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An Integrated Approach

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Preface

This study is an empirical assessment of continuing vocational training in Germany and discusses determinants and consequences of training. The work described in this dissertation was carried out at the Centre for European Economic Research (ZEW). I am very grateful to my supervisor Prof. Dr. Dr. h.c. mult. Wolfgang Franz, who supported and encouraged me throughout this work. I would like to thank him for always having a sympathetic ear to my questions and for very helpful assistance. I am also indebted to Prof. Dr. Walter Oechsler, who kindly accepted to be my second supervisor. My work benefited from discussions with him and his doctoral students.

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Mannheim, April 2007 *Anja Kuckulenz*

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1

Introduction

Countries endowed with higher education tend to experience faster growth. The main investment in education after schooling (including tertiary education) is continuing training. Schooling and training together make up the prevailing skill formation in a developed economy. Education (and therefore also training) affects the productivity of an economy in several ways. First, education is important for successful research activities which, in turn, enhance growth. Second, education produces human capital, i.e. knowledge accumulation, and therefore productivity growth. Investments in human capital are, thus, a core element of a knowledge-based society and crucial for sustained economic growth. While primary and secondary education has been in the focus of researchers for many years, there is far less profound evidence on continuing training. James Heckman declares continuing training to be a blind spot in the vision of politicians and policy analysts: "[...] the work experience and skills acquired in the workplace in the form of job search, learning by doing and workplace education are often neglected in popular discussions because they are not well measured. Post-school learning is an important source of skill formation that accounts for as much as one third to one half of all skill formation in a modern economy. Because much of this learning takes place in informal settings outside of educational institutions, it gets neglected by the educational technocrats and the politicians who equate skill formation with classroom learning. Once we recognise the importance of informal sources of learning for skill formation, we think about policies to foster skill in a different way" (Heckman, 2000: 6).

Against the background of international competition, continuing training and its impact on productivity are the centre of interest in academia as well as in public discussions. Moreover, it is recognised by now that continuing training and its impact on labour market outcomes are anything but homogeneous.

In particular, there are large differences in training participation rates for low- and high-skilled workers and also with respect to other personal, job and firm characteristics. The impact of training on productivity and wages

is heterogeneous in terms of observed and unobserved characteristics. Besides differences regarding training participants, also the type of training is important to consider. In analysing the impact of training on labour market outcomes, a broader approach should be taken which includes external effects of continuing training. Hence, the prerequisite of informed discussion and policy advice on continuing training is a sound theoretical and empirical analysis of relevant features taking heterogeneity into account. This is what this work is devoted to.

It is often claimed that upgrading workers' skills could help to meet the challenges entailed in technological and structural change as well as population ageing. The German Council of Economic Experts (*Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung*) stated in its annual report for 2000/2001 that firms will have to meet challenges and compete with their ageing workers. The fact that the participation rate of older workers in continuing training is currently so low is due on the one hand to youth-centred personnel management and on the other to workers' anticipation of early retirement. This implies barriers to activate the whole potential of human capital in the economy. Neither youth-centred personnel policies nor early retirement are sustainable if economic and demographic conditions change (Sachverständigenrat, 2000: 219).

The OECD points to the same challenge and asks for more detailed knowledge on lifelong learning and continuing training after schooling and formal education: "While much is known about what governments and individuals expend to promote learning within formal education institutions, far less is known about the extent of learning at the workplace or in other settings outside formal education and after the completion of initial education" (OECD, 2002: 247).

In the following chapters, single topics are discussed that are particularly important for learning at the workplace or in other settings outside formal education. Specifically, the determinants of training participation as well as the consequences of an investment in skill formation are empirically investigated. Important questions surrounding continuing training to be answered are:

A) Determinants of continuing vocational training

- Who participates in continuing training? Do firms invest in training older employees?
- Do firms provide continuing training mainly when they face the pressure of competition? Or do firms see continuing training as a long-term investment in human capital?

B) Consequences of continuing vocational training

- Does heterogeneity matter for the wage effect of training? Do some groups of employees profit more from training than others? What is the reason for this difference?

- Does continuing training aggravate differences between skill groups? Do low-educated employees fall further behind during their professional life? To what extent are schooling and continuing training complementary?
- Does continuing training really lead to human capital formation or is it more of a signalling or motivational instrument?
- Can firm-provided continuing training also be used in other firms? To what extent does it provide general/specific knowledge?
- Is there a difference between individual and social returns to continuing training which would suggest governmental intervention in order to internalise external effects of continuing training?

Ultimately, this study aims at contributing to the debate on reforms of the educational system and the organisation of the labour market in the light of technical change and globalisation. It also provides prerequisites for an informed discussion on continuing training. Lifelong learning is one of the educational matters concerning policy makers in all industrialised countries as it constitutes an important building block of the educational system. The importance of heterogeneity of training participation and of returns to training has been recognised by now and will be brought into focus throughout all chapters.

In chapter 2, I start with a general introduction on continuing training in Germany and emphasise how training is defined in empirical research. This sets the stage for chapters 3, 4, and 5, where specific issues concerning continuing training that are debated in academia as well as in public are discussed. Chapter 3 presents wage effects of continuing training. In contrast to many former studies, which calculate only the average effect of continuing training, I explicitly account for the heterogeneity of training participants. Additionally, different types of training that vary in the degree of firm specificity are considered here. This difference between general and firm-specific training is picked up in chapter 4. Here, the study elaborates on determinants and consequences of these two training forms, and it is tested to what extend continuing training in Germany has a firm-specific component. In chapter 5, wage and productivity effects of training are compared in order to find out how the training rent is shared between employer and employee. In addition, this comparison enables me to estimate whether there exist positive externalities of continuing training between employees as suggested by parts of the literature on education. In the following, the single sections are briefly outlined.

Chapter 2 overviews continuing training in Germany with a focus on continuing training in empirical research. In section 2.1, the main building block of the literature on continuing training – human capital theory – is introduced. An overview of the training literature is provided while specific topics are discussed in each section.

Section 2.2 provides an introduction to educational policy in Germany and describes the legal background of further education. Continuing training is an important measure of active labour market policy in Germany. It is not part of

the later analysis in this study, where only (firm-related) continuing training for employees is discussed; government-provided training for the unemployed is excluded. Nevertheless, the importance of this measure in active labour market policy is briefly discussed. Besides, the potential financial support for continuing training that firms or individuals can receive from governmental or other institutions are listed. As it is also shown, continuing training is a topic in a number of collective agreements. The section on the institutional background concludes with a description of the suppliers of continuing training.

Section 2.3 presents a description of the empirical relevance of continuing training in Germany using an international comparison. Afterwards, information on training incidence and on the costs of continuing training in Germany is provided.

Section 2.4 gives an insight into continuing training in empirical research. Empirical work on continuing training in Germany provides surprisingly divergent evidence of the incidence of training. This makes it difficult to compare different econometric analyses of the impact of training on labour market outcomes difficult. Three large German data sets are used to study training incidence, determinants of training, and the correlation between continuing vocational training and wages. Results are compared in order to analyse the extent to which differences in estimated wage effects of continuing vocational training are due to the data set used and how the training variable is defined. This exercise provides important help for two problems. It serves to find the data set that fits best in answering certain research questions on continuing training, and beyond, it allows for hints on the degree of caution I need to employ when interpreting empirical results from different sources.

Chapter 3 discusses the heterogeneity of the wage effect of training and provides empirical evidence. In particular, section 3.1 discusses why heterogeneity should not only play a role in training participation but also in the wage effect of training. It points to the endogeneity problem researchers face when evaluating the impact of continuing training on wages. Unobserved heterogeneity induces the endogeneity problem because third factors influence training participation and wages simultaneously. Instrumental variable estimation is capable of solving the endogeneity problem; and using a full set of interaction terms enables me to estimate heterogeneous wage effects. The empirical results suggests that, first, wage effects of training are positive on average. Second, wage effects of training are heterogenous. Third, wage effects differ by skill group and other personal, firm, and job characteristics.

Section 3.2 uses the same methodology to investigate sector differences in the effects of training. Continuing training in personal services is analysed in detail and compared to the economy as a whole. The personal services sector is particularly interesting because it is a growing low-wage sector. Results suggest that training participation in personal services is not lower than average participation in the economy as a whole. On average, however, there is no impact of continuing training on wages in the personal services sector.

In section 3.3, the analysis of section 3.1 is extended by allowing for selection on unobservables. In particular, the expected return to training, which partly depends on unobservable characteristics, is likely to be a crucial criterion in the decision whether to take part in a training measure. It is accounted for the likely possibility that workers' selection into training measures is based on unobserved heterogeneity by using recent advances in estimating returns to schooling, which allow for selection on unobservables, and apply it to the estimation of the impact of training on earnings. Allowing heterogeneity to be unobserved by the econometrician, but assuming that individuals may act upon this heterogeneity, completely changes the interpretation and properties of commonly used estimators.

Section 3.4 analyses the effect of different types of training on wages. It is distinguished between two types of training: internal and external training. The former includes training inside firms (e.g., quality circles) while the latter comprises training taking part outside firms (e.g., attending trade fairs). Results suggest that internal training, which seems to be mainly firm-specific, has no impact on wages. External training, in contrast, which seems to be mainly general training, has a positive impact on wages.

Section 3.5 concludes chapter 3 with a short summary of the results of the individual sections. In all sections, heterogeneity in wage effects of continuing training is shown to be crucial. Differences between skill and age groups as well as with respect to other personal, job, and firm characteristics are shown. Since low-skilled have a lower chance to participate in training and profit less from participation, a focus is set on this group. The personal services sector, a low-wage sector, is examined in detail, and results show that in this sector, the average effect of training on wages is lower compared to the entire economy. Taking selection into training into account increases the estimated training coefficient slightly but does not qualitatively change the results. In the empirical analysis, allowing for the possibility that individuals consider the expected returns to training reduces the estimated return to training. This finding shows that probably those individuals who have a high-expected return to training choose to participate. In addition, evidence for heterogeneity of the wage effect of different training forms is presented. Training of a mainly general nature has a positive effect on wages while training including mainly firm-specific contents does not affect wages.

Chapter 4 focusses on how mobility between jobs may change the relation between continuing training and wages described in previous chapters. This offers insights on the firm-specificity of training. In more detail, the relationship between training, mobility, and wages is empirically analysed in two ways. First, the correlation between training and mobility is examined. Mobility is expected to increase or to remain unchanged if training provides mostly general human capital while a decreasing mobility is expected when training is mostly specific and not transferable between employers. Second, wage effects of mobility allowing for training participation are considered. I expect job change after general training to have a positive or zero wage effect,

while specific capital should decrease wages or will have no effect after a job change because a new employer will not reward the human capital that is unproductive in the new job.

The empirical evidence suggests that training does inhibit some specific capital. The probability of being mobile is negatively correlated with the probability of participating in training. Furthermore, both the partial correlation and the wage effects of (exogenous) mobility are negative for the group of training participants while there is no effect for the group of non-training participants. Finally, participation in training negatively affects the probability that the individual – subjectively – is better off after a job change.

Chapter 5 estimates and compares wage and productivity effects of continuing training in order to analyse who gains from workers' training. Investments in continuing training are undertaken in order to raise the level of qualification in a firm and to secure its economic performance. There are also arguments for subsidising continuing training relating to the society's social and economic benefits from such investments which ought to boost productivity and growth. The main argument are the positive external effects of continuing training which induce welfare gains and technological progress.

Whether these investments in training are profitable to the individual, the firm, and society as a whole is still unclear although the question is of considerable importance. Most studies on the productivity impact of training take wages as a proxy for productivity. The focus of this chapter is on comparing wage and productivity effects in order to study how the training rent is shared between employers and employees. The use of advanced econometric techniques allows me to account for endogeneity and time-invariant, unobserved factors.

In more detail, wage and productivity effects are estimated and compared using panel data on the industry level in order to analyse the extent to which employer and employees gain from continuing training. The study demonstrates that the rent-sharing aspect of training is important for employer and employees in Germany. Results suggest that both employer and employees profit from the investment in human capital. The estimated productivity effects of training are higher, on average, than the wage effects.

Since the estimated effect of continuing training on productivity exceeds the effects estimated by comparable studies using firm level data, my results hint to the existence of external effects of training on a sector level, that is, spillovers from training between firms in the same sector.

The results in chapter 3 suggested that skill group heterogeneity of the training impact on wages should be considered. In order to shed light on this issue and to analyse whether the impacts of participating in training on wages and on productivity differ for low- and high-skilled workers, I differentiate between these two groups in section 5.6. This extension makes it possible to analyse whether there are spillovers between the two skill groups. It is tested whether training participation of high-skilled has an influence on wages of low-skilled or the other way around.

High-skilled workers seem to capture a larger share of the rent than low-skilled workers. This result is consistent with the findings in chapter 3. In addition, no positive external effects of firm-provided training between employees of different skill groups are found. Therefore, the empirical evidence suggests that there are no spillovers from continuing training between skill groups.

Chapter 6 sums up and interprets the results. Policy-relevant findings are emphasised in order to provide a basis for an informed discussion on continuing training in Germany.

Overall, this research aims at carrying out an in-depth analysis of continuing training attainment in Germany and its consequences on individual labour market outcomes as well as on firms' added value. The extent and nature of heterogeneity between skill groups is carefully examined in all the chapters. Observed differences in continuing training attainment and in the wage effects of training are accounted for. Heterogeneity between skill groups is analysed. Differences in personal, firm, job characteristics, and other attributes are also examined carefully. In addition, this study allows for selection on unobservables.

By revealing the heterogeneity of the wage effect, by taking job mobility into account, and by comparing it to the productivity effect, this study adds to the empirical literature on continuing training in Germany in three main fields. First, it is shown in detail who participates in continuing training and which participants profit from training in terms of higher wages. Second, heterogeneity of skill participants (most importantly with respect to qualification) in training participation as well as in returns to training is examined carefully. In addition, differences between general and specific training are taken into account. Third, with the analysis on the industry level, externalities from training are captured that are missed out in other micro-level studies.

In the analysis, rich representative data sets are used that include abundant information on personal, firm, and job characteristics. I apply advanced econometric methods which account for endogeneity. Thus, I provide evidence for the importance of a differentiated analysis of continuing training, which the OECD called for in its Employment Outlook 2004: "Still, little is known about the labour market impact of adult learning. To what extent do workers who receive training enjoy better job prospects to the detriment of their non-trained counterparts? Are the effects different across demographic groups and what do empirical findings suggest as regards lifelong learning strategies?" (OECD, 2004: 183).

Finally, this study aims at giving policy advice concerning firm-provided continuing training by revealing some specific possibilities of government intervention. Policy suggestions on three main issues are offered. First, certain groups are identified that have a low chance to participate in continuing training. The gap between low and high-skilled widens if low-skilled employees have less educational opportunities. One goal of educational policies is to narrow

this gap, and one way might be the support of continuing training for the low-skilled.

Second, it is estimated whether firm-provided training is mainly general or firm specific. In case training produces general human capital that increases productivity also outside the training-providing firm, there would be an argument for subsidising firm-provided continuing training because incentive mechanism are not efficient, and a hold-up problem may exist.

Third, the study tries to identify positive externalities of continuing training between employers and firms by comparing wage and productivity effects on an industry level. The new literature on growth theory stresses the role of education. Increasing returns to education are often assumed because of positive externalities to human capital in production. Some tentative evidence suggests that the magnitude of this effect observed at the economy-wide level may exceed the observed effect at micro-levels indicating possible externalities. The empirical basis for the assumption of spillovers at the firm, industry, sector, or economy-wide level is essentially unknown. This study tries to fill this gap by estimating spillovers at the industry level in Germany since externalities deriving from continuing training have not been estimated in former work. The identification of spillovers is crucial for policy makers because in this case, external effects exists that cannot be internalised by firms. This result would suggest government intervention to reach the social optimum of continuing training.

2

Continuing Training[1]

Lifelong learning and continuing training are widely discussed topics in academia and are also often in the centre of public debates. In order to introduce the topics discussed in the following chapters, I will start this chapter with a brief overview of the training literature. Then, the institutional background regarding continuing training in Germany is described and some facts and figures are presented to demonstrate the empirical relevance of continuing training in Germany.

Broadly defined, continuing vocational training comprises all more or less organised or structured activities – whether they lead to a recognised qualification – which aim to provide people with knowledge, skills, and competencies that are necessary and sufficient in order to perform a job or a set of jobs. Employees in continuing training, thus, undertake work preparation or adapt their skills to changing requirements. The content of continuing vocational training can be job-specific, directed to a broader range of jobs or occupations, or a mixture of both; it may also include general education elements. However, the definition of continuing vocational training (CVT) in individual countries is different. And more than that, also within a country, the definition varies between data sources. This makes empirical research difficult because it is non-trivial what kind of training is included in training measures and how these can be compared to other measures.

The remaining part of the section is, therefore, devoted to continuing training in empirical research and includes an empirical application. On the basis of three large individual data sets, determinants of training as well as correlations with wages are discussed with respect to differences in how the training variable is set up and defined in the various data sets. The analyses illustrate the importance of these differences in empirical work and give a hint which data sets are most suitable to answer certain research questions.

[1] This chapter draws on Kuckulenz (2006a).

2.1 Theoretical Background: A Short Introduction to the Training Literature

The basic building block of the training literature is the human capital theory. What is meant by human capital explains Gary S. Becker as follows: "To most people capital means a bank account, a hundred shares of IBM stock, assembly lines, or steel plants in the Chicago area. These are all forms of capital in the sense that they are assets that yield income and other useful outputs over long periods of time. But these tangible forms of capital are not the only ones. Schooling, a computer training course, expenditures of medical care, and lectures on the virtues of punctuality and honesty also are capital. That is because they raise earnings, improve health, or add to a person's good habits over much of his lifetime. Therefore, economists regard expenditures on education, training, medical care, and so on as investments in human capital. They are called human capital because people cannot be separated from their knowledge, skills, health, or values in the way they can be separated from their financial and physical assets" (Becker, 2002).

Modern human capital research got underway in the late 1950s, its main proponents being Gary Becker, Jacob Mincer, and Theodore Schultz (Becker, 1962 and 1964; Mincer, 1958; Schultz, 1961). Their ideas, focussing on investments in and returns to education, have provided the theoretical basis for decades of ensuing research.

The three main components of human capital are:

1. early ability (acquired in early childhood or innate),
2. qualifications and knowledge acquired through formal education, and
3. skills acquired during working life through on-the-job training.

While there is very little work on early ability (an exception is Cunha, Heckman, Lochner & Masterov, 2005), the literature on schooling, in contrast, is extensive. Much of the empirical research has analysed the relationship between education and wages, which is due to the abundance of high quality data sources on both. There is evidence for a large range of countries covering different time periods. A large number of extensive reviews on human capital have been written. For example, Heckman, Lochner, and Todd (2003) or Franz (2003) for a discussion of the theoretical foundations of the Mincer model; Card (1999) for the estimation of the causal effect of education on earnings; and the OECD Employment Outlook (1998: ch. 4.) for an international comparison of the returns to investment in human capital. Harmon and Oosterbeek (2000) review the empirical estimates of the return to schooling. See Harmon, Oosterbeek and Walker (2003) for a discussion of the microeconomic literature as well as Sianesi and van Reenen (2003) for the empirical macroeconomic literature on the returns to education.

In this study, I concentrate on the third component of human capital – on skills acquired during working life through on-the-job training. An intro-

duction to the literature on continuing vocational training is provided in this section. The relevant theoretical issues are discussed in detail in each chapter.

The literature on continuing vocational training draws heavily on the literature on schooling. However, empirical research on continuing training has lagged behind the research on schooling and formal education. Only recently, there have been attempts to directly measure the effects of accumulating human capital through training. Among the first empirical papers using information on training to estimate its impact on wages are Mincer (1988), J. Brown (1989), and Barron, Black, and Loewenstein (1989). In many aspects, similar questions are asked in the training literature, as in the schooling literature and the same econometric problems have to be handled by economists. Nevertheless, the literature on training covers certain aspects which are not discussed in the comparable literature on schooling. These relate to the fact that training can be a shared investment between employer and employee and that training can be (partly) firm-specific. For a non-technical review of the empirical evidence on the returns to education for the individual, the firm, and the economy at large, see Blundell, Dearden, Meghir, and Sianesi (1999). Leuven (2005) provides a survey of the theoretical literature on the economics of private sector training. Existing evidence on workplace training in Europe from different data sources is reviewed by Bassanini, Booth, Brunello, De Paola, and Leuven (2005). A tentative review of the literature that estimates wage returns to training is provided by Leuven (2004). More detailed discussions of the literature can be found in each of the following chapters.

2.2 Institutional Background

In section 2.2, I review the institutional background of continuing vocational training. I start with a general description of educational policy in Germany and then discuss the legal background of further education. Then, I introduce the reader to continuing training as a measure of active labour market policy. In the following, I describe how continuing vocational training is promoted and financially supported by governmental institutions in Germany. Specifically, I concentrate on adult education centres, tax deductions, and the promotion of continuing training in small and medium-sized businesses. Discussion then goes on to consider other forms of financial promotion and advice relating to continuing training and the role of continuing training in collective agreements. In the last section, I provide an overview of the main suppliers of further education.

2.2.1 Educational Policy

In Germany, responsibility for education is held by the states (*Laender*) rather than by the federal government. This is true for both primary and secondary

education as well as for tertiary education. In its coalition agreement, the new federal government has proposed to strengthen the autonomy of the German Laender regarding educational policy.

The public financing of education is split between the federal government, the Laender, and the municipalities. About 80% of the financial resources invested into schools originate from the states, with municipalities accounting for the remaining 20% mainly for maintaining school buildings. The Laender are responsible for the financing of universities, except for additional grants from the federal level for new buildings and large purchases. Financial assistance, partly as a grant and partly as a (student) loan, is provided by the federal government and the Laender according to the Federal Education and Training Assistance Act (*Bundesausbildungsförderungsgesetz,* BAföG).[2]

In view of the financial structure of education in Germany, most variation in public expenditure on education arises between the 16 Laender (Ammermüller, Kuckulenz & Zwick, 2006). In addition to large differences in the Laender spending on education, some variation also appears between the more than 440 municipalities. Most pupils attend state schools that are free of charge. All institutions of higher education are essentially free as well. The share of private education spending in Germany is higher than in comparable countries: While 4.5% of the GDP is invested by the state, private entities invest 1.2% of the GDP. These private investments are mainly concentrated on the dual apprenticeship system and on continuing training at the workplace (Klös & Weiss, 2003).

2.2.2 Legal Background of Further Education

In the German federal law, there is no general right to participation in continuing training. Due to the institutional setting, continuing training participation is regulated by Laender laws, collective agreements, or individual agreements between employers and employees. Most importantly, the Laender are empowered to pass laws governing the right to further education, the promotion of training, and regulation of special company leave for this purpose. Furthermore, these laws include regulations with respect to the institutions providing further education and their sponsorship (BMBF, 2004). For example, in 12 Laender (out of 16), employees have the right to take extra days of vacation in order to participate in training courses and seminars (all Laender except Baden-Wuerttemberg, Bavaria, Saxony, and Thuringia). This regulation goes back to the late 1960s when education and qualification of the workforce was offensively promoted in Germany. Regulations in collective agreements that regard continuing training are discussed in section 2.2.5.

Specifically, employees can claim to take off one week from work per year and participate in a continuing vocational training course of their choice.

[2] Article § 56 of the BAföG says that the BAföG payments will be split between federal government (65%) and Laender (35%).

These activities do not have to supply the participants with firm-specific or industry-related knowledge. Employees can choose to participate in courses that do not directly qualify for their current job but supply them with general skills. For example, this provision also encompasses training courses aiming at deepening participants' political understanding. The idea is that such courses increase the understanding of social and political relations and will, in turn, stimulate political and social discussion and the assumption of responsibilities in a democratic country. This "education holiday" is mostly used to learn a foreign language or a computer programme. Such training days have the status of working days, i.e. they are paid by the employer. Direct training costs are paid by the employee.

Employees are mainly involved in initiation and implementation of continuing training through the works council. For details of the workers' participation regarding continuing training, see chapter 8.2.4 in Oechsler (2006).

2.2.3 Continuing Training as a Measure of Active Labour Market Policy

Continuing training is one of the most important instruments used by governmental institutions to mitigate discrepancies in qualificational demand and supply of workers (see, e.g., Fitzenberger & Speckesser, 2005; Lechner, Miquel & Wunsch, 2004 and 2005). These courses are aimed at the unemployed in particular and are designed to even out the lack of specific qualifications and to reduce periods of unemployment. The provision of training courses makes up a large share of spending on active labour market policies (see Table B.1 and B.2 in the appendix showing the expenditure on active and passive labour market policies and the number of participants in the quantitatively most important active labour market policies (ALMP) measures). Fitzenberger and Prey (2000) find positive, though only partially significant long-run effects of training on employment or wages. Lechner et al. (2004) present evidence for negative employment effects of public sector-sponsored training programmes in the short run and positive employment effects over a horizon of about 4 years. The negative lock-in effect for the period immediately following the beginning of the programme and the significant positive effect on employment a year after the beginning of the programme are affirmed by Fitzenberger and Speckesser (2005).

Total spending on continuing training by the Federal Employment Agency (*Bundesagentur für Arbeit*) increased from around 3 billion euros in the late 1980s to a peak of about 9 billion euros in 1992 (on a large scale, continuing training was offered to employees in the former eastern part of Germany after reunification). Thereafter, the Federal Employment Agency's spending on continuing training decreased to about 6.5 billion euros in the late 1990s.

Training courses for the unemployed are also financed by the Federal Employment Agency. In 2001, the Federal Employment Agency spent 4.78 billion

euros on such courses. Separate information on spending on training courses for the unemployed for 2002 onwards is not available, as this funding is included in a single mixed category with training courses aimed at disabled people. Spending on continuing training aimed at other groups (not for unemployed) is estimated to be 1.99 billion (see Berger, 2004).

2.2.4 Financial Furtherance of Continuing Training

No mature concept of how to promote and finance continuing vocational training has yet been implemented.[3] Instead, there are a number of ways in which individuals can receive financial support that enables them to participate in continuing training. The main ones are listed in this section.

Adult Education Centres

The largest share of public investments in lifelong learning (some 2.5 billion euros in 1998) goes to adult education centres (*Volkshochschulen*). Public spending to help financing these centres adds up to 400 million euros. The Laender and municipalities share the financing of this institution, which offers a large variety of courses and seminars in all large, medium-sized and sometimes small cities with about 150 to 250 million euros, respectively. For the development of the financial structure of adult education centres in the last 10 years, see Fig. B.1 in the appendix. In total, 2,441 of these adult education centres exist in Germany (see Table B.3 in the appendix for their distribution among the Laender). After four decades of continuing growth of these institutions, it has begun to stagnate or even decline in 2003 and 2004. The numbers of participants, teachers, and course hours as well as revenues from course fees were declining (Pehl, 2005).

Tax Deductions

One important aspect of financial promotion of continuing training by the federal government is indirect: Participation in further education can be included in income tax returns as professional expenses or special expenses. This is the case if further education is deemed to maintain and deepen occupational knowledge and skills in a learned profession in which the individual is not currently employed. Such expenses are tax deductible as special expenses up to an amount of 900 euros per annum.

[3] One of the few suggestions about how to promote and finance continuing vocational training in Germany was made by the Council of Economic Experts for Education at the Hans-Boeckler-Stiftung (see Busse & Heidemann, 2005).

This differs from the tax treatment of continuing education in the framework of the profession in which the individual is employed. Costs for this type of training are, in principle, deductable as professional expenses. For more detailed information on laws concerning continuing training and on the exact rules regarding which spending is deductible from taxes and alternative methods of financing training participation, refer to Dohmen (2003).

There is no special tax law for companies that pay for the continuing vocational training of their employees. Further education measures are regarded as operating expenses reducing a company's asset and, thus, its tax base.

Other Financial Furtherance and Advice

There are also other ways, in addition to tax relief, in which companies, private individuals, and employees can obtain financial support. Foundations, associations, banks, and some Federal Offices (see next section) offer funding for the training of private individuals and employees as well as to companies which provide further education to their workforce. One particular focus is on the promotion of continuing vocational training by small and medium-sized businesses. For example, the Merchant Bank Berlin (*IBB Beteiligungsgesellschaft mbH*) aims to boost the employment skills of employees in small and medium-sized businesses by funding continuing vocational training.

The chambers of commerce and industry offer advice regarding further education to companies and employees. They help firms to identify further education needs, to set up comprehensive firm internal continuing training concepts, and provide information about potential financial support. The chambers of commerce and industry also provide help to employees and inform them about admission requirements, innovative qualification concepts, and the promotion of continuing training. Additionally, they are helpful in the search for adequate providers of further education and for the quality evaluation of training courses and seminars.

Promotion of Continuing Training in Small and Medium-Sized Businesses

The Federal Office of Economics and Export Control (*Bundesamt für Wirtschaft und Ausfuhrkontrolle*, BAFA)[4] targets at the improvement of the achievement potential and competitiveness of small and medium-sized businesses (SMBs) and at facilitating adoption to changing economic conditions of the SMBs. Most furtherance of continuing vocational training for employees

[4] BAFA is a superior federal authority subordinated to the Federal Ministry of Economics and Technology (*Bundesministerium für Wirtschaft und Technologie*, BMWi).

and private persons as well as for unemployed is done by the Federal Employment Agency or the job centres. In 2003, the Federal Employment Agency and the federal government spent 6.8 million euros for the promotion of continuing vocational training.

In 2002, a law has been enacted which especially promotes continuing training in SMBs. Firms which pay for continuing vocational training can be refunded by the Federal Employment Agency from 50 to 100% for their expenses of extra labour requirements. One prerequisite for the refund is that firms temporarily employ unemployed workers to meet their extra labour requirements while part of the staff participates in continuing vocational training. Unskilled or less qualified workers can take part in continuing vocational training without causing additional expenses for the employer. The payment of the fee can be fully borne by the Federal Employment Services. Furthermore, in small firms with less than 100 employees, expenses for further education for employees over 50 years can be paid by the Federal Employment Services.

2.2.5 Continuing Training in Collective Agreements

In addition to federal and Laender laws, it is also important to take German collective bargaining laws into account when examining the legal rights to participate in and receive direct or indirect funding for further education. There exist numerous (partly extensive) single arrangements in German collective bargaining agreements regarding further education, but collective bargaining agreements do not contain any systematic provisions governing the area-wide furtherance of qualification. Continuing vocational training has been a topic covered by collective agreements since the 1960s (Bahnmüller, 2002). Until recently, the promotion of further education in collective bargaining agreements was not extended to all branches of trade and industry. During the 1990s, trade unions succeeded in negotiating collective agreements which encompasses continuing vocational training in various economic sectors (Bispinck, 2000). Examples include the promotion of continuing training in the textile industry in the relevant 1997 collective agreement, the initiation of a qualification fund in the agricultural sector in 1995, and the collective agreement encouraging further education in the metal industry in Baden-Wuerttemberg in 2001. One famous example of the integration of advanced vocational training in collective bargaining agreements is the 5000x5000 Volkswagen AG company agreement model, which enabled unemployed workers to take on jobs which included different phases of continuing qualification.

For a thorough discussion of continuing vocational training and collective agreements, general trends and perspectives, and the description of the examples given above, see also Bahnmüller (2002) or Bispinck (2000). A list of qualification and continuing training regulations regarding general training or training for specific purposes is given in the appendix (Table B.4). In addition, the German Council of Economic Experts (*Sachverständigenrat zur*

Begutachtung der gesamtwirtschaftlichen Entwicklung) discussed continuing training in collective agreements in its annual report in 2000.

As works councils play an important role in industrial relations in Germany, they are important players in discussions on the provision of continuing vocational training. Works councils generally promote qualification of the workforce because lifelong learning is regarded as a prerequisite to secure employment.

Some companies conclude company agreements to promote and/or provide continuing vocational training. 8% of training firms have concluded such vocational training agreements in 1999. For large firms (those with more than 1000 employees), the share is over 40% (European Commission, 2002).

2.2.6 Suppliers of Further Education

"Lifelong learning" is a growing market with a large number of agents providing training courses and seminars to firms and individuals. The largest amalgamation of providers of further education is the *Wuppertaler Kreis e.V.*, the Federal Association of Continuing Vocational Training (*Bundesverband betriebliche Weiterbildung*), which was founded in 1955 at the initiative of the Federation of German Industries jointly in collaboration with key actors of the German economy (*Bundesvereinigung der Deutschen Arbeitgeberverbände*, BDA; *Deutscher Industrie- und Handelskammertag*, DIHK) and a handful of large companies. Today, the Wuppertaler Kreis has about 50 members, which are renowned institutions for further education. They are all committed to uphold common quality standards. Altogether, these institutions have an annual turnover of about 1.2 billion euros. With about 11,000 employees and more than 40,000 freelancers, more than 110,000 training courses and seminars are provided in around 800 locations in Germany. For a list of the largest 20 institutions offering training in Germany, see Table B.5 in the appendix. The suppliers of continuing training in the Wuppertaler Kreis are responsible for further education in almost every branch of trade and industry. These institutions underline the importance of continuing training for companies and their employees, contribute to its quality assurance by setting up high quality standards, and undertake research projects on themes relating to further education.

2.3 Some Stylised Facts

In global product and labour markets, knowledge becomes obsolete at an increasingly faster pace. In order to catch up with ongoing technological and organisational changes, recurrent refreshing of know-how is essential for employers and employees and for the economy as a whole. Firms, individuals,

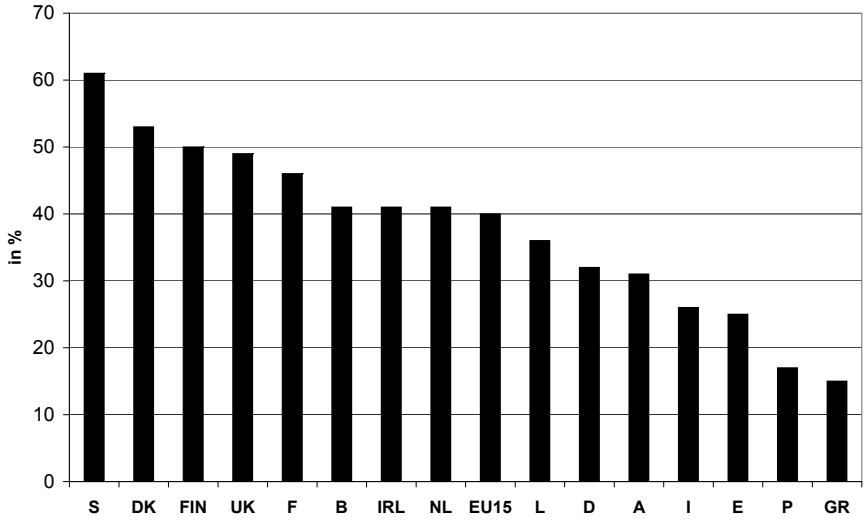
and the government are consequently financially engaged in lifelong learning and continuing education.

In this section I start with comparing continuing training in Germany with other European countries. I regard participation rates and the costs of continuing training. Then, I describe the participation and cost structure of continuing training in Germany in more detail. In addition, I show how participation rates and investment in training evolved during the last decade.

2.3.1 Training in Europe

In an international context, Germany ranks somewhere in the (lower) middle in terms of participation in continuing training. According to the Second Continuing Vocational Training Survey (CVTS 2), 32% of employees took part in continuing training in 1999 (see Fig. 2.1). In Scandinavian countries, participation is much higher (and is highest in Sweden at 61%). Only in the southern European countries Italy, Spain, Portugal, and Greece, less than 30% of employees participate in continuing training.

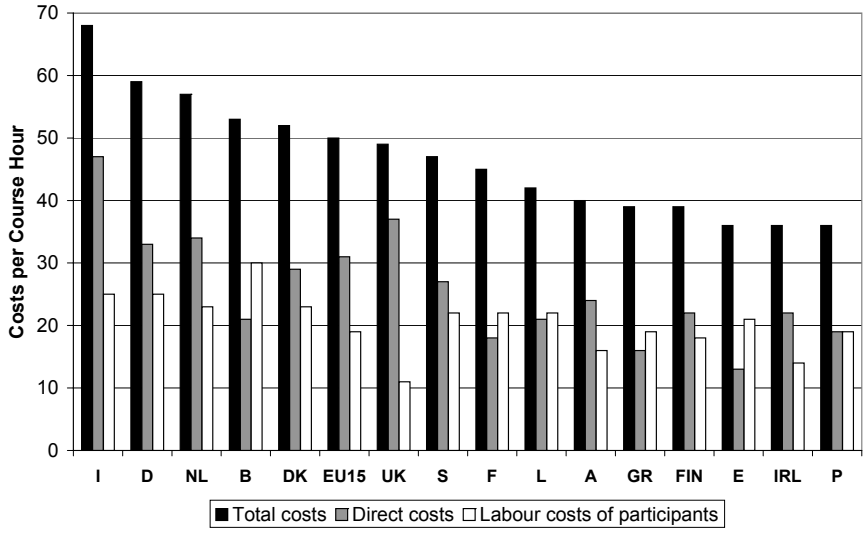
Fig. 2.1. Percentage of employees participating in CVT courses in 1999



Source: Estimation by the author on the basis of the CVTS 2. For country abbreviations, see glossary.

The Second European Continuing Vocational Training Survey (CVTS 2) was conducted in the year 2000 in order to obtain comparable data for all European Union Member States (plus 9 candidate countries and Norway) on the quantitative and qualitative structures of continuing vocational education and training in enterprises. In total, about 76,000 enterprises participated in the survey, 3,184 of them in Germany. The European Commission plans to make the European Continuing Vocational Training Survey a regular institution. The next survey, focussing on "Development of a methodology for a long term strategy on the Continuing Vocational Training Survey" is scheduled for the year 2006.

Fig. 2.2. Costs of CVT courses per course hour, by type of costs in 1999

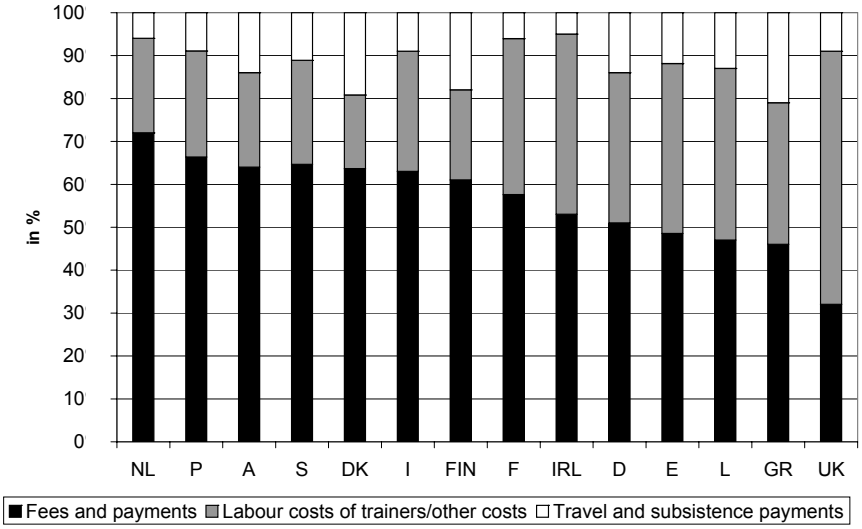


Source: Estimation by the author on the basis of the CVTS 2. For country abbreviations, see glossary.

While participation rates in Germany are centred in the middle in comparison to other European countries, Germany leads the ranking in one respect: Continuing vocational training costs per hour (measured in purchasing power standards) are only higher in Italy. Fig. 2.2 shows the total costs of training distinguishing between direct costs and labour costs of participants. The group of countries with the highest continuing vocational training costs per hour consists of Italy, Germany, Netherlands, Belgium, and Denmark. The

same group of countries has rather low participation rates. Denmark is an exception. Despite high training costs, the training participation rate is one of the highest. In Germany, rates are below European average participation, and costs of continuing vocational training courses are above European average.

Fig. 2.3. Structure of the direct costs of CVT courses in 1999



Source: Estimation by the author on the basis of the CVTS 2. For country abbreviations, see glossary.

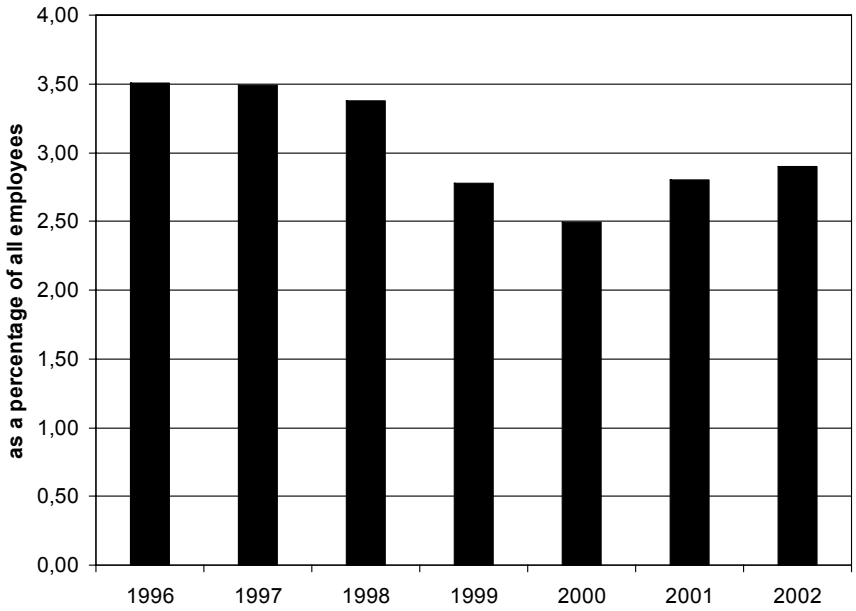
Fig. 2.3 depicts the structure of direct continuing vocational training costs. Direct costs comprise fees and course payments, labour costs of trainers, as well as travel, board, and lodging costs. The largest share of these direct costs consists of fees and course payments, which account for up to 70% of the total direct costs. In Germany, fees and payments make up only 50% of the total direct training costs. Travel, board, and lodging costs as well as the labour costs of trainers in particular are above European average in Germany.

2.3.2 Participation and Investment in Continuing Training

In Germany, participation in continuing training has slightly increased significantly in recent decades. In the late 1990s, participation in continuing training

decreased, bottoming out in the year 2000. In 2001 and 2002, participation rates slightly increased again but have not returned to the rates prevalent in the 1990s (see Fig. 2.4).

Fig. 2.4. Trend in participation rates of continuing training (1996-2002)



Share of employees who participated in training during 4 weeks prior to the survey. For detailed information on the data, compare section 2.4.2.
Source: Estimation by the author on the basis of the German Microcensus.

Within Germany, training intensity varies largely between participant groups (see Table 2.1). Men participate more frequently than women and also spend more time in training. Participation in training also differs by age and education. In section 2.4 and in chapters 3 and 5, I will explicitly consider these differences. Low-skilled workers participate much less often than high-skilled workers. Those that eventually take part in training, however, spend much more hours in training than high-skilled workers. In addition, the frequency as well as the intensity of training vary by occupation, company size, and economic sector. Civil servants have a very high probability to take part in training. The training courses attended by civil servants are, however, on average rather short.

Table 2.1. Annual participation rates and time spent in continuing training (1999)

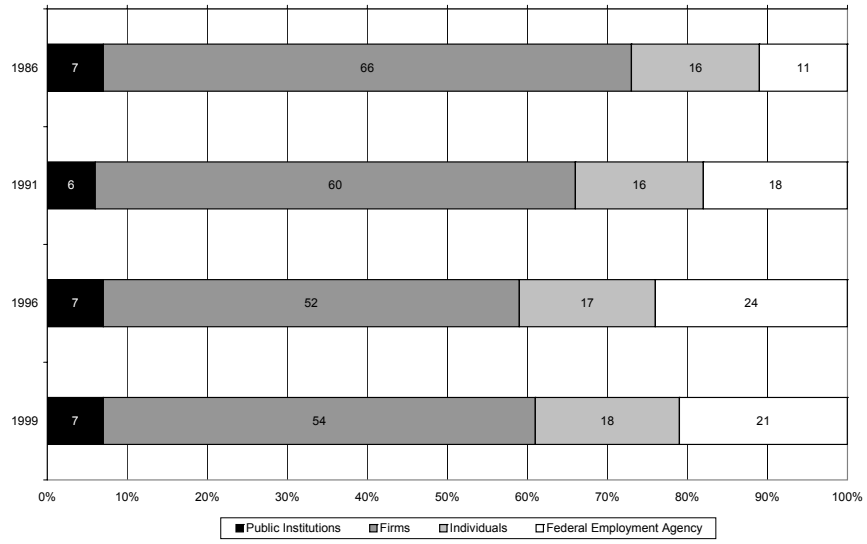
	Participation rate (in %)	**Time outlay of participants**
All interviewees	29	124
Gender		
Male	34	132
Female	23	113
Age		
19-34 years of age	31	137
35-49 years of age	36	130
50-64 years of age	18	90
Education		
No education	9	259
Apprenticeship (Lehre/Berufsfachschule)	27	126
Technical school/College	42	113
University/Technical university	43	95
Occupation		
Worker	24	130
Employee	46	105
Civil servants	60	60
Company size		
1-99 employees	35	131
100-999 employees	35	87
1000 employees and above	49	85
Economic sector		
Industry	35	85
Manual trades	35	120
Trade/Service	39	125
Public service	53	88

The first column shows the participation rate in continuing training by gender, age, education, occupation, company size, and economic sector. The second column shows the time outlay of the respective group of participants.
Source: Kuwan, Thebis, Gnahs, Sandau & Seidel (2003).

How costs of training and lifelong learning are split up between participants in training, employers, and the government is shown in Fig. 2.5. Firms bear the largest share of the costs with more than 50%. The Federal Employment Services and other public institutions financed between 20-30% of continuing training in Germany. Individuals payed between 15-20% of the total costs.

Therefore, firms are the main investors in post-school training and education. Table 2.2 shows the training costs of employers for the years 1992, 1995, 1998, and 2001. Total costs fluctuate around 900 euros per employee. Only in 1998, costs were significantly higher at 1,128 euros per employee. The largest

Fig. 2.5. Financing structure of continuing education



Shares of continuing training financed by public institutions, firms, individuals, and the Federal Employment Agency.
Source: Kuwan et al. (2003).

share of spending accounts for internal courses, which make up almost half of the annual training costs per employee. In addition, training costs for external courses and on-the-job learning are high. The share of personnel costs and of retraining measures significantly declined during the 1990s. If costs are broken down by economic sector, it is evident that employers in the service sector spent much more on training (per employee) during the 1990s when training costs per employee were almost twice as high for firms in the service sector than in the industrial sector. In contrast, the reverse was the case in 2001 when training costs per employee were higher for firms in the industrial sector than in the service sector.

