 1976, 1979). Otherwise the returns may be biased due to selectivity.

[6] It should be noted again that the micro-census provides only information on net monthly income in brackets. The earnings are transformed into hourly earnings. Persons whose main source of income is not earnings are not included in the analysis. Due to the limited information on earnings the level of the returns should be interpreted with caution. The detailed classification into fields of study leads to few observations for smaller fields, so that not all results are representative.

[7] This effect could also be due to negative selection of students into fields of study.

Table 6: Comparison of the estimates of the returns to education with and without correction for selectivity, 2002

	G e r m a n y	Old Laender	New Laender
Rate of return, with correction of the selection	7.85 %	7.74 %	6.67 %
Rate of return, without correction of the selection	7.49 %	7.70 %	7.57 %
T test on coefficients equality	0.7136	0.0478	0.8698
Inverse Mills factor (standard error)	0.1048 (0.0540)	0.0107 (0.1690)	-0.2110 (0.0644)
Wald test, independence of equations (likelihood > χ^2)	3.74 (0.0532)	0.00 (0.9493)	9.33 (0.0022)
Collinearity test: R^2	0.6768	0.5932	0.6235

Source: SOEP 2002, own computations.
Note: The T-test checks the hypothesis that the coefficients are equal (with statistical significance). A value of at least 1.96 would signify that the hypothesis of equal coefficients can be rejected at the 5 percent-significance-level. The inverse Mills factor results from the estimation of the selection equation of employment and is used as regressor in the wage equation, according to the correction for selectivity after Heckman (1976, 1979). The Wald-test checks for independence of the wage and employment equation. The level of significance at which the hypothesis of independence is rejected is stated in parenthesis. The Collinearity test refers to the regression of the inverse Mills factor on the regressors of the wage equation and can be interpreted as a sign for the quality of the instruments of the selection equation, which are weaker the more the value is close to 1.

Table 6 presents the estimates of the returns to education including the correction for selectivity for the year 2002 and compares them to the estimates without any correction. Table 7 additionally presents the returns separately for men and women.

Table 7: Comparison of the estimates of the returns to education with and without correction for selectivity, 2002 (by sex)

	O v e r a l l	M e n	W o m e n
Rate of return, with correction of the selection	7.85 %	6.59 %	6.74 %
Rate of return, without correction of the selection	7.49 %	6.89 %	7.64 %
T test on equality of coefficients	0.7136	-0.4561	-1.297
Inverse Mills factor (standard error)	0.1048 (0.0540)	-0.1776 (0.1054)	-0.4705 (0.0314)
Wald test, independence of equations (likelihood > χ^2)	3.74 (0.0532)	2.48 (0.1151)	121.64 (0.0000)
Collinearity test: R^2	0.6768	0.6179	0.4557

Source: SOEP 2002, own computations.

The results show that the estimates with and without correction for selectivity do not differ significantly for the cross-section of 2002. This also holds when the returns are estimated separately for each gender. Consequently, the estimates that have been presented so far do not have to be corrected (see identical results in Lauer and Steiner, 2000). The Wald-test for independence between the wage and selection equation shows that a certain selection seems to exist, i.e. employed individuals differ from non-employed individuals. However, this selection seems to lead to no bias in the estimated returns to education in 2002.[8]

[8] For West Germany the Wald-test implies that no selection exists in the year 2002.

5 Conclusion

Educational attainment and labor market outcomes are closely linked and both of high importance for modern societies. The analysis has shown that the distribution of qualification levels in Germany differs by gender and region. Men attain on average a higher qualification level than women, who more often have no vocational degree. In West Germany the share of persons with low degrees is higher than in East Germany, while persons living in East Germany more often have an apprenticeship or maturity degree. The differences between men and women are higher in West than in East Germany.

Concerning the development over time, an educational expansion is apparent. The share of tertiary level degrees increases continuously, while the share of persons with no vocational degrees decreases. The differences between men and women decrease over time as well. The educational expansion was especially strong for women in West Germany in the period 1985-2002 and is coherent with higher estimated returns to education for women in this time period. Women possibly had a higher incentive to invest in education in these years because their investment led to a high return on the labor market. The qualification level in East Germany stayed relatively constant on a high level, to which West Germany is approaching over the last decades. However, it is doubtful whether the qualification levels in West and East Germany and the skills that have been transmitted thereby are truly comparable.