Training costs differ widely according to the economic sector. As shown in Fig. A.2 in the appendix, employees in the banking and insurance industry take part in the most expensive training courses and seminars. On average, firms in this sector spend 2,825 euros per training participant. In other sectors, training costs are much lower. For example, firms in the mining and mineral extraction industry pay only 397 euros per course participant.

Table 2.2. Training costs of employers

	Euros per employee			
	1992	**1995**	**1998**	**2001**
Total costs	984	854	1,128	869
Type of costs distinguished:				
Personnel	124	84	162	64
Internal courses	441	288	562	345
External courses	192	192	215	258
Informational event	36	63	39	31
Retraining	19	15	2	4
On-the-job learning	131	167	111	138
Self-directed learning (computer/books)	32	38	35	24
Other costs	10	7	2	5
Economic sectors distinguished:				
Agricultural sector	-	439	-	-
Industrial sector	803	714	985	925
Services sector	2,013	1,369	1,713	711

Source: Institut der Deutschen Wirtschaft (2004).

In total, spending on continuing vocational training totalled around 39 billion euros in the year 1998. Investments in lifelong learning did not decrease significantly during the economic downturn in the first years of the new century. In 2001, firms invested almost the same amount in seminars and courses to refresh and deepen the knowledge of their workforce as they did in 1998. Total spending on continuing vocational training in 2002 accounted for 38 billion euros.

The investments made by employees are difficult to assess. The Cologne Institute for Economic Research (*Institut der deutschen Wirtschaft Köln,* IW) estimates that employees spent around 6 billion euros in 1998. This amount excludes indirect costs, e.g., if workers accept a lower wage while in training and, hence, implicitly pay for training. This assessment also excludes informal training forms, such as reading professional literature, internet courses, or courses via electronic devices.

While seminars and courses are the main source of lifelong learning costs, most people keep their knowledge up to date by reading technical literature. In 1999, 21.8% of the employees responding to a survey by the Cologne Institute for Economic Research took part in seminars and courses. Almost 55% indicated to read professional literature, and around 23% reported updating their know-how by using computer programmes. In the year 1999, private investment on seminars and courses, technical literature and internet courses, and DVD or other computer programmes was 185, 20.5, and 9 euros on average per person, respectively. In 2002, training participants' direct costs (course

fees and travelling costs) totalled 375 euros; indirect costs (foregone earnings) added up to 217 euros per participant (Nestler & Kailis, 2002).

2.4 Continuing Training in Empirical Research

In order to bring to light the data issue concerning continuing training, this section discusses three German data sets that include information on training. Differences in the definition of continuing training are examined and consequences for empirical research are discussed. First, the incidence of training is compared and reasons for differences in the data sets are discussed. Second, the determinants of various training measures are estimated. Third, the correlation of the training with wages is calculated. Finally, results are examined to discuss the influence of the definition of the training measures in empirical research.

2.4.1 Introduction

Labour economists have focussed on continuing vocational training for many years, and recent work provides new theoretical and empirical insights. Becker and Mincer laid the groundwork for human capital theory, which is the standard model for analysing continuing training (Becker, 1962 and Mincer, 1974). In this framework, continuing training is considered as an investment in human capital which is undertaken by firms in order to raise worker productivity. This increase in productivity represents a rent that can either result in higher profit or in higher wage. Empirical work on training with German data has mainly focussed on the determinants of training and on the impact of training on labour market outcomes. The participation in training (including formal and informal kinds of training[5]) reported varies, depending on the source: e.g., according to the Second Continuing Vocational Training Survey (CVTS 2), 31% of employees took part in continuing training in 1999. Kuwan et al. (2003) report that, in 1999, 48% of all employees participated in training. The findings of Garloff and Kuckulenz (2006) indicate that participation in training in 1998 was 22%. These examples underline the differences in the definition of training.

Econometric results are often surprisingly divergent. For example, the wage effect has been estimated to be significantly positive (e.g., Pannenberg, 1997

[5] Formal training is training that has a structured, formal, and defined curriculum; it may be conducted by supervisors, company training centres, businesses, schools, associations, or others. Formal training includes classroom work, seminars, lectures, workshops, and audio-visual presentations. Informal training is training that is unstructured, unplanned, and easily adapted to situations or individuals. Examples include having a co-worker showing how to use a piece of equipment or having a supervisor teaching a skill related to the job.

and 1998; Pfeiffer & Reize, 2001; Schömann & Becker, 2002; Kuckulenz & Zwick, 2003; Büchel & Pannenberg, 2004) or insignificant (e.g., Jürges & Schneider, 2005) and coefficients vary widely (see Table A.11 in the appendix for a summary of the empirical literature, where wage effects of training are estimated with German data; for a comparison of training returns in international studies, see Leuven, 2005).

One possible reason for this divergence in results is the econometric method used. This has been suggested by Kuckulenz and Maier (2006). The authors find a small positive impact of training on wages with ordinary least squares (OLS) estimation and a large positive impact when using instrumental variables (IV) estimation. Local instrumental variables (LIV) estimation, in contrast, reveals no impact of training on wages. The data set used might also be important given that there is no standard definition of training, and survey questions on continuing training differ tremendously. As shown by Bartel (2000) for the U.S., the type of data set has an important influence on the results. She compares studies that use large samples of firm-level or establishment-level data collected through mail or phone surveys with studies that use data from one or two companies and with company-sponsored case studies.

In this section, the data set used and the way in which the training variable is set up in various large data sets are explored, and the relevant differences are explained. The focus is on determining the magnitude of the impact of these differences on estimated results of the determinants of training on the one hand and on the correlation between training and wages on the other. I use three German individual data sets to compare how training variables are set up and to study how this difference in framing the training question influences the incidence of training reported in a data set. Additionally, I single out the impact of differences in set-up and definition of training on the econometric results when estimating determinants of training and the impact of training on earnings. It is shown that what is captured by continuing training in the data sets varies remarkably and makes comparisons of studies using different data sets difficult.

2.4.2 Data

German data sets that include information on continuing training can be divided into official statistics provided by governmental institutions, survey data provided by (economic) institutes, and other statistics of responsible departments. The survey data that includes information on training provided by institutes can be further split up into establishment and individual data. Table A.6 in the appendix lists available data sets with a training variable. In this section, three large survey data sets conducted with individuals are used: the German Socio-Economic Panel (GSOEP), the Microcensus (MZ), and the Qualification and Career Survey (BiBB/IAB). These are the main

sources used by economists to analyse the impact of training participation on earnings.[6] Here, data for 1998/1999 are used to make results comparable, since this is the latest available wave of the Qualification and Career Survey (BiBB/IAB). The data sets are described in the following section; Table A.7 in the appendix compares means and standard deviations of all variables used for the three data sets.[7]

To ensure that the samples in all three data sets are comparable, I consider samples with employees only – individuals that are out of work and the self-employed are excluded. Civil servants, pensioners, and those who did not reveal their professional status are also excluded. I only include individuals aged between 25 and 65 to ensure that individuals are of working age and have attained their first professional degree. The sample size is highest in the Microcensus with more than 100,000 observations, second highest in the BiBB/IAB data with around 18,000 observations, and lowest in the GSOEP with about 6,200 observations (see Table A.7).[8] Table A.7 shows that, in terms of covariates, the samples in the GSOEP, the MZ, and the BiBB/IAB data are comparable.[9] The outcome variable is problematic since net income is only included in the MZ data and gross income only in the BiBB/IAB data while both measures of income are included in the GSOEP. Average gross income is higher in the GSOEP than in the BiBB/IAB data even after controlling for income from other jobs. The training variable, which is the key variable here, will be comprehensively discussed below.

2.4.2.1 German Socio-Economic Panel (GSOEP)

The German Socio-Economic Panel (GSOEP) is a wide-ranging representative longitudinal study of private households in Germany that provides information on all household members.[10] In 2004, nearly 12,000 households and about 22,000 people were sampled. The same private households, persons, and families have been surveyed annually since 1984, and the survey has since been

[6] Other German data sources available, which are frequently used that include information on training, are the IAB-company panel and the Continuing Vocational Training Survey. Both surveys are conducted among firms, not individuals. Hence, individual wage effects cannot be estimated with these data sets.

[7] Numbers of observations decrease significantly in the regressions owing to gaps in the data. The wage variable, in particular, is unavailable for many individuals in the survey.

[8] Due to missing variables (especially income), the number of observations is lower in the estimations in the next section.

[9] Worth to mention is the difference in the share of women in the data set. I suspect that less women are included in the BiBB/IAB sample because the survey is only geared towards employees while the other surveys include all individuals living in Germany. When defining the samples, I may define some women as being employed who would not be included in the BiBB/IAB survey.

[10] For more detailed information, see http://www.diw.de/english/sop/index.html.

expanded to include various new samples. One special feature of the GSOEP data is that it is longitudinal in nature and can be used as a panel. Some of the many topics include household composition, occupational biographies, employment, earnings, health, and satisfaction indicators as well as subjects covered in topical modules of the survey. One of the modules cover the topic "education and training".

As has been pointed out by Pischke (2001), the GSOEP mainly includes formal training in this supplementary data. In the GSOEP, training is not necessarily directly related to the employer. To account for this, I take the training information from the so-called *calendarium*, which includes monthly information. This allows me to consider only those training spells which occurred "on-the-job", i.e. an individual took part in training and was employed in the same month. I use the survey that was undertaken in 2000 and include information about income, training participation, and all the covariates used in the regressions for 1999. All GSOEP variables (except for training) that are used in the estimations are listed in Table A.7.

2.4.2.2 Microcensus (MZ)

The Microcensus provides official representative statistics of the population and the labour market, involving 1% of all households in Germany every year (continuous household sample survey).[11] The total number of households participating in the Microcensus every year is about 370,000 (in total including about 820,000 individuals). I use the wave from the year 1999 to ensure comparability with the other data sets.

All households have the same probability of selection for the Microcensus. A one-stage stratified area sample is conducted, i.e. within the territory of the Federal Republic of Germany areas are selected in which all households and persons are interviewed. Every year, a quarter of all households included in the sample are exchanged. This means that every household stays in the sample for four years. Household numbers are not included in the scientific use file, and, therefore, the Microcensus cannot be used as a panel.

The purpose of the Microcensus is to provide statistical information on the economic and social situation of the population as well as on employment, the labour market, and education. The annual scientific use files of the Microcensus include characteristics on persons, family and household context, and – important for this study – information on employment, job search, unemployment, non-employment, general and vocational level of qualification as well as data on the level of the individual net incomes. Net income is given in 24 intervals. I take midpoints of the categories. The problem of earnings information given in categories is less severe than may first appear because categories are

[11] For more detailed information, see http://www.gesis.org/en/social_monitoring/GML/data/mc/index.htm.

quite small. In addition, individuals do not usually know their exact monthly income; the measurement error should, therefore, not be much higher than in other data sets. The Microcensus combines two advantages: huge sample size and a reasonable number of covariates. Unfortunately, the waves cannot be connected on an individual level, and I can only use cross-section information. The variables from the Microcensus used in the estimations are listed in Table A.7 (excluding the training variable).

2.4.2.3 Qualification and Career Survey (BiBB/IAB)

The German Qualification and Career Survey (BiBB/IAB) is a rich and representative German data set with information on 0.1% of all individuals employed. The surveys are conducted jointly by the Federal Institute for Vocational Education and Training (BiBB) and the Institute for Employment Research (IAB) operating as the Federal Employment Services' research institution. The surveys have been funded by the Federal Ministry for Education and Research and gather detailed information on qualification profiles and occupational developments as well as the organisational, technological, and qualification framework at the workplace. The BiBB/IAB-Survey comes somewhere in-between the large surveys that provide a huge number of observations but limited survey content (e.g., Microcensus) and selective surveys conducted with a specific spectrum of questions among a subset of individuals.

Earlier waves contain data gathered in 1979, 1985/1986, and 1991/1992. The most recent wave from 1998/1999, which sampled about 34,000 employees, is used in this analysis. The cross-section data allow the impact of training measures in 1994-98 on wages in 1998/1999 to be assessed. The outcome variable is log midpoints of earnings in 1998/1999 from 18 earnings categories in the data.[12] This variable has the advantage that earnings of highly paid workers are not censored from above, i.e. high earners are also included in the data set. Unfortunately, I do not have information about the exact income and, therefore, less variation in the outcome variable. An advantage of the BiBB/IAB data clearly is the huge number of covariates that include information on job, firm, and workplace characteristics.

The key explanatory variable I use is participation in training during the years 1994 to 1998. This dummy might stand for quite substantial amounts of training because employees might participate in various courses over a period of 24 months. In addition, only formal training courses are included in

[12] The problem of earnings information given in categories is less severe than it first seems. First, categories are quite small. Second, individuals do not usually know what their exact monthly income is; the measurement error is, therefore, also included in the other data sets. The highest earnings category is open. Since less than 1% of the employees are in this category, it does not influence the results what I choose as a midpoint.

the data set; short training spells are explicitly excluded. Note that apprenticeship training is also excluded. Additionally, I use various definitions of training: either including formal training only or also extending to informal training. I also make use of training indicators such as training in only one or in several years, and I separate several informal training forms. See Table A.7 in the appendix for the complete list of covariates (except training) with means and standard deviations.

2.4.3 Empirical Evidence

The empirical evidence is presented in four steps. First, for all three data sets, the training variables are discussed, and descriptive statistics for training are presented. Second, I estimate the determinants of the various training variables. Third, the three samples are used to estimate the same specification of the Mincer equation in order to analyse the correlation of training with earnings. Fourth, results from the descriptive statistics and the econometric analysis are compared to state how large the influence of the data set used and the definition of training is when analysing determinants of training participation and its correlation with earnings. The exact training-related questions asked in the surveys are listed in the appendix in Tables A.8 to A.10.

2.4.3.1 Descriptive Statistics

German Socio-Economic Panel (GSOEP)

In the GSOEP, I take the training information from the 1999 calendarium, which includes monthly information on the professional status. Individuals state in which months during the previous year (1998) they participated in training, which is defined as "company training, further training or retraining". The definition excludes training not considered relevant by respondents. There is no further help given on what type of training should be concluded. Given this set-up, I expect training participation to be underreported in the GSOEP calendarium (see also Jürges & Schneider, 2005). I also use data on the months of the year during which individuals were employed. There is no information available on whether training is firm-related or whether the firm pays for the training. Nevertheless, I am able to proxy on-the-job training by the coincidence of an employment relationship and participation in training in the same month. On average, 1.2% of the employees (i.e. only 42 people in the SOEP sample) participated in training while in an employment relationship during the year 1998. Almost 60% of those who participated took part in a training course during one month only. The exact hours, days, or weeks that were spent in training are unknown. The extent of training is,

thus, unknown; however, the survey question explicitly asks for only relevant continuing training to be taken into account.

In this data set, women participate more often than men.[13] Employees in eastern Germany take part in training less often than those in western Germany. Hence, West German women participate most (1.9%) while East German men participate least (0.8%). There is a difference in values when considering participation in training without taking into account whether individuals were employed at the same time. On average, 2.3% participate in training that can be employer related, government sponsored, or other training while not employed. Of course, training participation varies largely by age and by qualification. The incidence of on-the-job training (measured by the proxy variable) split by age and qualification groups is shown in Table 2.3 and 2.4.

Table 2.3. Participation in on-the-job training by age (GSOEP)

Age	On-the-job training (in %)	Months on-the-job training
25-29	0.03	0.13
30-34	0.02	0.05
35-39	0.01	0.02
40-44	0.01	0.02
45-49	0.00	0.01
50-54	0.01	0.02
above 55	0.00	0.00

Table 2.4. Participation in on-the-job training by qualification (GSOEP)

Qualification	On-the-job training (in %)	Months on-the-job training
No professional degree	0.00	0.00
Vocational school	0.02	0.05
Apprenticeship	0.01	0.04
Master craftsman	0.03	0.10
University of applied sciences	0.01	0.03
University	0.01	0.01

Younger employees participate much more often in training than their older colleagues; e.g., while 3% of employees in age group 25-29 indicated that they participated, only 0.3% of the employees in the over-55 age group

[13] This result contrasts with the results in Kuwan et al. (2003).

took part. Highly qualified employees undergo more training than less qualified employees. Although numbers of mean statistics are not ordered, it is not employees with a high-school diploma who participate most in training (1.9%), but those which passed the entrance examination for universities of applied sciences (3.7%). In the second column, the training variable used is an indicator for the number of months during which training took part, ranging from 0 to 12. Here, it is evident that young employees not only have a greater chance of participating in training, they also take part during more months than their older colleagues. The indicator can be interpreted as a proxy for the intensity of training although the exact time spent in courses and seminars is unknown. For highly skilled employees, training intensity is higher than for the low-skilled. For employees with an entrance examination for university of applied sciences, training intensity is exceptionally high, even much higher than for employees with a high-school diploma, who seem to take part less frequently and in shorter training.

Microcensus (MZ)

Several variables providing information on training are included in the 1999 Microcensus. First, there is a variable indicating whether individuals have taken part in training while the survey is conducted; another variable states whether individuals took part in firm-related continuing training during the last 4 weeks. Information is also provided to indicate whether this training is part of an internship or apprenticeship, both of which types I exclude.[14] Unfortunately, there is no information on when exactly (during which months) training took place. On average, 5.8% of the employees participate in continuing training in one month (4 weeks). Like in the GSOEP, also according to the MZ, women participate more often than men, and employees in eastern Germany take part in training more often than those in western Germany. Hence, West German women participate most (7.2%); East German men participate least (4.7%). This first measure contains only firm-related training.

Second, another training variable includes general training (not firm related) during employment. Specifically, the MZ includes information on whether individuals participated in general training while in an employment relationship during the last 4 weeks. On average, 0.8% of the employees took part in general training during the last four weeks. Women in western Germany form the group which participates most in general training (1.4%); West German men participate least (0.5%). Information on the location of general training is also included. The incidence of on-the-job training split by age and qualification groups is shown in Table 2.5 and 2.6.

Training participation is broken down into age groups in Table 2.5. Younger workers take part in firm-related training more often than older

[14] There is complementary information on the purpose of training which is not used here. The location and duration of training is also indicated.

Table 2.5. Participation in firm-related continuing training by age (MZ)

Age	Continuing training (in %)	General training (in %)
25-29	0.09	0.01
30-34	0.07	0.01
35-39	0.06	0.01
40-44	0.06	0.01
45-49	0.05	0.01
50-54	0.04	0.01
above 55	0.03	0.00

workers. In contrast, participation in general training does not differ for age groups; only workers aged 55 and older appear to participate less than others. Regarding qualification, Table 2.6 indicates that highly skilled workers participate much more often in work-related continuing training than low-skilled. The highly skilled also participate more in general training than the low-skilled, but the difference in participation is less significant.

Table 2.6. Participation in firm-related continuing training by qualification (MZ)

Qualification	Continuing training (in %)	General training (in %)
No professional degree	0.02	0.00
Vocational school	0.08	0.02
Apprenticeship	0.05	0.01
Master craftsman	0.09	0.01
University of applied sciences	0.11	0.01
University	0.12	0.02

Qualification and Career Survey (BiBB/IAB)

The BiBB/IAB data set from 1998/1999 contains detailed information on training participation during the last 5 years. I use several training variables. First, a dummy variable indicating whether individuals took part in training courses or seminars during the last, the last 2, or the last 3 years is applied. On average, 21% of the employees participated in training courses or seminars in the previous year, 30% participated over the previous 2 years, and 43 % participated during the previous 3 years. Alternatively, the incidence of training may have increased over the years. These numbers suggest that individuals are likely to take part in training again when they have participated in the past.

Second, in addition to this formal training, the data also captures more informal training types. I use dummy variables for whether individuals attended lectures or fairs, whether they read technical literature, took part in on-the-job training or other company training measures, whether they did an internship or took over special tasks for the purpose of training.

- 20% and more of the employees took part in the following training types in the two-year period prior to the survey: technical literature, specialised lectures, on-the-job training, trade fairs.

- Around 15% took on special tasks, took part in company training measures or in other training.

- Only 3% undertook an internship.

- Based on all informal types of training, I generate a dummy variable indicating whether individuals took part in any type of informal training during the last 2 years. The share of employees that participated in some informal training is 63 %.

A much wider definition of training includes both formal and informal training forms and combines this last measure of informal training with the dummy indicating whether individuals took part in training courses and seminars during the last 2 years. Taking this wide definition, 65% of the employees in this data set participated in training in the last 2 years. Hence, almost all employees taking part in formal training, i.e. training courses or seminars, also participate in some informal training. Tables 2.7 and 2.8 show the incidence of training within 2 years split by age and qualification group for training courses and seminars and for all training types.

Table 2.7. Participation in formal and informal continuing training by age (BiBB/IAB)

Age	**Formal and informal training (in %)**	**Formal training (in %)**
25-29	0.63	0.20
30-34	0.67	0.23
35-39	0.67	0.22
40-44	0.68	0.22
45-49	0.64	0.21
50-54	0.64	0.20
above 55	0.60	0.16

In Table 2.7, participation is shown for age groups. There is no difference in participation in continuing training when all types of training (formal and

Table 2.8. Participation in continuing training by qualification (BiBB/IAB)

Qualification	Formal and informal training (in %)	Formal training (in %)
No professional degree	0.36	0.08
Vocational school	0.63	0.23
Apprenticeship	0.61	0.18
Master craftsman	0.82	0.31
University of applied sciences	0.87	0.36
University	0.89	0.41

informal training) are used, nor when only formal training (courses and seminars) is considered. In contrast, when training participation is split up by skill group (Table 2.8), differences between the groups are huge. While about 50% of low-skilled workers participate in training comprising formal and informal training, around 85% of highly skilled workers participate in the same training measures. Differences are even more severe when only formal training courses are considered: Participation in training courses and seminars among the highly skilled is more than twice as high as participation among the low-skilled.

2.4.3.2 Determinants of Training

The descriptive statistics above suggest that certain individuals have a higher probability of participating in training than others. This will be analysed in this section using training variables from all three data sets. Since the response variable training T is binary, with values 0 and 1, I estimate by means of the probability of taking part in training p by probit

$$\begin{aligned} p &= \Pr(T = 1) \\ &= \Pr(a_1' \cdot S + a_2 \cdot age + a_3 \cdot age^2 + a_4 \cdot gender \\ &\quad + a_5 \cdot white + a_6' \cdot Laender \geq 0), \end{aligned} \tag{2.1}$$

where a are the coefficients of explanatory variables that are to be estimated. I include the same explanatory variables as below in the Mincer regression: a schooling vector S, where schooling consists of dummies indicating highest completed schooling and professional degree (schooling degree: without school-leaving certificate, lower secondary school, intermediate secondary school, entrance examination for university of applied sciences, high-school diploma; professional degree: no professional degree, vocational school, apprenticeship, master craftsman, university of applied sciences, university). The other regressors are age and age^2 and dummies for $gender$, for $white$-collar workers, and for the $Laender$.

GSOEP

In the GSOEP, the training variable is on-the-job training in the last year. I use both, a dummy variable and the number of months during which an individual took part in on-the-job training in the previous year (I estimate this equation by simple OLS). Table 2.9 shows in column 1 that participation in on-the-job training is mainly determined by schooling. Highly qualified employees have a higher probability of taking part in training than low-qualified (the reference category includes workers without a school degree). The dummies indicating the professional degree (without professional degree, vocational school, apprenticeship, master craftsman, university of applied sciences, university) are almost all insignificant. Only master craftsmen are more likely to participate in on-the-job training. Age does not play a significant role, neither does the sex of the worker nor whether they are blue or white collar or the region in which they live. Comparing the determinants of the training dummy with the results from the OLS estimation using the number of training months, only few differences are evident. The schooling variables are also the main determinants of training participation (column 2 in Table 2.9). Additionally, age and age^2 are significant. Results suggests that age is negatively correlated with the number of training months and age^2 is positively correlated, meaning that older employees take part in less training than younger employees.

MZ

In the MZ, I use a variable for training participation in the last 4 weeks. This variable only includes continuing vocational training. The probit estimation is only able to explain a small part of the variation in the probability of taking part in training (see Table 2.10). Also for this training variable, determinants of training are qualification and the dummy for white-collar workers (see first column, Table 2.10).

Highly qualified and white-collar workers take part more often than less qualified (the reference categories are "no schooling degree" and "no professional degree") and blue-collar workers. Age and sex are insignificant in determining training. Some of the Laender dummies have an influence. In particular, workers living in poorer regions (in eastern Germany) are less likely to take part in training.

A second variable in the MZ indicates whether individuals took part in general training during the last four weeks. Results of the probit estimation are shown in the second column of Table 2.10. The main difference in the determinants of continuing vocational training and general training is that the indicators for the professional degree have a stronger positive influence on continuing vocational training than on general training. The schooling dummies are also significant in determining continuing vocational training but have no influence on general training. Females seem to take part more often

Table 2.9. Determinants of training (GSOEP)

	On-the-job training		**Months on-the-job training**	
	Coefficient	**z-value**	**Coefficient**	**t-value**
Age	-0.02	(-0.26)	-0.02	(-2.27) **
Age^2	-0.00	(-0.35)	0.00	(2.17) **
Female	0.11	(0.72)	0.02	(0.73)
White-collar worker	0.22	(1.23)	0.01	(0.25)
No schooling degree		Reference		
Lower secondary school	4.44	(3.91) ***	-0.00	(-0.26)
Intermediate secondary school	4.72	(4.01) ***	0.03	(1.51)
Entrance examination for university of applied sciences	5.12	(4.23) ***	0.25	(2.04) **
High-school diploma	5.06	(4.28) ***	0.11	(2.37) **
No professional degree		Reference		
Vocational school	0.41	(1.68) *	0.03	(1.29)
Apprenticeship	0.11	(0.53)	0.03	(1.94) *
Master craftsman	0.62	(2.27) **	0.09	(1.81) *
University of applied sciences	-0.26	(-0.71)	-0.11	(-2.11) **
University	-0.38	(-1.09)	-0.07	(-1.61)
Hesse		Reference		
Schleswig-Holstein	-0.02	(-0.06)	0.01	(0.53)
Hamburg			-0.03	(-1.85) *
Lower Saxony	0.11	(-0.37)	0.05	(1.16)
Bremen	0.54	(1.09)	0.27	(1.02)
North Rhine-Westphalia	-0.21	(-0.74)	0.02	(0.58)
Rhineland-Palatinate	0.12	(0.36)	0.02	(0.92)
Baden-Wuerttemberg	-0.00	(-0.00)	0.04	(1.04)
Bavaria	-0.15	(-0.50)	0.04	(1.20)
Berlin	-0.25	(-0.57)	-0.01	(-0.57)
Mecklenburg-Western Pomerania	0.37	(1.11)	0.02	(0.77)
Brandenburg	-0.18	(-0.52)	-0.02	(-0.98)
Saxony-Anhalt	-0.17	(-0.46)	-0.01	(-0.66)
Thuringia	-0.16	(-0.43)	0.01	(0.32)
Saxony	-0.39	(-1.11)	-0.01	(-0.39)
Log Likelihood	-192.92			
R^2			0.02	

Number of observations is 3,511 in the first column and 3,554 in the second column. In the first column, Hamburg was dropped, and 43 observations were not used.
Significance levels: $*$: 10% $**$: 5% $***$: 1%.

in general training while the indicator is insignificant in the probit regression explaining work-related continuing training. The regional indicators have more explanatory power in the first column than in the second. Workers in eastern Germany (poorer regions) participate less often in continuing training.

Table 2.10. Determinants of training (MZ)

	Formal and informal training		General training	
	Coefficient	**z-value**	**Coefficient**	**z-value**
Age	0.00	(0.80)	-0.01	(-0.28)
Age^2	-0.00	(-2.32) **	-0.00	(-0.39)
Female	-0.01	(-0.29)	0.22	(5.06) ***
White-collar worker	0.40	(13.36) ***	0.34	(5.67) ***
No schooling degree		Reference		
Lower secondary school	0.27	(1.28)	-0.29	(-1.11)
Intermediate secondary school	0.42	(1.96) **	-0.19	(-0.73)
Entrance examination for university of applied sciences	0.48	(2.20) **	-0.02	(-0.09)
High-school diploma	0.49	(2.22) **	-0.12	(-0.45)
No professional degree		Reference		
Vocational school	0.36	(5.82) ***	0.40	(3.47) ***
Apprenticeship	0.17	(3.34) ***	0.16	(1.64)
Master craftsman	0.40	(6.84) ***	0.35	(3.11) ***
University of applied sciences	0.39	(5.88) ***	0.30	(2.36) **
University	0.40	(6.04) ***	0.41	(3.17) ***
Hesse		Reference		
Schleswig-Holstein	0.11	(1.61)	-0.04	(-0.25)
Hamburg	0.01	(0.07)	-0.21	(-1.07)
Lower Saxony	-0.17	(-3.10) ***	-0.18	(-1.66) *
Bremen	0.05	(0.53)	-0.06	(-0.35)
North Rhine-Westphalia	-0.03	(-0.75)	-0.08	(-0.92)
Rhineland-Palatinate	0.01	(0.22)	0.10	(1.02)
Baden-Wuerttemberg	0.07	(1.50)	0.09	(0.96)
Bavaria	0.11	(2.41) **	0.04	(0.51)
Berlin	0.01	(0.11)	0.13	(1.16)
Mecklenburg-Western Pomerania	-0.06	(-0.67)	-0.05	(-0.29)
Brandenburg	-0.02	(-0.27)	0.16	(1.40)
Saxony-Anhalt	-0.35	(-5.25) ***	-0.09	(-0.84)
Thuringia	-0.31	(-3.77) ***	-0.36	(-2.13) **
Saxony	0.07	(1.30)	0.13	(1.30)
Log Likelihood	-7737.13		-1967.29	

Number of observations is in the first column 44,981, in the second column 43,382.
Significance levels: $*$: 10% $**$: 5% $***$: 1%.

BiBB/IAB

In the BiBB/IAB survey, there is more detailed information on continuing vocational training. I use dummy variables indicating participation in courses and seminars over the last 5 years. I also know whether individuals took part in eight other types of continuing training. In Table 2.11, the determinants

of participation in training courses and seminars in the last 2 and 5 years are documented, respectively.

Table 2.11. Determinants of training (BiBB/IAB)

	Training last 2 years		**Training last 5 years**	
	Coefficient	**z-value**	**Coefficient**	**z-value**
Age	0.07	(7.57) ***	0.08	(8.72) ***
Age^2	-0.00	(-7.89) ***	0.00	(-8.86) ***
Female	-0.13	(-5.31) ***	-0.16	(-6.91) ***
White-collar worker	0.55	(20.40) ***	0.55	(22.30) ***
No schooling degree		Reference		
Lower secondary school	-0.23	(-2.80) ***	-0.28	(-3.66) ***
Intermediate secondary school	0.03	(0.38)	0.01	(0.09)
Entrance examination for university of applied sciences	0.26	(2.78) ***	0.23	(2.66) ***
High-school diploma	0.20	(2.34) **	0.13	(1.65) *
No professional degree		Reference		
Vocational school	0.41	(5.66) ***	0.47	(6.91) ***
Apprenticeship	0.35	(7.97) ***	0.39	(9.83) ***
Master craftsman	0.63	(12.34) ***	0.71	(14.76) ***
University of applied sciences	0.62	(9.96) ***	0.64	(10.90) ***
University	0.60	(10.04) ***	0.63	(11.08) ***
Hesse		Reference		
Schleswig-Holstein	-0.07	(-1.09)	-0.04	(-0.66)
Hamburg	-0.09	(-1.08)	-0.06	(-0.77)
Lower Saxony	0.01	(0.10)	0.05	(1.03)
Bremen	0.28	(2.70) ***	0.32	(3.11) ***
North Rhine-Westphalia	0.04	(0.98)	0.05	(1.11)
Rhineland-Palatinate	0.15	(2.58) ***	0.05	(0.87)
Baden-Wuerttemberg	0.06	(1.11)	0.09	(1.96) *
Bavaria	-0.02	(-0.48)	-0.05	(-1.01)
Berlin	-0.19	(-3.14) ***	-0.12	(-2.04) **
Mecklenburg-Western Pomerania	-0.26	(-3.44) ***	-0.10	(-1.43)
Brandenburg	-0.15	(-2.29) **	-0.04	(-0.67)
Saxony-Anhalt	-0.17	(-2.54) **	-0.07	(-1.11)
Thuringia	-0.12	(-1.73) *	0.09	(1.38)
Saxony	-0.15	(-2.64) ***	-0.01	(-0.11)
Log Likelihood	-9824.10		-11015.75	

Number of observations is 17,625 in the first column, 17,815 in the second column.
Significance levels: $*$: 10% $**$: 5% $***$: 1%.

In the probit estimation, almost all of the variables included are significant (mainly due to the large sample size). Older employees have a higher chance of taking part in training than younger ones (although this positive impact decreases with age), and women participate less than men. White-collar

workers have a much higher probability of participating than blue-collar workers. Highly skilled workers participate more often than low-skilled workers, and both schooling and professional degree are relevant. Most of the German Laender dummies are also significant indicating that workers in poorer regions (mainly in eastern Germany) participate less than workers in richer regions. There are very few differences in the determinants of training if account is taken of the last 5 years instead of just the last two.[15] The determinants of the eight other types of continuing training are shown in Tables 2.12 and 2.13.

It is striking that, for some types, the variation in participation is much better explained than for others. In particular, whether individuals attend lectures or fairs and whether they read technical literature is explained best by the control variables. In these types of training, highly qualified workers participate much more often than low-qualified, older workers more often than younger workers, white-collar more than blue-collar workers, and women less than men. Schooling plays no role at all and age a very minor role in determining on-the-job training, internship, the taking over of special tasks for the purpose of training, quality circles, and other company training measures. Again, women participate less often (except for internship) and white-collar more than blue-collar workers (except for on-the-job training).

2.4.3.3 Correlation Between Training and Wages

In the econometric analysis, I estimate the correlation of training with earnings by extended Mincer equations. The Mincer equation can be derived from human capital theory (as outlined, e.g., by Franz, 2003). The standard equation includes log earnings Y on the left hand side and schooling s, experience ex, experience squared ex^2, and an unobservable error term ϵ on the right hand side:

$$\ln Y = \beta_0 + \beta_1 \cdot s + \beta_2 \cdot ex + \beta_3 \cdot ex^2 + \epsilon. \tag{2.2}$$

I use log wages instead of log earnings in order to capture differences in hours worked. Instead of years of schooling I use dummy variables for the highest educational outcome. Given the educational system in Germany, the assumption of linear returns to schooling is unlikely to hold, and educational outcome rather than years of schooling fits German data better (Franz, 2003). I have to use an indicator for potential labour market experience because direct information on labour market experience is not available in all data sets. Usually, age minus years of schooling minus 6 is used as a proxy. I use *age* instead because I am not interested in the interpretation of the coefficient. In addition to the standard variables, I include a training variable T and dummies for *sex*, for *white*-collar workers, and for the German *Laender*. Hence, I estimate the hourly wage regression as follows:

[15] I also estimated probit equations for training participation in the last year and in the last 3 years. Results are very similar to the ones presented here.

$$\ln w = \beta_0 + \beta_1' \cdot S + \beta_2 \cdot age + \beta_3 \cdot age^2 + \beta_4 \cdot T + \beta_5 \cdot sex + \beta_6 \cdot white + \beta_7' \cdot Laender + \epsilon. \tag{2.3}$$

GSOEP

In the GSOEP, I estimate the impact of on-the-job training over the last year on gross and net wages. Results of the Mincer regressions are shown in Table 2.14. Strikingly, on-the-job training does not impact gross or net wages. In the left hand columns, I use a training dummy and the number of months in which individuals report having taken part in training to estimate the correlation with net wages. In the right hand columns, I use the same measures to calculate the correlation with gross wages. The covariates explain around 36% of the variation in net wages and around 40% of the variation in gross wages. The explanatory power of net wages is lower because I do not include any household information in the wage regression, such as indicators for married status or the number of children in the household. As expected, wages increase with age (this positive correlation decreases with age). Women and people living in eastern Germany earn less, and white-collar workers and those with high schooling and professional degrees earn more.

MZ

With the MZ, I analyse the impact of continuing vocational training and of general training over the last 4 weeks on net wages. I find a positive and significant correlation for both measures (see Table 2.15). The impact of continuing vocational training on net wages is stronger in comparison to general training. All other determinants of wages are similar in both columns, and coefficients have the expected sign.

The wage regressions using the Microcensus explain the variation in net wages somewhat better than the wage regressions using the GSOEP. In the former, almost all covariates are significant – even the regional indicators which (probably owing to the smaller sample size) were not exclusively significant in the wage regression with the GSOEP. The training variable, which I am interested in, is also significant in the wage regression – no matter whether work-related continuing training or general training is used or not. The correlation with wages is higher for general training than for work-related continuing training. All other coefficients have the expected signs.

Table 2.12. Determinants of training (BiBB/IAB)

	Trade fair		Lectures		On-the-job		Company measures	
	Coefficient	**z-value**	**Coefficient**	**z-value**	**Coefficient**	**z-value**	**Coefficient**	**z-value**
Age	0.01	(1.23)	0.03	(3.29) ***	0.01	(1.09)	0.08	(7.34) ***
Age^2	-0.00	(-1.36)	-0.00	(-2.92) ***	-0.00	(-2.66) ***	-0.00	(-7.02) ***
Female	-0.46	(-16.97) ***	-0.22	(-9.08) ***	-0.03	(-1.30)	-0.20	(-7.32) ***
White-collar worker	0.59	(19.31) ***	0.66	(23.35) ***	-0.01	(-0.41)	0.32	(10.67) ***
No schooling degree	Reference							
Lower secondary school	-0.19	(-2.18) **	-0.29	(-3.55) ***	-0.09	(-1.04)	-0.10	(-1.07)
Intermediate secondary school	-0.00	(-0.02)	-0.02	(-0.25)	-0.05	(-0.55)	0.06	(0.62)
Entrance examination for university of applied sciences	0.22	(2.24) **	0.29	(3.16) ***	-0.01	(-0.07)	0.16	(1.52)
High-school diploma	0.18	(1.96) *	0.21	(2.48) **	0.01	(0.09)	0.14	(1.38)
No professional degree	Reference							
Vocational school	0.30	(3.29) ***	0.43	(5.58) ***	0.17	(2.41) **	0.40	(4.86) ***
Apprenticeship	0.45	(8.07) ***	0.45	(9.39) ***	0.15	(3.56) **	0.37	(7.03) **
Master craftsman	0.83	(13.54) ***	0.77	(13.89) ***	0.15	(2.94) **	0.52	(8.68) **
University of applied sciences	0.88	(12.50) ***	0.83	(12.83) ***	0.17	(2.74) ***	0.42	(6.02) ***
University	0.95	(13.67) ***	0.95	(15.00) ***	0.16	(2.60) ***	0.32	(4.57) ***
Hesse	Reference							
Schleswig-Holstein	-0.02	(-0.30)	-0.06	(-0.88)	0.01	(0.10)	-0.11	(-1.46)
Hamburg	-0.13	(-1.27)	-0.16	(-1.72) *	-0.22	(-2.26) **	-0.30	(-2.76) ***
Lower Saxony	0.03	(0.51)	0.00	(0.08)	0.06	(1.13)	-0.00	(-0.01)
Bremen	0.13	(1.15)	0.13	(1.15)	0.22	(2.07) **	0.05	(0.44)
North Rhine-Westphalia	0.16	(3.33) ***	0.11	(2.31) **	0.11	(2.37) **	0.09	(1.75) *
Rhineland-Palatinate	0.11	(1.80) *	0.12	(2.03) **	-0.08	(-1.35)	-0.02	(-0.34)
Baden-Wuerttemberg	0.16	(2.85) ***	0.19	(3.74) ***	0.11	(2.15) **	0.15	(2.70) ***
Bavaria	0.08	(1.49)	0.08	(1.49)	-0.04	(-0.71)	-0.05	(-0.83)
Berlin	-0.13	(-1.96) **	-0.24	(-3.70) ***	0.09	(1.50)	0.10	(1.44)
Mecklenburg-Western Pomerania	-0.27	(-3.01) ***	-0.27	(-3.44) ***	0.46	(6.29) ***	-0.04	(-0.49)
Brandenburg	-0.25	(-3.19) ***	-0.16	(-2.33) **	0.14	(2.07) **	-0.08	(-1.10)
Saxony-Anhalt	-0.20	(-2.65) ***	-0.15	(-2.16) **	0.17	(2.47) **	-0.22	(-2.74) ***
Thuringia	-0.09	(-1.22)	-0.00	(-0.05)	0.35	(5.19) ***	-0.04	(-0.53)
Saxony	-0.08	(-1.20)	-0.03	(-0.51)	0.27	(4.71) ***	0.01	(0.22)
Log Likelihood	-7729.17		-9112.09		-9236.26		-7315.65	

Number of observations is 17,852. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table 2.13. Determinants of training (BiBB/IAB)

	Internship		Special assignment		Technical literature		Other training	
	Coefficient	**z-value**	**Coefficient**	**z-value**	**Coefficient**	**z-value**	**Coefficient**	**z-value**
Age	-0.03	(-1.93) *	0.04	(3.55) ***	0.01	(1.38)	0.04	(4.31) ***
Age^2	0.00	(1.69) *	-0.00	(-4.10) ***	-0.00	(-0.95)	-0.00	(-4.14) ***
Female	0.06	(1.51)	-0.17	(-6.20) ***	-0.23	(-9.75) ***	-0.12	(-4.50) ***
White-collar worker	0.30	(5.50) ***	0.33	(10.79) ***	0.69	(24.87) ***	0.31	(10.26) ***
No schooling degree				Reference				
Lower secondary school	-0.38	(-2.76) ***	-0.18	(-1.95) *	-0.20	(-2.44) **	-0.19	(-2.14) **
Intermediate secondary school	-0.22	(-1.60)	-0.02	(-0.18)	0.12	(1.39)	-0.06	(-0.63)
Entrance examination for university of applied sciences	-0.12	(-0.77)	0.07	(0.73)	0.37	(4.03) ***	0.06	(0.56)
High-school diploma	0.01	(0.06)	0.10	(1.03)	0.40	(4.59) ***	-0.03	(-0.31)
No professional degree				Reference				
Vocational school	0.05	(0.35)	0.27	(3.24) ***	0.36	(4.74) ***	0.29	(3.51) ***
Apprenticeship	0.01	(0.14)	0.35	(6.78) ***	0.46	(10.05) ***	0.26	(5.22) ***
Master Craftsman	0.10	(1.01)	0.54	(9.09) ***	0.87	(16.33) ***	0.35	(6.02) ***
University of applied sciences	0.23	(2.17) **	0.44	(6.27) ***	0.85	(13.39) ***	0.37	(5.38) ***
University	0.45	(4.40) ***	0.41	(5.98) ***	0.98	(15.80) ***	0.35	(5.18) ***
Hesse				Reference				
Schleswig-Holstein	-0.02	(-0.16)	0.10	(1.37)	-0.11	(-1.67) *	-0.03	(-0.43)
Hamburg	0.03	(0.19)	-0.11	(-1.11)	-0.34	(-3.76) ***	-0.37	(-3.47) ***
Lower Saxony	0.09	(0.94)	0.01	(0.16)	-0.08	(-1.60)	-0.10	(-1.79) *
Bremen	0.36	(2.12) **	-0.06	(-0.48)	-0.21	(-1.86) *	-0.22	(-1.73) *
North Rhine-Westphalia	0.06	(0.66)	0.14	(2.87) ***	0.03	(0.67)	-0.14	(-2.82) ***
Rhineland-Palatinate	-0.11	(-0.91)	-0.06	(-0.88)	-0.10	(-1.62)	-0.04	(-0.57)
Baden-Wuerttemberg	0.07	(0.72)	0.07	(1.17)	-0.01	(-0.18)	-0.04	(-0.78)
Bavaria	0.02	(0.21)	0.03	(0.53)	0.00	(0.07)	0.02	(-0.37)
Berlin	0.14	(1.32)	0.08	(1.19)	-0.25	(-4.00) ***	0.10	(1.51)
Mecklenburg-Western Pomerania	0.51	(4.46) ***	-0.18	(-2.04) **	-0.09	(-1.25)	-0.23	(-2.67) ***
Brandenburg	0.11	(0.87)	-0.20	(-2.56) **	-0.00	(-0.06)	0.31	(4.45) ***
Saxony-Anhalt	0.24	(2.10) **	-0.02	(-0.28)	-0.13	(-1.98) **	0.04	(0.54)
Thuringia	0.36	(3.24) ***	0.07	(0.96)	-0.03	(-0.41)	0.13	(1.82) *
Saxony	0.31	(3.08)	-0.06	(-0.91)	0.01	(0.25)	0.21	(3.38) ***
Log Likelihood	-2538.27		-7475.32		-9342.12		-7545.29	

Number of observations is 17,852. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table 2.14. Correlation of training with wages (GSOEP)

	Net wage				Gross wage			
	On-the-job		Months on-the-job		On-the-job		Months on-the-job	
	Coefficient	t-values	Coefficient	t-values	Coefficient	t-values	Coefficient	t-values
Training	0.05	(1.05)	0.01	(0.69)	0.04	(0.68)	0.00	(0.21)
Age	0.04	(7.79) ***	0.04	(7.80) ***	0.03	(6.86) ***	0.03	(6.88) ***
Age^2	0.00	(6.46) ***	0.00	(6.46) ***	0.00	(5.60) ***	0.00	(5.61) ***
Female	-0.24	(-19.06) ***	-0.24	(-19.09) ***	-0.20	(-15.42) ***	-0.20	(-15.44) ***
White-collar worker	0.15	(10.69) ***	0.15	(10.67) ***	0.18	(12.92) ***	0.18	(12.91) ***
No schooling degree	Reference							
Lower secondary school	0.03	(1.24)	0.03	(1.23)	0.06	(2.55) **	0.06	(2.54) **
Intermediate secondary school	0.09	(3.33) ***	0.09	(3.32) ***	0.14	(5.58) ***	0.14	(5.57) ***
Entrance examination for university of applied sciences	0.11	(3.08) ***	0.11	(3.06) ***	0.15	(4.63) **	0.15	(4.59) **
High-school diploma	0.11	(3.80) ***	0.11	(3.78) ***	0.18	(6.26) **	0.18	(6.24) **
No professional degree	Reference							
Vocational school	0.11	(4.89) ***	0.11	(4.87) ***	0.11	(5.03) **	0.11	(5.02) **
Apprenticeship	0.08	(4.58) ***	0.08	(4.58) ***	0.08	(4.09) **	0.08	(4.08) **
Master craftsman	0.11	(4.48) ***	0.11	(4.45) ***	0.12	(4.35) **	0.11	(4.33) **
University of applied sciences	0.25	(7.21) ***	0.25	(7.19) ***	0.27	(7.87) ***	0.27	(7.86) ***
University	0.22	(7.16) ***	0.22	(7.17) ***	0.26	(8.39) ***	0.26	(8.40) ***
Hesse	Reference							
Schleswig-Holstein	-0.01	(-0.32)	-0.01	(-0.32)	-0.02	(-0.46)	-0.02	(-0.46)
Hamburg	0.04	(0.84)	0.04	(0.85)	0.05	(1.00)	0.05	(1.01)
Lower Saxony	-0.02	(-0.58)	-0.02	(-0.59)	-0.02	(-0.83)	-0.02	(-0.84)
Bremen	-0.04	(0.64)	-0.04	(-0.65)	-0.01	(-0.20)	-0.02	(-0.21)
North Rhine-Westphalia	-0.02	(-0.87)	-0.02	(-0.86)	-0.02	(-0.74)	-0.02	(-0.74)
Rhineland-Palatinate	-0.02	(-0.62)	-0.02	(-0.63)	-0.01	(-0.20)	-0.01	(-0.21)
Baden-Wuerttemberg	0.03	(1.08)	0.03	(1.08)	0.02	(0.58)	0.02	(0.58)
Bavaria	0.02	(0.62)	0.02	(0.64)	0.01	(0.36)	0.01	(0.36)
Berlin	-0.13	(-3.63) ***	-0.13	(-3.62) ***	-0.13	(-3.47) ***	-0.13	(-3.46) ***
Mecklenburg-Western Pomerania	-0.34	(-9.60) ***	-0.34	(-9.62) ***	-0.37	(-10.21) ***	-0.37	(-10.21) ***
Brandenburg	-0.27	(-7.67) ***	-0.27	(-7.66) ***	-0.32	(-8.67) ***	-0.32	(-8.66) ***
Saxony-Anhalt	-0.32	(-8.75) ***	-0.32	(-8.74) ***	-0.37	(-9.97) ***	-0.37	(-9.97) ***
Thuringia	-0.38	(-11.45) ***	-0.38	(-11.44) ***	-0.43	(-12.70) ***	-0.43	(-12.69) ***
Saxony	-0.34	(-11.32) ***	-0.34	(-11.31) **	-0.40	(-12.78) **	-0.40	(-12.77) **
F()	(28, 3327) 62.65		(28, 3327) 62.65		(28, 3303) 76.28		(28, 3303) 76.28	
R^2	0.36		0.36		0.40		0.40	

A constant is included in the estimations. Number of observations is in the first and second column 3,356, in the third and fourth column 3,332.
For all regressions, Prob > F is 0.00. Significance levels: * : 10% ** : 5% *** : 1%.

BiBB/IAB

There is a variety of training indicators in the BiBB/IAB data set. The correlation of participation in training courses and seminars in the last 2 and 5 years, respectively, with wages are shown in the first two columns of Table 2.16.

If training took place more recently (i.e. in the last 2 years), the impact on wage is somewhat stronger than if training took place over a longer time span (over the last 5 years). The correlation is positive and highly significant for both indicators. All other coefficients in the wage regression have the expected signs and are similar not only in the first two columns but also for the regressions using other types of training.

The eight different kinds of training are put separately in wage regressions, and results are shown in Tables 2.17 and 2.18. The wage regressions using the BiBB/IAB data are able to explain around 34% of the variation in gross wages, somewhat less than the variation in gross wages explained by the GSOEP. The indicators for attending lectures, reading technical literature, and company measures such as quality circles seem to have the strongest impact and are highly correlated with wages. The indicator for attendance at fairs, the assumption of special tasks for the purpose of training, other company training measures, and on-the-job training are also positively correlated with wages, but less so than the first three measures. Internship does not influence wages, and the coefficient even has a negative sign. All other variables in the hourly wage regression have the expected positive sign, are significant (except for some regional indicators), and do not differ with the training measure used.

2.4.4 Comparison of Results

Large differences in training indicators are already apparent in the descriptive statistics. The reported incidence of training over a period of one year is as low as 1.9% in the GSOEP calendarium including company training, further training, and retraining. There, individuals are employed in the same month they participate in training. The reason for the extreme low training incidence in the GSOEP might be that individuals are asked to report only relevant training courses and seminars (see also Jürges & Schneider, 2005). It is likely that only long and formal training courses are reported. In addition, the recall problem might be more severe in this survey than in the others because no further help is provided as to which type of training to consider. Alternatively, results with the GSOEP are less robust due to the low number of training participants and, hence, also less reliable.

In the MZ, participation 4 weeks prior to the survey is 5.8 %. In the BiBB/IAB data, the reported incidence of training in one year is as high as 21% for training courses and seminars. When help is provided to remember training activities by giving many examples of formal and informal training

Table 2.15. Correlation of training with wages (MZ)

	Net Wage			
	Continuing training		**General training**	
	Coefficient	**t-values**	**Coefficient**	**t-values**
Training	0.02	(2.47) **	0.07	(3.77) ***
Age	0.04	(24.08) ***	0.04	(23.22) ***
Age^2	0.00	(19.67) ***	0.00	(19.00) ***
Female	-0.27	(-64.31) ***	-0.28	(-63.92) ***
White-collar worker	0.16	(36.41) ***	0.16	(36.24) ***
No schooling degree		Reference		
Lower secondary school	0.48	(9.47) ***	0.48	(9.48) ***
Intermediate secondary school	0.54	(10.67) ***	0.54	(10.68) ***
Entrance examination for university of applied sciences	0.58	(11.18) ***	0.57	(11.12) ***
High-school diploma	0.59	(11.47) ***	0.59	(11.50) ***
No professional degree		Reference		
Vocational school	0.14	(14.84) ***	0.14	(14.64) ***
Apprenticeship	0.11	(17.06) ***	0.11	(16.96) ***
Master craftsman	0.20	(24.05) ***	0.21	(24.06) ***
University of applied sciences	0.28	(26.41) ***	0.29	(26.24) ***
University	0.32	(27.65) ***	0.32	(27.57) ***
Hesse		Reference		
Schleswig-Holstein	-0.02	(-1.85) *	-0.02	(-1.85) *
Hamburg	0.01	(0.65)	0.02	(1.03)
Lower Saxony	-0.01	(-1.58)	-0.01	(-1.30)
Bremen	-0.04	(-2.48) **	-0.03	(-2.04) **
North Rhine-Westphalia	0.02	(2.81) ***	0.02	(3.12) ***
Rhineland-Palatinate	-0.02	(-2.27) **	-0.02	(-1.75) *
Baden-Wuerttemberg	0.04	(4.26) *	0.04	(4.67) ***
Bavaria	0.01	(1.53)	0.01	(1.84) *
Berlin	-0.14	(-13.54) ***	-0.14	(-12.82) ***
Mecklenburg-Western Pomerania	-0.36	(-26.72) ***	-0.36	(-26.04) ***
Brandenburg	-0.32	(-30.25) ***	-0.32	(-29.82) ***
Saxony-Anhalt	-0.34	(-36.92) ***	-0.33	(-36.13) ***
Thuringia	-0.37	(-32.27) ***	-0.37	(-31.67) ***
Saxony	-0.35	(-38.44) ***	-0.35	(-37.47) ***
F()	(28, 43321) 732.75		(28, 41777) 718.80	
R^2	0.35		0.35	

A constant is included in the estimations.
Number of observations is in the first column 43,350, in the second column 41,806.
For all regressions, Prob > F is 0.00.
Significance levels: * : 10% ** : 5% *** : 1%.

types, more than 60% of the employees in the BiBB/IAB sample report having participated in some kind of training over the last 2 years. This reasoning

Table 2.16. Correlation of training with wages (BiBB/IAB)

	Training last 2 years		**Training last 5 years**	
	Coefficient	**t-value**	**Coefficient**	**t-value**
Training	0.12	(18.97) ***	0.11	(18.02) ***
Age	0.02	(9.02) ***	0.02	(8.83) ***
Age^2	0.00	(6.04) ***	0.00	(5.87) ***
Female	-0.21	(-31.75) ***	-0.21	-(31.57) ***
White-collar worker	0.10	(13.89) ***	0.10	(13.49) ***
No schooling degree		Reference		
Lower secondary school	0.00	(0.03)	0.01	(0.30)
Intermediate secondary school	0.07	(3.22) ***	0.07	(3.38) ***
Entrance examination for university of applied sciences	0.14	(5.77) ***	0.15	(5.96) ***
High-school diploma	0.15	(6.45) ***	0.16	(6.72) ***
No professional degree		Reference		
Vocational school	0.11	(5.27) ***	0.09	(4.59) ***
Apprenticeship	0.11	(10.54) ***	0.11	(10.29) ***
Master craftsman	0.21	(15.57) ***	0.20	(15.14) ***
University of applied sciences	0.23	(12.82) ***	0.22	(12.66) ***
University	0.31	(17.87) ***	0.30	(17.57) ***
Hesse		Reference		
Schleswig-Holstein	-0.03	(-1.93) *	-0.04	(-2.20) **
Hamburg	-0.03	(-1.43)	-0.04	(-1.58)
Lower Saxony	-0.01	(-0.66)	-0.01	(-0.83)
Bremen	-0.02	(-0.84)	-0.02	(-0.92)
North Rhine-Westphalia	0.02	(1.97) **	0.02	(1.94) *
Rhineland-Palatinate	-0.03	(-2.13) **	-0.03	(-1.88) *
Baden-Wuerttemberg	0.03	(2.06) **	0.02	(1.49)
Bavaria	-0.01	(-1.04)	-0.01	(-0.97)
Berlin	-0.14	(-8.30) ***	-0.14	(-8.60) ***
Mecklenburg-Western Pomerania	-0.37	(-17.91) ***	-0.37	(-18.40) ***
Brandenburg	-0.33	(-17.05) ***	-0.34	(-17.43) ***
Saxony-Anhalt	-0.40	(-21.24) ***	-0.40	(-21.69) ***
Thuringia	-0.34	(-17.96) ***	-0.35	(-18.53) ***
Saxony	-0.38	(-25.11) ***	-0.39	(-25.56) ***
F()	(28, 15090) 270.99		(28, 152,40) 274.23	
R^2	0.35		0.35	

A constant is included in the estimations.
Number of observations is in the first column 15,119, in the second column 15,269.
For all regressions, Prob > F is 0.00
Significance levels: $*$: 10% $**$: 5% $***$: 1%.

suggests that the recall problem is much higher in the GSOEP than in the other data sets.

As well as the way in which the training question is phrased and whether the recall problem is minimised by providing examples, an important role

may also be played by the position of the question in the questionnaire and whether the question is read and explained by an interviewer. The question is placed more prominently in the BiBB/IAB survey and in the MZ than in the GSOEP, which might explain the very low incidence in the GSOEP. Even more important in explaining the extremely low incidence of training in the GSOEP calendarium is the fact that only "important" training spells are considered (employees might consider very few training types as important and do not report most training spells).

The type of training is defined differently in the various data sets and makes an important difference not only in the econometric analysis but also in descriptive statistics. For example, around 6 % of the employees in the MZ report take part in training today or over the last 4 weeks while just less than 1% report general training over the last 4 weeks. In the section discussing the participation rates in various training forms in the BiBB/IAB, huge differences are apparent as well. The time span considered also differs widely and should be carefully taken into account when comparing numbers on training incidence. 21% of the employees took part in training courses and seminars last year, 30% took part over the last 2 years, and 43% participated within the last 3 years in the BiBB/IAB sample.

The difference in participation for men and women and eastern and western Germany is similar in all samples: Women participate more often than men, and employees in western Germany participate more often than those in eastern Germany, ceteris paribus. Differences in age groups are most evident in the GSOEP, where young employees participate more often in training and where training for young employees is also most intensive. In the MZ, the same pattern holds for firm-related continuing training but not for general training. In the BiBB/IAB data, no difference in participation by age groups is evident, neither for training courses and seminars nor for the indicator comprising formal and informal training courses. Similarly in all samples, participation rates vary strongly by qualification (especially for training intensity) for firm-related training and for formal training.

In the probit estimations, the most important determinants of training are qualificational indicators. Participation increases with both higher schooling and professional degrees. In the GSOEP, all other variables have no significant influence on training participation. This might be due to the small sample size since only 42 people in the sample participated in continuing training. In the MZ, the dummy for white-collar workers is also positive and significant as well as some regional indicators, indicating that participation in poorer East German regions is lower. In the BiBB/IAB data, where average incidence of training is highest, females and young workers participate less in continuing training, ceteris paribus. This contrasts with the first look at the descriptive statistics where females appeared to participate more often than men. Participation rates in training courses and seminars do not differ by region, but fewer employees take part in informal training in poorer regions (in eastern Germany).

Some interesting differences in determinants appear when comparing the various training types in the BiBB/IAB data. For example, older employees visit lectures more often, participate more frequently in company measures such as quality circles, or take on special learning-related tasks. In contrast, older employees take part less often in internships, and age plays no significant role in determining visits to trade fairs, on-the-job training, or reading technical literature. Females participate less in trade fairs, lectures, company measures, and read technical literature less often. White-collar workers have a higher probability of participating in all training types but on-the-job training. On-the-job training is also the only type of training where employees in eastern Germany participate more often; West German employees participate more in all other types of training. The schooling degree significantly determines visits to trade fairs, attendance at lectures, and the reading of technical literature. None of the remaining training types are determined by schooling degrees but only by professional degrees. Internship is the only type of training that is not determined by qualification.

The correlation of training to wages varies between the data sets and training variables used. In the GSOEP, no significant correlations between training participation and net or gross wages are apparent. The insignificance of the coefficients is mainly due to the very small sample size (only 42 training participants). In the other data sets used, I find positive and significant correlations between training and wages. In the MZ, correlations between continuing vocational training and net wages as well as general training and net wages are both positive. The estimated coefficient and t-value in the wage regression is much higher for general training than for continuing vocational training. This is in line with the finding in Kuckulenz and Zwick (2003) that (firm-) specific training leads to higher wage increases than training of a more general nature. The wage regressions with the BiBB/IAB data reveal a strong positive correlation between wages and continuing training (including formal and informal training), (formal) training courses and seminars, trade fairs, lectures, company measures, special assignments, and technical literature. For on-the-job training, internship, and other training, correlations with wages are less strong or insignificant.

The estimated coefficients in the wage regressions are probably biased and inconsistent estimates of the causal effect of training on wages because endogeneity of training is not accounted for. For example, if motivated and able employees take part in training more often than less motivated and able employees, the coefficients overestimate the impact of training on wages. The reason for the likely overestimation is that these individuals, who have a high probability of participating in training, are also likely to earn more even without their participation in training. But this is not important in the context discussed here, where the interest is in differences between different training variables in various data sets, and not in the exact size of the effect from training participation on wages.

2.4.5 Conclusion

The analysis of training incidence, determinants of training, and the correlation of training and wages with three German data sets including training information from the year 1998 revealed huge differences in the definition of training variables. The training question is set up in various ways and placed in more or less prominent positions in the survey. Sometimes the question is posed in a broader way, and examples are given, so that many employees remember having taken part in some training. In the GSOEP, where individuals were asked to report the exact month in which training took place, very few individuals reported participating in training. The most important reason for this seems to be the framing of the survey question which asked individuals to report only relevant training courses. The GSOEP is less suitable for econometric analysis of the training variable than the MZ and the BiBB/IAB data because of the very small sample size. The advantage of the GSOEP – that individuals can be followed over several years and that wages before and after training participation can be observed – is diminished by the small sample size. An alternative might be to use only certain years in which additional questions on continuing training are included in the GSOEP (like Pischke, 2001, using the data from 1989).

Results are very similar in the MZ and the BiBB/IAB data. Both are reliable data sets and have their advantages: The sample size is larger in the MZ, but the BiBB/IAB data offers more information on the type of training and the timing. The type of training is important for the determinants of training as well as for the correlation with wages. Hence, making comparisons of studies analysing determinants of training or the impact of training on wages is anything but a trivial task. Account not only needs to be taken of the econometric method when comparing estimates; great importance also attaches to the way the training variable is defined, how the survey question is posed, and the type of training – formal or informal, general or firm specific, all or just "relevant" training – which is included. One should be careful when interpreting econometric results because training variables may capture very diverse kinds of training.

In the following, I will mainly use the BiBB/IAB data with its huge number of observations and large spectrum of questions. The "Qualification and Career Survey" suits my research questions well since I focus on employees when analysing continuing training. A disadvantage of the data set is that it is only available for certain years. Hence, in chapter 5, where panel data is needed for the empirical analysis, I use the Microcensus.

Table 2.17. Correlation of training with wages (BiBB/IAB)

	Trade fair		Lectures		On-the-job		Company measures	
	Coefficient	**t-values**	**Coefficient**	**t-values**	**Coefficient**	**t-values**	**Coefficient**	**t-values**
Training	0.09	(11.74) ***	0.12	(18.24) ***	0.02	(3.11) ***	0.12	(16.18) ***
Age	0.02	(9.87) ***	0.02	(9.63) ***	0.03	(9.97) ***	0.02	(9.23) ***
Age^2	0.00	(6.92) ***	0.00	(6.72) ***	0.00	(7.00) ***	0.00	(6.32) ***
Female	-0.20	(-30.43) ***	-0.20	(-31.23) ***	-0.21	(-32.17) ***	-0.21	(-31.66) ***
White-collar worker	0.11	(15.14) ***	0.10	(13.77) ***	0.12	(16.83) ***	0.11	(15.80) ***
No schooling degree				Reference				
Lower secondary school	0.00	(0.00)	0.00	(0.20)	0.00	(0.13)	0.00	(0.09)
Intermediate secondary school	0.08	(3.44) ***	0.07	(3.41) ***	0.08	(3.43) ***	0.07	(3.30) ***
Entrance examination for university of applied sciences	0.15	(6.09) ***	0.14	(5.78) ***	0.16	(6.32) **	0.15	(6.08) **
High-school diploma	0.16	(6.79) ***	0.15	(6.57) ***	0.16	(6.94) **	0.16	(6.75) **
No professional degree				Reference				
Vocational school	0.11	(5.31) ***	0.10	(5.07) ***	0.11	(5.31) **	0.10	(4.98) **
Apprenticeship	0.12	(10.92) ***	0.11	(10.55) ***	0.12	(11.30) ***	0.12	(10.83) ***
Master craftsman	0.21	(15.79) ***	0.20	(15.43) ***	0.23	(16.97) ***	0.22	(16.27) ***
University of applied sciences	0.23	(13.01) ***	0.22	(12.62) ***	0.25	(13.99) ***	0.24	(13.62) ***
University	0.31	(17.58) ***	0.29	(16.83) ***	0.33	(18.69) ***	0.32	(18.60) ***
Hesse				Reference				
Schleswig-Holstein	-0.04	(-2.09) **	-0.04	(-2.09) **	-0.04	(-2.12) **	-0.04	(-2.08) **
Hamburg	-0.03	(-1.44)	-0.03	(-1.36)	-0.03	(-1.48)	-0.03	(-1.35)
Lower Saxony	-0.01	(-0.76)	-0.01	(-0.71)	-0.01	(-0.71)	-0.01	(-0.84)
Bremen	-0.01	(-0.51)	-0.01	(-0.52)	-0.01	(-0.46)	-0.01	(-0.53)
North Rhine-Westphalia	0.02	(1.74) *	0.02	(1.71) *	0.02	(2.01) **	0.02	(1.81) *
Rhineland-Palatinate	-0.03	(-1.90) *	-0.03	(-2.03) **	-0.03	(-1.73) *	-0.03	(-1.89) *
Baden-Wuerttemberg	0.02	(1.45)	0.02	(1.20)	0.02	(1.66)	0.02	(1.21)
Bavaria	-0.01	(-1.13)	-0.02	(-1.22)	-0.01	(-0.95)	-0.01	(1.02)
Berlin	-0.14	(-8.60) ***	-0.14	(-8.32) ***	-0.15	(-8.74) ***	-0.15	(-9.08) ***
Mecklenburg-Western Pomerania	-0.37	(-17.95) ***	-0.37	(-17.84) ***	-0.38	(-18.26) ***	-0.38	(-18.31) ***
Brandenburg	-0.33	(-17.06) ***	-0.33	(-17.17) ***	-0.34	(-17.35) ***	-0.34	(-17.35) ***
Saxony-Anhalt	-0.40	(-21.20) ***	-0.40	(-21.50) ***	-0.40	(-21.56) ***	-0.40	(-21.47) ***
Thuringia	-0.34	(-17.75) ***	-0.34	(-17.86) ***	-0.35	(-17.94) ***	-0.34	(-18.05) ***
Saxony	-0.39	(-25.10) ***	-0.39	(-25.36) **	-0.39	(-25.26) **	-0.39	(-25.61) **
F()	(28, 15268) 261.38		(28, 15268) 269.32		(28, 15268) 251.15		(28, 15268) 266.87	
R^2	0.34		0.35		0.33		0.34	

A constant is included in the estimations. Number of observations is 15,297.
For all regressions, Prob > F is 0.00. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table 2.18. Correlation of training with wages (BiBB/IAB)

	Internship		Special assignment		Technical literature		Other training	
	Coefficient	**t-values**	**Coefficient**	**t-values**	**Coefficient**	**t-values**	**Coefficient**	**t-values**
Training	-0.01	(-0.78)	0.08	(10.71) ***	0.10	(15.32) ***	0.04	(5.41) ***
Age	0.03	(9.97) ***	0.02	(9.77) ***	0.02	(9.89) ***	0.02	(9.81) ***
Age^2	0.00	(7.02) ***	0.00	(6.78) ***	0.00	(6.98) ***	0.00	(6.88) ***
Female	-0.21	(-32.18) ***	-0.21	(-31.75) ***	-0.21	(-31.24) ***	-0.21	(32.05) ***
White-collar worker	0.12	(16.80) ***	0.11	(16.00) ***	0.10	(13.92) ***	0.12	(16.38) ***
No schooling degree				Reference				
Lower secondary school	0.00	(0.17)	0.00	(0.03)	0.00	(0.12)	0.00	(0.08)
Intermediate secondary school	0.08	(3.41) ***	0.08	(3.48) ***	0.07	(3.31) ***	0.08	(3.45) ***
Entrance examination for university of applied sciences	0.16	(6.32) ***	0.16	(6.29) ***	0.14	(5.85) **	0.16	(6.28) **
High-school diploma	0.16	(6.96) ***	0.16	(6.93) ***	0.15	(6.41) **	0.16	(6.96) **
No professional degree				Reference				
Vocational school	0.11	(5.35) ***	0.11	(5.25) ***	0.11	(5.18) **	0.11	(5.29) **
Apprenticeship	0.12	(11.36) ***	0.12	(11.01) ***	0.11	(10.68) ***	0.12	(11.23) ***
Master craftsman	0.23	(17.01) ***	0.22	(16.48) ***	0.20	(15.21) ***	0.23	(16.84) ***
University of applied sciences	0.25	(14.06) ***	0.24	(13.76) ***	0.22	(12.84) ***	0.24	(13.88) ***
University	0.33	(18.79) ***	0.32	(18.51) ***	0.30	(17.05) ***	0.32	(18.59) ***
Hesse				Reference				
Schleswig-Holstein	-0.04	(-2.11) **	-0.04	(-2.22) **	-0.04	(-2.03) **	-0.04	(-2.10) **
Hamburg	-0.03	(-1.52)	-0.03	(-1.40)	-0.03	(-1.17)	-0.03	(-1.41)
Lower Saxony	-0.01	(-0.70)	-0.01	(-0.69)	-0.01	(-0.54)	-0.01	(-0.62)
Bremen	-0.01	(-0.40)	-0.01	(-0.30)	0.00	(0.14)	-0.01	(-0.34)
North Rhine-Westphalia	0.03	(2.07) **	0.02	(1.89) *	0.02	(2.00) **	0.03	(2.18) **
Rhineland-Palatinate	-0.03	(-1.75) *	-0.03	(-1.70) *	-0.02	(-1.67) *	-0.03	(-1.75) *
Baden-Wuerttemberg	0.02	(1.73) *	0.02	(1.61)	0.02	(1.64)	0.02	(1.75) *
Bavaria	-0.01	(-0.97)	-0.01	(-0.98)	-0.01	(-1.06)	-0.01	(-0.98)
Berlin	-0.15	(-8.71) ***	-0.15	(-8.80) ***	-0.14	(-8.33) ***	-0.15	(-8.76) ***
Mecklenburg-Western Pomerania	-0.38	(-18.10) ***	-0.37	(-18.10) ***	-0.37	(-18.10) ***	-0.37	(-18.09) ***
Brandenburg	-0.34	(-17.33) ***	-0.34	(-17.17) ***	-0.34	(-17.35) ***	-0.34	(-17.53) ***
Saxony-Anhalt	-0.40	(-21.45) ***	-0.40	(-21.57) ***	-0.40	(-21.33) ***	-0.40	(-21.53) ***
Thuringia	-0.34	(-17.77) ***	-0.34	(-17.94) ***	-0.34	(-17.92) ***	-0.35	(-17.91) ***
Saxony	-0.39	(-25.11) ***	-0.39	(-25.20) **	-0.39	(-25.53) **	-0.39	(-25.34) **
F()	(28, 15268) 250.88		(28, 15268) 258.57		(28, 15268) 267.78		(28, 15268) 252.86	
R^2	0.33		0,34		0.34		0,33	

A constant is included in the estimations. Number of observations is 15,297.
For all regressions, Prob > F is 0.00. Significance levels: * : 10% ** : 5% *** : 1%.

3

Heterogeneous Effect of Training on Earnings[1]

While there is a broad literature on the average wage effect of training, little is known about the effects of different training forms and about the effects for heterogeneous training participants. As noted in the OECD Employment Outlook 2004: "Available evidence on employee training focuses on the average effect on wages and productivity – thus, leaving aside the issue of how training affects workers' employment prospects in general, as well as for specific groups" (OECD, 2004: 184).

The OECD notes only four exceptions, where the training impact for specific groups is considered. These are Bassanini and Brunello (2003), Leuven and Oosterbeek (2004), Arulampalam, Booth, and Bryan (2004), and Kuckulenz and Zwick (2003).

This study adds two aspects to the literature on earnings effects of training which capture the claim made by the OECD to look at heterogeneity. First, the earnings effect of training is calculated for different "types" of employees, i.e. discriminating between qualification level, experience, job tenure, and other attributes. Second, I distinguish between the earnings impact of external and internal training. For the empirical analysis, I use the "Qualification and Career Survey", a rich German data set with information on 0.1% of all individuals employed in Germany in 1998/1999, which was introduced in section 2.4.2.

This chapter consists of four sections, each focussing on the heterogeneity of the effect of continuing training on earnings. In the first section, I use a one-step full-information maximum likelihood and a two-stage least squares estimation to regress the impact of training participation on earnings correcting for the endogeneity of training participation. By using a broad list of employee and employer characteristics, I try to avoid omitted variable bias. Interacting training with all explanatory variables in the earnings equation allows me to calculate heterogeneous training returns for employees and firms

[1] This chapter draws on Kuckulenz and Zwick (2003 and 2005), Zwick and Kuckulenz (2005), and Kuckulenz and Maier (2006).

with different characteristics. I find the training earnings mark-up to be positively correlated with qualification and experience.

In the second section, I use a similar methodology to take personal, firm, and job characteristics into account when estimating the heterogeneous impact of training on earnings for the case of personal services. I calculate the earnings effect of training for different "types" of employees in the personal services sector. I specifically compare the results of the low-wage sector with the results of the entire economy. The correction for selection into training by using supply-side changes as external instruments leads to a decrease in the training coefficient in the personal services sector while the coefficient increases in the entire economy. A further comparison of the results for the personal services sector with those for the entire economy reveals that, on average, employees in personal services gain less from participation in continuing training.

The third section of this chapter considers the likely possibility that individuals take their expectation on the return to training into account when deciding about training participation. As the first chapters have shown, the return to training is heterogeneous and likely to differ between individuals depending on observed as well as unobserved factors. The expected return to training, which partly depends on unobservable characteristics, is likely to be a crucial criterion in the decision whether to take part in training. Therefore, the decision to take part in continuous training is likely to be influenced by the expected returns to training. Hence, participants and non-participants in training are unlikely to have the same observed and hypothetical returns. Severe econometric problems are, therefore, posed by the endogeneity of training decisions.

I try to account for the likely possibility that worker selection into training is based on unobserved heterogeneity by using recent advances in estimating returns to schooling, which allow for selection on unobservables, and apply it to estimating the impact of training on earnings. Allowing heterogeneity to be unobserved by the econometrician, but assuming that individuals may act upon this heterogeneity, completely changes the interpretation and properties of commonly used estimators.

Specifically, I use the local instrumental variables (LIV) method, which allows for observed as well as unobserved heterogeneity. Moreover, selection into training may depend on both. The LIV point estimate is much lower than the relevant OLS and IV estimate (and is therefore insignificant).

The last section of the chapter inhibits an analysis of the heterogeneity of the impact of training on earnings in another dimension. Here, differences in the type of training are considered. Additionally, various groups of training participants are differentiated as already done in the first two sections of this chapter. The analysis of internal and external training reveals that this result is mainly driven by external training. Internal training has a small but significantly negative earnings effect. The correction for selection into training leads to an increase in the training coefficients and a decrease of its significance.

3.1 Instrumental Variable Estimation

3.1.1 Introduction

While the literature on the returns to schooling has recognised that returns may vary across schooling types and participants, heterogeneous earnings returns to continuing training have been analysed much less. Some authors have looked at differences in training returns between employees with different educational backgrounds (Lynch, 1992; Blundell, Dearden & Meghir, 1996; OECD, 1999 and 2004), age (OECD, 2004), or tenure (Pannenberg, 1998). It may be that other individual characteristics explaining the individual wage, such as professional status or the labour market history, also have an impact on training returns, however. Therefore, the main contribution of this section is to take heterogeneity in training returns into account for many individual characteristics. In contrast to most of the literature, heterogeneous training effects on earnings are jointly estimated for all groups.

Also employer characteristics determine the productivity impact of training and the bargaining power of the employee. Hence, the increase in productivity caused by training must not directly correspond to the wage effect of training. In addition, bargaining and rent-sharing between employer and employee should have an impact on the share of the rent generated by training which is granted to the training participant (Dearden, Reed & van Reenen, 2000; Manning, 2003; Arulampalam et al., 2004). Nevertheless, in the literature, the wage impact of training is frequently just taken as (the lower bound of) the productivity impact of training (Blundell, Dearden & Meghir, 1999). To my knowledge, employer characteristics and the bargaining position between training participant and employer have so far not been considered in empirical work. This section, therefore, also differentiates the wage impact of training by employer size, economic situation, industrial sector, and other employer characteristics that might indicate the bargaining position of the employer and shows that training wage effects not only reflect the productivity impact of training, such as standard human capital theory suggests (Becker, 1962), but also the bargaining position.

The approach I choose here compares the earnings effects of many subgroups of employees and includes a broad variety of employer information. In addition, by including around 100 explanatory variables and interacting the training variable with all covariates in the wage equation, I reduce heterogeneity that remains unobserved in more parsimonious regressions and separate the correlation of earnings with training from potential correlations of training with other covariates.

It is frequently argued that the group of employees participating in training is different from the group that does not obtain training with respect to observable and unobservable characteristics. Firms may offer training to those workers who are expected to be more productive after training or, alternatively, to those workers who expect wage gains from training participation may

select themselves into training courses. Therefore, adequate instrumental variables have to be found that explain the selection into training participation in order to correct for treatment selection. I use several different identifying variables in order to show that results are robust with respect to the instrument used.

3.1.2 Background Discussion and Econometric Methods

In order to explain individual wages, economists traditionally use the so-called *Mincer equation*, a standard tool in human capital theory (Mincer, 1974; Heckman, Lochner & Todd, 2003). Wages are explained by *schooling*, *experience*, and *experience squared*. Schooling is used as a proxy for human capital, and it is assumed that workers are paid according to their productivity (Green, Ashton & Felstead, 2001). In the standard Mincer equation, the growth of earnings over working life, i.e. the experience wage profile, reflects individual returns to investments in human capital and seniority wages.[2] Experience enters also as a squared term in order to allow diminishing marginal returns. This means, however, that post-school human capital investments are proxied by work experience or, in other words, are left as a black box. In order to capture part of post-school investments in human capital, I use a dummy for participation in continuing vocational training T in the previous 2 years as an additional explanatory factor for current earnings:

$$\ln Y = \mu_0 + \alpha T + \beta_1' S + \beta_2 Exp + \beta_3 Exp^2 + e, \tag{3.1}$$

where ln Y is the natural logarithm of earnings, S a schooling vector, Exp experience, Exp^2 experience squared, while $\alpha, \mu_0, \beta_1, \beta_2$, and β_3 are parameters to be estimated.[3] The error term is assumed to follow a standard normal distribution, i.e. $e \sim \mathrm{N}(0, \sigma^2)$.

Besides training, schooling, and experience, several other factors determine wages. Tenure is frequently used to proxy firm-specific skill formation in the work place (Green et al., 2001). Labour productivity may also be enhanced by computer usage and overtime work (Matteucci, O'Mahony, Robinson & Zwick, 2005). In addition, productivity and pay should depend on the specific professional status. Other income determinants that are closer related to the bargaining position between employer and employee than to the individual productivity of the employee are firm size, the economic situation of the

[2] "The human capital earnings function contains, among other variables, years of (work) experience, (...), which enters in a non-linear fashion. Its coefficients are interpretable as post-school human capital investment parameters" (Mincer, 1991: 32).

[3] In the traditional Mincer equation, schooling is measured in years of schooling and is included as a linear term. I prefer a less restrictive functional form where I include dummies for the highest educational achievements.

firm, whether the employer grants profit-sharing or incentive wages, a temporary work contract, and foreign citizenship. In addition, the economic sector and the region of the employer should play a role. I, therefore, include these employer and employee characteristics in the earnings equation by adding a vector X.

It is well-known that training participants differ from those employees who do not receive training (Heckman, 2000). In order to validate these differences in the wage equation, I use a Chow test for the equality of the two sets of coefficients in the extended Mincer equation for training participants and non-participants in eq. (3.2). The test reveals that participants and non-participants not only differ with respect to training but also in several other respects. Therefore, the earnings equations should be estimated separately for training participants and non-participants.[4] An alternative way of separating the two groups is to add interaction terms of the training dummy with all covariates vector S, Exp, Exp^2, and vector X. These interaction terms allow us to identify heterogeneous wage returns of training for different groups of employees and firm characteristics. With this specification, deviations from the average treatment effect for specific groups are extracted (Card, 2000).

Heterogeneity in training returns cannot only be explained by differences in productivity effects of training but also by differences in bargaining power on training rents between employer and employee. Lazear (1979) notes that earnings and productivity at a given point in the career do not have to correspond. Employees may first receive wages that are lower than their productivity and, at a later stage of their professional career, can profit from early investments in their human capital. This may result in a positive interaction term between tenure and training participation. On the other hand, training demand should be highest for firm entrants. The productivity effect of training should then be highest for this group as well. If the productivity effect is stronger than the rent-sharing effect, this implies a negative estimated coefficient for tenure. The return to training for workers with low qualifications should be higher if individuals with low qualifications are constrained in their choice of education. On the other hand, it may be that employer-provided training is complementary to education (Blundell, Dearden & Meghir, 1999) and, therefore, favours higher skilled employees. Establishments in economic favourable situations as well as establishments that share rents should pay a higher training wage mark-up. Also, interactions between sector and training may reveal differences in bargaining power between employer and employee (Arulampalam et al., 2004). According to standard human capital theory, employees with temporary contracts should not differ from other employees in productivity increases after training. When bargaining power plays a role, however, employees with temporary contracts are expected to enjoy a lower training wage mark-up.

[4] The test statistic is: $F(108, 8107) = 2.08$, $Prob > F = 0.00$.

Sample averages are subtracted from the interaction terms of training with the explanatory variables in order to ensure that the estimated interaction coefficients are the average treatment effects for the subgroups (Wooldridge, 2002). It is assumed that with the extensive list of covariates all differences between training participants and employees without training during the observation period are captured by the interaction terms with the observables and that the difference between error terms e for training participants and non-participants is zero. Then, the average treatment effect of training α can be obtained from:

$$\begin{aligned}\ln Y = {} & \mu_0 + \alpha T + \beta_1' S + \beta_2 Exp + \beta_3 Exp^2 + \beta_4' X \\ & + \delta_1' T(S - \overline{S}) + \delta_2 T(Exp - \overline{Exp}) + \delta_3 T(Exp^2 - \overline{Exp^2}) \\ & + \delta_4' T(X - \overline{X}) + e, \end{aligned} \tag{3.2}$$

where the upper bars indicate sample averages of the explanatory variables.

3.1.3 Endogeneity of Training

Employees who participate in training may not be randomly selected, and therefore, the ignorability of treatment assumption implicit in eq. (3.2) may be violated. Permanent differences among individuals and transitory fluctuations in the determinants of training may be correlated with earnings and the returns to training (Blundell, Dearden & Meghir, 1999). This means that the impact of training included as a dummy variable in an OLS earnings equation might be biased because the error term of the earnings equation is correlated with the probability of receiving company training. The cross-section data do not allow me to control for time-invariant unobserved heterogeneity in wages that are correlated with training by taking individual-specific fixed effects. This proviso is, to some extent, outweighed by the fact that the data set contains an exceptionally extensive set of time-invariant explanatory variables that are potentially correlated with training participation and earnings.

In order to consider the effect of an endogenously chosen treatment (training), a treatment effects model is estimated here that measures the unobserved net benefit T^* from training. Assuming that firms offer training only if the net benefit is positive yields:

$$\begin{aligned} T^* &= \gamma_0 + \gamma_1' S + \gamma_2 Exp + \gamma_3 Exp^2 + \gamma_4' X + \gamma_5' Z + u \\ T &= 1, \text{ if } T^* > 0 \\ T &= 0, \text{ if } T^* \leq 0, \end{aligned} \tag{3.3}$$

where γ_0,γ_2, and γ_3 are coefficients and γ_1,γ_4, and γ_5 are vectors of coefficients to be estimated. Z is a vector of instruments not included in X, determining whether an individual takes part in training or not, and the error term $u \sim$N(0,1), corr$(e, u) = \rho$. The binary response model is estimated by probit.

External instruments Z that intuitively explain the selection process in the establishment and are correlated with training incidence but not with earnings are used in the estimations (Griliches & Mairesse, 1998). The identifying strategy used here is proposed, for example, by Card (2000). Supply-side sources of variation in training are used as external instrumental variables in this analysis. Specifically, information whether the employer restructured the establishment during the period in which training was offered is used (technical and organisational restructuring). It is well-known that firms have to offer more training after restructuring in order to update the skills of their employees to match new skill demands (Acemoglu & Pischke, 1999; Green et al., 2001). Therefore, participation in training is higher if restructuring has taken place in a firm, irrespective of individual employee characteristics. It can be assumed that some employees participate in training only because the firm restructured recently, and training, therefore, comes close to a random eligibility variable. As a consequence, the variations in training supply variables satisfy the assumption that the instruments are uncorrelated with other latent employee characteristics that may affect earnings or, in other words, with unobserved employee heterogeneity (Card, 2000; Wooldridge, 2002). It is assumed that restructuring in a firm influences wages only indirectly through training. It can be shown that, conditional on the set of explanatory variables, the instruments do not have an impact on wages paid.[5] It cannot be excluded that the value of training increases after restructuring, and therefore, the coefficient of the IV might estimate still biased. Remember that this IV procedure measures training returns of those employees who participate in training because the firm restructures (Card, 2000).

In order to check the robustness of the results, also other instruments are used: First, information on the subjective need for training is included. This variable can explain training incidence, but it is not correlated with unobserved employee characteristics that influence earnings capacity. A disadvantage of this measure might be that the productivity effect of employees who have a higher need for training might be higher, and therefore, wages react stronger to training for this subpopulation. Second, the sectoral share of firms and the share of firms by employment size that include training in their collective bargaining agreement is included. This variable may again explain a higher individual training incidence irrespective of unobserved individual characteristics. A disadvantage of this variable may be, however, that the data are of a higher aggregation level, and there is no variation between employees in a certain firm size and industrial sector.

[5] I have tested for the relationship between wage and restructuring in the firm. Conditional on all covariates used here, there is no significant relationship. It can be suspected that restructuring in a firm might not lead to an immediate change in wages but increases wages only later when the investment pays off. With the cross-section data, it is not possible to test this hypothesis.

In the IV specification, first, the fitted probabilities of training participation $\widehat{T}^* = \widehat{P}(T^* > 0 \mid S, Exp, Exp^2, X, Z)$ are calculated from eq. (3.3). According to Wooldridge (2002), the earnings eq. (3.2) should then be estimated by IV using a constant, $\widehat{T}^*, S, Exp, Exp^2, X$, and the interactions of $\widehat{T}^*$ with all demeaned covariates as instruments for T and the interaction terms $T(S-\overline{S}), T(Exp-\overline{Exp}), T(Exp^2-\overline{Exp^2})$, and $T(X-\overline{X})$.[6] Therefore, T and the interaction terms are estimated by:

$$\begin{aligned} T^{**} &= \gamma_0 + \gamma_1' S + \gamma_2 Exp + \gamma_3 Exp^2 + \gamma_4' X + \gamma_5 \widehat{T}^* + \delta_1' \widehat{T}^*(S-\overline{S}) \\ &\quad + \delta_2 \widehat{T}^*(Exp-\overline{Exp}) + \delta_3 \widehat{T}^*(Exp^2-\overline{Exp^2}) + \delta_4' \widehat{T}^*(X-\overline{X}) + u, \\ T &= 1, \text{ if } T^{**} > 0, \\ T &= 0, \text{ if } T^{**} \leq 0. \end{aligned} \tag{3.4}$$

Note that this procedure deviates from simply using the fitted values $\widehat{T}^*$ as an explanatory variable or estimating T in a one-step IV estimation including S, Exp, Exp^2, X, Z, and the interactions of $\widehat{T}^*$ with all demeaned covariates in (3.2) as instruments for T and the interaction terms of T. The advantage of this estimation strategy is to obtain a valid estimator, the selection eq. (3.3) does not have to be properly specified, and the IV results are less sensitive to the choice of instruments (Wooldridge, 2002).

The earnings equation, therefore, is estimated as follows:

$$\begin{aligned} \ln Y &= \mu_0 + \alpha \widehat{T}^{**} + \beta_1' S + \beta_2 Exp + \beta_3 Exp^2 + \beta_4' X + \delta_1' \widehat{T}^{**}(S-\overline{S}) \\ &\quad + \delta_2 \widehat{T}^{**}(Exp-\overline{Exp}) + \delta_3 \widehat{T}^{**}(Exp^2-\overline{Exp^2}) + \delta_4' \widehat{T}^{**}(X-\overline{X}) + e, \end{aligned} \tag{3.5}$$

where $\widehat{T}^{**} = \widehat{P}(T^{**} > 0)$ is the estimated participation in training, and $\widehat{T}^{**}(S-\overline{S})$ and the following terms are the interaction variables from eq. (3.4). Eq. (3.4) and (3.5) are jointly estimated in a one-step full-information maximum likelihood estimation (FIML).

3.1.4 Data

For the empirical analysis, I use the BiBB/IAB data set "Qualification and Career Survey" that was introduced in section 2.4.2. The cross-section data allow an assessment of the impact of training measures in 1996-1998 on wages in 1998/1999. The sample contains more than 10,000 male (full-time) employees from West Germany. I include about 100 explanatory variables that capture the salient employer and employee characteristics for wage determination. Specifically, the following variables are used (see also Table C.1 in the appendix for the complete list with detailed descriptions):

[6] Compare procedure 18.2 in Wooldrigde (2002: 626).

- The endogenous variable is *log midpoints of earnings* in 1998/1999 from 18 earnings categories in the data. This variable has the advantage that earnings of highly paid workers are not censored from above. I use a maximum likelihood interval regression and OLS regressions on the category midpoints (see Trostel, 2004). The results are essentially the same. Therefore, the OLS estimation is preferred.

- The key explanatory variable is *participation in training* during the years 1996 to 1998. This dummy might stand for quite substantial amounts of training because employees might participate in various courses during 24 months. In addition, only formal training courses are included in the data set; short or informal training spells are explicitly excluded. Note that apprenticeship training is also excluded.

- The *external identifying variables* for training participation originate from questions on changes in the workplace during the period in which training took place (1996-1998). Two variables are used: *technical restructuring* (introduction of new production techniques, machines, production materials, or computer programmes) *and organisational restructuring* (reorganisation of departments or work groups). Alternatively, information on *subjective needs for training* are used.[7] In addition, data from the Continuing Vocational Training Survey (CVTS 2000) about sectoral shares of firm and shares of firms by employment size that include continuing training in their *collective bargaining agreement* are imputed.[8]

- *Further determinants of earnings* are those found in the Mincer equation, i.e. actual work experience[9], job tenure, former unemployment, and dummies for the highest educational achievement.[10] These variables are related to the situation in 1998/1999.

- Together with these standard variables, also dummies capturing the *professional status* are included, such as blue-collar or white-collar worker, or different sophistication levels of tasks.

- In addition, the following current *job characteristics* are used: computer use, profit-sharing, bonus payments, overtime work, whether a job is temporary, and 13 dummies for main job contents. These variables allow me

[7] In the survey, it is asked whether there are fields in which the employee sees the need to participate in continuing training. There are 18 different fields in which subjective need for training can be indicated.

[8] The CVTS data are from 1999 and, therefore, fit well to the BiBB/IAB data set.

[9] There is information in the data on when the individual started his or her first job, and I include dummies for discontinuation such as unemployment.

[10] In Germany, the highest schooling degree is more informative for the level of education than years of schooling (Georgellis & Lange, 1997).

to control a large part of the individual heterogeneity between the employees.[11] Some of these variables (e.g., working overtime) can be interpreted as indicators of intrinsic motivation.

- Additional control variables explaining earnings are *personal attributes*. A dummy for children and non-German nationality is included.

- Finally, some *employer characteristics* are included: seven dummies for firm size, 46 dummies indicating the economic sector of the employer, 11 dummies for the federal state the firm is located in, and a dummy indicating whether the firm is in a good economic situation in 1998/1999.

Only full-time employees (without self-employed) in West Germany are included because in 1998, there were still large differences in the labour market structures of the two parts of the country.[12] The analysis is restricted to male employees because the data do not allow me to model participation in the labour market simultaneously, which would be important for examining earnings effects for women.[13] This reduces the sample to around 9,800 individuals. The descriptive characteristics of the variables used can be found in Table C.1 in the appendix.

In order to obtain clean evidence on the earnings effects of employer-provided training, those training participants where one cannot be sure whether they were employed or unemployed while being trained are excluded (about 450 cases). The reason for this restriction in the sample is to exclude government-provided training aimed at those unemployed. Wage effects of training should differ for those employees who stay with a firm and those who move (Loewenstein & Spletzer, 2000; Lynch, 1992; OECD, 2004). In the data set, there are only very few individuals who change their employer after attending continuing training. No significant difference between job stayers and movers can be shown in the data set, and, hence, the sample is restricted to those who stay with their employer. The interrelation between continuing training and mobility between jobs, and wages is not in the scope of this chapter and will be discussed in detail in chapter 4.