The distribution of the fields of university degrees shows that the largest share of graduates (of almost one quarter) studied fields related to engineering. Similarly, relatively high shares of students graduated in languages and cultural studies. The latter is the most prominent degree for women, followed by studies to become teacher. The main difference between East and West Germany is the share of graduates in the field of engineering, which is higher in East Germany for both men and women.

The returns to education range from 8 to 10 percent in West and 7 to 8 percent in East Germany over the period 1985-2002. While the returns for women in West Germany were above the returns for men for most years, higher returns can be reported for men around the year 2000. In 2002, returns are higher for women again. Comparing the returns between West and East Germany shows higher returns for West German employees. It is noteworthy that the returns for an apprenticeship in East Germany are well below those in West Germany, while a higher share of employees in East Germany has invested in this qualification level. The estimates based on the micro-census are comparable to those estimated from the GSOEP for Germany. When we distinguish by region and gender, the estimates differ slightly.The reader should be reminded that the returns to education are estimated using Mincer equations. Due to the possible endogeneity of educational attainment the results should be interpreted cautiously.

The estimated returns to education by subject of degree are coherent with the distribution of subjects of degrees because each gender reaches the highest returns in those fields where its share is relatively high. For women this is in the fields of studies to become teacher, while for men this is law, business and economics and engineering. Especially for women the returns are higher in most subjects of degrees in West than in East Germany.

Literature

Ashenfelter, O. and C. Rouse (1998), Income, Schooling and Ability: Evidence from a New Sample of Identical Twins, *Quarterly Journal of Economics* 113 (1), 253-84.

Ashenfelter, O., C. Harmon and H. Oosterbeek (1999), A Review of Estimates of the Schooling/Earnings Relationship, with Tests for Publication Bias, *Labour Economics* 6 (4), 453-470.

Bellmann, L., A. Reinberg and M. Tessaring (1994), Bildungsexpansion, Qualifikationsstruktur und Einkommensverteilung, in: R. Lüdeke (ed.), *Bildung, Bildungsfinanzierung und Einkommensverteilung II*, Berlin.

Card, D. (1995), Earnings, Schooling and Ability Revisited, in: S. Polachek (ed.), *Research in Labor Economics* 14, Greenwich, JAI Press, 23-48.

Card, D. (1999), The Causal Effect of Education on Earnings, in: O. Ashenfelter and D. Card (eds), *Handbook of Labor Economics*, Vol. 3A, Amsterdam, North Holland.

Dustmann, C. and A. van Soest (1998), Public and private sector wages of male workers in Germany, *European Economic Review* 42, 1417-1441.

Franz, W. and V. Steiner (2000), Wages in the East German Transition Process – Facts and Explanations, *German Economic Review* 1 (3), 241-269.

Haisken-DeNew, J. und J. Frick (2003), Desktop Companion to the German Socio-Economic Panel Study, DIW Berlin, Version 7.

Harmon, C, H. Oosterbeek and I. Walker (2000), The Returns to Education: A Review of Evidence, Issues and Deficiencies in the Literature, Discussion Paper 5, Centre for the Economics of Education, London School of Economics.

Heckman, J. (1976), The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for Such Models, *Annals of Economic Social Measurement* 5 (4), 475-492.

Heckman, J. (1979), Sample Selection Bias as a Specification Error, *Econometrica* 47 (1), 153-161.

Heckman, J., L. Lochner and P. Todd (2003), Fifty Years of Mincer Earnings Regressions, NBER Working Paper No. 9732, Cambridge.

Jochmann, M. and W. Pohlmeier (2004), Der Kausaleffekt von Bildungsinvestitionen: Empirische Evidenz für Deutschland, Diskussionspapiere der Forschergruppe 'Heterogene Arbeit' 04/05.

Lauer, C. and V. Steiner (1999), Returns to Human Capital in Germany: Review of the Empirical Literature, in: Asplund. R. and P. Pereira (eds.), *Returns to Human Capital in Europe. A Literature Review*, 125-144, The Research Institute of the Finnish Economy.

Lauer, C. and V. Steiner (2000), Returns to Education in West Germany – An Empirical Assessment, ZEW Discussion Paper No. 00-04, Mannheim.

Lauer, C. (2003), Familiy Background, Cohort and Education. A French-German Comparison based on a multivariate ordered probit model of educational attainment, *Labour Economics* 10, 231-251.