[11] Some of these variables may also be endogenous in the earnings equation. I do not control this, however, because the variables mainly serve as control variables for employee heterogeneity.

[12] Only employees working 30 hours and more per week are included. Merely 2.6% of the male employees work less than 30 hours. A dummy for working overtime is used in order to take hours worked into account. The results do not change qualitatively, however, if log hourly wages are used instead of log earnings as the dependent variable.

[13] In order to include women, one would need to correct for sample selection in the earnings equation. This is impossible since only those women who participate in the labour market are included in the data.

3.1.5 Descriptive Statistics

In total, 55% of the male employees participated in some kind of training in the years 1996-1998. Participation in training depends on the qualification of the employee. Analogously to the literature (Blundell, Dearden & Meghir, 1996; Heckman, 2000; Pischke, 2001), I find that individuals with higher education participate more often in continuing training, and private sector training mainly excludes low-skilled persons. Training attendance of employees without a professional degree is lowest: Only 28% have participated in some kind of training. In contrast, 85% and more of the employees with a university degree have taken part in continuing vocational training during the last 2 years (see Table 3.1).

Table 3.1. Participation in training (sorted by qualification)

Education	**Men in %** **N = 10,279**
School attainment	
Without school-leaving certificate	42.19
Lower secondary school	44.49
Intermediate secondary school	64.25
Entrance examination for university of applied sciences	83.20
High-school diploma	80.11
Professional/Vocational training	
Without professional degree	31.14
Full-time vocational school	53.93
Apprenticeship	52.42
Master craftsman	77.80
University of applied sciences	88.01
University	86.17

Note: Data applies to full-time working males.
Source: BiBB-IAB 1998/99, own calculations.

3.1.6 Empirical Evidence

In order to check the robustness of the results with respect to the estimation specification, I first estimate the slightly modified Mincer equation according to eq. (3.1). The results of the Mincer equation are in line with similar studies for Germany (Franz, 2003). As expected, income is higher for workers with more experience. It increases at a decreasing rate, however, since the coefficient for experience squared is negative. With more school attainment and a higher professional degree, income increases. Training participation in the years 1996-1998 increases earnings on average by 16 percentage points in 1998/1999 (compare column 2 in Table 3.2).

The additional firm and job characteristics and some other individual attributes in the extended Mincer equation have the expected signs (Georgellis & Lange, 1997; see column 3 in Table 3.2). The coefficients of experience and experience squared are almost unchanged while the measured earnings effects of school and vocational education decrease. Besides, company tenure leads to a concave earnings profile. Earnings increase with professional status. Employees who work with a computer, work overtime, receive incentive wages, or participate in profit-sharing earn more. Employees with previous unemployment spells, with a temporary work contract, and foreigners earn less. Larger firms and firms in a good economic situation pay more. The net return to training in the extended Mincer equation decreases from 16 to 5%. The adjusted R^2 rises from 0.32 to 0.47, which indicates that the variables controlling for workplace and personal characteristics, professional career, professional status, and other attributes uncover part of the sample heterogeneity that is not observed in the standard Mincer equation.

In order to evaluate the average treatment effect of training on earnings properly, I account for heterogeneity between participant groups. Heterogeneity in training effects on earnings is captured by interaction terms between all demeaned explanatory variables and the training dummy. The estimated average treatment effect of training participation increases slightly from 5 to 6 percentage points in this specification. Column 4 of Table 3.2 reports the interaction effects.[14] The impact of training on earnings is smaller for employees with a low school education. Heckman (2000) stresses that trainability of higher skilled people is higher. Therefore, it does not seem surprising that the productivity effect of training is smaller for less skilled individuals, who accordingly receive a lower wage mark-up. Lynch (1992) does not find differences in earnings effects of training between different school education groups in the U.S., however. Blundell, Dearden, Meghir, and Sianesi (1999) and OECD (1999) report even larger wage gains from training for employees with lower education for France, the Netherlands, and Great Britain, while for Germany, the interaction effects between training and less than upper secondary education and upper secondary education are negative but insignificant. Thus, the

[14] In order to keep Table 3.2 as simple as possible, I only report the signs and significance levels of the interaction terms.

results show no significant difference in the returns to training between low- and high-skilled workers in Germany.[15]

Long job tenure diminishes the impact of training on earnings in Germany (see also Pannenberg, 1998). This finding may be a consequence of a higher productivity impact of training for firm entrants because they have a stronger need for firm-specific training. Employees who use a computer at work enjoy a higher training earnings mark-up. This may also influence the productivity effect of training. Firms that offer incentive wages pay a higher mark-up to their trained employees in order to attribute their share of the training rent to them. Finally, training wage mark-ups in certain sectors, such as aircraft construction, precision engineering, telecommunications, or employees at self-employed medical doctors, are higher than in other sectors (not shown here). This suggests that not only productivity effects but also the bargaining process between employer and employee play a role for the training wage mark-up (Arulampalam et al., 2004). Including the interaction terms between the training dummy and the covariates does not change the coefficients of the most explanatory variables while some interaction terms take over the explanatory power of direct coefficients, and the adjusted R^2 slightly increases.

Finally, the possible endogeneity of training has to be taken into account. A Durbin-Wu-Hausman test shows that training is not exogenous using restructuring as instruments.[16] The first estimation step that explains the selection into training shows that higher educated employees and employees performing a high function in the firm get more training. In addition, employees who work with computers or overtime and get an incentive wage have a higher probability to receive training while foreigners and temporary workers receive less training (see Table 3.3). These training determinants are frequently observed (Lynch & Black, 1998; Goux & Maurin, 2000; Pfeiffer & Reize, 2001; Booth, Francesconi & Zoega, 2003). Finally, the two instruments are highly significant – employees in firms that restructure receive more training (Acemoglu & Pischke, 1999).

If the IV estimates are calculated according to eq. (3.5), most explanatory variables have the same impact on earnings as in the OLS result (eq. (3.3)) while the precision of the regression is generally lower. The average treatment effect of training increases from 5 to 9% difference in earnings for participants versus non-participants. Hence, after instrumenting for the selection into training, the earnings effect of continuing vocational training is larger than in the OLS estimation. This result is in line with most other studies (Bartel, 1995; Pannenberg, 1997; Blundell, Dearden & Meghir, 1999; Pischke, 2001; Carneiro, Heckman & Vytlacil, 2003).[17]

[15] For Great Britain, Blundell, Dearden, and Meghir (1999) find the highest returns to training for employees with no qualifications, however.

[16] The test statistics is: F(1, 6462) = 2.58, Prob > F < 0.05.

[17] An exception is the paper by Goux and Maurin (2000), who take post-training employee mobility and training selectivity simultaneously into account.

Table 3.2. Extended earnings equations with training

	Mincer with Training	Mincer Extended	OLS with Interactions	IV	IV with Interaction Terms
Training	0.16 (0.01)***	0.05 (0.01)***		0.09 (0.05)*	
Lower secondary school	-0.07 (0.01)***	-0.02 (0.01)**	– ***	-0.02 (0.01)*	– **
Entrance to university of applied sciences	0.12 (0.02)***	0.05 (0.02)***	+	0.05 (0.02)*	–
High-school diploma	0.15 (0.02)***	0.06 (0.02)***	–	0.06 (0.02)*	–
Without school-leaving certificate	-0.07 (0.03)**	-0.01 (0.03)	–	-0.01 (0.03)	–
Without professional degree	-0.13 (0.03)***	-0.07 (0.03)**	+	-0.07 (0.03)**	+
Apprenticeship	-0.02 (0.03)	-0.02 (0.03)	+	-0.02 (0.03)	+
Master craftsman	0.14 (0.03)***	0.04 (0.03)	+	0.03 (0.03)	+
University of applied sciences	0.23 (0.03)***	0.12 (0.04)***	+	0.12 (0.04)***	+
University	0.33 (0.03)***	0.22 (0.04)***	+	0.22 (0.04)***	+ **
Professional experience	0.02 (0.00)***	0.01 (0.00)***	+	0.01 (0.00)***	+ **
Professional experience (squared)	0.00 (0.00)***	0.00 (0.00)***	–	0.00 (0.00)***	–
Foreigners		-0.05 (0.02)***	+	-0.04 (0.02)***	–
Company tenure		0.00 (0.00)***	– **	0.01 (0.00)***	– ***
Company tenure (squared)		0.00 (0.00)*	+	0.00 (0.00)	+ ***
Children		0.06 (0.01)***	+	0.06 (0.01)***	+
Firm with 1-4 workers		-0.06 (0.02)***	+	-0.06 (0.02)***	+
Firm with 5-9 workers		-0.05 (0.01)***	+	-0.04 (0.01)***	–
Firm with 50-99 workers		0.06 (0.01)***	+	0.05 (0.01)***	+
Firm with 100-499 workers		0.08 (0.01)***	+	0.08 (0.01)***	+
Firm with 500-999 workers		0.11 (0.02)***	+	0.10 (0.02)***	–
Firm with more than 1000 workers		0.14 (0.01)***	+	0.13 (0.01)***	–
Skilled blue-collar worker		0.06 (0.01)***	–	0.06 (0.01)***	–
Assistant foreman		0.08 (0.02)***	–	0.07 (0.02)***	–
Master/foreman		0.17 (0.03)***	+	0.17 (0.03)***	–
Unskilled white-collar worker		0.06 (0.02)***	–	0.06 (0.02)***	–
White-collar worker with simple tasks		0.04 (0.02)*	–	0.04 (0.02)	–
White-collar worker with difficult tasks		0.11 (0.02)***	– **	0.11 (0.02)***	–
High-skilled white-collar worker		0.23 (0.02)***	–	0.22 (0.02)***	+
Executive white-collar worker		0.31 (0.03)***	+	0.30 (0.03)***	+
Unemployment		-0.04 (0.01)***	–	-0.04 (0.01)***	– **
Computer work station		0.04 (0.01)***	+ **	0.03 (0.01)***	+
Temporary work		-0.07 (0.02)***	–	-0.06 (0.02)***	–
Good economic situation		0.03 (0.01)***	+	0.03 (0.01)***	+
Overtime		0.05 (0.01)***	–	0.05 (0.01)***	–
Profit-sharing		0.06 (0.02)***	+	0.06 (0.02)***	+ **
Incentive wage		0.03 (0.01)***	– **	0.03 (0.01)***	–
F / R^2	201.45 / 0.32	54.01 / 0.47	/ 0.48	53.76 / 0.47	31.07 / 0.42

Significance levels: * : 10% ** : 5% *** : 1% (in parentheses: heteroscedasticity-robust standard errors). Number of observations: 6,563.
The following control variables have been added: Federal state (10), economic sector (46), job contents (13), and a constant.

The higher coefficient of the IV estimation in comparison to OLS may be the consequence of two effects familiar from the returns to education literature (Card, 1999 and 2000; Carneiro et al., 2003b). First, there might be a negative selection into training, i.e. individuals with lower earnings are more likely to take part in training, and training, therefore, is remedial. This is contrary to most findings in the literature, however. Goux and Maurin (2000) show that high-wage workers are more likely to be selected for training than other workers. Second, training participation might be measured with errors, and the OLS earnings estimation may therefore be downward biased (Griliches & Hausman, 1986). If the instruments capture part of the measurement errors, this bias decreases when instrumenting the training variable while the training coefficient increases.

The training dummy used here is indeed a very rough measure because a short course has the same value as a course that takes several weeks.[18] By using changes in the training supply side, I am able to avoid unobserved differences between treatment and control group, which are implicit in the use of instrumental variables and that may induce a further upward bias of the IV estimates (Bound & Jaeger, 1996). When correcting for endogeneity, the sign and significance of the interaction terms do not change much (see Table 3.2, column 6) – all significant interaction terms keep their signs. Now also the coefficients for the interaction terms of employees with university (of applied sciences) degrees are significant. Employees who were previously unemployed receive a significantly lower wage mark-up after training. Finally, firms that share profits with their employees pay a higher training wage mark-up.

In order to test the robustness of the IV estimates, I also use the subjective need for training and the sectoral share of firms with a collateral agreement including continuous training as alternative instruments. In this case, the training IV coefficients do not significantly differ from previous results for both cases. Also, the signs and significance of the training interaction terms are similar.

The results indicate a rather high earnings impact if I take the average amount of time devoted to training into account. Pischke (2001) calculates on average four weeks of training per employee per year in Germany. In addition, studies for other countries indicate lower earnings returns to training (compare, e.g., Blundell, Dearden, Meghir & Sianesi, 1999, and Booth et al., 2003 for Great Britain; Goux & Maurin, 2000 for France; Lynch, 1992 for the U.S.; and OECD, 2004). The large returns may be explained by the emphasis of the German wage-bargaining system on the acquisition of formal qualifications as a means for wage growth and by the argument that not only training determines wages but also those who attend training are on a high-wage growth career path, and training accompanies promotion (Georgellis & Lange, 1997; Blundell, Dearden & Meghir, 1999; Pischke, 2001). The estimation model tries

[18] Arulampalam & Booth (2001) find, however, that only the incidence, not the number of training spells, is significant for wage growth.

to reduce the impact of these biases, but I cannot control for differences in promotion probabilities between both groups of employees.

3.1.7 Conclusion

This section shows that the impact of participation in training in the years 1996-1998 on earnings in 1998/99 is significantly positive. The main addition to the literature is an elaboration on heterogeneous returns in the training earnings mark-up – the analysis includes interaction terms between training and all other explanatory factors in the earnings equation. I find that the effect of training on earnings differs between employees and their employers with a broad spectrum of different characteristics. High-skilled employees profit more from training than low-skilled workers; the training earnings mark-up decreases with company tenure. Employees with previous unemployment spells profit less from training while employees who work with a computer enjoy a higher training wage mark-up. Firms that share profits and pay incentive wages grant a higher training earnings mark-up. The last findings suggest that the training wage effect depends not only on the productivity increase induced by training but also on the bargaining position between employer and employee.

In order to correct endogeneity of training in the earnings regression, I use technical and organisational reorganisation in the firm as identifying variables. After correcting for the endogeneity of training participation, the measured training earnings mark-up increases from 5% in the OLS regression to 9% in the IV estimation. In order to test the robustness of the IV estimates, I repeat the exercise using subjective training needs of the employee and the sectoral and size-group share of firms that include continuous training in their collective agreement as instruments. The training coefficients of all versions do not significantly differ from each other, and the interaction terms with training are very similar.

3.2 Sector Differences in Training Returns: The Case of Personal Services

3.2.1 Background Discussion

This chapter addresses the earnings impact of continuing training in the personal services sector in Germany. On the one hand personal services is one of the sectors with the highest employment growth; on the other hand the share of low-paid workers is higher than in other sectors. While knowledge about the specific situation of low-wage earners in this sector is limited (Asplund & Salverda, 2004), an obvious way of increasing both, productivity and earnings in low-skilled consumer-related occupations, is for firms to increase their

Table 3.3. Selection into training (probit)

Technical restructuring	0.38 (0.04)***
Organisational restructuring	0.21 (0.04)***
Lower secondary school	-0.05 (0.04)
Entrance to university of applied sciences	0.04 (0.08)
High-school diploma	-0.13 (0.08)*
Without school-leaving certificate	-0.01 (0.12)
Without professional degree	-0.11 (0.12)
Apprenticeship	0.07 (0.11)
Master craftsman	0.32 (0.12)***
University of applied sciences	0.28 (0.14)**
University	0.26 (0.15)*
Professional experience	0.00 (0.01)
Professional experience (squared)	0.00 (0.00)**
Foreigners	-0.18 (0.07)**
Company tenure	0.04 (0.01)***
Company tenure (squared)	-0.00 (0.00)***
Children	0.12 (0.04)***
Firm with 1-4 workers	0.11 (0.08)
Firm with 5-9 workers	0.08 (0.06)
Firm with 50-99 workers	0.03 (0.06)
Firm with 100-499 workers	-0.00 (0.05)
Firm with 500-999 workers	0.09 (0.07)
Firm with more than 1000 workers	0.05 (0.06)
Skilled blue-collar worker	0.14 (0.06)**
Assistant foreman	0.41 (0.10)***
Master/foreman	0.30 (0.11)***
Unskilled white-collar worker	0.11 (0.11)
White-collar worker with simple tasks	0.15 (0.09)*
White-collar worker with difficult tasks	0.38 (0.07)***
High-skilled white-collar worker	0.57 (0.08)***
Executive white-collar worker	0.45 (0.10)***
Unemployment	-0.01 (0.04)
Computer work station	0.24 (0.04)***
Temporary work	-0.22 (0.08)***
Good economic situation	-0.04 (0.04)
Overtime	0.15 (0.04)***
Profit-sharing	0.02 (0.06)
Incentive wage	0.16 (0.04)***
Number of observations	7,635
Wald $chi^2(101)$	2159.14
Pseudo R^2	0.26

Significance levels : $*$: 10% $**$: 5% $***$: 1% (t-values and z-values in parentheses are based on heteroscedasticity-robust standard errors). The following control variables have been added: Federal state (10), economic sector (46), job contents (13), and a constant.

investment in employee training (Hughes, O'Connell & Williams, 2004). The provision of continuing training constitutes a major part of human capital investment (Heckman, 2000). An important proviso, however, is that training increases the earnings of this group of employees. Therefore, not only the average training effect on earnings in the personal services sector is calculated, but it is also differentiated between the wage effects for employees with different qualifications and professional status.

Heckman (2000) suggests that trainability increases with qualifications and tenure and that the effect of training on productivity is larger for higher educated employees. Therefore, it can be assumed that qualification level, tenure, and other employee characteristics have an impact on the earnings effects of training. While some studies of the latter take account of heterogeneous returns for different educational groups (e.g., Lynch, 1992; OECD, 1999), heterogeneity in the returns due to employer characteristics has not been analysed so far. It can be assumed, however, that some firms are able and willing to offer higher earnings mark-ups to participating employees. Therefore, this study also considers the effect of employer characteristics. Finally, additional comparisons of the earnings impact in the economy as a whole show whether the effects differ between the personal services sector and the rest of the economy, and whether the low-skilled fare better or worse in personal services.

It is frequently argued that employees who participate in training are different from the other employees in terms of unobservable characteristics (Heckman, 2000; Card, 1999). Employers might tend to offer training only to those individuals who are more trainable while better motivated individuals may be more likely to pursue off-the-job training (Lynch, 1992). In addition, some firms might be more prone than others to offer training, and therefore, some employees might have a higher probability of participating in training, irrespective of their personal characteristics (Zwick, 2004b). As already done in the previous chapter, supply-side variations are used here to identify training participation. More precisely, it is shown that employees in firms that have recently restructured their production technique or their organisation have a greater probability of participating in training, though it should be noted that firm restructuring does not have an immediate impact on their wages. This identification strategy has the advantage that it does not capture unobserved employee heterogeneity and thereby avoids biased estimation results (Card, 2000).

This section adds two new aspects to the literature on the earnings effect of training. First, it is shown that the effect varies between different types of employee and employer, that is, it is discriminated between qualification level, experience, job tenure, economic sector, firm size, and many other factors. Second, this study compares the impact of training offered in personal services with the training effects in the economy as a whole. The analysis corrects for the endogeneity of training participation by using instrumental variables. In the analysis, the BiBB/IAB data is used that was introduced in section 2.4.2.

This section is structured as follows. The next part briefly discusses the data set and the variables used. This is followed by the empirical evidence consisting of descriptive statistics, an estimation of the effect of training on the earnings of heterogeneous participants in training in the personal services sector, and a comparison of these effects with the effects for the economy as a whole. The concluding section summarises the results.

3.2.2 Data

In order to empirically analyse the impact of training on earnings, the BiBB/IAB "Qualification and Career Survey" from 1998/99 is used. These cross-section data do not allow me to control for unobserved heterogeneity by taking individual-specific fixed effects. This proviso is, to some extent, outweighed by the fact that the data contain an exceptionally extensive set of explanatory variables that are potentially correlated with training participation and wages. Specifically, the following variables are used (see also Table C.1 in the appendix for the complete list and section 3.1.4 for a discussion):

- The endogenous variable is *log midpoints of earnings* in 1998/1999.

- The key explanatory variable is *participation in training* during the years 1996-1998. Training comprises participation in courses or seminars, fairs, lectures, on-the-job training, specific company training, or taking over special tasks and reading technical literature, as well as internships or any other kind of continuing training. This study uses a wide definition of training, also including on-the-job training, technical literature reading, attending lectures, and visiting trade fairs. 58% of the employees participated in further training according to this definition (see Table B.4 in the appendix). Participation differs tremendously for low- and high-skilled employees: While only around 30% of the workers without professional degree participated in training, 50% of the employees with a vocational school degree or an apprenticeship training took part in some kind of training during the last 2 years, and about 80 % of high-skilled employees (master craftsman, university of applied sciences, and university degree) participated. Training participation also varies with age: 30-45 year old employees receive most training; older worker participate less (see Fig. C.1 and C.2 in the appendix).

- The *external identifying variables* for training participation originate from questions on the changes in the workplace during the period in which training took place (1996-1998). Two variables are used: *technical restructuring* (introduction of new production techniques, machines, production materials, or computer programmes) and *organisational restructuring* (reorganisation of departments or work groups).

- *Further explanatory variables* for earnings are those found in the Mincer equation, that is, actual work experience, job tenure, and dummies for the highest educational achievement. In addition, the following current job characteristics are used: computer use, profit-sharing, incentive wages, overtime work, and whether a job is temporary. Also previous unemployment spells are controlled for. These variables allow me to control a large part of the individual heterogeneity between the employees. Finally, seven dummies for the firm size are added plus a dummy for the location of the firm in East or West Germany. A further employer characteristic used is whether the firm is in a good economic situation in 1998/1999.

The following sectors are represented in the sample for personal services: The retail trade, laundries, hairdressers, chain store companies, kiosks and petrol filling stations, mail-order firms, passenger traffic and travel agencies, hotels and restaurants, hospitals, nursing homes and sanatoriums, medical practices, law practices, architectural practices, engineering practices, tax advisors, recreational organisations, sports and fitness establishments, and other trading and service firms (also see Hughes et al., 2004).

Only full-time employees – that is, those employees working 30 hours and more per week – are included in the sample. The analysis is restricted to male employees because the data do not allow me to model participation in the labour market simultaneously, which would be important for examining the earnings effects for women.[19] This reduces the sample for the entire economy to around 14,800 individuals, around 2,300 of whom were employed in personal services.

3.2.3 Empirical Evidence

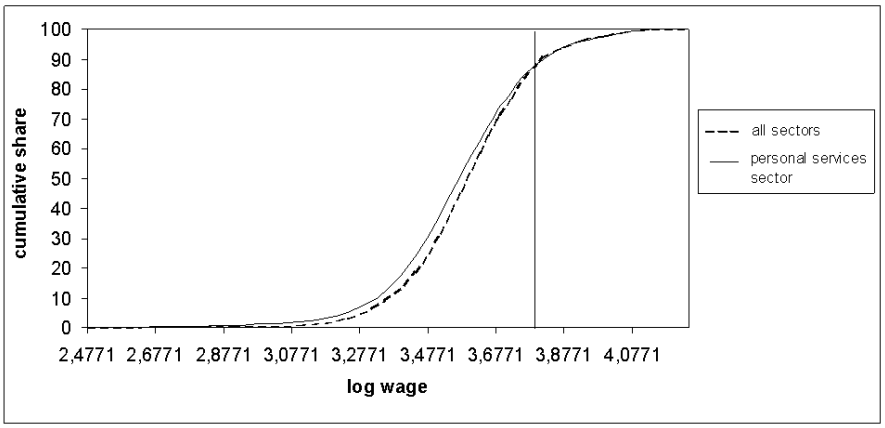
Descriptive Statistics

One of the reasons for concentrating on the personal services sector is the fact that this sector has a relatively high share of low-wage employees (Hughes et al., 2004). Fig. 3.1 shows that in 1998/1999, the share of employees with incomes below 2,000 euros per month was higher in this sector than in the entire economy. The average wage was 2,272 euros, compared with 2,346 euros in the economy as a whole. Note that these differences cannot be completely explained by differences in qualification structure because they are rather similar. Part of the explanation probably lies in the low average tenure and work experience in the personal services sector (see Table B.3 in the appendix).

The incidence of training in the years 1996-1998 was slightly higher in personal services than in the German economy as a whole, especially in the case

[19] In order to include women, one would need to correct for sample selection in the earnings equation. This is impossible since only those women who participate in the labour market are included in the data.

Fig. 3.1. Earnings shares in the personal services sector and the entire economy



Remark: Wages calculated in DM (1 DM = 0.51 euro).

of less qualified employees (see Table 3.4). Overall, the differences in training participation are rather small. This suggests that the higher incidence of low-paid workers in the restricted sample is not a consequence of less qualified employees receiving less training.

Table 3.4. Training participation

Employee groups	**Personal services sectors**	**All sectors**
All	0.69	0.66
Without school-leaving certificate	0.29	0.25
Lower secondary school	0.54	0.51
Intermediate secondary school	0.72	0.70
Entrance examination for university of applied sciences	0.81	0.88
High-school diploma	0.83	0.86

Source: BiBB-IAB 1998/99, own calculations.

Earnings Impact of Training

First, I estimate eq. (3.1), that is, the extended Mincer earnings equation, including the training dummy and a broad variety of employer and employee

characteristics but not the interaction terms between training and the other explanatory variables by OLS.[20] Here, the training coefficient for the personal services sector is 0.12 and significant (see column 2 in Table 3.5), which is larger than the training coefficient for the economy as a whole (see column 2 in Table B.2). If I allow for heterogeneity in the returns to training by adding the interaction terms in eq. (3.2), the average treatment effect during the period in question increases both for the restricted sample and for the economy as a whole (see column 4 in Tables 3.5 and B.2). This effect is already known from the analysis in section 3.1.

Table 3.5. Extended Mincer equations, personal services sector, endogenous variable: log earnings

	OLS		**OLS with interaction terms**		**IV**	
Exogenous variables	**Coeff.**	**t-values**	**Coeff.**	**t-values**	**Coeff.**	**t-values**
Training	0.12***	(6.52)	0.14***	(6.43)	0.01	(0.08)
Professional experience	0.02***	(5.54)	0.01***	(2.72)	0.02***	(5.53)
Professional experience (squared)	0.00***	(-3.69)	0.00	(-2.05)	0.00***	(-3.72)
Company tenure	0.01***	(3.42)	0.01***	(2.40)	0.01***	(3.40)
Company tenure^2	0.00	(-1.54)	0.00	(-0.96)	0.00	(-1.53)
Firm size 1-4	-0.10***	(-2.80)	-0.14***	(-2.33)	-0.10***	(-2.81)
Firm size 5-9	-0.06***	(-2.48)	-0.06	(-1.53)	-0.06***	(-2.46)
Firm size 50-99	0.05**	(2.1)5	-0.02	(-0.48)	0.06**	(2.16)
Firm size 100-499	0.10***	(4.23)	0.04	(0.95)	0.10***	(4.16)
Firm size 500-999	0.09***	(2.44)	0.09	(1.31)	0.10***	(2.46)
Firm size 1000+	0.11***	(4.42)	0.02	(0.37)	0.11***	(4.09)
Lower secondary school	-0.05***	(-2.43)	-0.05	(-1.51)	-0.06***	(-2.41)
Entrance examination for university of applied sciences	0.13***	(3.74)	-0.02	(-0.31)	0.13***	(3.70)
High-school diploma	0.15***	(5.21)	0.06	(0.90)	0.16***	(5.19)
Without school-leaving certificate	-0.22***	(-2.35)	-0.17	(-1.74)	-0.23***	(-2.50)
Without professional degree	-0.14***	(-2.68)	-0.18	(-1.49)	-0.17***	(-2.59)
Dual apprenticeship	-0.04	(-0.89)	-0.03	(-0.24)	-0.04	(-0.93)
Master craftsman	0.04	(0.78)	-0.01	(-0.11)	0.05	(0.95)
University of applied sciences	0.02	(0.42)	-0.02	(-0.13)	0.03	(0.50)
University	0.26***	(4.65)	0.15	(0.98)	0.26***	(4.66)
Unemployment	-0.01	(-0.73)	0.00	(0.03)	-0.01	(-0.73)
Computer	0.12***	(6.44)	0.14***	(3.99)	0.14***	(4.08)
Temporary work	-0.11***	(-3.44)	-0.12*	(-1.97)	-0.12***	(-3.38)
Good economic situation	0.05***	(3.05)	0.03	(0.85)	0.04***	(2.37)
Overtime work	0.12***	(5.87)	0.09***	(2.80)	0.13***	(4.96)
Profit-sharing	0.15***	(5.35)	0.14*	(2.08)	0.16***	(5.20)
Incentive wage	0.04*	(1.89)	0.00	(0.04)	0.05*	(2.02)
East	-0.31***	(-14.15)	-0.31***	(-7.32)	-0.30***	(-12.82)
Constant	7.74***	(122.84)	7.84***	(52.94)	7.80***	(76.85)
Interaction Terms						
Professional experience			0.00	(0.55)		
Professional experience (squared)			0.00	(-0.17)		
Company tenure			0.00	(-0.49)		
Company tenure (squared)			0.00	(-0.04)		
Firm size 1-4			0.07	(0.95)		
Firm size 5-9			-0.01	(-0.16)		
Firm size 50-99			0.11*	(1.88)		

to be continued...

[20] The estimation results are very similar if I estimate the earnings equation by interval regression techniques taking into account that the dependent variable is coded in intervals (Kuckulenz & Zwick, 2003).

...Table 3.5 continued

	OLS		OLS with interaction terms		IV	
Exogenous variables	**Coeff.**	**t-values**	**Coeff.**	**t-values**	**Coeff.**	**t-values**
Firm size 100-499			0.07	(1.45)		
Firm size 500-999			0.00	(-0.01)		
Firm size 1000+			0.14***	(2.43)		
Lower secondary school			-0.01	(-0.20)		
Entrance examination for university of applied sciences			0.19**	(2.16)		
High-school diploma			0.12	(1.57)		
Without school-leaving certificate			-0.17	(-0.73)		
Without professional degree			0.08	(0.58)		
Dual apprenticeship			-0.02	(-0.15)		
Master craftsman			0.06	(0.46)		
University of applied sciences			0.05	(0.27)		
University			0.11	(0.66)		
Unemployment			-0.02	(-0.59)		
Computer			-0.04	(-0.93)		
Temporary work			0.00	(0.06)		
Good economic situation			0.03	(0.88)		
Overtime work			0.06	(1.47)		
Profit-sharing			0.02	(0.22)		
Incentive Wage			0.05	(1.02)		
East			-0.01	(-0.22)		
Number of observations	1,983		1,983		1,983	
R^2	0.47		0.48		0.46	

Significance levels: $*$: 10% $**$: 5% $***$: 1%.
Source: BiBB-IAB 1998/99, own calculations.

The earnings effect of training is higher for employees who work for larger firms and have higher school qualifications. The OECD (1999) also finds that for Germany, there is a positive (albeit insignificant) correlation between earnings effect of training and level of education. For France, Italy, the Netherlands, and Great Britain, however, the OECD reports larger wage gains for employees with lower education.

A comparison of the personal services sector and the economy as a whole reveals that the additional earnings effect for trained employees with a longer tenure is lower in the personal services sector as is the earnings mark-up for trained employees with temporary contracts and overtime work. On the other hand, in the economy as a whole, less educated employees receive a lower earnings mark-up after training. Most of the other interaction effects between the covariates and the earnings impact of training are insignificant.

Before firm conclusions can be drawn from the empirical analysis, the selection issue has to be taken into account. In the first step, training participation is explained by technical and organisational restructuring and the explanatory variables from the earnings equation according to eq. (3.3). Table B.5 in the appendix shows that employees in firms that have recently been restructured have a higher probability of participating in training. In personal services, work experience and tenure do not have an impact on training incidence, whereas in the economy as a whole, the incidence of training increases in line with work experience and tenure. In both samples, better qualified employees have a comparatively greater probability of participating in training. This confirms the finding frequently reported in the literature (e.g., OECD, 1999;

Booth et al., 2003; Zwick, 2004a). Training is also offered more frequently to employees with overtime work and incentive payments.

The earnings impact of training changes markedly if training is estimated using instrumental variables, the predicted training values, and the list of explanatory variables in eq. (3.4). The estimated earnings effect of training becomes insignificant for the personal services sector if eq. (3.5) is estimated without the interaction terms in the square brackets (see column 6 of Table 3.5). For the German economy as a whole, however, the IV estimates increase and remain significant – see column 6 of Table B.2 (also compare section 3.1). This indicates that in the personal services sector, employees with unobserved higher wage-earning abilities have a greater chance of receiving training, but this is not the case in all sectors of the economy.

Unobserved firm characteristics are likely to have an important impact as well. Specifically, personal services firms that offer training are likely to pay more to employees who lack training. In other words, the higher earnings of training participants are not a result of training but are due to the selection of employees and firms with unobserved characteristics that are positively correlated with earnings. The positive selection effect in the personal services sector is found to be even stronger than the correction of measurement errors that induce a downward bias on the training coefficient in the OLS estimation (Griliches & Hausman, 1986).

Apart from differences in the earnings effects of training, the impact of the other explanatory variables is similar in both samples: Earnings increase with experience, tenure, and professional and school education. Larger firms and firms in a good financial position pay more. Employees with access to profit-sharing or incentive wages and computer users earn more. Employees with temporary contracts and those with previous unemployment spells earn less. These results are consistent with those in the literature (e.g., Lynch, 1992; OECD, 1999; Goux & Maurin, 2000; Pischke, 2001; Booth et al., 2003; Kuckulenz & Zwick, 2003).

3.2.4 Conclusion

The main finding of this section is that training does not lead to an earnings increase in the personal services sector, in contrast to the German economy as a whole in 1998/1999. In the personal services sector, the share of low-wage workers is higher than in the rest of the economy. These workers cannot improve their financial situation by undergoing training although firms in the sector do train a fair share of them. The impact of training on earnings is greater for higher qualified employees. This means that for the German economy as a whole, training increases earnings differences in sectors with positive training returns because higher educated employees share the rents generated by training.

Endogeneity of training is taken into account by instrumenting the training dummy by exogenous training supply changes. For the economy as a whole, the IV regression produced a higher estimate of the impact of training on earnings while for the personal services sector, the coefficient was significantly lower and insignificant. This result suggests that in the personal services sector, employees who obtain training have unobserved personal characteristics that increase their ability to earn more or to work in firms with unobserved characteristics that induce them to pay higher wages.

3.3 Non-Parametric Estimation: Local Instrumental Variables

3.3.1 Introduction

As suggested by the results of former sections, heterogeneity of employees plays a role not only in obtaining skills but also in economic consequences of education and training. As noted by the OECD (2004), little is known about how the training impact on wages varies across heterogenous training participants. The small empirical literature with German data has shown that training type as well as worker, job, and firm characteristics determine the wage impact of training. Recently, Pannenberg (1998), Jürges and Schneider (2005), and Kuckulenz and Zwick (2003) have compared the wage effects of subgroups of employees with German data. Other work concentrates on certain aspects of heterogeneity, for example, differences in training returns between employees with different educational backgrounds (Lynch, 1992; Blundell, Dearden & Meghir, 1996; OECD, 1999 and 2004), age (OECD, 2004), men and women (Pischke, 2001), or tenure (Pannenberg, 1998). Some of these papers come up with rather high estimates for the impact of training on wages, which could be explained by unobserved factors: for example, whether an employee is on a promotion path, climbing a steep ladder upwards or how able and motivated someone is. Pfeiffer and Reize (2001) interpret their results to show that training and career paths are intertwined and that higher wages may not actually be the consequence of training but result from excellent career management. Likewise, Pischke (2001) finds that selection in training seems not to be based on wage levels but rather on earnings growth. Frazis and Loewenstein (2005) find evidence of heterogeneity in returns. Their high estimates can be regarded as the return to training for the trained but cannot be extrapolated to the untrained.

Recent literature on the returns to schooling provides methods which allow that returns may vary across schooling types and participants. Carneiro et al. (2003) apply methods which allow for the likely fact that the expected return of the investment in human capital plays a role when deciding about the investment. Among others, also Blundell, Dearden, and Sianesi (2005) have noted

the importance of allowing for (observable) heterogeneity in return to education. Selection into training may depend much more on individuals' ability and motivation than does selection into schooling, where family background characteristics are the main determinants (Ammermüller, 2004; Lauer, 2002). Also, training costs and maybe even training returns are more obvious and hence may play a more crucial role for the decision to take part in training than for the schooling decision.

The study uses recent econometric methods, which allow for selection on unobservables, and applies it to estimating the impact of training on earnings. With German survey data from 1998/1999, I explore the heterogeneity of training returns and how this may effect participation in training. By using the Local Instrumental Variables (LIV) method, I account for the heterogeneity of training returns in the analysis and allow for observed as well as unobserved heterogeneity. Therefore, the assumptions are much less stringent than those of ordinary least squares or conventional IV regressions. In fact, if unobserved heterogeneity is relevant and individuals act upon it, OLS and linear IV estimates can be seriously misleading (see Heckman & Vytlacil, 2005).

The following section provides a brief discussion of the theoretical background and previous empirical work. In the following, first, the econometric method used is introduced; second, the data set is described; and third, the implementation and the estimation results are presented. The last section concludes and gives an outlook.

3.3.2 Background Discussion

It has been noted in the literature that bargaining and rent-sharing between employer and employee should have an impact on the share of the rent generated by training which is granted to the training participant (e.g., Dearden et al., 2000; Arulampalam et al., 2004). Therefore, heterogeneity in training returns cannot only be explained by differences in productivity effects of training but also by differences in individual, firm, and job characteristics which relate to the bargaining power of employer and employee. Lazear (1979) notes that wages and productivity at a given point in the career do not have to correspond. Employees may first receive wages that are lower than their productivity. At a later stage of their professional career, they can profit from early investments in their human capital. In contrast, training demand should be highest for firm entrants; also the productivity effect of training should then be highest for this group. The return to training for workers with low qualifications should be higher if individuals with low qualifications are constrained in their choice of education. On the other hand, it may be that employer-provided training is complementary to education (Blundell, Dearden & Meghir, 1999) and therefore, favours higher skilled employees.

In section 3.1, I find out with German data that the effect of training on earnings differs between agents with a broad spectrum of different characteristics and firms with different characteristics. High-skilled employees profit more from training than low-skilled workers; the training earnings mark-up increases with professional experience but decreases with company tenure. Employees with previous unemployment spells and employees with temporary contracts profit less from training. Smaller firms, firms in a good economic situation, and firms that share profits with their employees pay a higher training earnings mark-up. I interpret these findings as evidence that the training wage effect depends not only on the productivity increase induced by training but also on the bargaining position between employer and employee. Hence, the increase in productivity caused by training must not directly correspond to the wage effect of training. Nevertheless, the wage impact of training is frequently taken as (the lower bound of) the productivity impact of training (Blundell, Dearden & Meghir, 1999).

In addition to the determinants of training presented in sections 2.4 and 3.1, the decision to take part in continuous training is likely to be influenced by the expected returns to training. That is, those workers for whom the expected return is higher will obtain more training than other workers for whom the expected return is lower. Hence, participants and non-participants in training are unlikely to have the same observed and hypothetical returns. Severe econometric problems are, therefore, posed by the endogeneity of training decisions. While former empirical work with German data has extensively analysed the wage effect of training, none of them has accounted for the likely possibility that worker selection into training is based on the expected heterogeneous return to continuous training.

Previous work has solved the endogeneity problem by using a Heckman-type selection correction term from a training participation equation (e.g., Lynch, 1992). Also Blundell, Dearden & Meghir (1996) argue that continuous training might be correlated with transitory shocks to productivity and, therefore, include a Heckman correction term into their wage growth equation. Other authors tried to tackle the endogeneity problem by using instrumental variable estimation (Leuven and Oosterbeek, 2001; Kuckulenz & Zwick, 2003) or non-parametric matching methods (Gerfin, 2004). Also, fixed effects estimators have been used (Booth & Bryan, 2005; Pischke, 2001; Barron, Berger & Black, 1999), which produce unbiased estimates whenever unobserved individual effects are permanent. Leuven and Oosterbeek (2002) use a different approach to estimate the causal effect of training on wages by using information about workers who planned to participate in training but did not due to some exogenous event. They use this group of workers as the comparison group and assume that within their sample, participation in training is random.

The estimated least squares coefficient of the individual's choice parameter is only then to be interpreted as the causal effect of training on wages if workers are randomly assigned to take part in training. I have argued above that

employees are either chosen by the employer providing the training or that they select themselves into training. This implies that standard estimations using least squares produce biased results. Therefore, I rely on recent advances in estimating the returns to schooling using evaluation methods. In the literature, which was mainly spurred by Heckman and co-authors, schooling is treated as an endogenous variable in the standard wage function.

While former work on training in Germany relied on the unconfoundedness or selection on observables assumption, I want to explicitly allow for heterogeneity of wage effects of training and for selection on unoberservables. With detailed information about the qualification profile and professional history of workers, the organisational and technological condition of workplaces, as well as some employer characteristics, I am able to explain a large part of the variation in wages. Nevertheless, some characteristics which are crucial for the selection into training are missing. Above all, ability, motivation, and the information whether individuals are on a promotion path are likely to be important determinants of training. Former work has also shown that workers with higher wage growth participate more often in training (Pischke, 2001). With the cross-section data, I cannot account for this directly since wages are observed only once.

The advantage of the econometric model is that it allows the effect of training to vary both in terms of observed and unobserved factors. Firms may offer training to those workers who are expected to be more productive after training or those who expect wage gains from training participation may select themselves into training courses. Since the probability of treatment increases with the gains from treatment, I allow the impact of training on earnings to differ among individuals and for selection on gains. Hence, I assume that individuals are forward-looking agents who have expectations on the impact of training participation on their wage. Adequate instrumental variables have to be found that explain the selection into training participation in order to correct for treatment selection. I should stress again that under the heterogeneity assumptions stated above, conventional IV methods will not yield unbiased results. To get reliable results, much stronger assumptions on effect heterogeneity or individual choice behaviour have to be imposed, which might be implausible in this case. Therefore, if no stronger assumptions can be made, evaluation methods as the local IV model are necessary to estimate the impact of training on earnings.

3.3.3 Econometric Model

The causal effects of training on earnings are analysed within the framework of econometric evaluation methods. These methods take heterogeneous effects of training for each individual into account, which may depend on observable or unobservable factors. Allowing heterogeneity to be unobserved by the

econometrician, but assuming that individuals act upon this unobserved heterogeneity completely changes the interpretation and properties of common estimators considering (observed) heterogeneity. Carneiro et al. (2003) as well as Heckman and Vytlacil (2005) show that conventional IV estimators substantially misestimate the average marginal return and policy-relevant effects.

Two main streams of non-experimental methods taking unobserved heterogeneity into account can be distinguished. First, there are methods which control for the correlation between individual factors and programme participation by using an adequate instrument. The second approach is to measure all individual factors that may be the cause of the correlation between individual factors and programme participation and then, for example, match on these observed variables (Blundell, Dearden & Sianesi, 2005). For a review of different approaches, see Heckman, LaLonde, and Smith (1999) or Caliendo and Hujer (2005). Imbens (2004) describes methods for selection on observables; Angrist (2004) focusses on models where selection is influenced by unobservable heterogeneity. While selection models try to model the complete selection process, the IV method, which is used here, focusses on searching a source of independent variation affecting the decision to participate but not the outcome (earnings). Other estimation strategies are based on difference-in-difference estimation, which erase only time-invariant selection.

In the following, a formal description of the basic framework of evaluation econometrics is given. Let D indicate the choice of treatment, that is

$$D = \begin{cases} 1 \text{ if the individual receives treatment,} \\ 0 \text{ otherwise.} \end{cases}$$

Concerning the outcome variable, it is assumed that latent values exist for every possible value of the treatment variable. These latent outcome variables are denoted by Y_1 and Y_0 for $D = 1$ and $D = 0$, respectively. Only one of the two latent outcomes can be observed as every individual can solely choose one treatment status. Therefore, the observed outcome is given by $Y = DY_1 + (1 - D)Y_0$. In the binary treatment case at hand, it means that every individual would receive an income in the treated as well as in the untreated case. Y_1 is observed for participants and Y_0 for non-participants.

The causal effect of treatment D on the outcome variable Y is defined to be

$$\Delta = Y_1 - Y_0. \tag{3.6}$$

This difference is unobservable for every individual as either Y_1 or Y_0 cannot be observed. Therefore, averages of (3.6) for various subgroups are considered. The average treatment effect Δ^{ATE} is the effect on an average individual of the population, whereas the average treatment effect on the treated Δ^{TT} and the average treatment effect on the untreated Δ^{TUT} state the effects for the subpopulations of treated and untreated individuals, respectively. Formally, the effects are defined by

$$\Delta^{\text{ATE}} := E[Y_1 - Y_0] \tag{3.7}$$

$$\Delta^{\text{TT}} := E[Y_1 - Y_0 | D = 1] \tag{3.8}$$

$$\Delta^{\text{TUT}} := E[Y_1 - Y_0 | D = 0] \tag{3.9}$$

All effects can be defined conditional on X, for example $\Delta^{\text{ATE}}(x) = E[\Delta | X = x]$.

In the empirical analysis of this section, I use the Local Instrumental Variable (LIV) method of Heckman and Vytlacil (1999, 2000, 2001, 2005). First, the framework and underlying assumptions are described. Then, I line out another causal effect, the marginal treatment effect, which was defined by Heckman and Vytlacil (1999), and the relationships with various types of causal effects are shown. Finally, the estimation strategy is outlined.

The treatment indicator D is modelled by a latent index model:

$$D = 1(\mu_D(Z) - U_D \geq 0). \tag{3.10}$$

$1(A)$ is the indicator function, that is $1(A) = 1$ if A is true and $1(A) = 0$ otherwise. $\mu_D(Z)$ is a function of some instrumental variables Z. The latent outcomes are functions of some observable variables X and unobservable factors U_0 and U_1, i.e. $Y_i = g(X, U_i)$, for $i = 1, 2$. Participation in training corresponds to $D = 1$, non-participants are identified by $D = 0$.

Heckman and Vytlacil (1999, 2000, 2001, 2005) state the following assumptions:

- Given X, $\mu_D(Z)$ depends in a non-trivial way on Z. This corresponds to the usual assumption of instrument relevance in linear IV models, that is, the instruments have to influence the training decision after controlling for other covariates X.

- U_D is independent from X, and all error terms in the model are independent from Z given X. This is the usual exclusion restriction of IV models which states that Z has no influence on the dependent variable after accounting for the covariates X. A detailed discussion of these assumptions in the context of evaluation models is given by Vytlacil (2002).

- The error term U_D of the latent index model (3.10) is assumed to be absolutely continuous with respect to Lebesgue measure.

- Furthermore, $E|Y_1|$ and $E|Y_0|$ are assumed to be finite, which guarantees the existence of $E[Y]$.

- For every individual, the probability of participation $P(D = 1)$ lies strictly between 0 and 1, given the observable characteristics X.

With this set-up, Heckman and Vytlacil (1999, 2000, 2001, 2005) define the marginal treatment effect, which is the causal effect of D given X and U_D:

$$\Delta^{\text{MTE}}(x,u) = E[Y_1 - Y_0 | X = x, U_D = u] \tag{3.11}$$

The marginal treatment effect provides a framework to obtain expressions for various average treatment effects. Heckman and Vytlacil (1999, 2000, 2001) derive the following relationships:

$$\Delta^{\text{ATE}}(x) = \int_0^1 \Delta^{\text{MTE}}(x,u)du \tag{3.12}$$

$$\Delta^{\text{TT}}(x) = \int_0^1 \Delta^{\text{MTE}}(x,u)\frac{1 - F_{P(Z)|X}(u|x)}{E[P(Z)|X]}du \tag{3.13}$$

$$\Delta^{\text{TUT}}(x) = \int_0^1 \Delta^{\text{MTE}}(x,u)\frac{F_{P(Z)|X}(u|x)}{E[1 - P(Z)|X]}du. \tag{3.14}$$

Here, $P(Z)$ is short for $P(D = 1|Z)$. Therefore, integration of the suitable weighted marginal treatment effects over the $[0,1]$ interval yields estimates of treatment effects for different subpopulations. The basic ingredient of this procedure is the marginal treatment effect. To get an estimate of it, the LIV estimator was proposed by Heckman and Vytlacil (1999, 2000, 2001, 2005):

$$\widehat{\Delta}^{\text{MTE}}(x, P(z)) = \frac{\partial E[Y|X = x, P(Z) = P(z)]}{\partial P(z)} \tag{3.15}$$

The LIV method estimates the marginal treatment effect for $u = P(z)$. This can be seen by forming the derivative of the expectation of Y given $P(Z)$ and noting that $Y = DY_1 + (1 - D)Y_0$.

The definition of the local average treatment effect Δ^{LATE} of Imbens and Angrist (1994) can be used to motivate the marginal treatment effect. The LATE is defined by

$$\Delta^{\text{LATE}}(x, P(z), P(z')) =$$
$$\frac{E[Y|P(Z) = P(z), X = x] - E[Y|P(Z) = P(z'), X = x]}{P(D = 1|Z = z) - P(D = 1|Z = z')}. \tag{3.16}$$

This is the treatment effect for the subgroup of individuals who change their treatment status due to a change of the instrument Z from z to z'. This subgroup of the so-called *compliers* cannot be identified in a given data set. For comments and criticism of this concept, see Heckman (1997) and Angrist, Imbens, and Rubin (1996) and the accompanying discussions. Considering $P(z) \to P(z')$, the expression of the LATE tends to the derivative of the conditional expectation of Y:

$$\lim_{P(z)\to P(z')} \Delta^{\text{LATE}}(x, P(z), P(z')) = \frac{\partial E[Y|X = x, P(Z) = P(z)]}{\partial P(z)}. \tag{3.17}$$

The LIV estimator estimates some sort of marginal LATE. Therefore, the marginal treatment effect can be interpreted as the effect on an individual with observable characteristics X and unobservables U_D which is indifferent to participation.

3.3.4 Data

For the empirical analysis, the BiBB/IAB data set "Qualification and Career Survey" from 1998/1999 is used that was introduced in sections 2.4.2 and 3.1.4.

3.3.5 Implementation and Results

The basic building blocks of the empirical analysis are estimates of $\Delta^{\text{MTE}}(x,u)$. For this purpose, estimates of the derivative of the conditional expectation of Y given X and $P(Z)$ are needed. The latent outcome equations are specified as:

$$\ln Y_1 = \alpha_1 + X\theta_1 + U_1 \tag{3.18}$$
$$\ln Y_0 = \alpha_0 + X\theta_0 + U_0. \tag{3.19}$$

The observable outcome is, therefore, given by

$$\begin{aligned}\ln Y &= D\ln Y_1 + (1-D)\ln Y_0 \\ &= \alpha_0 + X\theta_0 + D(\alpha_1-\alpha_0) + DX(\theta_1-\theta_0) \\ &\quad + DU_1 + (1-D)U_0.\end{aligned} \tag{3.20}$$

From this, the conditional expectation of $\ln Y$ given X and $P(Z)$ follows as

$$\begin{aligned}E[\ln Y|X,P(Z)] = \alpha_0 + X\theta_0 + P(Z)(\alpha_1-\alpha_0) + P(Z)X(\theta_1-\theta_0) + \\ P(Z)E[U_1|P(Z)] + (1-P(Z))E[U_0|P(Z)].\end{aligned} \tag{3.21}$$

The derivative of (3.21) with respect to $P(Z)$ is given by

$$\frac{\partial E[\ln Y|X,P(Z)]}{\partial P(Z)} = (\alpha_1-\alpha_0) + X(\theta_1-\theta_0) + K(P(Z)), \tag{3.22}$$

where $K(P(Z)) = \frac{\partial(P(Z)E[U_1|P(Z)]+(1-P(Z))E[U_0|P(Z)])}{\partial P(Z)}$. To estimate $\Delta^{\text{MTE}}(x,u)$, pointwise estimates for all X and U (within the [0,1] interval) are needed. To reduce the dimension of the problem, the expectation is modelled as a partial linear model. The constant term and the term depending on X enter the conditional expectation linearly, whereas $K(P(Z))$ is modelled non-parametrically. To estimate these characteristics of the equation, the "double residual regression" of Heckman, Ichimura, Smith, and Todd (1998) is used. This slight variation of the partial linear model of Robinson (1988) is tailored for the evaluation of binary treatment effects. Eq. (3.20) is rewritten in the following form:

$$\begin{aligned}\ln Y = \alpha_0 + X\theta_0 + D(\alpha_1-\alpha_0) + DX(\theta_1-\theta_0) + DU_1 + (1-D)U_0 \\ + P(Z)E[U_1|P(Z)] + (1-P(Z))E[U_0|P(Z)] \\ - P(Z)E[U_1|P(Z)] - (1-P(Z))E[U_0|P(Z)].\end{aligned} \tag{3.23}$$

The term $DU_1 + (1-D)U_0 - P(Z)E[U_1|P(Z)] - (1-P(Z))E[U_0|P(Z)]$ is gathered in an error term ε, which has mean zero given $P(Z)$ by construction:

$$\begin{aligned}\ln Y = \alpha_0 + X\theta_0 + D(\alpha_1 - \alpha_0) + DX(\theta_1 - \theta_0) \\ + P(Z)E[U_1|P(Z)] + (1-P(Z))E[U_0|P(Z)] + \varepsilon. \qquad (3.24)\end{aligned}$$

In parlance of partial linear models, the term $P(Z)E[U_1|P(Z)]+(1-P(Z))$ $E[U_0|P(Z)]$ is the non-parametric component. From this, the conditional expectation of $\ln Y$ given $P(Z)$ follows:

$$\begin{aligned}E(\ln Y|P(Z)) = \alpha_0 + E(X|P(Z))\theta_0 + P(Z)(\alpha_1 - \alpha_0) \\ + P(Z)E(X|P(Z))(\theta_1 - \theta_0) + P(Z)E[U_1|P(Z)] \\ + (1-P(Z))E[U_0|P(Z)]. \qquad (3.25)\end{aligned}$$

Subtracting (3.25) from (3.24) yields:

$$\begin{aligned}\ln Y - E[\ln Y|P(Z)] = (X - E[X|P(Z)])\theta_0 + (D - P(Z))\times \\ (\alpha_1 - \alpha_0) + (DX - P(Z)E[X|P(Z)])(\theta_1 - \theta_0) + \varepsilon. \qquad (3.26)\end{aligned}$$

The conditional expectations $E[X|P(Z)]$ are estimated pointwise by locallinear regressions. After forming the differences, (3.26) is estimated by OLS. Using the estimated residuals from this regression, the derivatives of $P(Z)E[U_1|P(Z)]+(1-P(Z))E[U_0|P(Z)]$ can be estimated by the appropriate coefficients of local polynomial regressions. Using the empirical distributions of $F(P(Z)|X)$, the weights for the integration of $\Delta^{\mathrm{MTE}}(x,u)$ over $[0,1]$ can be computed. Using the empirical distribution of X, unconditional treatment effects can be obtained. To judge the significance of the estimated effects, confidence intervals based on 50 bootstrap samples are computed.

The propensity score is specified as a probit model. The estimated coefficients are contained in Table B.6 in the appendix. All instruments are significant. Of greater interest for the LIV estimator is Table B.8 in the appendix: The estimated propensity score covers the whole $[0,1]$ interval as it is necessary for parameter estimation in the LIV model.

The estimated treatment effects and the bootstrap confidence intervals are contained in Table 3.6. The point estimates of the treatment effects are negative. However, the confidence intervals show that the effects are not statistically significant. Therefore, no statements about the sign of the effect can be made. The wide confidence intervals show a considerable uncertainty about the causal effect of training.

The point estimates are lower than the relevant OLS estimate, which is 0.03 (t-value: 3.62) and considerably lower than the standard IV estimator using the same instruments, which is 0.21 (t-value: 2.37). The LIV estimates, which rely on much weaker assumptions on individual behaviour, differ from conventional estimates (regarding the point estimates). This is in line with the supposition stated in the literature that estimates which do not account for

Table 3.6. Estimates of the treatment effects

	Original sample	**Bootstrap samples**	
		Confidence intervals	
		90%	95%
TUT	-.077	(-.123, .015)	(-.145, .039)
ATE	-.073	(-.119, .015)	(-.142, .038)
TT	-.063	(-.112, .014)	(-.134, .032)

(unobserved) heterogeneity and the selection in this regard are upward biased. It can be interpreted from this result that training does not have an impact on earnings itself but only in combination with unobserved factors. It is likely that training is part of a promotion path and that not a certain training, but a career track as a whole, leads to earnings growth. Firms provide training to individuals only when the expected return of this investment is positive. Hence, training participants might be more able and motivated and, therefore, also be on such a track with higher earnings growth. When this unobserved heterogeneity is taken into account in the selection into training, the positive training impact estimated by conventional OLS or IV estimates vanishes.

3.3.6 Conclusion

With German survey data from 1998/1999, this study examined the heterogeneity of training returns and whether these may have an effect on training participation. Using the local IV method, which allows for the likely fact that the expected return of the investment in human capital plays a role when deciding about the investment, it is possible to account for heterogeneity of training returns in earnings equations. The LIV estimator allows for observed as well as unobserved heterogeneity, and selection into training may depend on both. Former work on the wage impact of training has suggested that selection on unobservables might be important and, hence, traditional estimators used might incorporate an upward bias.

The LIV estimate is much lower than the relevant OLS and IV estimate (and furthermore, insignificant). There seems to be no causal effect of training on wages when considering that more able and motivated individuals participate in training or those which are on a promotion path where training courses are part of the way. For future work, it would be helpful to use comprehensive information on career tracks and promotion in order to distinguish the impact of certain personnel measures.

3.4 The Influence of Different Training Types on Earnings

The first three sections of chapter 3 discussed the role of observed and unobserved heterogeneity of training participants in estimating the wage effect of training on earnings. This chapter focusses on another dimension of heterogeneity, that is, on differences in the type of training.

3.4.1 Introduction

Differences in earnings for participants and non-participants in training differ widely across qualification groups, professional career, and job attributes. As seen in section 3.1, low-skilled workers do not gain from training when they just entered the job market; they may even have to pay for it by receiving a lower income. Low-skilled workers with experience do not participate often, but if they attend training, they do receive higher earnings. High-skilled workers receive most training, and they benefit from it, especially when they have long professional experience. Hence, heterogeneity between selected groups of workers is important in this context and should be taken into account, not only when estimating the selection into training but also in the earnings equation.[21] In addition, different training forms should be distinguished, which has not been done in this study so far. Therefore, the training dummy will now be replaced with factors comprising different types of training. In studies on the impact of training on wages, usually training incidence is measured and not the kind or specificity of training. Only few authors differentiate between on-the-job and off-the-job training (Lynch, 1992; Pischke, 2001), employer-provided and non-employer-provided training (Blundell, Dearden & Meghir, 1999), formal and non-formal training (Pfeiffer & Reize, 2001), and between general and specific training (Loewenstein & Spletzer, 1997). Assuming that no labour turnover costs exist, the wage effects of general and specific training should differ. Firm-specific training does not increase the productivity of workers in other firms, and subsequently, no wage increase is necessary to keep the worker in the present job. In contrast, general training increases the productivity of a worker in at least one other job. Therefore, employees may profit from general training by increased wages. As a consequence, it can be assumed that the impact of training on wages depends on the degree of specificity of the training received (Lynch, 1992; Blundell, Dearden, Meghir & Sianesi, 1999; Arulampalam et al., 2004). In practice, it is not trivial to distinguish between general and specific training since continuing vocational training often comprises both. In addition, it is hard to measure the training content (Booth & Snower, 1996; OECD, 1999,). The classifications "on-the-job", "employer-provided", and "non-formal" are usually used as proxies for

[21] Ceteris paribus, the wage effect differences between employees with low and high experience and between different skill levels are significant.

training with more firm-specific elements while "off-the-job", "non-employer-provided", and "formal" training may be more general and easier portable between jobs (Loewenstein & Spletzer, 1997). Overall, empirical studies find that training measures with higher general contents have a stronger earnings effect than training measures with higher firm-specific contents. Lynch (1992) finds significantly positive returns from previous off-the-job training while previous on-the-job training does not lead to an earnings increase. Pischke (2001) also stresses that training during work hours has lower returns than training during leisure time. Loewenstein and Spletzer (1997) do not find differences between the interactions of the earnings effect of training with self-assessed dummies indicating whether all, most, some, or none of the skills were useful outside of the company, however. They attribute this result to measurement error and rent- and cost-sharing between employers and employees. In an empirical analysis of firm provided continuing training, Barrett and O'Connell (2001) find that general training yields higher productivity effects than firm-specific training. They rely on efficiency wage arguments and the literature on psychological contracts as potential explanations for these findings that obviously conflict with the implications of Becker's work. Autor (2001) points to the importance of self-selection and screening that play a role for temporary help firms to provide their workers with training. According to his argumentation, offering firm-sponsored training will differently attract workers of greater unobserved ability (self-selection) while the coupling of training with testing of skills will facilitate the screening of worker's abilities. Blundell, Dearden, and Meghir (1999) find that employer-provided training as well as qualification training have a significant impact on the earnings prospects of individuals.

3.4.2 Empirical Strategy and Results

In order to analyse the earnings impact of different training forms, the training dummy is replaced with dummies comprising different types of training. From the correlation matrix showing the different training types, it becomes already clear that all training types are significantly positively correlated (see Table C.8 in the appendix). Some correlation coefficients are very high, for example between participating in training courses or seminars and attending lectures. Therefore, individuals who take part in one type of training are likely to receive also other types of training; but one cannot evaluate the earnings impact of all training types separately. Instead, this study uses a factor analysis as a technical method which provides me with information which types of training can be grouped and distinguished from another group of training types. All training forms are then assigned either to internal or to external training, following the results of the factor analysis. It detects two independent factors with eigenvalues above 1. Both factors explain about 52% of the total variance and clearly attribute every training form to one of both factors (see Table C.9 in the appendix).

Table 3.7. Participation in internal and external training in (%)

Qualification	Internal	External
School attainment		
Without school-leaving certificate	29.27	41.87
Lower secondary school	28.19	43.17
Intermediate secondary school	38.90	63.11
Entrance examination for university of applied sciences	45.05	82.78
High-school diploma	42.06	79.67
Vocational training		
Without professional degree	19.98%	27.67%
Full-time vocational school	36.09%	49.57%
Apprenticeship	32.92%	51.86%
Master craftsman	44.48%	78.93%
University of applied sciences	47.61%	87.05%
University	42.70%	86.70%
Total	34.50%	57.62%

Full-time working males in %.
Source: BIB/IAB 1998/99, own calculations.

By introducing dummies for internal (the employee participated in on-the-job training, quality circles, or took over special tasks) and external training (participation in courses and seminars, trade fairs, lectures, and reading of specialist literature), this study attempts to differentiate between the earnings effects of training forms with more or less specific contents. In Table 3.7, participation in internal and external training is described by the level of education. For internal training, there is a clear trend visible that high-skilled workers participate more often (about 40%) than low-skilled workers (about 30%). In the case of external training, this tendency is even more obvious: While 86% of employees with a university degree take part in external training, less than 30% of the unskilled (without professional degree) participate. Columns 1 and 2 in Table 3.8 show the results of the simple OLS earnings equations including a dummy for internal or external training. The impact of external training is significantly positive and higher than that of internal training.[22] The coefficients of the other variables in the extended income equation are as expected and similar to those found in the previous regression using the training dummy.

In analogy to the analysis above, endogeneity of training has to be taken into account in this specification as well. Hence, two regressions with instrumental variables for the two training dummies are estimated. The selection

[22] This confirms the stronger bivariate correlations between the four external training variables and earnings in comparison to the three internal training variables (see Table C.8 in the appendix).

into the two types of training differs, as can be seen in Table C.10 in the appendix. Participation in external training is explained much better by the variables at the right hand side than participation in internal training, as indicated by the adjusted R^2 of 0.35 and 0.12, respectively. The estimated coefficients only vary slightly between the regressions determining internal and external training. The main difference is that internal training depends to a much lesser extent on school attainment, professional education, and professional status than external training (Altonji & Spletzer, 1991). In a specific sample for employees of age 14-21, Lynch (1992) finds an increasing training incidence with experience for company-provided training while the incidence of off-the-job training decreases with tenure. Likewise, Bartel (1995) finds an increasing training incidence with length of services for core training while the incidence of the other training forms decreases significantly. These differences between the training forms with respect to experience and training are not found in the German context. Workplace and individual characteristics have similar impacts on the training dummy as well as on the internal and external training dummy.

Table 3.8. Earnings equations with external or internal training

Variable	**External training (OLS)**	**Internal training (OLS)**	**External training (IV)**	**Internal training (IV)**
Training	0.06***	0.01*	0.18*	0.08
	(0.01)	(0.01)	(0.10)	(0.14)
Education and vocational training				
School attainment				
Without school-leaving certificate	0.01	0.00	0.04	0.04
	(0.03)	(0.03)	(0.04)	(0.11)
Lower secondary school	-0.01	0.00	0.02	0.05
	(0.01)	(0.01)	(0.02)	(0.08)
Entrance examination for	0.03	0.08***	0.02	0.03
university of applied sciences	(0.03)	(0.02)	(0.05)	(0.16)
High-school diploma	0.06**	0.08***	0.06	0.10*
	(0.03)	(0.02)	(0.04)	(0.06)
Professional education				
Without professional degree	-0.07**	-0.06*	-0.10*	-0.09
	(0.03)	(0.03)	(0.06)	(0.42)
Apprenticeship	-0.01	-0.01	-0.00	0.00
	(0.03)	(0.03)	(0.05)	(0.43)
Master craftsman	0.04	0.05	-0.00	0.01
	(0.04)	(0.03)	(0.06)	(0.45)
University of applied sciences	0.07	0.11***	-0.01	0.15
	(0.05)	(0.04)	(0.12)	(0.39)
University	0.15***	0.20***	-0.02	0.15
	(0.05)	(0.04)	(0.12)	(0.36)

to be continued...

...Table 3.8 continued

Variable	External training (OLS)	Internal training (OLS)	External training (IV)	Internal training (IV)
Professional career				
Professional experience	0.01***	0.01***	0.01**	0.01
	(0.00)	(0.00)	(0.00)	(0.00)
Professional experience (squared)	-0.00***	-0.00***	-0.000**	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Company tenure	0.01***	0.01***	0.01***	0.01*
	(0.00)	(0.00)	(0.00)	(0.01)
Company tenure (squared)	-0.00***	-0.00**	-0.00***	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Unemployment	-0.02**	-0.04***	-0.00	-0.01
	(0.01)	(0.01)	(0.02)	(0.05)
Professional status				
Skilled blue-collar worker	0.07***	0.08***	0.05*	0.07*
	(0.02)	(0.02)	(0.03)	(0.04)
Assistant foreman	0.09***	0.07***	0.12**	0.01
	(0.03)	(0.03)	(0.05)	(0.09)
Master craftsman	0.13***	0.16***	0.20***	0.19***
	(0.04)	(0.03)	(0.07)	(0.07)
Unskilled white-collar worker	0.07***	0.08***	0.08*	0.06
	(0.02)	(0.02)	(0.04)	(0.08)
White-collar worker with simple tasks	0.04*	0.039**	0.05	0.05
	(0.02)	(0.02)	(0.04)	(0.11)
White-collar worker with difficult tasks	0.14***	0.13***	0.17***	0.19**
	(0.02)	(0.02)	(0.04)	(0.09)
High-skilled white-collar worker	0.20***	0.23***	0.09*	0.16*
	(0.02)	(0.02)	(0.05)	(0.09)
Executive white-collar worker	0.26***	0.34***	0.07	0.31***
	(0.04)	(0.03)	(0.11)	(0.09)
Civil servant in clerical grade	0.15***	0.09***	0.11*	0.19*
	(0.03)	(0.03)	(0.06)	(0.10)
Civil servant in higher service	0.24***	0.16***	-0.07	0.32*
	(0.06)	(0.03)	(0.42)	(0.16)
Civil servant in senior service	0.58***	0.36***	0.48	0.44***
	(0.06)	(0.04)	(0.61)	(0.14)
Workplace characteristics				
Computer work station	0.03**	0.04***	0.02	0.04
	(0.01)	(0.01)	(0.03)	(0.05)
Temporary work	-0.04*	-0.06**	-0.03	-0.02
	(0.02)	(0.02)	(0.03)	(0.06)
Good economic situation	0.03***	0.04***	0.00	0.01
	(0.01)	(0.01)	(0.02)	(0.03)
Overtime	0.05***	0.05***	0.05***	0.06**
	(0.01)	(0.01)	(0.02)	(0.03)
Profit-sharing	0.05**	0.07***	-0.01	0.07

to be continued...

...Table 3.8 continued

Variable	External training (OLS)	Internal training (OLS)	External training (IV)	Internal training (IV)
	(0.02)	(0.02)	(0.04)	(0.19)
Incentive wage	0.05***	0.04***	0.04***	0.07
	(0.01)	(0.01)	(0.02)	(0.04)
Individual characteristics				
Children	0.06***	0.08***	0.05***	0.03
	(0.01)	(0.01)	(0.01))	(0.05)
Foreigner	-0.04**	-0.05***	-0.04)*	-0.10
	(0.02)	(0.02)	(0.02))	(0.09)
Size of firm				
1-4	-0.07**	-0.05**	-0.10**	-0.03
	(0.03)	(0.02)	(0.04)	(0.10)
5-9	-0.06***	-0.06***	-0.04*	-0.07
	(0.02)	(0.02)	(0.02)	(0.11)
50-99	0.04**	0.02	0.04*	0.05
	(0.02)	(0.01)	(0.02)	(0.04)
100-499	0.06***	0.06***	0.07***	0.04
	(0.01)	(0.01)	(0.02)	(0.04)
500-999	0.10***	0.08***	0.12***	0.15**
	(0.02)	(0.02)	(0.03)	(0.06)
1,000 and more	0.12***	0.10***	0.16***	0.15***
	(0.02)	(0.01)	(0.02)	(0.04)
Selected interaction variables				
Professional experience	0.01	0.00	0.02***	0.02
	(0.00)	(0.00)	(0.01)	(0.02)
Professional experience (squared)	-0.00	-0.00	-0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Company tenure	-0.01***	-0.00	-0.02***	-0.02
	(0.00)	(0.00)	(0.01)	(0.01)
Company tenure (squared)	0.00**	0.00	0.00***	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Firm size: 1,000 and more	-0.01	0.04**	-0.09**	-0.14
	(0.02)	(0.02)	(0.04)	(0.11)
Lower secondary school	-0.05***	-0.07***	-0.11***	-0.21
	(0.02)	(0.02)	(0.04)	(0.15)
Unemployment	-0.02	0.01	-0.07**	-0.08
	(0.02)	(0.02)	(0.03)	(0.13)
Computer work station	0.03	0.02	0.05	0.01
	(0.02)	(0.02)	(0.04)	(0.14)
Temporary work	-0.09**	-0.04	-0.10	-0.22
	(0.04)	(0.04)	(0.09)	(0.24)
Good economic situation	0.02	-0.00	0.08***	0.07
	(0.02)	(0.02)	(0.03)	(0.06)
Profit-sharing	0.02	0.00	0.10*	0.01
	(0.03)	(0.03)	(0.05)	(0.32)

to be continued...

...Table 3.8 continued

Variable	**External training (OLS)**	**Internal training (OLS)**	**External training (IV)**	**Internal training (IV)**
White-collar worker with	-0.09**	-0.05	-0.12	-0.18
difficult tasks	(0.40)	(0.04)	(0.18)	(0.24)
Civil servant in clerical grade	-0.18***	-0.08*	-0.07	-0.27
	(0.05)	(0.05)	(0.19)	(0.25)
Civil servant in senior service	-0.18**	-0.05	0.179	-0.44
	(0.07)	(0.05)	(0.50)	(0.41)
Civil servant in higher service	-0.36***	-0.12**	-0.26	-0.34
	(0.07)	(0.06)	(0.68)	(0.34)
Constant	7.80***	7.80***	7.95***	7.92***
	(0.06)	(0.06)	(0.09)	(0.33)
R^2	0.51	0.50	0.44	0.29

Remarks: The heterogeneity robust standard errors are in brackets. Also included: 13 dummies for job content, 46 dummies for economic sector, and 11 dummies for the federal state. Number of observations: 8,325.
Significance levels: $*$: 10% $**$: 5% $***$: 1%.

The results of the instrumental variable regression are shown in Table 3.8, columns three and four.[23] The impact of external training on earnings increases after correcting for the selection bias while the t-value decreases but, nevertheless, stays significant. The effect of participation in internal training on earnings also increases but turns insignificant. Obviously, the results in former sections of this chapter, where a training dummy was included in the earnings regressions, are driven by the external training types. The internal training, in contrast, does not have an impact on earnings.

The coefficients of the other explanatory variables in the extended earnings equation, including the two types of training, do not deviate from the model with the training dummy. The adjusted R^2 is lower for the IV regression including internal training (0.29) than the one including external training (0.44). Furthermore, the interaction terms of external training with the covariates are better determined than those of internal training and are similar to those of the training dummy. A joint IV estimation of internal and external training did not lead to satisfactory results because the predicted external and internal training variables, all interaction terms between internal and external training, and all explanatory variables are used as instruments here. This increase in the number of instruments reduces the determination of the training variables and all other coefficients because the sample size was obviously not sufficient for such a large number of instruments.

[23] The Durbin-Wu-Hausman test confirms that internal and external training are both endogenous in the wage equation [the F-statistic for internal training is: F(1, 8000) = 2.85, Prob > F = 0.09 while the F-statistic for external training is: F(1, 8000) = 23.29, Prob > F = 0.00].

3.4.3 Conclusion

This section has shown that external training has a higher impact on earnings of training participants than internal training. The coefficients of the other variables in the extended Mincer equation are as expected and similar to those found in the previous sections of this chapter using the training dummy. Without controlling for endogeneity, external training (i.e. participation at trade fairs, lectures, courses and seminars, and reading of specialist literature) has a significant positive impact on earnings (the estimated OLS coefficient is 0.06). The earnings effect of internal training (i.e. on-the-job training, quality circles, and special tasks) is also significant and positive (the estimated OLS coefficient is 0.01).

Taking endogeneity into account and instrumenting the training decision, the coefficient of external training rises from 0.06 to 0.17, internal training turns insignificantly positive with a coefficient of 0.08. Hence, participation in internal training does not translate into higher earnings while external training mainly drives the result derived with a dummy for training participation.

Assuming that external training contains more general human capital contents, this result is plausible. According to this assumption, external training increases human capital that can be also used in other firms and, hence, the market value of the employee. In order to keep the trained employee, the firm has to pay a wage mark-up. Otherwise, the trained employee has an incentive to change the job and profit from a higher wage in another firm.

If internal training increases mainly the firm-specific human capital of training participants, the firm is not likely to pay a high-wage mark-up. The reason is that the outside options of the employee have not improved by internal training. Hence, the expected increase in wage after internal training is lower than for external training. This is suggested by the results of this section which give a first insight on differences between the impacts of different training forms.

3.5 Summary of Results and Conclusion

This chapter elaborates on differences in the effect of training on earnings for various groups of participants and two types of training. It is shown that differences in wage effects of continuing training are crucial and should be taken into account instead of merely concentrating on the average effect, as the majority of former training literature does. Differences between skill and age groups as well as with respect to other personal, job, and firm characteristics are shown. Since low-skilled have a lower chance to participate in training and profit less from participation, a focus is set on this group.

The personal services sector, a low-wage sector, is examined in detail, and results show that in this sector, the average effect of training on wages is

lower compared to the entire economy. Taking selection in training measures into account increases the estimated training coefficient slightly but does not qualitatively change the results. Allowing in the empirical analysis for the possibility that individuals consider the expected return to training reduces the estimated return to training. This finding shows that those individuals which have a high expected return to training choose to participate or are selected (by their employer) into training.

In addition, evidence for heterogeneity of the wage effect of different training forms is presented. Summing up, participation in internal training does not translate into higher earnings while external training mainly drove the result derived with a dummy for training participation. It is argued here that external training entails more general training contents; therefore, my results confirm that mainly general human capital leads to higher earnings. Training of a mainly general nature (external training) has a positive effect on wages while training including mainly firm-specific contents (internal training) does not affect wages.

Chapter 4 picks up the topic of general and specific continuing training. Coherences of general and specific training with job mobility and wages are examined in detail in the theoretical discussion. These interrelations are used in order to test whether firm-provided continuing training in Germany is mainly general or specific training.

4

Training, Mobility, and Wages: Specific Versus General Human Capital[1]

This chapter considers training, mobility, and wages together in order to test whether firm-provided training contains a firm-specific component. From a human capital perspective, company training increases the productivity of a match while from an informational perspective, it improves the knowledge about the quality of a particular job match. From both points of view, training is expected to influence wages, mobility, and wage effects of mobility. Wages contain information about the productivity change or the updated knowledge through training, and so does mobility. These interrelations are used in order to empirically test whether training exhibits mainly general or specific human capital in two particular ways.

First, mobility effects of training can serve as a test whether training contains firm-specific features but are also interesting in themselves. One reason is that mobility can disturb the investment decision of a firm that decides about providing training. Also, mobility can be efficiency enhancing if bad job matches are dissolved, which were detected due to training. Mobility is expected to increase or to remain unchanged if training contains mostly general human capital, in contrast, decreasing mobility is expected when training is mostly specific and not portable between employers. Hence, regressions explaining mobility with training participation as the explanatory variable are used as a first test whether training generates general or specific human capital.

As a second empirical test, wage effects of mobility after training are considered. In the light of rent-sharing between employers and employees, a positive or zero wage effect of a job change after general training is expected. Specific capital should decrease wages after a job change because a new employer will not reward the specific capital that was useful in the old job. Thus, wage effects of mobility can be seen as a distinction between those two forms of human capital. To evaluate the wage effects of mobility, reported wages

[1] This chapter draws on Garloff and Kuckulenz (2006).

are used directly, but, in addition, the judgement of employees whether they profited from their last job change is used, a unique feature of the data set.

This study tries to identify a causal effect of training on mobility and on the wage effect of a job change to distinguish between specific and general human capital. As proposed by modern search theory, this study takes into account that mobility can be endogenous in the wage regression. Also, endogeneity of the training decision with respect to the mobility decision is accounted for since there might be a selection into training or mobility.

Summarising, this study finds empirical evidence in favour of training inhibiting job-, firm- or occupation-specific capital. The probability of being mobile seems to be negatively correlated with the probability of participating in training. Furthermore, both the partial correlation and the wage effects of (exogenous) mobility seem to be negative for the group of training participants while there is no effect for the group of non-training participants. Furthermore, using a subjective measure whether individuals profited from their last job change, this study finds that participation in training negatively affects the propensity to be better off after a job change.

4.1 Introduction

Employees can pursue various strategies over their professional life to increase their wage. They can invest in (general or specific) human capital to increase productivity and to be paid accordingly, or they can search for better paid jobs (see Antel, 1986). Training and mobility decisions are not separable. They influence each other and should be simultaneously analysed. Individuals may choose to stay with an employer after (specific) training, or they may choose to change the employer after (general) training in order to reap the benefit from training if the old employer keeps part of the training rent.

Firms invest in training activities in order to raise the level of qualification of their workforce and to secure strong economic performance. In Germany, about 40% of the employees obtain training during one year.[2] Four years before, in the years 1995/96, the participation in training seems to have been a bit lower with about 7.1 million members of the German workforce participating in training (see Franz, 2003). Employees aged between 35 and 50 have the highest training participation shares. In 2001, firms in Germany invested almost 17 billion euros in training their workforce (see Weiss, 2003). Hence, firm-provided training is considered one of the major post school investments in human capital. Human capital plays an important role in the process of economic growth, and individuals' labour market outcomes are linked to their educational attainment. Wage effects of training have been examined and discussed extensively in the literature (see, e.g., Pischke, 2001; Kuckulenz

[2] Cf. Kuwan et al. (2003).

& Zwick, 2003; Büchel & Pannenberg, 2004; Jürges & Schneider, 2005, for Germany or Pfeiffer, 2001, for a review of microeconometric studies). Fewer papers focus on labour turnover and training.[3]

In this chapter, I test whether firm-provided training inhibits a specific component using an indirect way of testing. Specifically, I use the interrelations between training, mobility, and wages in order to empirically test whether training exhibits mainly general or specific human capital. This is done in two different ways where mobility effects and wage effects of mobility are interpreted in terms of the specificity of the skills that have been acquired in training courses.[4]

The specificity of the contents of training courses is interesting for several reasons. First, if firm-provided training is general, there might exist a hold-up problem, a case of underinvestment. Consider the case where an employer pays for the (general) training of an employee under the premise that the individual is paid below marginal productivity afterwards. Clearly, the individual has an incentive to renegotiate the wage after the investment since the investment costs sink. If firms anticipate the renegotiation, they will underinvest in training, and there is scope for government intervention. Second, the specificity of training investments has been discussed in the context of international differences in labour mobility and unemployment developments (see, e.g., Wasmer, 2003). In this view, the specificity of human capital is central for the adaptability of a system to a changing environment. If, for example, skill-biased technical change accelerates the turbulence in an economy and, therefore, turnover increases, general skills become more important since they can be used in many firms. On the other hand, in an economy with a low degree of turnover, a high degree of specificity of skills might guarantee a high labour productivity. Finally, the degree of specificity of company-provided training has also been discussed theoretically and empirically by Acemoglu and Pischke (1998 and 1999) with a focus on the investment in training. They find that under certain conditions firms are willing to invest in general training and show with German survey data that, indeed, part of the firm-provided training in Germany is general (see also Booth & Zoega, 2004, who provide conditions under which firms provide general training).

The remaining chapter is set up as follows. First, two hypotheses are derived in order to empirically test whether training also provides participants with specific skills. Second, the data set is introduced and described. Third,

[3] Early work that is concerned with specific training and turnover is, for example, Oi (1962) and Deere (1987). Newer work that deals with mobility and training, mostly in the context of frictional labour markets, is, for example, Zweimüller and Winter-Ebmer (2003), Owan (2004), and Adnett, Bougheas and Georgellis (2004).

[4] As argued above, training in specific skills is often observationally equivalent to training that generates information about the quality of a particular match and that is lost upon termination of the match. For an empirical attempt to distinguish between these two kinds of specific capital, see Nagypal (2004).

the estimation strategy is lined out. Fourth, empirical results are examined, which are split in three parts. The study tests whether training participation is correlated with mobility and the propensity of switching jobs. Then, controlling for the endogeneity of job mobility, it examines the wage effects of job changes for individuals that have participated in training and for individuals that have not. In addition, the individuals' judgements are used whether their last job change was beneficial to assess the training effect on the wage effect of mobility. Finally, I sum up, conclude, and give an outlook.

4.2 Derivation of Hypotheses and Estimation Strategy: Mobility Effect of Training and Wage Effect of Mobility

To my knowledge, there are no theoretical models in the training literature which explicitly show the relationship between training participation, mobility, and wage effects (of mobility). Nevertheless, like previous papers (e.g., Antel, 1986; Spletzer & Loewenstein, 1998), using insights from human capital theory and search theory, it can be argued that this relationship exists. The coherences between training, mobility, and wages can be used as tests whether training exhibits firm specific human capital.

4.2.1 Mobility Effect of Training: Hypothesis Derivation

The decision to invest in training on the side of the firm and on the side of the individual is influenced by (expected) mobility. On the one hand, firms are expected to invest in general training of the workforce only if they are able to appropriate part of the returns to the productivity increase. This implies that firms are only likely to invest in general training if they can restrict workers' mobility afterwards or if firms expect the mobility of workers to be small.[5] One reason for a low labour mobility can be found in the existence of labour market frictions. For example, Acemoglu and Pischke (1999) and Holzner (2005) show that in the case of the existence of frictions and wage bargaining, it can be optimal for firms to invest in general training.[6] On the other hand, mobility might be the desired result (see, e.g., Felli & Harris, 2004). Training might serve screening purposes and might be performed in order to distinguish good

[5] One reason for this might be that there are complementarities between general and specific human capital (see, e.g., Casas-Arce, 2005). In this case, the investment in general capital on the side of the firms induces individuals to invest (more) in specific capital and, thus, the mobility of the individuals is reduced.

[6] The investment decision in training in the case of frictions has also been examined by Quercioli (2005), who discusses the decision to invest in specific capital in the context of an equilibrium search model.

from bad matches and sort out the bad ones (e.g., trainee programs might be partly performed for this reason). In this case, mobility would be high after training because bad matches are wedded out.

If training generates a rent due to higher worker productivity, it depends on how this rent is shared, whether the employer wants to keep the trained worker, or whether the employee has an incentive to stay with the firm. From the employer's point of view, this means that as long as there is a rent generated by training, a firm prefers to lay off workers that have not obtained training to those workers which have participated in training. If a worker gains from participation in training and cannot be sure to obtain the same wage mark-up from another employer (e.g., due to asymmetric information or specificity of training), the probability for a trained worker to quit and search for a new job will be lower than for a non-trained worker. This implies that the effect of training on the probability of switching jobs reveals information about the nature of training and rent-sharing.

For training that generates specific human capital, even in a competitive market, there is no unique solution of how to assign the existing rent between employer and employee. The employer might want to pay the individual a wage above the outside option in order to prevent the individual from changing the employer. It is a reasonable strategy for an employer to provide specific training to workers and to finance this via a low employee turnover through wages below marginal productivity and above the outside option. Another argument for wages above the outside option is that there is a hold-up problem if an individual is able to extract, ex-post, a part of the (quasi-)rent by renegotiating after training costs sink. Thus, negative mobility effects of training are to be expected in case training imparts specific skills and in the realistic case where individuals capture a non-zero part of the return to investment in training.

If training provides individuals with general skills, this should not alter the mobility decision in a competitive market. This is because skills are fully paid for in such a world. If, however, the market is not competitive, the effect on mobility is less clear. Mobility may be affected by investments in general skills since market imperfections can technologically turn general into de facto specific skills (see Acemoglu & Pischke, 1999). This is the case when mobility is constrained or when the outside wage offer (distribution) does not increase one to one with (the productivity effect of) general skills. It is conceivable that the employing firm does not fully recognise general skills from training because if the firm has paid for (part of) the training, it wants to profit from it and keep (part of) the rent. Then, there could be a mobility-increasing effect of general training if other firms are willing to pay for the increased productivity. Hence, for training-generating general human capital, I expect zero or positive effects on mobility. In the empirical application, I will interpret a zero effect of training on mobility as training that contains only general human capital although theoretically, it is possible that firms pay out their outside option to individuals in the case of specific training.

The following proposition summarises the above arguments:

Proposition 4.1. *If training only contains general human capital, then the mobility decision of workers is unaffected if workers are paid their outside option (the competitive case); or the mobility decision is positively affected when workers are paid below their outside option (the rent-sharing case). If training contains a specific component, the mobility effect is expected to be negative since in general, individuals are paid above their outside option. In case this component is relatively small, a zero effect of training on mobility can be expected.*

4.2.2 Mobility Effect of Training: Estimation Strategy

It is assumed that the error term in the decision of being mobile is normally distributed, and therefore, the mobility decision is modelled as a probit model. According to this model, the probability of changing the employer depends on a vector X, which, in that case, contains individual characteristics, job characteristics, firm characteristics, and a constant on a parameter vector β and on the unobservable error term ϵ. Both firm and job characteristics refer to the current job, that is, the job an individual changes to. This should not be a critical assumption; unfortunately, no data on the previous job is available. Therefore, these characteristics are only included as controls rather than giving an interpretation as (causal) effects on mobility. For the standard interpretation as coefficient, one would need to assume that job and firm characteristics are unaffected by the job change, which is a strong assumption.

$$JC^* = P(JC = 1|X, T) + \epsilon = \Phi(\beta' X + \gamma T) + \epsilon \tag{4.1}$$

$JC = 1$ means job change, T is training participation, γ is the effect of training on the probability to change the job. JC^* can take the values 0 and 1. The model is estimated by maximising the likelihood function as it is standard with binary choice models, where the likelihood function is the product of the cumulated density function (of the normal distribution) for job changers and of the survivor function for job stayers.

Note, however, that training might be endogenous with respect to mobility, for example in the case of specialisation in search or in training as suggested in Antel (1986). In order to generate exogenous variation of the probability of training participation, I use the training intensity by industry, estimated from an earlier wave of the data set in use.[7] It is reasonable to assume (and can be empirically shown) that training intensity in 1991/1992 is uncorrelated with the wage in 1998/1999 while inertia and structural differences across industries suggest that it is (significantly) correlated with training participation

[7] Note that the common use of industry dummies and the training intensity by industry is not a contradiction since the training intensity is on a more disaggregated level.

in 1999 (see Table C.2). Since it is easier to interpret the results, although I estimate an instrumental variable probit, too, I display the results for a Linear Instrumental Variable model.[8] Furthermore, I do not directly use the instruments in the IV procedure. Instead I use the predicted values from a first-stage probit model for training participation as an instrument since this is the optimal instrument if the model is correctly specified and since that procedure has some nice robustness properties (see Wooldridge, 2002).[9] More precisely, I estimate a probit model for training participation including all covariates from the job change equation plus the external identifying variable (training intensity in 1991 by industry).[10] The predicted value from this model is used as instrument in a standard IV approach. To be a bit more formal:

$$JC^* = \delta' X + \alpha T + u \tag{4.2}$$

is the (linear probability) model to be estimated by 2SLS, where X contains a constant, T is training participation as before, and u is an error term. Again, JC^* takes the values 0 or 1. The instrument is the predicted probability for participating in training $\hat{P}(T = 1|X, Z) = \Phi(\hat{\zeta}' Z + \hat{\lambda}' X)$ deduced from the probit model $P(T = 1|X, Z) = \Phi(\zeta' Z + \lambda' X)$. When estimating the model as 2SLS, I use a robust estimator for the variance-covariance matrix since standard errors are heteroscedastic by construction when estimating a binary response model as linear regression model.

4.2.3 Wage Effect of Mobility: Hypothesis Derivation

Wage effects of mobility are closely linked to the question of mobility of individuals after training participation if individuals have participated in training before. This is interesting because the wage effect of a job change to a new firm reveals information about the skills of an individual which are transferable across firms. Discussing the wage effect of mobility after training, human capital theory predicts wage losses if training has provided the individual with specific skills. In the case of general training, under rent-sharing, individuals might be paid below their outside option. In this case, there could be wage

[8] Instrumental variable methods for probit models are discussed, for example, in Newey (1987). Results from an instrumental variable probit estimation are available upon request. They do not differ in sign and significance from the results I display here.

[9] In fact, I only need the linear projection of training on the set of covariates and the predicted participation probability of the (potentially) misspecified model to actually depend on the participation probability.

[10] Recognise that in a strict sense, I do not need exclusion restrictions. Although theoretically, the functional form identifies the effect of training, in empirical work, it is very common to use additional exclusion restrictions to circumvent problems with multicollinearity.

gains from a job change. For this to be true, it does not matter whether mobility is endogenous or exogenous.[11]

Following Loewenstein and Spletzer (2000), I interpret the empirical effect of training on wages as an indicator for the degree of specificity of the training obtained. I test whether workers who change their job after training are paid less than those workers which do not change their job after training. A "high" wage of job movers after training may indicate that employers share costs of and returns to general training and that full gains from training investments can be reaped by employees at a new employer. A "low" wage of job movers, in contrast, might indicate that firm- (or job-) specific skills are lost, and productivity in the new firm is lower (see also Loewenstein & Spletzer, 1998; Booth & Bryan, 2002; Gerfin, 2004). Hence, if training provides individuals with specific skills and if returns are shared, a job change after training is predicted to have a negative effect on wages. There is no theoretical prediction for a job change without training. If a job change also invokes a negative coefficient, the effect of a job change after training is bigger in absolute values. In case of general skills and the presence of rent-sharing between employer and employee, the predicted coefficient of a job change after training is positive or zero because it is not certain whether the part of the rent which is captured by the firm providing training is also obtained by a new employer. Therefore, estimating the coefficient of job change in a wage regression after participating in training gives a hint whether training is mainly firm specific or general.

The following proposition summarises the arguments:

Proposition 4.2. *If training provides individuals with general skills, a job change after training implies no wage change (in the case of a competitive market) or a positive wage change if the firm captures a part of the rent generated by training (the rent-sharing case). If training also contains specific human capital, I expect the wage change caused by job mobility to be negative since, in general, the worker will be able to extract a part of the rent generated by specific training. Again, if the firm-specific component is relatively small, a zero effect can be expected.*

4.2.4 Wage Effect of Mobility: Estimation Strategy

In order to calculate the wage effect of mobility, a Mincer equation is estimated, and the coefficient of job change after training is interpreted. In the regression, I control for a variety of demographic variables including the variables of an enhanced Mincer equation, experience and tenure, and the square of both. Mobility effects for the group of training participants and individuals that have not participated in training are treated separately because training participants and non-training participants might be systematically different.

[11] From this point of view, individuals receive their outside option if they change jobs, independently of whether job-to-job transitions are exogenous or endogenous.