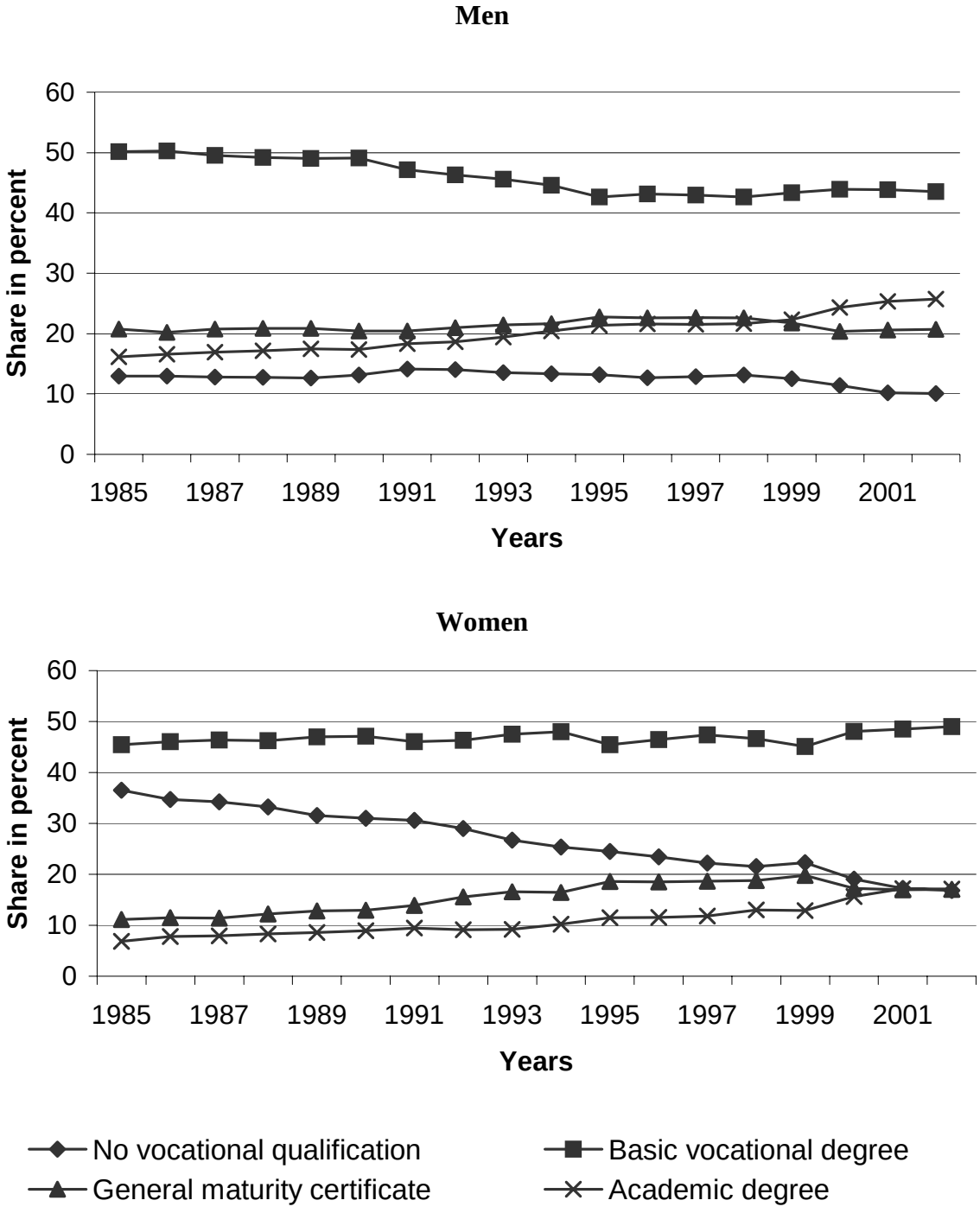
Mincer, J. (1974), Schooling, Experience, and Earnings, National Bureau of Economic Research, New York.

Pfeiffer, F. (1999), Labour market specialisation and earnings of engineers and scientists in Germany, in: OECD, Mobilising human resources for innovation. Proceedings from the OECD workshop on science and technology labour markets 17 May 1999, Paris, 77-90.

Statistisches Bundesamt (2003), *Bildung im Zahlenspiegel 2003*, Wiesbaden.