More formally, for training participants the following equation is estimated:

$$lnY = \beta_1' X + \beta_2 JCT + e, \tag{4.3}$$

where lnY are log earnings, X contains schooling, experience (squared), tenure (squared), and various demographic variables but also firm, job and industry characteristics, a constant, and β_1' is the coefficient vector. β_2 is the influence of a job change after training (JCT) on earnings; e represents an unobservable error term. For non-participants, a similar equation is estimated.

There are some remarks to make, however. The analysis above assumes that in order to consistently estimate the wage effect of job-to-job transitions after training, job movers and stayers are otherwise similar. This is not sufficient, however, because the decision to change a job depends on various factors, such as previous training. Mobility is endogenous if the mobility decision is taken because of the outside wage while mobility is exogenous when mobility takes place for reasons that do not depend on the outside wage. It is not problematic to use exogenous mobility in a wage regression while the use of endogenous mobility leads to a bias.

Notice that if individuals are paid their outside option on their current job, mobility cannot be endogenous. The reason is that other firms do not pay higher wages, hence, a higher wage cannot be the reason for the job change. If individuals are not paid their outside option and if the decision to change a job is taken as assumed in search theory (individuals change their job to earn higher wages), there is an endogeneity problem. To see this, recognise that from this point of view, the decision to change a job is made on the basis of the current wage and outside wage offers that arrive at irregular time intervals and that are random draws from a wage offer distribution. Hence, wage and job mobility are determined simultaneously.

Still, involuntary job mobility is not enough to guarantee exogeneity of the job change variable with respect to the wage since firms might lay off people because of wages being too high. Using information whether the partner is working and whether there are children in schooling age helps me to identify the wage effect of exogenous and involuntary mobility.[12] The analysis of wage effects of job moves is based both upon a comparison of stayers and movers accounting for endogeneity (that is, a 2SLS approach) and upon the direct appraisal of the individuals whether the job change ameliorated their

[12] Following Dustmann and Meghir (2005) and for comparison reasons, for training participants, also firm closure is used as an instrument, yielding very similar results.

professional position.[13] For all estimated models, a robust variance-covariance estimator is chosen since wages are generally assumed to be heteroscedastic.[14]

An alternative approach to evaluate the job change effect for training participants and non-training participants is to use the direct subjective judgement of individuals whether they profited from their last job change and to explain this dummy variable by participation in training. Clearly, this study restricts its attention to job changers in this case. Note that there is no reason to suppose an endogeneity problem in this case since only job changers are considered. There would be a problem of endogeneity if the training participation decision depended on the perceived returns to future mobility.

4.3 Data and Descriptive Evidence

For the empirical analysis, the BiBB/IAB "Qualification and Career Survey" from 1998/99 is used, which was introduced in section 2.4. The survey is implemented every 7 years, but it is not a panel. Hence, it is impossible to observe and compare wages before and after training and/or job changes directly.[15] The cross-section data on employed individuals in Germany contain detailed information on the qualification and the professional career of each individual, the organisational and technological environment of jobs, and the qualifications demanded for jobs. Furthermore, information about the employer and some personal attributes are included. Specifically, the following variables are used (see also Table D.1 and Table D.2 in the appendix for the complete list with detailed descriptions):

[13] For the same reason why a job change is endogenous in a wage regression, tenure is also endogenous. By including information on the number of previous employers, however, one can account for a source of endogeneity in tenure.

[14] Note that the selection in training is clearly endogenous with respect to the wage. Therefore, analogous to Wolf and Zwick (2002), the model is estimated including (Heckman) correction terms from a probit model for training participation. Since the results are virtually unaffected and since the coefficients are even not always significant, the results without the Heckman correction are displayed.

[15] To discuss interrelations between training, mobility, and wages, it would be optimal to use a large panel data set where individuals are observed before and after training and job changes. For Germany, the Socio-Economic Panel (GSOEP) is the only available panel data set including this information. It also provides direct information on whether training is general or firm specific. For my purpose, the GSOEP contains too little observations, however. For example, only four individuals in the data set took part in on-the-job training in 1998 and changed their job afterwards (own calculations from GSOEP 2000). This means that thorough empirical testing of my hypotheses is impossible.

- The wage variable is *log midpoints of earnings* from 18 categories. Midpoints of the intervals are used in the same way other authors have done it (see, e.g., Kuckulenz & Zwick, 2003; Pfeiffer & Reize, 2001).[16]

- The first key variable is *participation in training during the last 5 years*. The first question is whether the individual participated in courses or seminars in this time period. The second inquiry is on the year in which the last training course took place.[17] By combining both questions, dummies for participation in training in either one specific year or in several years are obtained. Since it is known when training took place, this information can be later used to distinguish between training before or after job changes. An important measurement problem of my training variables is that they do not include information on the length and costs of the training attended. Hence, I cannot control for training intensity when estimating effects on wage and mobility.

- The second key variable is *job change*. This variable is not directly observed. To construct the job change variable and the date of job change, information on the number of employers is used together with the question since when one works for the actual employer. It is also asked why people have changed the employer and whether they profited from the job change. The judgement of the individual whether it has directly profited from the employer change is used as endogenous variable in order to assess the effect of training on the probability to change the job.[18]

- To control for selection into training in the mobility equation, several *identifying variables* are used. The results are similar for most of them. Based on theoretical arguments, finally, the *training intensity by industry*, estimated from an earlier wave (1991/1992) of the BiBB/IAB survey, is cho-

[16] The first category includes all earnings below 600 DM, the second includes earnings from 600 DM until 1,000 DM. The following categories comprise earnings intervals of 500 DM up to 6,000 DM. From 6,000 DM to earnings of 10,000 DM, the intervals are in steps of 1,000 DM. The next category comprises earnings from 10,000 DM until 15,000 DM, and the last category includes all earnings of 15,000 DM and above. Most earnings can be found in the categories between 3,000 DM and 5,000 DM, see Table D.1 in the appendix for descriptive statistics.

[17] There are two questions on the participation in continuing training. First, "Please think about the last 5 years, i.e. the time from 1994 until today. Did you attend, during that time, any seminars or courses which serve your continuous process of education?" Second, "In which year did the course take place?"

[18] Note that the job change variable not only includes direct job-to-job transitions. It also includes, for example, individuals who transit through unemployment before working for the next employer. For comparison reasons, I have constructed a job change variable for individuals that are never unemployed before the interview. The results do not differ much, though.

sen. Using imputed data from the Continuing Vocational Training Survey (CVTS 2000) about *sectoral shares of firms and shares of firms by employment size that include continuous training in their collective bargaining agreement* yields quite similar results.[19]

- As discussed above, job change is partly endogenous in the wage regression. In principal, there is some information on exogenous job change in the data set, which I can use as instrumental variables. Namely, firm closure and occupational changes for health or family reasons are used. In the wage regression, unfortunately, these instruments do not generate enough variation or are not exogenous. Hence, *two further variables as instruments* are used, which cause variation in the job change equation but not in the wage equation. First, information on the fact whether the employed individual has a *partner that is employed*, is used as well. It is reasonable to assume (and is empirically shown) that this variable is not related to an individual's earnings while it is very realistic to think that the individual is more bound to a region, so that there are less job offers and, therefore, less employer changes. Second, a dummy whether the individual has *children between 6 and 17 years* is used. To see why, in the wage equation, I control for the number of children since this is (significantly) correlated with the wage. But it is shown that whether the children are in schooling age does affect mobility while it should (and empirically does) not affect earnings.

- *Further explanatory variables* are those found in the Mincer equation, that is, work experience (and its square)[20], job tenure (and its square), former unemployment, and dummies for the highest educational achievement.[21]

- Along with these standard variables, some dummies capturing the *professional status* are included, such as blue-collar or white-collar worker, civil servant, or different sophistication levels of tasks.

- In addition, the following *job characteristics* are used: computer use, profit-sharing, bonus payments, overtime work, whether a job is temporary, and main job contents. These variables allow me to control a large part of the individual heterogeneity between the employees.[22] Some of these variables can be interpreted as indicators for intrinsic motivation.

[19] The CVTS data is from 1999 and, therefore, fits well to the BiBB/IAB data set.
[20] It is known when the individual started his or her first job, and I include dummies for discontinuation such as unemployment.
[21] In Germany, the highest schooling degree is more informative for the level of education than years of schooling (see Georgellis & Lange, 1997).
[22] Some of these variables may also be endogenous in the earnings equation. This is not controlled here, however, because the variables mainly serve as control variables for employee heterogeneity.

- Additional control variables explaining earnings are *personal attributes*. Dummies for females, having children, and German nationality are included.

- Finally, it is also controlled for *firm size*, and a dummy indicating whether the individual lives in East or West Germany is included because earnings as well as costs of living still differ between the two regions.

Hours worked vary widely in the data, and there is a number of implausibly high reported values. Therefore, only full-time employees are included in this study.[23] During the last 5 years, 44% of the employees attended at least one continuing vocational training course or seminar. This proves that, for a large part of the employees, training takes place. Of those workers who participated, almost 50% participated last year (1998), 20% participated 2 years ago in the last training course or seminar, and for the remaining employees, the last training took place more than 2 years ago. When looking at all employees, around 70% have changed the job at least once, that is, they worked at least for two different employers. During the previous year, almost 12% of the employees changed their job.[24] Several reasons why the last job ended are distinguished in the data set.

In particular, 66% of the individuals state that it was their own desire to leave the former employer, 12% had to leave because the firm wanted them to, 7% left because their fixed-term contract ended, and 15% state that the firm went bankrupt. In their new job, 70% of the job changers are happier than before, for 21% the situation is unchanged, and 9% of the individuals state that they are unhappier in the new job than they were in the old job. Not surprisingly, out of those individuals who changed the job because it was their own desire to do so, 80% are happier in their new job. Likewise, 17% of those individuals who did not want to leave the firm state that the situation in the new job is worse than in the old one. Combining training and mobility, it is interesting to know whether individuals are less likely to change jobs after they participated in training. Given the descriptive statistics, this seems to be the case. After 1994, 23% of the employees have changed their job, but only 11% of those which took part in training during this time period changed their job afterwards.

[23] Only employees working 30 hours and more per week are included. I also use a dummy for working overtime in order to take hours worked into account.

[24] The number of job changes is somewhat higher in the data set used here, compared to other German data sets (see, e.g., Fitzenberger & Garloff, 2005). The reason is that here, job-to-job transitions are not directly observed and, hence, some individuals who enter a new job after staying at home or after being unemployed for a while are also included as job changers.

4.4 Empirical Results: Mobility Effect of Training and Wage Effect of Mobility

This section discusses the empirical results. First, the mobility effect of training is discussed. Second, results on the wage effect of mobility are presented.

4.4.1 Mobility Effect of Training

Looking at Table 4.1, there is a negative partial correlation between training and mobility. Individuals that have participated in training before 1997 change jobs less often after 1997 than otherwise comparable individuals. When taking into account that participation in training might be endogenous with respect to the mobility decision, the effect of training, and instrumenting by the training intensity by industries from the last wave of the BiBB/IAB survey, it increases in absolute value (compare training coefficient in Tables 4.1 and 4.2).[25] If an individual has more than two previous employers, this increases the probability of a job change and points to the fact that the number of previous job changes is an important predictor for future job changes. This is in accordance with specialisation in search or specific training as proposed by Antel (1986) or with the "hobo syndrome" by Ghiselli (1974), where employees have an intrinsic motivation to change jobs after some years.

Interpreting and comparing the point estimates of the two approaches means that exogenous training participation has, on average, a bigger negative partial correlation with labour mobility than training participation in the population. That is, if somebody is admitted exogenously to training, he or she is more likely to stay in the firm. This is counterintuitive and contradicts the Antel (1986) story where people are assumed to specialise in training or search.

Because of this counterintuitive result, I perform a Durbin-Wu-Hausman test for exogeneity of training given the instruments. Exogeneity for the instruments in use cannot be rejected. From this, it can be concluded that one should not overinterpret the IV results, and, thus, the probit results are preferred. Summarising, the results point to a negative effect of training on mobility. This is consistent with training inhibiting specific capital for the employer or the match which would be lost upon job change.

[25] To see that there might be an endogeneity problem, recognise that an individual who wants to change the employer has no incentive to invest in employer-specific human capital. The number of observations slightly differs between the two approaches since there are some differences in the industry classification between the two waves. The first stage results are printed in the appendix (see Table C.2).

Table 4.1. Does training affect labour mobility?

Variable	Coefficient	Std. Err.
Training before 1997	-0.09**	0.05
Individual characteristics		
More than two previous employers	0.56***	0.04
Professional experience	-0.05***	0.01
Professional experience (squared)	0.00***	0.00
Unemployment	0.50***	0.04
Age	-0.04***	0.01
Lower secondary school	-0.00	0.04
Entrance to university of applied sciences	0.05	0.08
High-school diploma	0.12	0.07
Without school-leaving certificate	-0.07	0.12
Without professional degree	-0.13**	0.05
University of applied sciences	0.09	0.09
University	0.23**	0.09
Other controls		
Not married, East Germany, household size (3), sex, children, children's age (3), full-time vocational school, master craftsman, temporary work, computer work station, firm size (6), white-collar worker, economic sectors (4), overtime, profit-sharing, incentive wage, working hours, partner employed, firm failure, occupational change (2), restructuring, need for training.		
Intercept	0.29	0.20
N	9,335	
Log-likelihood	-3721.98	
$\chi^2_{(48)}$	1640.67	

In parentheses are the number of dummies included.
Significance levels: $*$: 10% $**$: 5% $***$: 1%.

4.4.2 Wage Effect of Mobility

As a second empirical test, wage effects of mobility after training are considered. In the light of rent-sharing between employers and employees, a positive wage effect of a job change after general training is expected while specific capital should decrease wages after a job change because a new employer will not reward the specific capital that was useful in the old job (a zero effect can be in line with both). As expected after the first test result, both estimates, the partial correlation as well as the wage effect of an employer change, are found to be negative for the subgroup of training participants (see Tables 4.3 to 4.4). Both least squares and IV methods yield a significant negative coefficient, and the effect increases in magnitude when endogeneity of the employer change is taken into account.[26] An exogenous job change is, as ex-

[26] Again, the number of observations differs because of some missing values for the instruments. The first stage estimation can be found in the appendix (see Table C.3).

Table 4.2. IV estimates of the effect of training on job mobility

Variable	Coefficient	Std. Err.
Training before 1997	-0.51**	0.25
Individual characteristics		
More than two previous employers	0.13***	0.01
Professional experience	-0.02***	0.00
Professional experience (squared)	0.00***	0.00
Unemployment	0.13***	0.01
Age	-0.01***	0.00
Lower secondary school	-0.03*	0.02
Entrance to university of applied sciences	-0.00	0.02
High-school diploma	0.02	0.02
Without school-leaving certificate	-0.03	0.03
Without professional degree	-0.04***	0.02
University of applied sciences	0.02	0.03
University	0.04	0.03
Other controls		
Not married, East Germany, household size (3), sex, children, children's age (3), full-time vocational school, master craftsman, temporary work, computer work station, firm size (6), white-collar worker, economic sectors (4), overtime, profit-sharing, incentive wage, working hours, partner employed, firm failure, occupational change (2), restructuring, need for training.		
Intercept	0.49***	0.06
N	8,915	
R^2	0.02	
$F_{(48,8866)}$	36.88	

In parentheses are the number of dummies included.
Significance levels: $*$: 10% $**$: 5% $***$: 1%.

pected, associated with a higher wage loss than an endogenous job change, i.e. individuals voluntarily decide to change the job on the basis of a wage comparison. Clearly, in the individuals' decision to change a job, the wage that an alternative job would pay plays a crucial role. This is confirmed by the results. The fact that both endogenous and exogenous employer changes yield a wage loss for the group of training participants was predicted from the hypothesis that training incorporates a substantial share of employer- or job-specific capital. This confirms the results from the previous section. Recognise, however, that the difference between the IV estimator and the OLS estimator implies that there is endogenous mobility, pointing to the fact that a simple human capital interpretation is not admissible.

Since search theory predicts a negative effect of job changes in the absence of specific capital as well, the population of non-training participants and wage effects of job changes are considered in this group (see Tables C.4 to

Table 4.3. Participants in training: Correlation of job change and wages

Variable	Coefficient	Std. Err.
Job change after training	-0.03*	0.02
Individual characteristics		
More than two previous employers	0.00	0.01
Professional experience	0.00	0.00
Professional experience (squared)	0.00***	0.00
Company tenure	0.00***	0.00
Company tenure squared	0.00	0.00
Unemployment	-0.06***	0.01
Age	0.01***	0.00
Lower secondary school	-0.06***	0.01
Entrance to university of applied sciences	0.07***	0.02
High-school diploma	0.06***	0.02
Without school-leaving certificate	-0.00	0.04
Without professional degree	-0.09***	0.03
University of applied sciences	0.10***	0.02
University	0.23***	0.02
Other controls		
Not married, foreigner, handicapped, East Germany, household size (3), sex, children, full-time vocational school, master craftsman, temporary work, computer work station, firm size (6), professional position (4), economic sectors (47), overtime, profit-sharing, incentive wage, working hours.		
Intercept	7.22***	0.10
N	4,552	
R^2	0.55	
$F_{(85,4466)}$	65.05	

In parentheses are the number of dummies included.
Significance levels: $*$: 10% $**$: 5% $***$: 1%.

C.6 in the appendix).[27] The correlation between the job change variable and wage is not significantly different from zero. Taking endogeneity of employer changes into account as well as using a dummy variable for whether the partner is employed and for the age of children as instruments, again yields an insignificant coefficient for job change. Summarising, (exogenous) job changes seem to have no significant effect on wages for the group of non-training participants. This finding is consistent with individuals being paid their outside option on average.

Finally, information is used, where individuals judge themselves whether they profited from their last job change (see Table 4.5). A probit model for the group of job changers with training (before the job change) as the explanatory variable yields a negative coefficient, which is significant. Note that a special-

[27] This is the so-called *wage ladder effect*, the effect from self-selection in higher paying jobs.

Table 4.4. Participants in training: IV estimates of the effect of a job change on wages

Variable	Coefficient	Std. Err.
Job change after training	-0.08**	0.04
Individual characteristics		
More than two previous employers	0.00	0.01
Professional experience	0.00	0.00
Professional experience (squared)	0.00***	0.00
Company tenure	0.01*	0.00
Company tenure squared	0.00	0.00
Unemployment	-0.06***	0.01
Age	0.01***	0.00
Lower secondary school	-0.06***	0.01
Entrance to university of applied sciences	0.06***	0.02
High-school diploma	0.06***	0.02
Without school-leaving certificate	0.00	0.04
Without professional degree	-0.08***	0.03
University for applied sciences	0.09***	0.02
University	0.22***	0.02
Other controls		
Not married, foreigner, handicapped, East Germany, household size (3), sex, children, full-time vocational school, master craftsman, temporary work, computer work station, firm size (6), white-collar worker, economic sectors (47), overtime, profit-sharing, incentive wage, working hours, firm failure, occupational change (2).		
Intercept	7.19***	0.11
N	4,488	
R^2	0.55	
$F_{(87,4400)}$	64.17	

In parentheses are the number of dummies included.
Significance levels: $*$: 10% $**$: 5% $***$: 1%.

isation in training or search does not predict endogeneity of training in this equation because it predicts a correlation between job change and training but not a correlation between the wage change through a job change and training.[28] From this result, it can be concluded that training participation seems to have a negative effect on the propensity to improve upon the perceived position through a job-to-job change. This seems to be the most convincing test because it is the most direct evidence on the specificity of training substance. It supports the former result that training inhibits specific human capital, which is lost when switching to a different job.

[28] In addition, it is found in the mobility estimation that the null hypothesis of exogeneity could not be rejected, so that this sort of endogeneity is probably not present.

Table 4.5. Effect of training on subjective change in the position after an employer change

Variable	Coefficient	Std. Err.
Occupational change after training	-0.13*	0.07
Individual characteristics		
More than two previous employers	0.17**	0.08
Professional experience	-0.03**	0.01
Professional experience (squared)	0.00	0.00
Company tenure	-0.02	0.11
Company tenure squared	0.02	0.02
Unemployment	-0.40***	0.07
Age	-0.01	0.01
Lower secondary school	0.07	0.08
Entrance to university of applied sciences	-0.04	0.15
High-school diploma	-0.07	0.12
Without school-leaving certificate	-0.01	0.19
Without professional degree	0.15	0.10
University of applied sciences	-0.15	0.15
University	-0.30**	0.15
Other controls		
Not married, foreigner, handicapped, East Germany, household size (3), children, sex, full-time vocational school, master craftsman, temporary work, computer work station, firm size (6), white-collar worker, economic sectors (47), overtime, profit-sharing, incentive wage, working hours, partner employed, occupational change (2), restructuring, need for training.		
Intercept	1.10	0.84
N	3,260	
Log-likelihood	-1204.63	
$\chi^2_{(85)}$	273.81	

In parentheses are the number of dummies included.
Significance levels: $*$: 10% $**$: 5% $***$: 1%.

4.5 Conclusion

In this chapter, the effects of training on mobility and the effect of training on the wage effects of mobility are analysed. These results are used to interpret the degree of specificity of training. All in all, the results suggest that there is a negative effect of training on job change. As far as the wage is concerned, there are stable causal negative effects of both employer and occupational changes on wages for the group of training participants. For the group of non-training participants, there is no significant relationship between a job change and wages. The interpretation of this result is that individuals are on average paid their outside option. This suggests that training, indeed, has a specific component which is lost for exogenous and endogenous, for voluntary

and involuntary job changes. Note that this is also consistent with the idea that training generates information on the quality of a particular match.

Using the direct judgement from job changers whether they profited from job change seems to bear the best information, however, since it is easier to find the adequate control group. One can take the group of individuals that has profited from a job change and compare training participants and non-participants. Here, this study finds that training reduces the probability of an amelioration through job change. Thus, from this view, training can also be interpreted as incorporating employer- (or job-) specific human capital.

Summing up, the evidence points to the fact that most training seems to generate some specific capital. This specific capital can induce a real productivity increase in the respective firm. In addition, it can increase information about the quality of the match. These findings are somewhat in contradiction to other findings that most training is general. Nevertheless, it may well be the case that training provides both, firm-specific and general human capital. Future work should try to better capture the heterogeneity of training and distinguish between various kinds of training when testing for specificity.

Chapter 5 will shed light on the issue whether training in Germany induces, on average, a productivity increase and/or a wage increase.

5

Comparison of Wage and Productivity Effect: A Sectoral Analysis[1]

Most studies on the productivity impact of training take wages as a proxy for productivity. The focus of this chapter is on comparing wage and productivity effects in order to study how the training rent is shared between employers and employees. Using panel data from 1996-2002, this chapter analyses the impact of continuing training on wages and productivity in a Cobb-Douglas production framework. Using system generalised method of moments (GMM) techniques allows to account for endogeneity and time-invariant unobserved factors. Results suggest that the training rent is shared between employer and employee because a positive effect of continuing training on both wages and productivity is calculated. High-skilled workers seem to capture a larger share of the rent than low-skilled workers.

5.1 Introduction

Investments in continuing training are undertaken in order to raise the level of qualification in a firm and to secure its economic performance. There are also arguments for subsidising continuing training which relate to the society's perceived social and economic benefits from such investments which ought to boost productivity and growth. The main arguments are positive external effects of continuing training which induce welfare gains and technological progress. Whether these investments in training are profitable to the individual, the firm and society as a whole are still of considerable importance. While most studies for Germany take wages as a proxy for productivity and find a positive effect of training on productivity, the impact is ambiguous in the few studies using direct measures of productivity. Also, in recent work on training effects on wages, where panel data and advanced econometric methods

[1] This chapter draws on Kuckulenz (2006b).

are used, the positive effect of training vanishes (for Germany, see Jürges & Schneider, 2005; Kuckulenz & Maier, 2006).

Human capital externalities play a prominent role in recent growth theory (Barro, 2001). In empirical work with individual data, some recent studies try to estimate the externality caused by education (e.g., Ciccone & Peri, 2002; Acemoglu & Angrist, 2000). While investment in continuing training is alleged to give rise to spillover benefits, empirical support for the existence of such positive external effects is scarce and weak, however. Recently, Martins (2005) reports large firm-level social returns from on-the-job training accruing from spillovers that benefit less educated workers. No statistically significant effect of education on earnings is found by Isacsson (2005). In addition, knowledge about how the rent resulting from investment in training is shared between employer and employee is scarce (see, e.g., Booth et al., 2003; Dearden, Reed & van Reenen, 2005).

In this chapter, both wage and productivity effects are estimated and compared with panel data on the industry level in order to analyse who gains from investments in training. To the best of my knowledge, it is shown for the first time with German data that the rent-sharing aspect between employer and employee is important for company-provided training. Results show that employer and employee both profit from the investment in human capital. The estimated productivity effects of training are higher than the wage effect. In addition, the results hint to the existence of positive external effects from training on productivity. Comparing the estimated coefficients with the results of comparable studies using firm data, this study finds evidence for knowledge spillovers between firms in the same sector. Previous work has shown that the training impact on wages differs for low- and high-skilled workers (e.g., Kuckulenz & Zwick, 2003). In order to shed light on this issue and to analyse whether the impacts of participating in training on wages and on productivity differ between low- and high-skilled workers, it is differentiated between these two groups. This extension enables me to analyse whether there are spillovers between the two skill groups.

This chapter proceeds as follows: Section 5.2 discusses the results from previous literature. Section 5.3 explains how the data set is set together, and section 5.4 presents some descriptive statistics. Section 5.5 describes the estimation strategy. Section 5.6 discusses the results for the basic model, and section 5.7 for the extension where I differentiate between low- and high-skilled workers. Section 5.8 summarises and concludes.

5.2 Background Discussion

Wages, profits, and rent-sharing have been a topic for macroeconomists as well as for labour economists (e.g., Blanchflower, Oswald & Sanfey, 1996; MacLeod & Malcomson, 1993). Empirical evidence has shown that when firms become

more prosperous, workers eventually receive some of the gains (Hildreth & Oswald, 1997; Arai, 2003; Estevao & Tevlin, 2003). The central prediction of non-competitive theories is also that rents are divided between firms and employees (e.g., M. Brown, Falk & Fehr, 2004). In a randomised field experiment, Fehr and Götte (2004) show that workers are willing to supply more labour when their wage increases. This is not in line with standard life cycle models but can be explained by preference spillovers across periods and reciprocate behaviour. Only few theoretical and empirical work has focussed on the relationship between training investments and rent-sharing. Booth and Zoega (1999) show that turnover in a company comprises a negative externality. By causing the firms' discount rate to exceed the social discount rate, high turnover, thus, leads to an underinvestment in training. Burdett and Smith (2002) find within a matching model that rent-sharing diminishes the worker's incentive to acquire skills, but the subsequent improved matching prospects may offset the initial disincentive to invest. McLaughlin (1994) and Piekkola and Kauhanen (2003) show that highly educated workers are the main target of rent-sharing. Thus, it is important to take heterogeneity of the workforce into account.

If there is a positive productivity effect of training, there is a rent to share, and either wages should increase, firms value added per worker, or both. How the rent is shared between employer and employee may depend on several aspects. First, the productivity increase from training can be divergent for different training forms and can differ for heterogenous participants. Thus, it can influence how the training rent is shared. Second, the rent-sharing obviously depends on who pays for training. Third, whether an employee profits from training may also be influenced by the respective bargaining power of the worker and the firm. Former evidence suggests that it is likely that workers have less bargaining power (ceteris paribus) if they are less qualified, if they work for a large firm, when they just entered a firm, or when they are on a fixed-term contract. Firms are likely to have less bargaining power (ceteris paribus) when few workers with comparable human capital are available, when workers are not restricted in their mobility, or when demand for workers is much higher than supply in a labour market (Kuckulenz & Zwick, 2003).

Former empirical evidence on productivity effects of training is rather mixed (see, e.g., Blundell, Dearden, Meghir & Sianesi, 1999; Dearden et al., 2000; Zwick, 2005). An important part of this heterogeneity might be due to the varying methodological strategies. Cross-section estimations might be biased because some explanatory variables, like capital and labour, are endogenous (Griliches & Mairesse, 1998; Boon & van der Eijken, 1997). Unobserved time-invariant factors, such as technological change in economic sectors, which can be correlated with both, training and productivity, cannot be accounted for. Unless one controls for these fixed effects, the importance of training for productivity may be overestimated. This study uses panel estimation methods, which eliminate unobserved time invariant heterogeneity. Some studies have pointed to the endogeneity of training: The decision to invest in training

is likely to depend on firm's performance. Empirical studies show that less productive firms tend to invest more in training (see Dearden et al., 2000; Zwick, 2002). It is likely that firms may reallocate idle labour to training activities when they face a downturn in demand in their industry. Therefore, it is crucial to control for endogeneity of continuing training because, otherwise, the true productivity contributions of training will be understated.

Recently, comparisons of wage and productivity effects of training were made in empirical papers (Bartel, 1995; Rennison & Turcotte, 2004; Lopez-Acevedo, 2003; Dearden et al., 2000). In these studies, the effect of training on both wages and productivity is computed, which allows to estimate the shares accrued to the firm and to the worker, respectively. Bartel (1995) uses performance scores as an indicator for productivity and finds a positive impact of training on wage growth as well as on productivity. Using Spanish firm-level data, Alba-Ramirez (1994) finds a positive correlation between training investments and productivity as well as with wages. Dearden et al. (2000) estimate a positive effect of training on productivity with a British panel of aggregated data (on industry level) and find that the impact is underestimated when taking wages as a proxy. In studies with Canadian and Mexican linked employer-employee data, this result is confirmed. Lopez-Acevedo (2003) shows with Mexican linked employer-employee data that both employer and employees benefit from investments in training. Likewise, Rennison and Turcotte (2004) estimate with Canadian data a positive impact of (computer) training on wages and productivity controlling for various firm and worker characteristics. Also in this study, training has a larger impact on productivity than on wages, hinting at the sharing of costs and returns to training as suggested by Becker (1964). Ballot, Fakhfakh, and Taymaz (2002) use panels of French and Swedish firms to explore whether firms or workers benefit from training. They find that although the employees obtain significant benefits, firms obtain the largest part of the training rent. The authors conclude that firms can rationally invest in training, and that, hence, the hold-up problem leading to underinvestment in training by firms may be less severe than suggested by theoretical work (MacLeod & Malcomson, 1993).

Regarding the literature on German data, no study seems to concentrate on the training impact on productivity and wages simultaneously and to explore the issue of rent-sharing. Closest to this analysis is Hempell (2003), where investments in information and communication technologies and firm-sponsored training programmes are analysed. Using panel data from German service companies for the period 1994-1998, the impact of these investments on firm productivity is explored and compared to the impact on wage costs.

Former work does not distinguish between training for low- and high-skilled workers to analyse whether there are differences in the impacts of training on wages and on productivity between skill groups. In the extension, it is therefore explored whether there are differences for low- and high-skilled workers in the productivity effect of training and how the rent resulting from training is shared. Also, it is tested whether there are externalities of training

participation, specifically spillover effects between skill groups. This is done by estimating the impact of training high-skilled workers on average wages of low-skilled workers and by estimating the impact of training low-skilled workers on average wages of high-skilled workers. The idea is that workers share their new knowledge with other workers (e.g., high-skilled workers teach their new knowledge to co-workers). Alternatively, high-skilled workers might organise their work better after training. In that case, also low-skilled workers profit from training participation of their team leaders or a foreman.

5.3 Data Set

Several types of data sets provide the opportunity to analyse wage and productivity effects of continuing training. Case studies are a good alternative if an indicator for workers' individual productivity as well as their wage is available. Bartel (1995) uses data from the personnel record of a company to estimate the impact of training on wage growth and job performance. The drawback of this type of study is that it is not representative data, and therefore, no inference can be made for workers as a whole. During the last years, linked employer-employee data sets became available for more and more countries. Here, the individual data set of workers includes a firm number for the employer. That way, it can be identified which workers are employed by the same firm. Thus, firm-specific effects can be controlled for, and information about the firms' characteristics can be imputed from a firm level data set. Hence, this type of data set is first best to use when estimating productivity effects of continuing training.

Dearden et al. (2000) have shown, however, that it is also possible to use data aggregated on the industry level for analysing wage and productivity effects of continuing training. This approach is also taken here. The advantage of using aggregate data on the sectoral level is that external effects of training between firms in the same sector are included. Comparing the estimated coefficients with results from similar studies that conducted the analysis with firm data allows me to estimate the size of these external effects.

Information from two sources is merged to construct a panel data set. The main source is the German Microcensus, a 1% sample of households in Germany. Information is aggregated on the industry level, and industry data taken from the German National Accounts (NA) is appended. The compound panel data set consists of 58 industrial sectors in the cross-section dimension and of 7 years in the time series dimension, 1996 to 2002. In the Microcensus, the survey questions on continuing training were completely changed from 1995 to 1996. For this reason, earlier years cannot be used. Later years are not available yet. The following variables from the German National Accounts are used:

- gross value added,
- gross fixed capital formation,
- number of occupied persons,
- fixed assets as a proxy for capital.

A number of variables from the German Microcensus are merged to this panel data set on an industry level. The main variable of interest is continuing training. In the years 1996 to 1998, two measures are available: participation in continuing training during the last 4 weeks and during the last year. The latter measure is the preferred one because more employees indicate to participate in training during the last year than during the last 4 weeks, and hence, the expected impact on sector productivity is also higher. Unfortunately, this measure of continuing training is not available for waves 1999 to 2002, so I have to choose the second best measure in order to use a longer time series of data. Hence, the variable of interest is the sectoral share of workers that took part in continuing training during 4 weeks prior to the survey. There are two important advantages of the data set. First, training participation is measured every year, and it is possible to analyse the impact of training not only on current productivity but also on future productivity. Former work has shown that continuing training seems to have a lagged impact on productivity, and lagged training indicators are included in this analysis (see Bartel, 1995; Zwick, 2005). Second, the outcome variable, value added, also includes training costs. In contrast to many other studies, this study can, therefore, make inferences on the impact of training on firm profitability. Other variables are:

- average net hourly wage (no information about gross wages) of all workers and separately for low- and high-skilled,
- average working time per sector,
- share of part-time contracts and share of temporary contracts,
- qualification (the proportion of high-skilled is included, which are those who have a university/university of applied sciences degree),
- enterprise size (the proportion of large firms with more than 1,000 employees is included),
- job tenure (7 variables indicating the share of employees per sector with a certain tenure are used),
- and, as a proxy for fluctuation in a sector, the proportion of workers per sector who changed the employer during the last year (i.e. sectoral share of workers that change the job per year). In chapter 4, it was discussed that (expected) worker mobility determines the decision of firms to provide training and that firms lose human capital if workers switch jobs.

Additionally, the proportion of women and an indicator for East Germany to take into account differences in productivity and wages between east and west Germany are included (see Falk & Pfeiffer, 1998). The number of observations is 406 (58 sectors in 7 years). For means and standard deviations of all variables used in estimations, see Table D.1 in the appendix.

5.4 Descriptive Statistics

Participation in training varies between economic sectors, over time, and by personal characteristics. Fig. 5.1 shows participation in training per year. In the years 1996 to 2002, around 3% of the employees took part in training during 4 weeks prior to the survey. Training participation decreased in the late 1990s and slightly increased again in 2001 and 2002. The share of workers that indicate to take part in on-the-job training (4 weeks prior to the survey) is 5% in the British Labour Force Survey, which is significantly higher than in the German Microcensus (Dearden et al., 2000).

There is a considerably dispersion of training incidence across sectors. The share of training participants 4 weeks prior to the survey varies from 0 for some sectors in some years (fishery, leather trade, nutrition trade, recycling, and hotel and restaurant industry) to more than 8% (data handling and databases, education and teaching, banking sector, and insurance industry). A list of all sectors and the incidence of training, i.e. mean participation in training by sector, is given in the appendix (Table D.2). Personal characteristics play a major role in determining training participation. Distinguishing between low- (without tertiary education) and high-skilled (with tertiary education) employees, it can be noted that the probability to take part in training is, on average, about 2.5 times higher for high- than for low-skilled workers. Training participation also varies widely by age. Young employees participate much more than older employees: Around 5% of employees below 30 and less than 1% of employees above 55 take part in training.

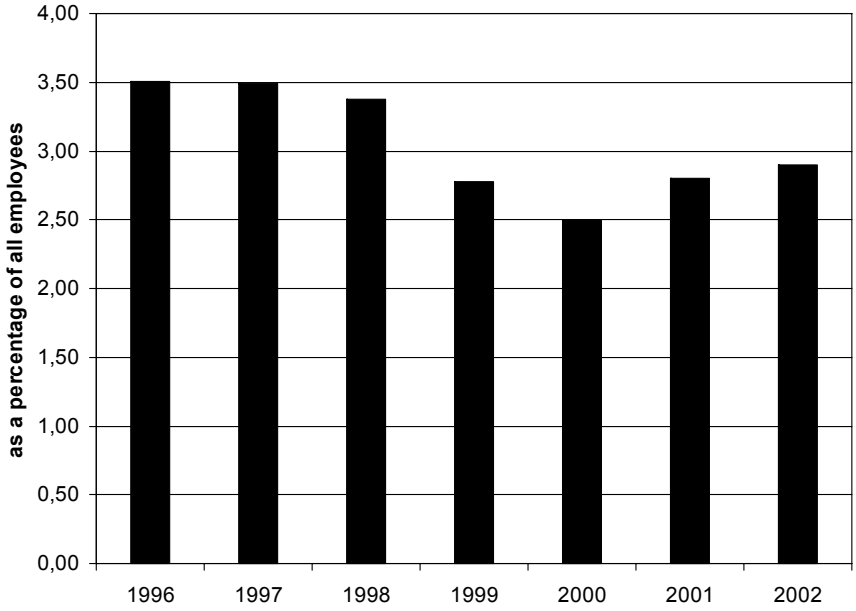
Using the median of training participation per sector, I divide the economic sectors into two groups: those with a high and those with a low incidence of training. The mean characteristics of these two groups of sectors are given in Table 5.1. Evidently, they also differ in other characteristics than the incidence of training. Economic sectors with a high incidence of training employ a higher share of high-skilled and more women. In addition, firms in these sectors are larger and more profitable (have a higher value added) than average, and employees have a higher average tenure and are paid a higher wage. Specifically, I am interested in the correlation between wages and productivity with training. Fig. 5.2 and 5.3 show the bivariate relationship of training and productivity as well as of training and wages. A clear picture appears for the relation between training and wages; the correlation is strongly positive. The relationship between training and productivity is less clear, but the fitted line is pointing upward, showing a weaker positive relationship. In the following, the nature of these relationships are explored in more detail.

5.5 Basic Model

In the basic model, I follow Dearden et al. (2000 and 2005) and estimate the impact of the sectoral average training participation on average wage and pro-

Fig. 5.1. Trend in participation rates in continuing training (1996-2002)

Share of employees who participated in training during 4 weeks prior to the survey. For detailed information on the data compare section 2.4.2.



Source: Estimation by the author on the basis of the German Microcensus.

ductivity. In the extension, in contrast, it is distinguished between low- and high-skilled workers, and average values for each skill group are used.

5.5.1 Estimation Strategy

In order to quantify the impact of continuing training on wages and productivity, a simple Cobb-Douglas production function following Bartel (1995), Black and Lynch (2001), and Dearden et al. (2000) is used:

$$Q = AL^{\alpha}K^{\beta}, \tag{5.1}$$

where Q is value added, A is a Hicks neutral efficiency parameter, L is effective labour, and K is capital. Assuming that effective labour improves with training, effective labour can be written as:

$$L = N^{U} + \gamma N^{T}, \tag{5.2}$$

Table 5.1. Sector means for low and high training intensive sectors

Variables	**LOW**	**HIGH**
Hourly wage	16.36	20.00
Number employed	9331.96	10435.42
Value added	23.21	43.54
Investments	4.09	11.21
Capital	32.45	35.39
Training	0.02	0.04
Working hours	38.27	36.51
Part-time	0.17	0.20
Job change	0.11	0.09
Large firms	0.18	0.26
High-skilled	0.12	0.33
Women	0.37	0.49
Temporary contract	0.05	0.08
Tenure 0-4	0.39	0.33
Tenure 5-9	0.22	0.21
Tenure 10-14	0.12	0.14
Tenure 15-19	0.07	0.09
Tenure 20-29	0.11	0.14
Tenure 30-39	0.05	0.05
Tenure >40	0.01	0.01
Age 17-20	0.02	0.01
Age 21-25	0.07	0.07
Age 26-30	0.12	0.12
Age 31-35	0.16	0.15
Age 36-40	0.15	0.16
Age 41-50	0.26	0.28
Age 51-65	0.22	0.22

Remark: Sectors are divided in two groups of equal size using the median of training frequency per sector. This table shows the mean characteristics of these two groups.

where N^U are untrained and N^T are trained workers, and hence, the total number of workers N is $N = N^U + N^T$. Trained workers are expected to be more productive than untrained workers, and hence, $\gamma > 1$. Substituting eq. (5.2) into (5.1) gives:

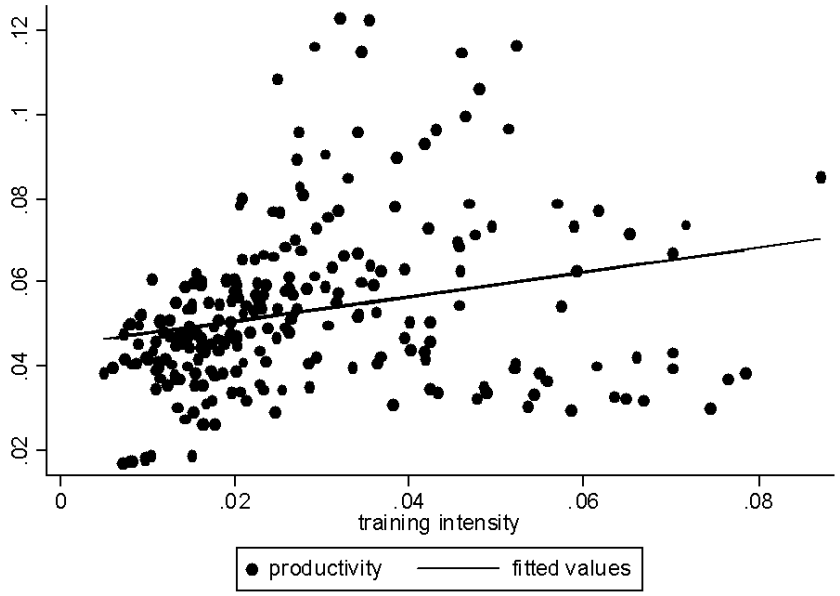
$$Q = A(N^U + \gamma N^T)^\alpha K^\beta,$$

which can be rewritten as

$$Q = A(1 + (\gamma - 1)Train)^\alpha N^\alpha K^\beta, \tag{5.3}$$

where $Train = \frac{N^T}{N}$. If $(\gamma - 1)Train$ is small, the approximation $\ln(1+x) = x$ can be used, and the production function can be rewritten in logarithmic form as:

Fig. 5.2. Training and productivity



Remark: Scatterplot of value added per worker and the frequency of training per sector.

$$logQ = \log A + \alpha(\gamma - 1)Train + \alpha \log N + \beta \log K. \tag{5.4}$$

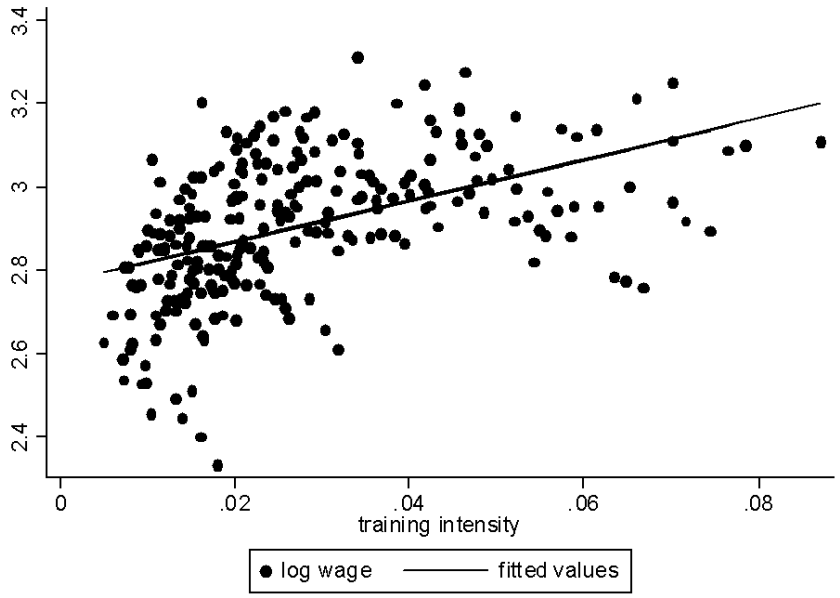
If the industry exhibits constant returns to scale, i.e. $\alpha + \beta = 1$, then (5.4) can be written in terms of labour productivity:

$$log\frac{Q}{N} = \log A + (1 - \beta)(\gamma - 1)Train + \beta \log \frac{K}{N}. \tag{5.5}$$

In case trained workers are no more productive than untrained, i.e. $\gamma = 1$, the coefficient of $Train$ will be 0. A large number of other variables that are assumed to have systematic influences on productivity are captured in A. Notably, proxies for human capital (education, age, tenure), working hours, turnover rate, gender, regional composition, proportion of large firms, and temporary contracts are included. Additionally, year dummies are included in the estimations to control for year fixed effects.

Instrumental variables that are correlated with training but uncorrelated with productivity or GMM techniques are two commonly used approaches in order to take endogeneity into account. Since valid external instruments

Fig. 5.3. Training and hourly wage



Remark: Scatterplot of average log wage and the frequency of training per sector.

are difficult to find, recent GMM techniques that exploit information in the levels and in difference equations are chosen here (for an intuitive guide to panel data models, refer to Bond, 2002; for an application of GMM estimation to production functions, see Blundell & Bond, 2000). The estimation strategy controls for observed time-invariant sector heterogeneity by using system GMM panel regressions. It simultaneously controls for endogeneity of continuing training by using internal instrumental variables. The system GMM estimator proposed by Arellano and Bover (1995) avoids the poor finite sample properties of the simple within estimator or the simple GMM estimator. The former takes first differences to eliminate unobserved firm-specific effects and the latter uses lagged internal instruments to correct for simultaneity in the first-difference equations. It is problematic to use lagged levels as instruments because they are usually only weakly correlated with the subsequent first differences of these variables and, therefore, have weak explanatory power (Blundell & Bond, 2000). To overcome this problem, the system GMM estimator uses the lagged first differences as instruments for the equations in first differences, assuming that the internal instruments are correlated with cur-

rent values but independent of the error term. As with any valid instrumental variables strategy, this estimator corrects for any bias arising from measurement error in the dependent variable and the regressors. The Hansen test for overidentification of the model and serial correlation tests are reported since the GMM estimator depends on the absence of second order serial correlation in the error term (Dearden et al. 2000). A negative first order correlation, in contrast, is consistent with the assumptions of the model. Summarising, the system GMM estimator avoids inconsistencies incurred by unobserved heterogeneity and simultaneity of the choice of training, capital, labour, wages, and output (Blundell & Bond, 2000; Black & Lynch, 2001; Hempell, 2003; Zwick, 2006; Gürtzgen, 2005). Hence, the resulting basic empirical model for the logarithm of value added (productivity) per worker y_{it} of sector i in period t is:

$$y_{it} = \beta_1 Train_{it} + \beta_3 k + \beta_2 x + \eta_i + \epsilon_{it},$$

where k represents the logarithm of capital per worker, x is a vector of explanatory variables, η_i denotes time-invariant unobserved sector-specific effects impacting productivity, and the error term ϵ_{it} is assumed to be asymptotically normally distributed. To account for aggregation bias, data is weighted by the number of employed in each economic sector.[2] Similarly, wage regressions are estimated, where average wage w_{it} in sector i in period t is explained by exactly the same inputs that enter the production function:

$$w_{it} = \beta_1 Train_{it} + \beta_3 k + \beta_2 x + \eta_i + \epsilon_{it}.$$

With this specification, it is possible to assess and compare the wage and productivity impact of continuing training to have a first idea how the training rent is shared between employers and employees.