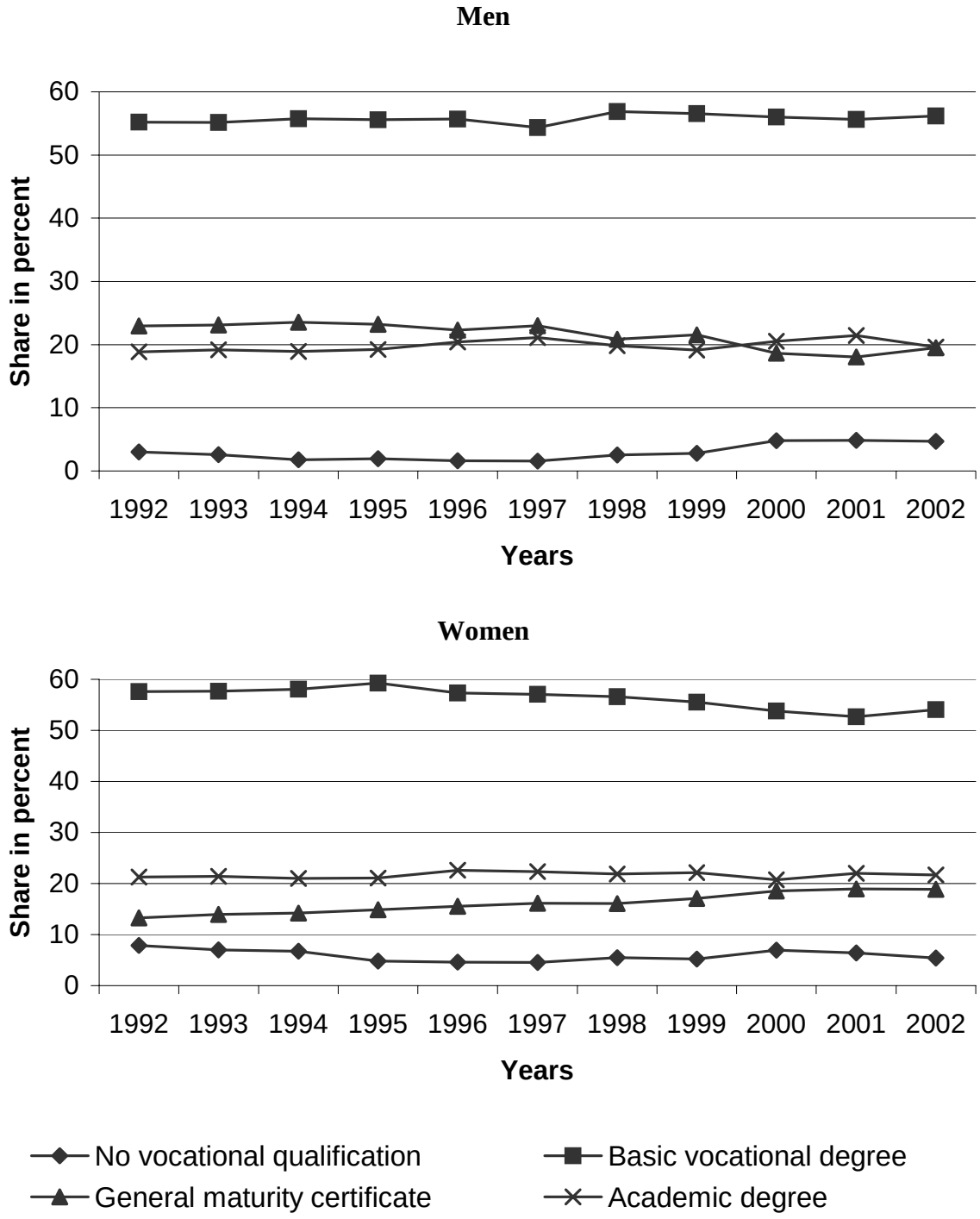
Appendix

Figure A: Development of the distribution of qualification levels in West Germany by sex



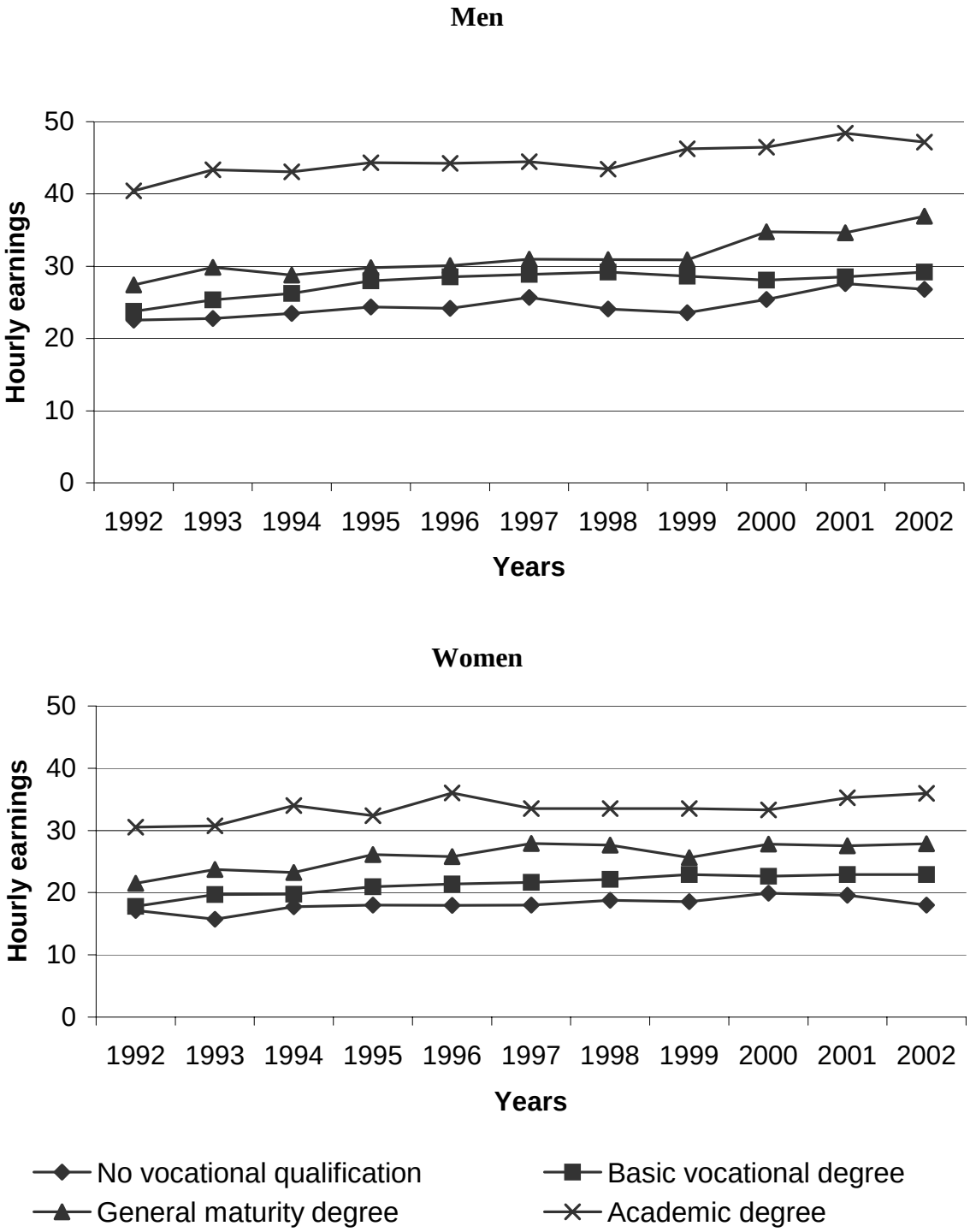
Source: SOEP, waves 1985 to 2002, own calculations.
Note: Share in the four aggregated educational categories of West German men and women aged between 30 and 60 years.

Figure B: Development of the distribution of qualification levels in East Germany by sex



Source: SOEP, waves 1992 to 2002, own calculations
Notes: Share in the four aggregated educational categories of East German men and women aged between 30 and 60 years.

Figure C: Real hourly earnings by level of qualification and sex



Source: SOEP, waves 1992 to 2002, own computations.
Note: In German Mark, deflated (base year: 1991). Aggregated educational categories. The computations refer to employed persons (without self-employed persons) aged between 30 and 60 years.