5.5.2 Empirical Results

First, the data is pooled to estimate productivity and hourly wage regressions with simple static pooled Ordinary Least Squares (POLS) to have a benchmark result. Results are shown in Table 5.2. The training coefficient is significantly positive in the hourly wage regression (second column) and positive but insignificant in the productivity regression (first column). The higher R^2 in the second column suggests that the variation in average hourly wages per sector is better explained by the covariates than the variation in sectoral

[2] It is expected that the fixed effects will control for much of the problem of aggregation biases in industry level data. Also, logs of means, and not the means of logs, are taken when aggregating. As long as the higher order moments of the distributions are constant over time in an economic sector, they will be captured by a fixed effect. If they evolve at the same rate across industries, they will be picked up by time dummies (see also Dearden et al., 2000).

productivity. A high share of high-skilled and investments are positively related with productivity and with hourly wages. The share of women and of firms per sector located in East Germany are negatively related with hourly wages but not with productivity. There is no significant relation between age and productivity, but the share of young workers is negatively related with hourly wages. This hints at the existence of seniority wages (Lazear, 2000). Average tenure in a sector and the indicator for fluctuation are (weakly) negatively related with wages and not significantly related with productivity. The share of employees with temporary contracts is higher in sectors that are less productive and pay lower hourly wages. Labour and capital are positively related with productivity (although capital is not significant in the estimation) and are insignificant in the wage regressions. Firm size and hourly wages are significantly positively correlated. The productivity regression shows no significant relation between the share of large firms and the outcome variable.

In addition, four different models are estimated for the productivity regression as well as for the hourly wage regression with system GMM.[3] In the various models the number of regressors and the exogeneity assumptions are varied. All models include lagged terms not only for capital and labour but also for training. The reason is that current training might be inappropriate because workers might be less productive when spending time in training.[4] The first model is the most restrictive one, assuming endogeneity of capital and labour as well as exogeneity of all other variables. The second model assumes endogeneity of capital, labour, and training. The third and fourth model are the least restrictive models, allowing for endogeneity of all regressors except for the regional indicator and the time dummies. In the second and the fourth model, dummies indicating the share of age groups per sector are added as additional regressors. The specific assumptions of the empirical models are described in the tables together with the results. The system GMM results of the productivity regression are reported in Table 5.2 and those of the hourly wage regression are reported in Table 5.3. Included in the tables are also the Arellano-Bond tests for autocorrelation. AR(1) is expected in first differences, but higher-order autocorrelation indicates that some lags of the dependent variable, which might be used as instruments, are in fact endogenous, thus, bad instruments. Also a test of over-identifying restrictions is reported, i.e. whether the instruments as a group appear exogenous. For all models, test statistics show that the models are well specified. It is also tested with Hansen difference statistics whether additional moment conditions are fulfilled. Testing the specification with endogenous capital, labour, and training against the more restrictive specification where training is exogenous, a

[3] Alternatively, also the first difference GMM estimator is used for the calculations, but I obtained much more reasonable results using the system GMM estimator. Specifically, the additional instruments used in the system GMM estimator are both valid and informative in this context.

[4] To test for robustness, also higher lags of capital, labour, and training were included, but none of them was significant in the estimations.

Table 5.2. POLS

Variables	**Productivity regression**		**Hourly wage regression**	
	Coeff.	**t-values**	**Coeff.**	**t-values**
Training	2.83	(1.42)	0.79	(1.90)*
ln capital	0.02	(0.23)	-0.02	(-1.28)
ln investments	0.44	(6.22)***	0.04	(3.17)***
Large firms	0.56	(0.87)	0.22	(1.96)*
Temporary contract	-4.72	(-3.93)***	-0,94	(-4.02)***
ln labour	0.07	(2.12)**	0.00	(-0.60)
Job change	-1.00	(-0.64)	-0.61	(-2.08)**
High-skilled	0.99	(1.89)*	0.77	(7.94)***
Women	-0.07	(-0.19)	-0.34	(-6.77)***
Tenure 0-4		reference		reference
Tenure 5-9	1.29	(1.22)	0.01	(0.03)
Tenure 10-14	0.30	(0.20)	-0.35	(-1.30)
Tenure 15-19	1.43	(1.18)	0.30	(1.17)
Tenure 20-29	-1.76	(-0.84)	0.12	(0.54)
Tenure 30-39	-1.37	(-0.55)	-0.62	(-1.98)*
Tenure 40-51	-9.71	(-1.61)	-2.39	(-2.77)***
Age 17-20		reference		reference
Age 21-25	6.23	(0.84)	1.92	(1.83)*
Age 26-30	1.12	(0.18)	0.71	(0.70)
Age 31-35	2.79	(0.49)	1.31	(1.27)
Age 36-40	0.90	(0.14)	1.25	(1.19)
Age 41-50	-0.12	(-0.02)	1.23	(1.21)
Age 51-65	4.92	(0.74)	1.72	(1.72)*
Intercept	-2.76	(-0.48)	1.95	(2.05)**
Observations		361		364
Sectors		52		52
R^2		0.83		0.90

Significance levels : $*$: 10% $**$: 5% $***$: 1%.

low p-value indicates that the training variable is endogenous. In contrast, testing the other additional regressors for exogoneity, the Hansen difference statistics suggest that additional moment conditions are fulfilled. Hence, the second model is the preferred specification, but nevertheless, the results of all four specifications are reported here.

Table 5.3. Productivity regressions: System GMM results

Model	**1**		**2**		**3**		**4**	
	Coeff.	**z-values**	**Coeff.**	**z-values**	**Coeff.**	**z-values**	**Coeff.**	**z-values**
Training	3.14	(1.89)*	4.93	(1.71)*	5.87	(2.44)**	0.96	(0.35)
Training t-1	5.05	(2.45)**	5.11	(2.27)**	4.98	(2.55)**	2.30	(1.07)
ln capital	-0.70	(-0.80)	0.19	(1.11)	-0.71	(-1.04)	0,11	(0.14)
ln capital t-1	0.97	(1.20)			0.79	(1.15)	-0.09	(-0.12)
ln investments	0.21	(2.20)**	0.28	(3.86)***	0.11	(0.88)	0.23	(1.94)*
ln inv. t-1	0.15	(0.90)	0.08	(0.57)	0.37	(2.61)***	0.19	(1.51)
ln labour	0.03	(0.38)	0.05	(1.04)	0.06	(1.38)	-0.84	(-0.96)
ln labour t-1							0.92	(1.03)
Job change			-3.08	(-1.84)*	-2.99	(-1.14)	-1.96	(-1.04)
Large firms	-0.29	(-0.45)					0.43	(0.71)
High-skilled	0.45	(0.70)	-0.18	(-0.28)	-0.34	(-0.80)	0.76	(1.48)
Women	0.16	(0.44)	-0.12	(-0.33)	0.22	(0.68)	-0.06	(-0.20)
Tenure 0-4	reference		reference		reference		reference	
Tenure 5-9	2.82	(2.01)**	0.35	(0.37)	1.38	(1.08)	1.12	(1.01)
Tenure 10-14	1.26	(0.93)	0.40	(0.32)	-0.32	(-0.15)	0.24	(0.16)
Tenure 15-19	2.48	(1.93)*	1.07	(1.11)	2.38	(1.65)*	1.73	(1.23)
Tenure 20-29	-3.39	(-1.36)	-2.93	(-1.60)	-4.67	(-1.52)	-2.14	(-1.11)
Tenure 30-39	1.16	(0.44)	-3.26	(-1.51)	0.84	(0.27)	-0.76	(-0.29)
Tenure 40-51	4.54	(0.81)	-10.48	(-1.93)*	6.23	(1.06)	-10.25	(-1.78)*
Age 17-20			reference				reference	
Age 21-25			12.72	(2.95)***			9.35	(1.29)
Age 26-30			8.66	(2.27)**			4.08	(0.61)

to be continued...

...Table 5.3 continued

Model	**1**		**2**		**3**		**4**	
	Coeff.	**z-values**	**Coeff.**	**z-values**	**Coeff.**	**z-values**	**Coeff.**	**z-values**
Age 31-35			11.39	(3.00)***			7.18	(1.30)
Age 36-40			7.71	(2.21)**			3.68	(0.61)
Age 41-50			8.21	(2.48)**			3.31	(0.59)
Age 51-65			12.41	(3.01)***			8.30	(1.28)
Temporary contract							-4.50	(-3.67)***
Intercept	-1.22	(-1.31)	-9.62	(-2.69)***	-0.02	(-0.02)	-5.99	(-1.05)
Instruments	$\ln(\text{hours/N})_{t-2,t-3}$ and $\ln(\text{K/N})_{t-2,t-3}$ in difference equations; $\Delta\ln(\text{hours/N})_{t-1}$ and $\Delta\ln(\text{K/N})_{t-1}$ in levels equations		as (1); additional $\text{training}_{t-2,t-3}$ in difference equations; $\Delta\text{training}_{t-1}$ in levels equations		all variables treated as endogenous (except time and regional dummies)		all variables treated as endogenous (except time and regional dummies)	
Hansen	0.73		1.00		1.00		1.00	
AR(1) (p-value)	0.02		0.00		0.01		0.03	
AR(2) (p-value)	0.45		0.47		0.50		0.86	
Sectors	52		52		52		52	
Observations	309		309		309		309	

Note: The dependent variable is the average log hourly wage per worker. All variables are first differenced. Results are reported for one-step system GMM estimators. The robust estimator of the covariance matrix of the parameter estimates were calculated; the resulting standard error estimates are consistent in the presence of any pattern of heteroscedasticity. All specifications include a constant, time dummies, and an east-west dummy. Estimation by "xtabond2" command in STATA/SE 8.2.
Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table 5.4. Hourly wage regressions: System GMM results

Model	**1**		**2**		**3**		**4**	
	Coeff.	**z-values**	**Coeff.**	**z-values**	**Coeff.**	**z-values**	**Coeff.**	**z-values**
Training	0.98	(2.10)**	1.47	(2.15)**	1.56	(2.52)**	1.16	(2.04)**
Training t-1	0.54	(1.36)	0.03	(0.08)	0.68	(1.40)	-0.01	(-0.03)
ln capital	0.10	(0.47)	-0.03	(-1.37)	-0.19	(-2.29)**	0.04	(0.27)
ln capital t-1	-0.11	(-0.50)			0.17	(2.00)**	-0.05	(-0.39)
ln investments	0.04	(1.58)	0.05	(2.22)**	0.04	(1.25)	0.06	(2.63)***
ln investments t-1	0.01	(0.30)	0.00	(0.00)	0.01	(0.33)	-0.02	(-1.08)
ln labour	0.00	(-0.34)	0.00	(0.06)	0.00	(-0.19)	-0.22	(-1.25)
ln labour t-1							0.22	(1.21)
Job change			-0.80	(-2.28)**	-0.84	(-1.89)*	-0.70	(-2.22)**
Large firms	0.10	(0.69)					0.17	(1.55)
High-skilled	0.61	(5.74)***	0.55	(5.16)***	0.52	(5.14)***	0.69	(7.90)***
Women	-0.30	(-5.70)***	-0.35	(-6.54)***	-0.35	(-5.45)***	-0.34	(-7.16)***
Tenure 0-4	reference		reference		reference		reference	
Tenure 5-9	0.30	(1.34)	-0.08	(-0.38)	-0.06	(-0.23)	-0.06	(-0.25)
Tenure 10-14	-0.05	(-0.19)	-0.36	(-1.56)	-0.38	(-1.22)	-0.39	(-1.48)
Tenure 15-19	0.70	(2.32)**	0.41	(1.44)	0.50	(1.39)	0.21	(0.73)
Tenure 20-29	0.31	(1.72)*	0.19	(0.90)	-0.02	(-0.06)	0.20	(0.88)
Tenure 30-39	-0.40	(-1.06)	-0.64	(-1.88)*	-0.42	(-0.94)	-0.67	(-1.90)*
Tenure 40-51	0.94	(1.02)	-0.37	(-0.45)	1.09	(1.28)	-2.25	(-2.51)**
Age 17-20			reference				reference	
Age 21-25			2.00	(2.33)**			3.35	(3.12)***
Age 26-30			0.93	(1.10)			1.93	(1.83)*

to be continued...

...Table 5.4 continued

Model	**1**		**2**		**3**		**4**	
	Coeff.	**z-values**	**Coeff.**	**z-values**	**Coeff.**	**z-values**	**Coeff.**	**z-values**
Age 31-35			1.92	(2.15)**			2.68	(2.57)**
Age 36-40			1.16	(1.40)			2.28	(2.11)**
Age 41-50			1.49	(1.88)*			2.51	(2.49)**
Age 51-65			1.72	(1.97)**			2.96	(2.85)***
Temporary contract							-0.84	(-3.85)***
Instruments	$\ln(\text{hours/N})_{t-2,t-3}$ and $\ln(\text{K/N})_{t-2,t-3}$ in difference equations; $\Delta\ln(\text{hours/N})_{t-1}$ and $\Delta\ln(\text{K/N})_{t-1}$ in levels equations		as (1); additional $\text{training}_{t-2,t-3}$ in difference equations; $\Delta\text{training}_{t-1}$ in levels equations		all variables treated as endogenous (except time and regional dummies)		all variables treated as endogenous (except time and regional dummies)	
Hansen	0.50		0.98		1.00		1.00	
AR(1) (p-value)	0.01		0.01		0.01		0.00	
AR(2) (p-value)	0.19		0.08		0.59		0.31	
Sectors	52		52		52		52	
Observations	312		312		312		312	

Note: The dependent variable is the average log hourly wage per worker. All variables are first differenced. Results are reported for one-step system GMM estimators. The robust estimator of the covariance matrix of the parameter estimates were calculated; the resulting standard error estimates are consistent in the presence of any pattern of heteroscedasticity. All specifications include a constant, time dummies, and an east-west dummy. Estimation by "xtabond2" command in STATA/SE 8.2.
Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table 5.3 contains the results of the productivity regressions. Like in the pooled OLS regression, the estimated training coefficient is positive. In the system GMM regressions, the coefficient of training is, however, significant. Both contemporaneous training and lagged training have a positive and significant impact on productivity. That is, those sectors with high participation in continuing training achieve a higher value added per worker in the year where training took place and also in the next year. Only in the last model, the impact of training on productivity is insignificant. The model is probably overloaded with regressors and instruments. Thus, hardly any significant coefficients remain. Capital and labour are positive but not significant in the regressions. Investments per worker have a positive and significant impact on sectoral productivity and fluctuation proxied by job changes within a sector; the share of temporary contracts have a negative influence on sector productivity.[5] Evidence for average tenure in a sector is mixed. Contrasting the results from pooled OLS regressions, the age dummies are positive and significant in the system GMM regressions. Therefore, a higher share of older workers per sector seems to have a positive impact of productivity.

Results from the hourly wage regressions are given in Table 5.4. Like in the pooled OLS regression, the estimated training coefficient is positive and significant. While in the productivity regression, both contemporaneous and lagged training have a significant impact on productivity; in the hourly wage regressions, only contemporaneous training is significant. Investments (lagged and contemporaneous) have a positive influence on wages similar to the impact of investments on productivity. The impact of capital on wages seems to be insignificant. Only in Model 3, there is a negative impact of contemporaneous capital intensity on wages and a positive impact of lagged capital intensity on wages. Fluctuation in a sector as well as the share of contemporary contracts have a negative influence on hourly wages (which is, again, similar to the results in the productivity regression). The share of high-skilled workers and the share of women do not have any impact on sectoral productivity. In the wage regressions, these indicators are highly significant in all models. A large share of high-skilled workers is related to high hourly wages, and a high share of women in a sector is related to low average wages in a sector. Again, the evidence for tenure is rather mixed. As in the productivity regression, the age variables are positive and significant, i.e. seniority wages are prevalent: A high share of older workers is related to high average wages in a sector.

As noted by Dearden et al. (2000), grouping of data on the industry level has the advantage that spillovers of continuing training are included in the productivity effect. For example, if workers with higher human capital are more likely to generate new ideas and innovations, which may spill to other employees, even in other firms (within the industry), micro-level estimation underestimates the true impact of continuing training because externalities

[5] Sectoral fluctuation includes job changes within the sector and entrees as well as from other sectors.

to human capital acquisition are not taken into account. In a non-technical review of the empirical evidence on the returns to education for the individual, the firm, and the economy at large, Blundell, Dearden, Meghir, and Sianesi (1999) note that there exists hardly any empirical evidence on the returns to training including externalities.

Similar studies with German data using firm level survey data also find positive effects of training on productivity. Zwick (2004b and 2006) estimates a positive training coefficients close to 1 with similar econometric methods. Here, the estimated coefficients are higher, and therefore, suggest that knowledge spillovers exist between firms in the same sector. Of course, not the entire difference in coefficients has to reflect positive externalities. Differences in the data set used can also explain differences in estimation results, as is shown in chapter 2.

5.6 Differentiation Between Low- and High-Skilled

In an extension of the basic model based on Dearden et al. (2000 and 2005), I allow for worker heterogeneity in the basic production function. This enables me to separately estimate the impact of training on productivity for low- and high-skilled workers. Additionally, I separately estimate the impact of training on own average wages for both skill groups and on the average wage of the other group. This may hint to the existence of externalities between workers or, more specifically, between different skill groups. If, for example, training high-skilled employees exhibits a positive external effect because they transmit the new knowledge to the low-skilled employees, there could be a positive impact of training high-skilled workers on wages of low-skilled workers.

5.6.1 Extension of the Model

The same simple Cobb-Douglas production function used above is also used in the extended model, which differentiates between low- and high-skilled workers:

$$Q = AL_L^{\alpha} L_H^{\beta} K^{\gamma}. \tag{5.6}$$

Here, L_L is effective low-skilled labour, and L_H is effective high-skilled labour. Assuming that effective labour is improved by training, it can be written as

$$L_L = N_L^U + \delta N_L^T \tag{5.7}$$

and

$$L_H = N_H^U + \epsilon N_H^T, \tag{5.8}$$

where N_L^U are untrained low-skilled workers, and N_L^T are trained low-skilled workers, N_H^U are untrained high-skilled workers, N_H^T are trained high-skilled

workers. The total number of workers N is $N = N_L + N_H$ comprising low-skilled workers N_L, $N_L = N_L^U + N_L^T$, and high-skilled workers N_H, $N_H = N_H^U + N_H^T$. I expect that trained workers are more productive than untrained workers, and hence, $\delta > 1$ and $\epsilon > 1$. Substituting equations (5.7) and (5.8) into (5.6) gives

$$Q = A(N_L^U + \delta N_L^T)^\alpha (N_H^U + \epsilon N_H^T)^\beta K^\gamma. \tag{5.9}$$

I can rewrite eq. (5.9) as

$$\begin{aligned} Q &= A(N_L - N_L^T + \delta N_L^T)^\alpha (N_H - N_H^T + \epsilon N_H^T)^\beta K^\gamma \\ &= A(N_L + (\delta - 1)N_L^T)^\alpha (N_H + (\epsilon - 1)N_H^T)^\beta K^\gamma \\ &= A(N_L + (\delta - 1)Train_L N_L)^\alpha (N_H + (\epsilon - 1)Train_H N_H)^\beta K^\gamma, \end{aligned}$$

where $Train_H = \frac{N_H^T}{N_H}$ is the proportion of high-skilled trained workers in all high-skilled workers, and $Train_L = \frac{N_L^T}{N_L}$ is the proportion of low-skilled trained workers in all low-skilled workers. Rewriting yields

$$Q = A(1 + (\delta - 1)Train_L)^\alpha (1 + (\epsilon - 1)Train_H)^\beta K^\gamma N_L^\alpha N_H^\beta. \tag{5.10}$$

If $(\delta - 1)Train_L$ and $(\epsilon - 1)Train_H$ are small, the approximation $\ln(1+x) = x$ can be used, and the production function can be rewritten in logarithmic form as

$$\begin{aligned} logQ &= \log A + \alpha \log(1 + (\delta - 1)Train_L) + \beta \log(1 + (\epsilon - 1)Train_H) \\ &\quad + \gamma \log K + \alpha \log N_L + \beta \log N_H \\ &= \log A + \alpha(\delta - 1)Train_L + \beta(\epsilon - 1)Train_H + \gamma \log K + \alpha \log N_L \\ &\quad + \beta \log N_H. \end{aligned}$$

Rewritten in terms of capita (subtract $\log N$ from both sides) gives

$$\begin{aligned} log\frac{Q}{N} &= \log A + \alpha(\delta - 1)Train_L + \beta(\epsilon - 1)Train_H \\ &\quad + \gamma \log K + \alpha \log N_L + \beta \log N_H - \log N. \end{aligned} \tag{5.11}$$

For the case of constant returns to scale ($\alpha + \beta + \gamma = 1$),

$$\begin{aligned} log\frac{Q}{N} &= \log A + \alpha(\delta - 1)Train_L + \beta(\epsilon - 1)Train_H \\ &\quad + \gamma \log K + \alpha \log N_L + \beta \log N_H - (\alpha + \beta + \gamma) \log N \end{aligned} \tag{5.12}$$

and

$$\begin{aligned} log\frac{Q}{N} &= \log A + \alpha(\delta - 1)Train_L + \beta(\epsilon - 1)Train_H \\ &\quad + \gamma \log \frac{K}{N} + \alpha \log \frac{N_L}{N} + \beta \log \frac{N_H}{N}. \end{aligned} \tag{5.13}$$

If trained workers are as productive as untrained workers, i.e. $\delta = 1$ and $\epsilon = 1$, then the coefficients of $Train_H$ and $Train_L$ will be 0.

5.6.2 Empirical Results

To compare productivity effects with wage effects of training low- and high-skilled workers, I, once again, estimate wage regressions using the same specification as in the productivity equation. I separately use the average wage of low- and high-skilled workers to estimate the effect of training for low- and for high-skilled workers on their own wage and on wages of the other skill group. That way, I am able to test for differences in rent-sharing between firms and high-skilled employees as well as firms and low-skilled employees. As derived from the theoretical considerations, I suspect that high-skilled employees are able to capture a higher share of the training rent than low-skilled employees. Besides, I can find evidence whether differences in the wage mark-up between low- and high-skilled workers are due to differences in the productivity impact. Alternatively, high- and low-skilled workers might take part in different types of training, leading to different productivity impacts. In addition, the bargaining power is important. Even if the productivity impact of training is similar for both skill groups, differences in the impact on wages can arise if one skill group has more bargaining power in capturing (part of) the training rent.

Additionally, I test whether there are externalities of continuing training between skill groups. For example, when high-skilled workers receive training, this may not only raise their own productivity but also the productivity of low-skilled and hence, increase wages for both groups. In that case, training of high-skilled workers contains a positive externality due to positive spillovers from training on the productivity of the low-skilled.

In the first column of Table 5.5, estimates of the influence of low- and high-skilled training participation on average wages of the low-skilled is presented. The estimated coefficients are insignificant. In contrast, lagged training participation of the high-skilled workers increases their average wage; training of the low-skilled does not impact the average wage of high-skilled workers (second column of Table 5.5). In the third column, the impact of low- and high-skilled workers' training participation on value added per worker is shown. The results suggest that only training of low-skilled workers has an impact on productivity while training of high-skilled workers has no significant influence. There are two possible explanations for the zero effect of training high-skilled workers on productivity. First, the group of high-skilled workers, as it is defined here, is very small (they only comprise 20% of the employees). Hence, their individual productivity may raise after training but may not have an significant effect on sector productivity. A second possible reason is that high-skilled workers often take part in relatively expensive (external) training courses, and firms pay for it. These expenses reduce the value added.

Summing up, it seems that training low-skilled workers increases productivity and that firms capture the gain from training, since value added is increased by training, but low-skilled workers do not receive a wage mark-up after training. For high-skilled workers, results suggest the contrary. There

seems to be a rent to share after training. In the case of high-skilled employees participating in training, not the firms gain from the productivity increase, but the high-skilled workers are the ones to receive a wage mark-up.

5.7 Conclusion

The analyses in this chapter provide evidence for the existence of rent-sharing between firms and workers. On average, both employers and employees profit from the investment in human capital since sectoral training intensity increases both sectoral value added per worker as well as sectoral average hourly wages. The productivity effect of training is about three times higher than the wage effect. In addition, training has a lagged impact on productivity but not on wage levels.

The basic model is extended to differentiate between low- and high-skilled workers. The results from the analysis with two types of workers are in line with the results in chapter 3. High-skilled workers receive a wage mark-up from participating in training while low-skilled workers, on average, experience no wage effect of training. There seems to be a positive impact of training low-skilled workers on productivity but no impact of training high-skilled workers. This might be explained by the either high-training costs (which decrease value added) or, more likely, by the small number of high-skilled workers. With the data on sector level, I cannot measure the productivity increase of only one skill group but only of the whole sector.

The analysis on a sectoral level allows the estimation of external effects between workers and firms. In particular, I estimate the impact of training one skill group on wages of the other group. The idea is that high-skilled workers might transmit knowledge acquired in training to low-skilled workers or they may organise work procedures more efficiently or improve production processes after training which also affects low-skilled workers. In the empirical analysis with aggregated data, I find no evidence for external effects of training between the skill groups.

Since the estimation of the impact of training on productivity is on a sectoral level, it includes spillover effects between firms in the same sector. Such spillover effects are existent if firms learn with each other, if they copy from each other, or if job changes between firms in the same sector induce human capital to be transmitted. The impact of training on productivity estimated here is much higher than calculated effects of training on productivity with firm level data. Zwick (2004b and 2006), for example, finds an impact of training on firm productivity that is only one third of the impact on sector productivity estimated in this study. Even though both data sets used are representative for Germany, the difference in the coefficient can be (partly) explained by the difference in the data sets used. Nevertheless, the results

suggests that external effects of continuing training exist in Germany. This is in line with the findings of Dearden et al. (2000).

The training measure used here is crude, including all types of training. I cannot distinguish whether the training measures for high-skilled are different from training for low-skilled. Given previous evidence (see section 2.4 and chapter 3), it is likely that the type of training differs between the skill groups. This could also explain why the impact of training varies between skill groups as suggested in the extension. While low-skilled workers often participate in internal and firm-specific training, high-skilled workers often take part in external training that is more general and where the new knowledge would be useful in other firms as well (see section 3.4). This is in line with the results of this chapter: High-skilled workers increase their general human capital in training and receive a wage mark-up afterwards. In contrast, low-skilled workers increase their firm-specific human capital in continuing training and do not obtain a higher wage after training participation.

This analysis is restricted to the training impact on wages and productivity. Other important aspects are not taken into account. It may well be that also low-skilled workers profit from training participation even if they do not receive a wage mark-up. Positive effects from training on job security and on satisfaction with the job are very likely.

Table 5.5. System GMM with two skill groups: Wage and productivity regressions

	Hourly wage low-skilled		**Hourly wage high-skilled**		**Productivity**	
	GMM		**GMM**		**GMM**	
	Coeff.	**z-values**	**Coeff.**	**z-values**	**Coeff.**	**z-values**
TrainingL	-0.01	(-0.02)	-1.01	(-1.22)	2.20	(1.74)*
TrainingL t-1	-0.37	(-0.75)	-0.14	(-0.17)	1.09	(0.89)
TrainingH	0.49	(1.61)	-0.29	(-0.62)	-0.26	(-0.76)
TrainingH t-1	-0.15	(-0.99)	0.68	(3.45)***	0.03	(0.10)
Capital	0.02	(0.14)	-0.10	(-0.35)	0.83	(2.03)**
Capital t-1	-0.05	(-0.37)	0.08	(0.30)	-0.80	(-1.95)*
Investments	-0.05	(-1.11)	-0.01	(-0.18)	0.23	(4.62)***
Investments t-1	0.07	(1.90)*	0.01	(0.21)	-0.24	(-5.02)***
ln hourly-wage t-1	0.65	(2.99)***	0.68	(2.08)**	1.01	(22.03)***
Firm size 5	-0.33	(-3.10)***	0.24	(0.96)	-0.47	(-1.17)
Temp. contract	-0.17	(-0.69)	-0.09	(-0.20)	1.13	(2.13)**
Job change	-0.46	(-1.49)	-0.51	(-0.68)	-1.77	(-1.74)*
High-skilled	-1.64	(-1.69)*	-0.23	(-0.11)	-2.31	(-0.78)
Women	-0.17	(-2.22)**	-0.07	(-0.72)	-0.01	(-0.27)
Labour	0.01	(1.71)*	0.00	(0.11)	0.00	(0.23)
LabourH	0.22	(1.82)*	0.09	(0.40)	0.15	(0.49)
LabourL	-0.50	(-1.31)	0.10	(0.11)	-0.95	(-0.83)
Tenure 0-4	Reference		Reference		Reference	
Tenure 5-9	-0.01	(-0.04)	0.12	(0.31)	-0.22	(-0.68)
Tenure 10-14	0.20	(0.90)	-0.42	(-0.68)	-0.69	(-1.29)
Tenure 15-19	0.06	(0.20)	0.39	(0.76)	0.20	(0.42)
Tenure 20-29	-0.01	(-0.04)	-0.03	(-0.06)	-0.31	(-0.78)
Tenure 30-39	0.22	(0.59)	-0.09	(-0.12)	-1.00	(-1.46)
Tenure 40-51	1.84	(1.55)	0.38	(0.19)	3.10	(1.69)*
Instruments	$\ln(\text{hoursH/N})_{t-2,t-3}$, $\ln(\text{hoursL/N})_{t-2,t-3}$, $\text{training H}_{t-2,t-3}$, $\text{training L}_{t-2,t-3}$ and $\ln(\text{K/N})_{t-2,t-3}$ in difference equations; $\Delta\ln(\text{hoursH/N})_{t-1}$, $\Delta\ln(\text{hoursL/N})_{t-1}$, $\Delta\text{training H}_{t-1}$, $\Delta\text{training L}_{t-1}$ and $\Delta\ln(\text{K/N})_{t-1}$ in levels equations					
Hansen	0.99		0.99		0.99	
AR(1) (p-value)	0.00		0.02		0.11	
AR(2) (p-value)	0.85		0.33		0.32	
Observations	208		208		208	

Note: The dependent variable in the first column is the average log hourly wage for low- and high-skilled in the second and third column, and value added per worker in the fourth column. All variables are first-differenced. Results are reported for one-step system GMM estimators. The robust estimator of the covariance matrix of the parameter estimates were calculated and the resulting standard error estimates are consistent in the presence of any pattern of heteroscedasticity. All specifications include a constant, time dummies as well as an east-west dummy.
Estimation by "xtabond2" command in STATA/SE 8.2.
Significance levels: $*$: 10% $**$: 5% $***$: 1%.

6

Summary and Conclusion

This study is an economic analysis of continuing vocational training in Germany and its impact on productivity and wages. Throughout all chapters, the heterogeneity of the effect of continuing training is emphasised. To finalise the study in this chapter, I will draw conclusions from the key findings that emerge in the various analyses and identify areas where there seems to be scope for further research.

While primary and secondary education have been in the focus of researchers for many years, there is less profound evidence on continuing training. Repeatedly, the OECD has pointed to the particular relevance of continuing training for policy makers: "A skilled labour force is a prerequisite for success in today's economy. The education and training of current workers is likely to be the most effective means of maintaining and upgrading the skills of the current labour force. Given swiftly changing technologies, work methodologies and markets, policy-makers in many OECD countries are encouraging enterprises to invest more in training, and to promote more general work-related training of adults" (OECD, 2002: 247).

Investments in human capital are a core element of a knowledge-based society. The application of new technologies results in growing skill requirements, which for some groups may constitute obstacles to participation in working life. Skills development and lifelong learning are recognised to be important for integrating people into the labour market. Skilled people increase the productivity and adaptability of the workforce. In addition, the positive effect of training is enhanced by the positive spillover effects that training entails. Therefore, the Conference of G8 Labour and Employment Ministers annually reaffirms the commitment to the objectives of continued training and lifelong learning adopted by the 2002 Conference in Montreal.

This work suggests that the importance attached by policy makers to continuing training is not misplaced. Public discussions may have actually underestimated the importance of training and lifelong learning for modern economies in the past (see, e.g., the statement by James Heckman, chapter 1).

Even though there is a broad consensus among governments, trade unions, and employers that investment in human capital is a key to the future, there exists still a gap between the rhetoric of the public debate and reality. This study aims to set a prerequisite for an informed discussion and policy advice on educational matters concerning continuing training. It has been noticed that determinants and consequences of continuing training differ for heterogeneous agents. Throughout all chapters, the theoretical and empirical analyses, therefore, take heterogeneity of the impact of continuing training into account.

In chapter 2, it becomes obvious that, in Germany, relatively few workers participate in relatively expensive training courses and seminars. Participation rates between different groups of workers range widely. High-skilled workers participate more often than low-skilled workers. The finding of strong complementarity between the various types of human capital investments is evident throughout all chapters: Early achievement and qualifications are important determinants of future educational attainment. In turn, individuals with higher educational attainment undertake more on-the-job training. Those who have undertaken training in a previous period – with the current, but even with a former employer – are more likely to participate in further training.

Older employees are less likely to participate than their younger colleagues. This can be explained by a shorter investment horizon. Employees with a high occupational status participate more often than others, and also those who are employed in the public sector take part more often than others. Employees in a large firm have a higher probability to take part in training than employees in a small firm. Economies of scale make training affordable more easily for large firms. In addition, participation varies with a large number of other personal, job, and firm characteristics.

Chapter 3 discusses the role of heterogeneity in the wage effect of training. First, observed heterogeneity is taken into account, and it can be seen that the wage effect differs for various subgroups of workers. For example, high-skilled workers benefit more from training participation than low-skilled workers. Workers with more work experience receive a higher wage mark-up and, in contrast, workers with longer company tenure receive a lower wage mark-up. Job characteristics also play a role, and, for example, employees who work at a computer station benefit more from training participation than others. In addition, firm characteristics determine the impact of training on wages. There are significant differences between economic sectors. While, for the entire economy, the average wage effect of training is positive and significant, it is not significant for the personal services sector.

The reason for the differences in the wage effect can either be due to differences in the productivity effect or to differences in the bargaining position. If high-skilled workers receive a higher wage mark-up than low-skilled workers, this might be explained by differences in the productivity effect. High-skilled workers either learn better or take part in different types of training than low-skilled workers that induce a higher productivity effect. Some aspects

hint to the fact that the difference is not only in the productivity but also in the bargaining effect. One example is that workers who are employed in a firm that is in a good economic situation benefit more from training than those workers whose firm is in a less satisfactory situation. It seems plausible that, ceteris paribus, workers in the former firm have a better argument and more bargaining power when negotiating a wage mark-up after participating in training.

Unobserved heterogeneity is important to take into account when modelling selection into training. Unobserved factors, such as ability or motivation, determine heterogenous expectations on continuing training. Workers themselves select into training when they expect to profit from it, or firms will select those workers which they expect to have the highest increase in productivity after training. Accounting for unobserved heterogeneity in estimation of the wage effect of training effectuates the positive impact of training on wages to diminish and lose significance. Therefore, the average impact of training on earnings for participants and non-participants in training is zero when accounting for heterogeneous expectations. This result suggests that only some individuals have a positive return to training while others do not.

Another important determinant of the effect of training is the training type itself. Using two factors that comprise internal and external training types, respectively, I estimate a positive and significant effect of external training on earnings but no impact of internal training. External training can be interpreted to be of a more general nature. In contrast, internal training is expected to mediate more firm-specific contents. Alternatively, external training may be more formal than internal training. In that case, external training can be used in other firms because the training is certificated and can, therefore, be acknowledged outside the training firm.

High-skilled workers take part in external training types much more often than low-skilled workers. Participation in internal training does not vary much by qualification. Thus, the evidence in chapter 3 suggests that high-skilled workers participate often in general (or external) training, and they receive a wage mark-up after training. Low-skilled workers participate very few in training, and if they do participate, they take part in firm-specific (or internal) training and do not receive a wage mark-up after participation.

In chapter 4, three indirect ways of testing for firm specificity are used. All test results hint to the existence of some firm-specific human capital that is incorporated in training and lost when moving to another job. This should be interpreted carefully because, first, no statement about the extent of firm-specific training contents can be made (general training contents can be much larger) and second, this is an average result that does not account for the wide variety of training courses and seminars.

In chapter 5, wage and productivity effects of training are compared at a sectoral level. Results suggest that, on average, the training rent is shared by employer and employee. The productivity effect of training is about three

times higher than the wage effect. In addition, training has a lagged impact on productivity but not on wage levels.

The basic model in chapter 5 is extended to allow for differentiating between low and high-skilled workers. Results from the analysis with two types of workers are in line with results in chapter 3. They suggest that high-skilled workers receive a wage mark-up from participating in training while low-skilled workers, on average, experience no wage effect of training. There seems to be a positive impact of training low-skilled workers on productivity but no impact of training high-skilled workers. Combining this result with the evidence in chapter 3, it hints to a positive impact of general training on wages but no impact of specific training. The intuition behind this result is that firms are forced to pay higher wages if worker productivity increased after training. This is recognised and can be used by other firms. If this productivity increase is firm specific or if it is not acknowledged by other firms, there is no need for the training firm to pay higher wages after training. High-skilled workers participate more often in training that provides human capital that can be used in other firms; low-skilled workers, in contrast, take part more often in training that provides human capital which cannot be used outside the training firm. The zero effect of training high-skilled workers on productivity is most likely due to the small group of employees.

The analysis at a sectoral level allows the estimation of external effects between workers and firms. In particular, I estimate the impact of training one skill group on wages of the other group. The idea is that high-skilled workers might transmit knowledge acquired in training to low-skilled workers, or they may organise work procedures more efficiently or improve production processes after training which affects also low-skilled workers. In the empirical analysis, I find no evidence for external effects of training between skill groups.

I estimate the impact of training on productivity on a sectoral level, and, hence, the estimations include spillover effects between firms in the same sector. Examples for such spillover effects are firms which learn with each other, firms which copy from each other, or workers who change jobs between firms in the same sector and induce human capital to be transmitted. The resulting impact of training on productivity at the sectoral level is much higher than calculated effects of training on productivity with firm level data. Zwick (2004 and 2006), for example, finds an impact of training on firm productivity that is only one third of the impact on sector productivity estimated in this study. The difference in the coefficient can be (partly) explained by the difference in the used data sets. Nevertheless, due to the higher coefficient, the empirical evidence in chapter 5 suggests that external effects of continuing training exist in Germany. An important aspect to consider in this respect is that this study focusses on the training impact on wages and productivity. Other effects of training, such as higher job security or satisfaction with the job, have not been considered. These potentially positive effects would shift the socially optimal provision of training further upward and hence, the positive external effect

estimated here is only a lower bound. Thus, there is still scope for further research in this field.

It is evident that participation rates between different groups of workers widely range. High-skilled workers participate much more in training than low-skilled workers. It is still unclear whether skill begets skill or whether there are unobserved factors determining both schooling and training.

The human capital model yields straightforward predictions about the relationship of on-the-job training to wages and job mobility. Still, as discussed in former chapters, testing these predictions is a non-trivial task because of data issues. For empirical analyses of training, there is a need for high-quality longitudinal micro-data with detailed information about wages, mobility, and on-the-job training.

In order to estimate the return to training instead of the impact of training on wages, training costs would have to be considered. In the discussed data sets, there is no information on costs of training. For future work, it would be very valuable to have information on who pays for the training, what the direct costs are, and how long and intensive training is in the data sets.

With linked employer-employee data, including information on training attainment, costs and type of training, job changes, career paths, and promotions, a profound analysis would be possible to answer why participation rates in continuing training in Germany are rather low.

The ultimate aim of this study is to set a prerequisite for the public discussion on continuing training. Lynch (2005) provides suggestions on how academic economists can get involved in the policy debate to influence the direction of policy. She calls for more systematic evaluation of training programmes. I help closing this gap by providing empirical evidence for the continuing training attainment in Germany and its consequences on individual labour market outcomes as well as on firms' productivity. In addition, I estimate differences in individual and social returns to training.

The overall results presented here suggest that incentives to invest in continuing training exist for employees as well as for employers. On average, workers receive a wage mark-up after training, and firms gain from a positive productivity effect from training. Since continuing training seems to be partly firm specific, firms should be able to internalise (at least part of) the productivity effect. Thus, there seems to be no need for government intervention regarding continuing training attainment.

This study also suggests that the social return of training is higher than the individual return of continuing training due to positive external effects between firms. Thus, individual incentives seem not be strong enough to ensure that the provision of continuing training is at the social optimum.

Private training programmes have an advantage over public training programmes because, first, firms can train workers who are likely to benefit most, and second, they can tailor their training programmes to market needs. Education and training have a major role to play: they are essential for countries

and companies seeking to address the challenge posed by the new opportunities in the global market place.

The knowledge economy requires higher levels of skill and adaptability because newly created jobs will most likely not be the same as the jobs lost. Technological advances demand higher skills at an accelerating pace. Long-term structural shifts mean that today, more than ever, a knowledgeable and skilled workforce is the key to economic growth, increased productivity, global competitiveness, and social progress.

While some individuals are clearly better able to manage the process of acquiring new skills for themselves, others need considerable support. Even though, on average, individuals profit from training, incentives for certain groups to take part in continuing training appear to be rather low.

Improvement of formal education and lifelong learning are important goals of the former as well as the current German government. In particular, two groups of workers should be in the focus of policy makers if they aim to provide broad access to education and to enhance lifelong learning. Low-skilled workers have a low probability to participate in continuing training. In addition, their incentives to participate in continuing training are low since these workers receive, on average, no wage mark-up. Thus, without policy intervention, the gap between low- and high-skilled workers will further widen. Incentives to invest in human capital are lower for older workers, and participation rates are, hence, low. Thus, the governmental programmes to foster participation of older workers can be justified to reach the proposed goal of lifelong learning. As described in chapter 2, there exists considerable support for continuing vocational training for firms and individuals in Germany.

To make an overall policy conclusion, continuing training should be considered as part of comprehensive educational policies. James Heckman advocates a life cycle perspective: "in evaluating a human capital investment strategy, it is crucial to consider the entire policy portfolio of interventions together (training programmes, school-based policies, school reform, and early interventions) rather than focusing on one type of policy in isolation from the others. [...] Learning is a dynamic process and is most effective when it begins at a young age and continues through to adulthood" (Heckman, 2000: 50). The desirable policy strategy should, therefore, be to complement early interventions with policies for adult learning.

Appendix

A Further Tables and Figures for Chapter 2

Table A.1. Expenditure on active and passive labour market policies, 1991-1997

Total expenditure	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
in million DM	48,912	55,125	69,286	70,619	76,816	84,795	83,673
	Shares of total expenditure for active and passive labour market policy in %						
Training	13	12	10	9	10	10	8
Temporary wage subsidy	1	<1	<1	<1	<1	<1	<1
Short time work	1	2	5	2	1	1	1
Job creation schemes	6	6	4	4	4	4	3
Early retirement	1	<1	<1	<1	<1	<1	<1
Rehabilitation programmes	7	7	6	5	4	4	4
Unemployment benefits	33	36	43	47	46	46	47
Unemployment assistance	14	14	15	18	19	21	23
Other expenditure	25	23	18	16	15	14	13
Unemployment rate	6.2	6.4	8.0	9.0	9.1	9.9	10.8

Notes: Expenditures in million DM (approx. 500,000 euros) for West Germany. Training: further training, retraining, short programmes according to §41a EPA (abolished at the end of 1992). Temporary wage subsidies: subsidies during the phase of initial skill adaptation in a new job (*Einarbeitungszuschüsse*). Short time work: *Kurzarbeit*. Job creation schemes (JCS): *Arbeitsbeschaffungsmaßnahmen*. Early retirement: *Vorruhestand/Altersteilzeit/Altersübergangsgeld*. Unemployment benefits (UB): *Arbeitslosengeld*. 'Other expenditure' mainly includes counselling and job placement services as well as administrative costs of the FEA.

Source: Lechner et al. (2004).

Table A.2. List of sectors and firms with agreements concerning continuing training

AOK (1998): Agreement on tariffs for encouragement of competitiveness and for job security. Training measures for job security on application of the employer or employee. Accompanying measures to new kinds of work (quality circles, project report).

Banking business West (1983): Agreement on tariffs for security against economisation. Retraining and vocational training to avoid down arrangements and dismissal caused by economisation measures. Cost absorption, and if applicable, free time compensation by the establishment.

Book trade Bavaria (1997): Right to release for enhancement of the occupational qualification under enduring payments. In case of longer continuing special courses up to 6 months, without enduring payments.

Debis (1998): Annual education dialogue, cost absorption, and absorption of expenditure of time in case of task and establishment; specific measures by the employer, otherwise semi-partition of the expenditure of time, annual smallest claim of 5 days.

Deutsche Bahn AG (1993): Agreement on tariffs for vocational apprenticeship, retraining, and further training including arrangements on basic principles, enforcement, and financing of the measures.

Deutsche Postbank (1995): Training measures in the framework of teamwork.

Deutsche Telekom AG (1998): Agreement on tariffs about on-the-job training including frame arrangements on the operational-professional and occupational further training.

Deutsche Shell AG (1994): Proposals of further qualification, amongst others, for enhancement of the professional and personal competence. Charging with free time by reduction in working hours as the case may be by additional non-working shifts.

Printing industry West (1990): Encouragement of further training and retraining. Annual assessment of demand, cost absorption by the employer, assay of possibilities for adult-satisfied basic education, encouragement of women.

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...Table A.2 continued

Work on scaffolding industry (1996): Agreement on tariffs about occupational training and occupational further training. Commitment of conditions of encouragement, arrangements of financing.