Table A: Status quo of the distribution the level of qualification, 2000, by sex and region (in percent)

Highest degree obtained	Germany			Old Laender			New Laender		
	Overall	Men	Women	**Overall**	Men	Women	**Overall**	Men	Women
No vocational qualification									
No degree	**2.32**	2.16	2.47	**2.57**	2.38	2.76	**1.42**	1.39	1.46
Lower secondary education	**12.39**	9.15	15.64	**14.67**	10.80	18.53	**4.33**	3.33	5.35
Intermediate secondary education	**3.29**	2.27	4.31	**3.21**	2.00	4.42	**3.58**	3.21	3.94
Summation	***18.00***	*13.58*	*22.42*	***20.45***	*15.18*	*25.71*	***9.33***	*7.93*	*10.75*
Basic vocational education									
Lower secondary education + basic vocational degree	**27.37**	29.95	24.79	**31.21**	34.37	28.06	**13.78**	14.45	13.11
Intermediate secondary education + basic vocational degree	**21.85**	19.03	24.67	**16.75**	12.99	20.49	**39.92**	40.25	39.58
Summation	***49.22***	*48.98*	*49.46*	***47.96***	*47.36*	*48.55*	***53.70***	*54.70*	*52.69*
Intermediate qualification									
Vocational maturity certificate	**11.03**	12.50	9.56	**9.69**	12.10	7.28	**15.79**	13.90	17.70
General maturity certificate	**1.97**	2.00	1.93	**1.93**	2.01	5.28	**2.08**	1.96	2.21
General maturity certificate + vocational degree	**4.59**	4.16	5.01	**5.06**	4.52	2.17	**2.91**	2.91	2.91
Summation	***17.59***	*18.67*	*16.49*	***16.68***	*18.64*	*14.73*	***20.78***	*18.77*	*22.81*
Tertiary level qualification									
Lower tertiary education / school of engineering	**6.19**	8.25	4.13	**6.04**	8.35	3.74	**6.72**	7.89	5.53
(Technical) University	**7.71**	8.70	6.72	**7.55**	8.57	6.53	**8.30**	9.18	7.41
Ph.D.	**1.29**	1.82	0.76	**1.32**	1.91	0.74	**1.17**	1.53	0.80
Summation	***15.19***	*18.77*	*11.61*	***14.91***	*18.83*	*11.01*	***16.19***	*18.60*	*13.75*

Source: Micro-census 2000, own computations.
Note: The calculations refer to the population aged between 30 and 60 years. New Laender include Berlin.

Table B: Development of annual returns to education (in percent)						
	Germany		**Old Laender**		**New Laender**	
	Men	Women	Men	Women	Men	Women
1985	n/a	n/a	7.95	8.41	n/a	n/a
1986	n/a	n/a	8.14	9.15	n/a	n/a
1987	n/a	n/a	8.63	9.04	n/a	n/a
1988	n/a	n/a	8.06	9.81	n/a	n/a
1989	n/a	n/a	8.06	10.36	n/a	n/a
1990	n/a	n/a	8.00	10.27	n/a	n/a
1991	n/a	n/a	7.59	10.17	n/a	n/a
1992	7.60	7.03	8.39	10.12	6.08	7.52
1993	7.86	8.16	8.59	10.73	5.68	8.63
1994	7.40	7.40	7.90	9.25	6.24	7.45
1995	7.01	6.75	7.45	7.44	5.74	8.08
1996	7.22	7.53	7.58	8.58	6.45	7.71
1997	6.75	7.54	7.37	8.14	5.71	9.01
1998	6.67	6.35	6.94	6.60	5.71	8.21
1999	7.70	6.49	8.11	6.77	6.22	8.07
2000	7.16	6.63	7.58	6.88	6.25	7.40
2001	6.79	7.02	6.86	7.07	7.11	8.19
2002	6.89	7.64	7.02	7.68	6.56	8.78

Source: SOEP. Waves 1985 to 2002. Own computations.
Note: (n/a = not available). Rates of return based on hourly wages in percent for West German employed persons (without self-employed persons) aged between 30 and 60 years.

Table C: Exemplarily: Results of the wage equation estimation for the year 2002 (least squares estimation, dependent variable: logarithmic hourly wage)		
Variable	Estimated coefficient	Standard error
Number of school years	0.07	0.00
Potential professional experience in years	0.02	0.00
Square of the potential professional experience in years	-0.00	0.00
Constant	2.12	0.00
Number of observations	7072	
R^2	0.15	

Source: SOEP, waves 1985 to 2002, own calculations.
Notes: (n/a = not available). Rates of return based on hourly wages in percent for West German employed persons (without self-employed persons) aged between 30 and 60 years. All coefficients are significant at the 5-percent-level.