Wholesale and export trades Baden-Wuerttemberg (1997): During the family period: assay and use of external possibilities for schooling and further training. On demand, proposal of internal schooling.

Wood and plastics processing industry Baden-Wuerttemberg (1992): Annual assessment of demand and commitment of training measures regarding technical and organisational changes. By accepting, a high-order task follows a new in-arrangement.

Plumber and installer trade Berlin (1995): Obligation of the employer to offer occupational training measures. Volume/claim of 8 hours per calendar year and employee.

Agriculture and forestry (1995): Constitution of a qualification fund for development and security of competitive jobs trough qualification. Financing by employer's and employee's contribution.

Metal industry North Wuerttemberg/North Baden (1988): Annual assessment of demand and commitment of training measures regarding technical and organisational changes. Cost absorption by the establishment. If applicable, temporary surcharge of 3% if no high-order task is assigned.

Middle German broadcast (1993): Encouragement of occupational qualification, further training programmes, miscellaneous education measures. If applicable, grant of free time and cost absorption.

Sinitec (1998): Training measures; annual blanket withdrawal of 44 hours from the personal time balance of each employee for training measures.

Textile and clothing industry (1997): Agreement on tariffs for encouragement of vocational apprenticeship, retraining, and further training. Financing by an employer's contribution of 10 DM per employer and year. Commitment of conditions of encouragement by a commission whose members are employees and directors in the same proportion as in the establishment.

Table A.3. Participants in the quantitatively most important ALMP measures, 1991-1997

	1991	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Training (total)*	601	582	350	308	402	378	275
Further training (in % of total)	71	72	76	73	77	77	76
Short programmes (in % of total)	9	8	-	-	-	-	-
Retraining (in % of total)	12	14	21	24	20	20	21
Temporary wage subsidy	9	5	3	3	3	3	3
Job creation schemes**	83	78	51	57	70	70	59
Short-time work**	145	283	767	275	128	206	133

Notes: *Total number of inflows in 1,000 persons. **Yearly average in 1,000 persons. Short programmes are courses according to §41a EPA (abolished at the end of 1992). Temporary wage subsidies: subsidies during the phase of initial skill adaptation in a new job (*Einarbeitungszuschüsse*). Job creation schemes (JCS): *Arbeitsbeschaffungsmaß*nahmen. Short time work (STW): *Kurzarbeit*.

Source: Lechner et al. (2004).

Table A.4. Adult education centres (*Volkshochschulen*)

Baden-Wuerttemberg	552
Bavaria	1,075
Berlin	12
Brandenburg	35
Bremen	8
Hamburg	8
Hesse	66
Mecklenburg-Western Pomerania	34
Lower Saxony	87
North Rhine-Westphalia	146
Rhineland-Palatinate	117
Saarland	35
Saxony	35
Saxony-Anhalt	34
Schleswig-Holstein	173
Thuringia	24
TOTAL	2,441

Source: http://www.vhs.de/.

Table A.5. Largest (private) providers of continuing vocational training in Germany, 2004

Company	**Education Turnover** (million euros)
DAA Academy Ltd. (DAA Akademie GmbH), Hamburg	150* **
Volkswagen Coaching GmbH, Wolfsburg	145
DGB Ltd. (Berufsfortbildungswerk Bildungseinrichtung DGB GmbH), Duesseldorf	110**
Dekra Academy Ltd. (Dekra Akademie GmbH), Stuttgart	110**
SRH Learnlife PLC, Heidelberg	97**
Deutsche Bahn PLC Service Centre Education, Frankfurt/M.	86,2
Telekom Training, Bonn	83,5
TÜV Education + Consulting Ltd., Berlin	83
SAP Germany PLC (SAP Deutschland AG & Co. KG), Walldorf	75* #
LS training and services Ltd., Munich	70* 1 #
Grone School Foundation, Hamburg	67**
IBM Ltd. Learning Services, Stuttgart	65* #
Cognos PLC, Hamburg	58,9* **
IIR Deutschland Ltd., Sulzbach	50*
FAA Education Society Limited (FAA Bildungsgesellschaft mbH), Hamburg	47* **
Euroforum Germany Ltd., Duesseldorf	44*)
Bank Academy (Bankakademie e.V.), Frankfurt/M.	27
Unilog Integrata Training AG, Tuebingen	26,3#
Education Center for information processing occupations (Bildungszentrum für informationsverarbeitende Berufe e.V.), Paderborn	26,2**
Siemens AG - Automation and Drives, Nuremberg	22#

The table is based on controlled information from the companies and on estimations by Lünedonk. It refers to training sales in Germany or such accounted to Germany. This overview does not claim for completeness. It represents a sample of the biggest training providers.

* Estimated.

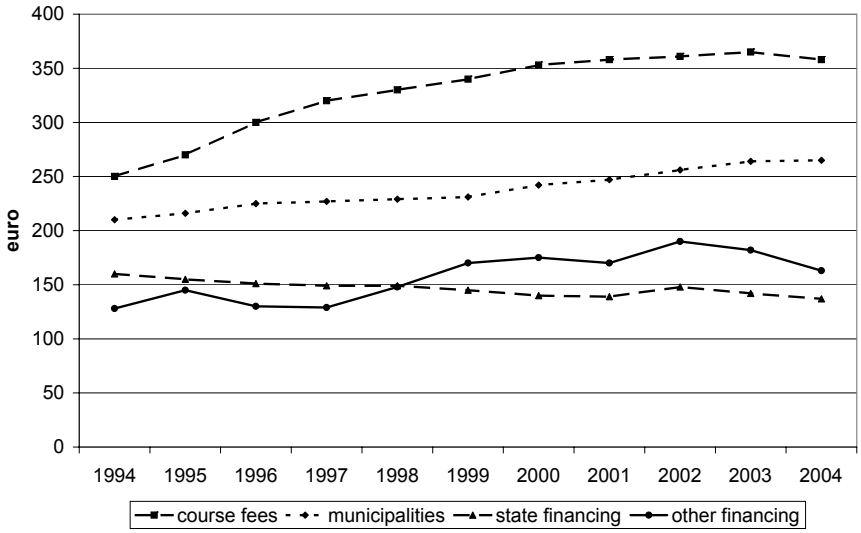
IT-Topics account for more than 50% of the training turnover.

** Long-term education accounts for more than 50% of turnover.

1 Until April 2004: Siemens Business Services Ltd. & Co. OHG; since 01.10.2004: part of bit Group, Graz.

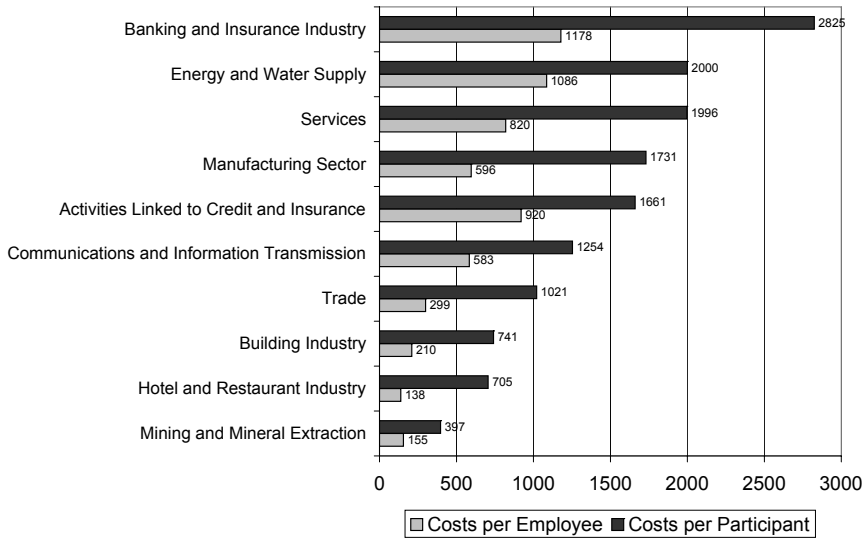
Source: http://www.luenendonk.de/download/LUE_Weiterbildung_2005_f090505.pdf.

Fig. A.1. Financing structure of adult education centres (*Volkshochschulen*), in million euros



Source: http://www.die-bonn.de/esprid/dokumente/doc-2005/pehl05_08.pdf.

Fig. A.2. Costs of continuing vocational training in Germany, 1999



Source: Statistisches Bundesamt (2002).

Table A.6. Data for further training

Name of the survey	Sponsor/enforcing institution	Kind of survey	Criteria of the survey
		Official statistics	
Microcensus	enforcement: Federal Statistical Office (*Statistisches Bundesamt*)/Statistical Offices of the Laender (*Statistische Landesämter*)	household sample about the population and the labor market; questions about further education with a sampling fraction of 0,5% of the population; periodicity: annual	* participants of advanced vocational training * participants of general further education * location of the measure * purpose * duration * socio-demographic information
Continuing Vocational Training Survey (CVTS)	European Commission/Eurostat enforcement for Germany: Federal Statistical Office (*Statistisches Bundesamt*)/Statistical Offices of the Laender (*Statistische Landesämter*)/Federal Institute for Vocational Training and Education (*Bundesinstitut für Berufsbildung, BIBB*)	establishment survey on European level (stratified random sample at businesses with more than 10 employees); periodicity: irregular 1994, 1999	* establishment provided offers of further education * participation quota * participation hours * socio-demographic information * cost
Statistics of the general education schools (evening schools)	enforcement: Federal Statistical Office (*Statistisches Bundesamt*)/Statistical Offices of the Laender (*Statistische Landesämter*) (coordinated statistics of the Laender)	total survey of the evening schools; periodicity: annual	* participants (students) * lessons * classes * socio-demographic information
Statistics of the technical schools (vocational schools)	enforcement: Federal Statistical Office (*Statistisches Bundesamt*)/Statistical Offices of the Laender (*Statistische Landesämter*) (coordinated statistics of the Laender)	total survey of the vocational schools; periodicity: annual	* participants (students) * final examinations * socio-demographic information
Statistics of the vocational education	enforcement: Federal Statistical Office (*Statistisches Bundesamt*)/Statistical Offices of the Laender (*Statistische Landesämter*)	total survey of the responsible departments for approval of further education examination and the examination for master craftsman's certificate; periodicity: annual	* participants of examinations * passed examinations * kind of degree/certificate * socio-demographic information

to be continued...

...Table A.6 continued

Name of the survey	Sponsor/enforcing institution	Kind of survey	Criteria of the survey
Social Security Code III (SGBIII) Statistics	Federal Employment Office (*Bundesanstalt für Arbeit*)	annual statistics; periodicity: annual	* admissions, stocks, retirements of participants * socio-demographic information * expenses
Statistics of guest auditors	enforcement: Federal Statistical Office (*Statistisches Bundesamt*)/Statistical Offices of the Laender (*Statistische Landesämter*)	total survey of the universities; periodicity: annual	* guest auditors * socio-demographic information
Surveys of (economic) institutes			
individual surveys			
Further education report system (*Berichtssystem Weiterbildung*)	Federal Ministry of Education and Research (*Bundesministerium für Bildung und Forschung*); enforcement: Infratest social research (*Infratest Sozialforschung*) in cooperation with the Institute for development planning and structure research (*Institut für Entwicklungsplanung und Strukturforschung*) and Helmut Kuwan, Social-scientific research and consulting, Munich (*Sozialwissenschaftliche Forschung und Beratung*)	sample survey of the population at the age of 19 to 64 (stratified random sample); periodicity: every 3 years (since 1979); since 1988 including other further education statistical data as integrated report	* participation quota * participation cases * further education volume * socio-demographic information * information concerning employment * structure of the activity * structure of the responsible bodies * motivational factors * structures of informal and self-directed learning * cost and financing * regional characteristics
BiBB/IAB surveys	Federal Institute for Vocational Training and Education (*Bundesinstitut für Berufsbildung, BIBB*)/Institute for Employment Research (*Institut für Arbeitsmarkt- und Berufsforschung, IAB*)	sample survey of employees older than 15 years with a regularly, paid employment of at least 10 hours per week; survey for gainful employment and educational biography; periodicity: irregular 1979, 1985/86, 1991/92, 1998/99	* participation quota * learning location * courses and other kinds of learning * socio-demographic information * demand for further education
German Socio-Economic Panel (GSOEP)	Federal Ministry of Education and Research (*Bundesministerium für Bildung und Forschung*)/German Research Foundation (*Deutsche Forschungsgemeinschaft*) enforcement: German Institute for Economic Research (*Deutsches Institut für Wirtschaftsforschung*), Infratest social research (*Infratest Sozialforschung*)	household sample of the resident population at the age of 20 to 65 with thematically emphases; periodicity: annual, on-the-job training: irregular 1989, 1993, 2000	* participation quota * socio-demographic information * duration of the measure * lessons * kind of event * motivating factors

to be continued...

...Table A.6 continued

Name of the survey	Sponsor/enforcing institution	Kind of survey	Criteria of the survey
Establishment surveys			
IAB-Betriebspanel	Institute for Employment Research (*Institut für Arbeitsmarkt- und Berufsforschung, IAB*)	establishment survey (stratified random sample at companies with at least one employee who is subject to social insurance contribution); periodicity: annual, on-the-job training: since 1997 every 2 years	* offers of on-the-job training * participation quota * subject areas * socio-demographic information * informal further education * financing
IW (Institute of the German Economy) survey on-the-job training	Institute of the German Economy (*Institut der Deutschen Wirtschaft, IW*) in cooperation with the board of trustees of the German Economy for vocational training (*Kuratorium der Deutschen Wirtschaft für Berufsbildung* - association of the central organisations of the economy)	establishment survey; periodicity: every 3 years (since 1992)	* offers of on-the-job training * participation cases * subject areas * courses and other kinds of learning * socio-demographic information * time organisation * cost
German life course study (*Deutsche Lebensverlaufsstudie, DELVA*)	Max-Planck-Institut (MPI) for education research (*für Bildungsforschung*)	persons in age-group cohorts; periodicity: irregular (last time 1998/1999)	
further education monitor (*Weiterbildungsmonitor, wbmonitor*)	Federal Institute for Vocational Training and Education (*Bundesinstitut für Berufsbildung, BIBB*)	provider of further education, persons; periodicity: up to twice per year	
Statistics of the responsible departments			
Statistics of the adult education programme	German Institute for Adult Education (*Deutsches Institut für Erwachsenenbildung*)	Achievement statistics (*Leistungsstatistik*) of all German adult education programmes; periodicity: annual	
Statistics of the protestant adult education	German Protestant joint venture for adult education (*Deutsche Evangelische Arbeitsgemeinschaft für Erwachsenenbildung*)	Achievement statistics (*Leistungsstatistik*); periodicity: annual	
Statistics of the catholic adult education	Catholic Federal joint venture for adult education (*Katholische Bundesarbeitsgemeinschaft für Erwachsenenbildung*)	Achievement statistics (*Leistungsstatistik*); periodicity: annual	

to be continued...

...Table A.6 continued

Name of the survey	**Sponsor/enforcing institution**	**Kind of survey**	**Criteria of the survey**
Statistics of the Chambers of Industry and Commerce	German Association of Industry and Commerce (*Deutscher Industrie- und Handelstag*)	Secondary statistics (*Sekundärstatistik*); periodicity: annual	
Statistics of the Chambers of Handicrafts	German Confederation of Skilled Crafts (*Zentralverband des Deutschen Handwerks*)	Secondary statistics (*Sekundärstatistik*); periodicity: annual	
Statistics of the Chambers of Agriculture	Chambers of Agriculture (*Landwirtschaftskammern*)	Secondary statistics (*Sekundärstatistik*); periodicity: annual	
Statistics of the "Berufsfortbildungswerk (bfw)" of the German Confederation of Trade Unions (DGB)	*Berufsfortbildungswerk* (bfw)	Secondary statistics (*Sekundärstatistik*); periodicity: annual	
Statistics of the correspondence courses	Federal Ministry of Education and Research (*Bundesministerium für Bildung und Forschung*); enforcement: Federal Statistical Office (*Statistisches Bundesamt*), Forum DistancE-Learning (*ehemals Deutscher Fernschulverband*)	Survey of the correspondence colleges; periodicity: annual	

Table A.7. Means and standard deviations of variables used in the data sets

	Microcensus 99		**SOEP 99**		**BIBB-IAB 99**	
Variables	**Means**	**Std. Dev.**	**Means**	**Std. Dev.**	**Means**	**Std. Dev.**
Female	0.33	0.47	0.36	0.48	0.30	0.46
East Germany	0.25	0.43	0.24	0.43	0.25	0.43
Age	41.09	9.81	41.40	9.85	41.41	10.14
Age 17-19	0.00	0.00	0.00	0.00	0.00	0.00
Age 20-24	0.00	0.00	0.00	0.00	0.00	0.00
Age 25-29	0.13	0.34	0.12	0.33	0.13	0.34
Age 30-34	0.18	0.38	0.18	0.38	0.18	0.38
Age 35-39	0.17	0.38	0.17	0.37	0.16	0.37
Age 40-44	0.15	0.36	0.15	0.36	0.15	0.36
Age 45-49	0.14	0.35	0.14	0.35	0.13	0.34
Age 50-54	0.10	0.30	0.10	0.31	0.10	0.30
Age 55 and above	0.12	0.33	0.13	0.34	0.14	0.35
Lower secondary school	0.40	0.49	0.38	0.49	0.42	0.49
Intermediate secondary school	0.36	0.48	0.34	0.47	0.36	0.48
Entrance examination for university of applied sciences	0.05	0.22	0.05	0.22	0.05	0.22
High-school diploma	0.17	0.38	0.17	0.38	0.16	0.37
Without school-leaving certificate	0.01	0.09	0.02	0.14	0.02	0.15
Without professional degree	0.08	0.27	0.11	0.32	0.10	0.30
Vocational school	0.07	0.25	0.11	0.31	0.03	0.17
On-the-job apprenticeship	0.58	0.49	0.56	0.50	0.62	0.48
Apprenticeship at school	0.65	0.48	0.65	0.48	0.65	0.48
Master craftsman	0.09	0.29	0.08	0.27	0.12	0.33
University of applied sciences	0.06	0.24	0.05	0.23	0.05	0.22
University	0.09	0.28	0.10	0.30	0.08	0.26
Gross monthly wage			4741.37	2110.17	4286.16	1957.06
Net monthly wage	3026.64	1556.66	2996.44	1395.08		
Blue-collar worker	0.40	0.49	0.39	0.49	0.42	0.49
White-collar worker	0.60	0.49	0.61	0.49	0.58	0.49
Hamburg	0.02	0.14	0.02	0.14	0.02	0.13
Lower Saxony	0.09	0.29	0.10	0.30	0.10	0.00
Bremen	0.01	0.08	0.01	0.08	0.01	0.09
North Rhine-Westphalia	0.20	0.40	0.24	0.42	0.20	0.40
Hesse	0.07	0.25	0.06	0.24	0.07	0.26
Rhineland-Palatinate	0.06	0.24	0.06	0.23	0.06	0.24
Baden-Wuerttemberg	0.12	0.33	0.10	0.30	0.12	0.33
Bavaria	0.15	0.35	0.13	0.34	0.14	0.35
Berlin	0.04	0.20	0.05	0.21	0.04	0.20
Brandenburg	0.04	0.20	0.03	0.18	0.04	0.20
Mecklenburg-Western Pomerania	0.03	0.16	0.02	0.15	0.03	0.16
Saxony	0.07	0.25	0.07	0.25	0.06	0.25
Saxony-Anhalt	0.04	0.19	0.04	0.19	0.04	0.19
Thuringia	0.04	0.19	0.04	0.19	0.04	0.19
Schleswig-Holstein	0.03	0.18	0.05	0.22	0.03	0.18
Number of observations	10,6262		6,212		17,915	

Table A.8. Training-related questions in the SOEP 1999 data set

German	English
SOEP1-99) (Alle) Sind Sie derzeit in Ausbildung? Das heißt: besuchen Sie eine Schule, Hochschule, machen Sie eine Berufsausbildung oder nehmen Sie an einem Weiterbildungslehrgang teil? Antworten : ja, nein; bei ja nächste Frage	SOEP1-99e) (All) Are you currently in some sort of education? In other words, do you attend a school or institution of higher education, are you engaged in an apprenticeship or are you participating in further education or training? Answers: yes, no; yes, next question
SOEP2-99) (Alle) Was für eine Ausbildung oder Weiterbildung ist das? Antworten: - Lehrgang/Kursus zur Weiterbildung - Berufliche Umschulung - Berufliche Fortbildung - Berufliche Rehabilitation - Allgemeine oder politische Weiterbildung - Sonstiges	SOEP2-99e) (All) What type of training or further education is that? Answers: - Seminar/course for further education and training - Professional retraining - Further education in your profession - Professional rehabilitation - Further education in politics or general - Other
SOEP3-99) (Nur Erwerbstätige) Wie wahrscheinlich ist es, dass innerhalb der nächsten zwei Jahre die folgenden beruflichen Veränderungen für Sie eintreten? Antworten: - Dass Sie sich durch Lehrgänge/Kurse weiterqualifizieren oder fortbilden? Skala von 0 bis 100 von „mit Sicherheit nicht eintreten“ bis „mit Sicherheit eintreten“	SOEP3-99e) (Only employees) How likely is it that within the next 2 years you will experience the following occupational changes? Answers: - That you will gain further qualifications or education through courses?
SOEP4-99) (Alle) Haben Sie im Zeitraum seit Anfang 1998 eine Schule, eine Berufsausbildung oder ein Hochschulstudium abgeschlossen? Wenn ja, wann war das? Antworten: - 1998 Monat ? - 1999 Monat?	SOEP4-99e) (All) Have you finished schooling, vocational training, or university education since the beginning of 1998? If yes, when? Answers: - 1998 month ? - 1999 month ?
SOEP5-99) (Alle) Um was für einen Bildungsabschluss handelt es sich? Antworten: - Beruflicher Ausbildungsabschluss - Betriebliche Umschulung - Sonstiges, z.B. Fortbildungslehrgang	SOEP5-99e) (All) What sort of a degree did you receive? Answers: - Vocational degree - Company retraining - Other, e.g., further training
SOEP6-99) (Alle) Und nun denken Sie bitte an das ganze letzte Jahr, also 1998. Antworten: Kalender mit allen 12 Monaten; diese ankreuzen, in welchen man „in betrieblicher Ausbildung/Fortbildung/Umschulung“ war	SOEP6-99e) (All) And think back now on all of 1998. Answers: calendar with all 12 months; cross the ones in which you were “in company training/further training/retraining”

Table A.9. Training-related questions in the Microcensus 1999 data set

German	**Englisch**
MZ1-99) Nehmen Sie gegenwärtig an einer Bildungsmaßnahme teil, oder haben Sie an einer solchen seit Ende April 1998 teilgenommen? Antworten: - Ja... ... an einer beruflichen Aus- oder Fortbildung bzw. Umschulung ... an einer Maßnahme der allgemeinen Weiterbildung ... sowohl an einer beruflichen Aus- oder Fortbildung bzw. Umschulung als auch einer Maßnahme der allgemeinen Weiterbildung - - Nein	MZ1-99e) Do you currently take part in an education measure or have you since the end of April 1998? Answers: - Yes... ... a vocational, training or retraining or further education ... a measure of general further education ... as well as - No
MZ2-99) Haben Sie an der beruflichen Ausbildung, Fortbildung oder Umschulung in den letzten 4 Wochen teilgenommen? Antworten: ja, nein	MZ2-99e) Did you take part in vocational training, retraining, or further education during the last 4 weeks? Answers: yes, no
MZ3-99) Ist (oder war) diese Maßnahme ein berufliches Praktikum oder eine Lehrausbildung? Antworten: - Ja... ... ein berufliches Praktikum ... eine Lehrausbildung - Nein, eine sonstige Ausbildung, Fortbildung, Umschulung	MZ3-99e) Is (or was) this measure a professional practical course or a *Lehrausbildung*? Answers: - Yes... ... a professional practical course ... a *Lehrausbildung* - No, a different training, retraining, further education
MZ4-99) Was ist (oder war) der Zweck dieser Maßnahme? Antworten: - Erste berufliche Ausbildung - Durch das Arbeitsamt geförderte Maßnahme der Aus- und Fortbildung, Umschulung - Berufliche Weiterbildung, und zwar... ... zur beruflichen Weiterentwicklung, Vertiefung von Fachkenntnissen, Anpassung an technologische Veränderungen ... zur Vorbereitung auf die Rückkehr ins Arbeitsleben nach längerer Unterbrechung ... zu sonstigen Zwecken	MZ4-99e) What is (or was) the purpose of this measure? Answers: - First job training - Measure of training, retraining, further education funded by the Federal Employment Office – Vocational further education... ... for vocational advancement, deepening specialised knowledge, accommodation on technical changes ... as preparation for return to working life after a long break ... other purposes

to be continued...

...Table A.9 continued

German	**Englisch**
MZ5-99) Wo beziehungsweise wie wird (oder wurde) diese Maßnahme überwiegend durchgeführt? Antworten: - Am Arbeitsplatz und in einer beruflichen Schule/Bildungseinrichtung - Unterricht an einer beruflichen Schule/Hochschule oder einer sonstigen Bildungseinrichtung - Am Arbeitsplatz - Durch Fernunterricht - Selbststudium - Tagungen, Seminare, Arbeitsgruppen	MZ5-99e) Where or rather how is (or was) this measure predominantly accomplished? Answers: - At working place and in vocational school/educational institution - Lessons at a vocational school/college or different educational institution - At working place - Through distance learning - Private study - Conferences, seminars, working groups
MZ6-99) Wie lange dauert (oder dauerte) diese Maßnahme insgesamt? Antworten: - unter 1 Woche - 1 Woche bis unter 1 Monat - 1 bis unter 3 Monate - 3 bis unter 6 Monate - 6 bis unter 12 Monate - 1 bis unter 2 Jahre - 2 Jahre und mehr - unbestimmte Dauer	MZ6-99e) How long does (or did) this measure take all in all? Anwers: - less than 1 week - 1 week to 1 month - 1 month to 3 months - 3 months to 6 months - 6 months to 12 months - 1 year to 2 years - more than 2 years - length is unknown
MZ7-99) Wie viele Ausbildungsstunden umfasst (oder umfasste) die Maßnahme üblicherweise pro Woche? Antwort: Angabe der Stundenanzahl	MZ7-99e) How many lessons does (or did) this measure usually contain per week? Answers: indication of the number of the lessens
MZ8-99) Haben Sie an der Maßnahme der allgemeinen Weiterbildung in den letzten 4 Wochen teilgenommen? Antworten: ja, nein, keine Angabe	MZ8-99e) Did you participate in the measure of general further education in the last 4 weeks? Answers: yes, no, n/a
MZ9-99) Wie oben: Frage nach dem wo bei allgemeiner Weiterbildung	MZ9-99) As above: question on where general training took place

Table A.10. Training-related questions in the BiBB/IAB 1998/99 data set

German	**Englisch**
BiBB1) Denken Sie nun einmal an die letzten 5 Jahre, also die Zeit von Anfang 1994 bis heute. Haben Sie in dieser Zeit Lehrgänge, Kurse oder Seminare besucht, die der Weiterbildung im Beruf oder der beruflichen Umschulung dienen? Antworten: ja, nein, weiß nicht	BiBB1e) Please think of the last 5 years, the time since the beginning of 1994 until today. Did you enrol for any courses, trainings, or seminars, which served further education in the job or vocational retraining? Answers: yes, no, don't know
BiBB2) In welchem Jahr haben Sie zuletzt an einem solchen Lehrgang oder Kurs teilgenommen?	BiBB2e) In which year did you lastly attend such a course or training?
BiBB3) Welche der folgenden Fortbildungsmöglichkeiten haben Sie in den vergangenen 2 Jahren (also seit Beginn 1997) genutzt, um zusätzliche Kenntnisse zu erwerben? (Mehrfachnennungen) Antworten: - Fachmessen, Kongresse, Ausstellungen besucht - An Fachvorträgen, Vorführungen, Präsentationen teilgenommen - Einarbeitung, Einweisung am Arbeitsplatz - An betrieblichen Maßnahmen wie Qualitätszirkeln, Lernstatt o.Ä. teilgenommen - Praktikum, Hospitation, Abordnung - Besondere Aufgaben übernommen, um berufliche Kenntnisse, Erfahrungen zu erweitern - Regelmäßige Lektüre von Fachzeitschriften, Fachliteratur - Anderweitig beruflich fortgebildet (aber nicht Lehrgänge, Kurse oder Seminare) - Nichts davon - Weiß nicht/verweigert	BiBB3e) Which of the following possibilities for further education did you use in the last 2 years (since 1997) to gain additional skills? Answers: - visited trade fairs, conventions, exhibitions - participated in lectures, performances, presentations - briefings, adjustment to the place of employment - participated in internal measures - internship, attendance, delegation - took special duties and responsibilities to extend the professional skills, experiences - regular reading of trade journals, technical literature - ulterior vocational upgrading - nothing from the above - don't know/refuse to answer

Table A.11. Impact of training in Germany

Authors	Data	Investigation period	Kind of researched qualification	Outcome variable	Methods	Results
Pannenberg (1995)	GSOEP west	1984-1991	1. off-the-job training 2. on-the-job training	1. probability of (re)employment 2. income	1. discrete hazard-rate model 2. fixed effects model	1. probability of employment: + 2. income: +
	GSOEP east	1990-1992	off-the-job training	1. probability of reemployment 2. income	1. discrete hazard-rate model 2. linear panel model with fixed effects	1. probability of reemployment: main effect: 0 2. income: main effect: -
Pannenberg (1997)	GSOEP west	1984-1991	on-the-job training and find of financing: * self-financed * shared-financed * employer-financed * employer-supported	1. starting wages 2. wages 3. job mobility 4. internal career ladder	1. OLS with corrected covariance matrix (White) 2. fixed effects model with corrected covariance matrix 3. Poisson model 4. Bivariate probit with mixed structure	1. on-the-job training: ++ self-financed: ++ employer-supported: ++ 2. on-the-job training: ++ shared-financed: ++ employer-financed: + 3. on-the-job training: n.s. 4. on-the-job training: n.s. employer-supported finance: -
Pannenberg (1998)	GSOEP	1989-1993	on-the-job training effect differentiated in tenure	income	linear panel model with fixed effects with robust covariance matrix	men: 3rd year tenure ++ remainder tenure: + (variance of coefficients 0-13) women: 3rd year tenure ++ remainder tenure: + (variance of coefficients 0-24, especially in the first years, more)

to be continued...

...Table A.11 continued

Authors	Data	Investigation period	Kind of researched qualification	Outcome variable	Methods	Results
Lechner (1999)	GSOEP east	1990-1994	on-the-job training	1. unemployment 2. full-time employment 3. income	framework: "potential outcome approach to causality" - non-parametric regression matching approach	1. unemployment: 0 2. full-time employment: 0 3. income: +
Pfeiffer & Reize (2001)	BiBB/IAB survey	1991-1992	formal and informal on-the-job training	1. determinants of training 2. income 3. income differentials	switching regression model with endogenous switching	partial correlation between income and training: employees (formal): 0,10 employees (informal): 0,078 self-employed: 0
Bellmann & Büchel (2001)	IAB establishment panel	1997-1998	on-the-job training	firm productivity	1. semi-logarithmic regression 2. Heckmann selection correction	1. firm productivity: + (highly significant) 2. firm productivity: + (under 10% level of significance)
Pischke (2001)	GSOEP west	1986-1989	on-the-job training	income	(fixed-effects regression) fixed growth rates estimation	during work hours: + (ns) during leisure time: ++ (ns) (especially women)
Schömann & Becker (2002)	GLHS west GSOEP east	1950-1993 1989-1993	1. on-the-job training 2. on-the-job training 3. off-the-job training (public financed)	1. income (west) job change/same job 2. job security (east) 3. probability of employment	1. job change: instrumental variable estimation 2. same job: stochastic differential equation with hazard rate 3. dynamic estimation with hazard rate 4. exponential model with hazard rate	1. job change: men: + women: + (only when job and employer change) same job: men: + women: + 2. job security: + 3. probability of employment: men: 0 women: +

to be continued...

...Table A.11 continued

Authors	**Data**	**Investigation period**	**Kind of researched qualification**	**Outcome variable**	**Methods**	**Results**
Hempell (2003)	Mannheim Innovation Panel in Services (MIP-S)	1994-1998	1. ICT-investments 2. firm-sponsored training	firm productivity	two-step system GMM estimator	1. firm productivity: 0 2. firm productivity: + (n.s.) 3. firm productivity (both): ++
Zwick (2004b)	IAB establishment panel	1997-2000	intensity of training (fraction of trained employees)	1. firm productivity (work councils) 2. firm productivity (no work councils)	1.1. system GMM estimator 1.2. instrumental variable estimation (IV) 2. fixed effects	1.1. firm productivity: + (only marginal significant) 1.2. firm productivity: + 2. firm productivity: 0
Büchel & Pannenberg (2004)	GSOEP BiBB/IAB survey	1984-2001 1998/1999	on-the-job training	1. income 2. course of career 3. risk of unemployment	longitudinal analysis 1. linear panel model with fixed effects 2. probit model 3. probit model	1. income: + 2. course of career: young west: + over 45 west: 0 male young east: + remainder east: 0 3. risk of unemployment: +
Jürges & Schneider (2005)	GSOEP west	1984-2000	on-the-job training	income	1.regressions (Hausmann-Taylor resp. fixed growth) 2. matching approaches	1. income: + (ns) 2. income: + (ns)
Zwick (2005)	IAB establishment panel	1997-2001	kind of training	firm productivity	cross-section analysis, switching regression model, two-step panel estimation (1st step: system GMM, 2nd step: fixed effects estimation)	formal external courses: ++ formal internal courses: + (short-run) informal: 0 on-the-job training: -

to be continued...

...Table A.11 continued

Authors	**Data**	**Investigation period**	**Kind of researched qualification**	**Outcome variable**	**Methods**	**Results**
Zwick (2006)	IAB establishment panel	1997-2000	intensity of training (fraction of trained employees)	firm productivity	1. fixed effects 2. instrumental variable estimation (IV)	1. firm productivity: + (only marginal significant) 2. firm productivity: +

B Further Tables and Figures for Chapter 3

Table B.1. Used variables in section 3.1

Variable	Share/ Average	Notes
	Earnings	
Less than 600 DM	0.07%	
Between 600 and 1,000 DM	0.16%	
Between 1,000 and 1,500 DM	0.56%	
Between 1,500 and 2,000 DM	1.25%	
Between 2,000 and 2,500 DM	4.31%	
Between 2,500 and 3,000 DM	7.69%	
Between 3,000 and 3,500 DM	11.87%	
Between 3,500 and 4,000 DM	14.87%	
Between 4,000 and 4,500 DM	14.48%	
Between 4,500 and 5,000 DM	12.28%	
Between 5,000 and 5,500 DM	7.59%	
Between 5,500 and 6,000 DM	6.93%	
Between 6,000 and 7,000 DM	7.58%	
Between 7,000 and 8,000 DM	4.10%	
Between 8,000 and 9,000 DM	2.52%	
Between 9,000 and 10,000 DM	1.37%	
Between 10,000 and 15,000 DM	1.73%	
15,000 DM and more	0.64%	
	School attainment	
Without school-leaving certificate	2.52%	
Lower secondary school	51.23%	
Intermediate secondary school	24.74%	Reference category
Entrance examination for university of applied sciences	7.60%	
High-school diploma	13.91%	
	Vocational training	
Without professional degree	12.63%	
Full-time vocational school	2.22%	Several years of professional training in school; reference category
Dual apprenticeship	60.16%	Several years of professional training in school and on-the-job
Master craftsman	11.34%	
University of applied sciences	5.79%	
University	7.85%	
	Training	
Courses and seminars	26.72%	Participation in courses and seminars

to be continued...

...Table B.1 continued

Variable	Share/ Average	Notes
Trade fair	18.09%	Participation in trade fairs
Lecture	25.90%	Participation in lectures
On-the-job	16.70%	Initial on-the-job training
Quality circle	14.07%	Participation in quality circles
Special tasks	12.86%	Tasks aiming at extending skills
Specialist literature	26.11%	Study of work-related literature
Any kind of training	57.50%	
External training	46.74%	
Internal training	33.74%	
Professional career		
Professional experience	22.69	Years from first job until today
Company tenure	13.86	Years from starting to work for a company until today
Unemployment	27.43%	Dummy = 1 if a person was ever employed, otherwise 0
Professional status		
Unskilled blue-collar worker	15.63%	Worker without professional degree
Skilled blue-collar worker	27.17%	Worker with degree from dual apprenticeship system or full-time vocational school; reference category
Assistant foreman	3.60%	
Master/Foreman	3.25%	
Unskilled white-collar worker	2.22%	
White-collar worker with simple tasks	3.98%	
White-collar worker with difficult tasks	11.36%	
High-skilled white-collar worker	16.00%	
Executive white-collar worker	4.96%	
Workplace characteristics		
Computer work station	48.21%	Work routine includes using the computer
Temporary work	4.87%	
Overtime	78.34%	Dummy = 1 if a person works overtime, otherwise 0
Profit-sharing	7.94%	
Incentive wage	21.62%	
Job content		13 Categories: training, procurement, testing, organisation, marketing, developing, manufacturing, negotiating, supervising, research, repairing, counselling, monitoring
Individual characteristics		
Children	51.37%	Dummy = 1 if a person has at least one child, otherwise 0
Foreigner	5.43%	Dummy = 1 if a person does not have German nationality, otherwise 0
Identifying variables		
Technical restructuring	24.68%	
Organisational restructuring	15.77%	
Employer characteristics		
Size of firm		7 Categories: number of employees is 1-4, 5-9, 10-49 (reference category), 50-99, 100-499, 500-999, 1000 and more
Federal state		11 Categories: all federal states of West Germany
Economic sector		46 Categories
Good economic situation	59.04%	Dummy = 1 if the company is in good economic situation, otherwise 0

Table B.2. Extended Mincer equations, all sectors, endogenous variable: log earnings

	OLS		**OLS with interaction terms**		**IV**	
Exogenous variables	**Coeff.**	**t-value**	**Coeff.**	**t-value**	**Coeff.**	**t-value**
Training	0.09	12.98	0.11	13.53	0.15	3.42
Professional experience	0.02	14.70	0.01	6.97	0.02	14.2
Professional experience (squared)	0.00	-10.62	0.00	-6.21	0.00	-9.94
Company tenure	0.01	6.74	0.01	6.09	0.01	6.50
Company tenure (squared)	0.00	-2.62	0.00	-2.55	0.00	-2.61
Firm size 1-4	-0.05	-3.23	-0.09	-3.04	-0.06	-3.29
Firm size 5-9	-0.06	-5.34	-0.08	-4.75	-0.06	-5.38
Firm size 50-99	0.04	3.75	0.01	0.82	0.03	3.72
Firm size 100-499	0.07	8.62	0.05	3.54	0.07	8.48
Firm size 500-999	0.08	6.99	0.07	3.17	0.08	6.68
Firm size 1000 and above	0.11	11.87	0.09	5.35	0.11	11.77
Lower secondary school	-0.05	-6.36	-0.01	-0.74	-0.04	-4.98
Entrance exam for university of applied sciences	0.12	9.57	0.07	1.85	0.12	11.22
High-school diploma	0.13	11.29	0.10	3.48	0.13	11.14
Without school-leaving certificate	-0.04	-1.36	0.00	0.08	-0.03	-0.98
Without professional degree	-0.10	-4.34	-0.12	-3.17	-0.09	-3.95
Dual apprenticeship	-0.01	-0.47	0.00	-0.10	-0.01	-0.59
Master craftsman	0.10	4.69	0.07	1.68	0.09	4.10
University of applied sciences	0.13	5.36	0.13	2.42	0.12	4.87
University	0.28	11.97	0.25	04.70	0.27	11.11
Unemployment	-0.04	-5.61	-0.03	-2.53	-0.04	-5.71
Computer	0.11	15.41	0.08	6.13	0.09	7.24
Temporary work	-0.09	-5.95	-0.06	-2.58	-0.09	-5.77
Good economic situation	0.07	11.14	0.05	4.82	0.07	11.50
Overtime work	0.08	11.32	0.07	6.27	0.08	9.53
Profit-sharing	0.12	9.44	0.05	2.70	0.12	9.27
Incentive wage	0.03	4.74	0.05	3.79	0.03	3.97
East Germany	-0.30	-36.15	-0.29	-17.63	-0.31	-35.00
Constant	7.81	302.23	7.85	173.96	7.79	251.51
Interaction terms						
Professional experience			0.00	1.91		
Professional experience (squared)			0.00	-0.22		
Company tenure			-0.01	-2.80		
Company tenure (squared)			0.00	1.35		
Firm size 1-4			0.05	1.36		
Firm size 5-9			0.03	1.59		
Firm size 50-99			0.04	1.77		
Firm size 100-499			0.03	1.61		
Firm size 500-999			0.02	0.69		

to be continued...

...Table B.2 continued

	OLS		OLS with interaction terms		IV	
Exogenous variables	**Coeff.**	**t-value**	**Coeff.**	**t-value**	**Coeff.**	**t-value**
Firm size 1000 and above			0.03	1.33		
Lower secondary school			-0.06	-4.23		
Entrance exam for university of applied sciences			0.06	1.53		
High-school diploma			0.05	1.53		
Without school-leaving certificate			-0.12	-1.45		
Without professional degree			0.03	0.59		
Dual apprenticeship			-0.02	-0.41		
Master craftsman			0.02	0.53		
University of applied sciences			-0.02	-0.39		
University			0.02	0.31		
Unemployment			-0.01	-0.83		
Computer			0.04	2.57		
Temporary work			-0.04	-1.37		
Good economic situation			0.02	1.99		
Overtime work			0.02	1.20		
Profit-sharing			0.08	2.88		
Incentive wage			-0.02	-1.41		
East Germany			-0.03	-1.43		
N	12,557		12,557		12,557	
R^2	0.46		0.47		0.46	

Source: BiBB-IAB 1998/99, own calculations.

Table B.3. Descriptive statistics – Average values and shares

Variables	Personal services sector	All sectors
Earnings (in euro)	2,272	2,346
Professional experience	20.63	22.30
Company tenure	9.73	12.77
Firm size 1-4	0.09	0.05
Firm size 5-9	0.13	0.09
Firm size 50-99	0.12	0.13
Firm size 100-499	0.16	0.21
Firm size 500-999	0.06	0.07
Firm size 1000 and above	0.11	0.14
Lower secondary school	0.37	0.43
Intermediate secondary school	0.33	0.32
Entrance examination for university of applied sciences	0.08	0.08
High-school diploma	0.21	0.17
Without school-leaving certificate	0.01	0.01
Without professional degree	0.11	0.10
Full-time vocational school	0.03	0.02
Dual apprenticeship	0.59	0.59
Master craftsman	0.09	0.12
University of applied sciences	0.07	0.07
University	0.11	0.10
Previously unemployed	0.34	0.30
Computer	0.54	0.50
Temporary work	0.09	0.06
Good economic situation of employer	0.52	0.56
Overtime work	0.81	0.81
Profit-sharing	0.11	0.08
Incentive wage	0.17	0.22

Source: BiBB-IAB 1998/99, own calculations.

Table B.4. Used variables in section 3.3

Variable	Share/Average	Notes
	Earnings	
Less than 600 DM	0.09%	
Between 600 and 1,000 DM	0.12%	
Between 1,000 and 1,500 DM	0.32%	
Between 1,500 and 2,000 DM	1.20%	
Between 2,000 and 2,500 DM	4.24%	
Between 2,500 and 3,000 DM	7.54%	
Between 3,000 and 3,500 DM	11.98%	

to be continued...

...Table B.4 continued

Variable	Share/Average	Notes
Between 3,500 and 4,000 DM	14.75%	
Between 4,000 and 4,500 DM	14.13%	
Between 4,500 and 5,000 DM	12.19%	
Between 5,000 and 5,500 DM	8.14%	
Between 5,500 and 6,000 DM	7.15%	
Between 6,000 and 7,000 DM	7.15%	
Between 7,000 and 8,000 DM	4.04%	
Between 8,000 and 9,000 DM	2.70%	
Between 9,000 and 10,000 DM	1.51%	
Between 10,000 and 15,000 DM	2.22%	
15,000 DM and more	0.53%	
School attainment		
Without school-leaving certificate	2.28%	
Lower secondary school	51.33%	
Intermediate secondary school	25.20%	
Entrance examination for university of applied sciences	7.93%	
High-school diploma	13.25%	
Vocational training		
Without professional degree	12.08%	
Full-time vocational school	2.37%	Several years of professional training in school
Dual apprenticeship	61.30%	Several years of professional training in school and on-the-job
Master craftsman	12.64%	
University of applied sciences	4.92%	
University	6.35%	
Training		
Training	58.08%	
Professional career		
Professional experience	21.87	Years from first job until today
Company tenure	12.91	Years from starting to work for a company until today
Unemployment	29.85%	Dummy = 1 if a person was ever employed, otherwise 0
Workplace characteristics		
Computer work station	49.37%	Work routine includes using the computer
Temporary work	49.36%	
Good economic situation	63.25%	
Working hours	177.21	Working hours per month
Overtime	79.95%	Dummy = 1 if a person works overtime, otherwise 0
Paid overtime	35.93%	
Overqualified	36.50%	

to be continued...

...Table B.4 continued

Variable	Share/Average	Notes
Profit-sharing	9.20%	
Incentive wage	24.11%	
Good economic situation	63.25%	Dummy = 1 if the company is in good economic situation, otherwise 0
Modern job	12.06%	
Individual characteristics		
Children	48.51%	Dummy = 1 if a person has at least one child, otherwise 0
Foreigner	5.43%	Dummy = 1 if a person does not have German nationality, otherwise 0
Not married	7.33%	
Handicapped	4.85%	
Other Variables		
Size of firm		7 categories
Professional status		12 categories
Federal state		11 categories
Economic sector		5 categories

Table B.5. Explanation of training incidence, probit model, endogeneous variable: Training dummy

Explanatory variables	Personal services sector		Entire economy	
	Coeff.	t-value	Coeff.	t-value
Technical restructuring	0.23	2.83	0.35	11.24
Organisational restructuring	0.36	3.57	0.25	6.42
Professional experience	0.01	0.92	0.02	3.78
Professional experience (squared)	0.00	-1.11	0.00	-4.86
Company tenure	0.00	0.28	0.01	2.11
Company tenure (squared)	0.00	-0.13	0.00	-0.45
Firm size 1-4	-0.04	-0.34	0.05	0.91
Firm size 5-9	0.06	0.61	0.06	1.38
Firm size 50-99	-0.02	-0.20	0.00	-0.07
Firm size 100-499	0.11	1.16	0.00	-0.13
Firm size 500-999	0.23	1.70	0.12	2.28
Firm size 1000 and above	-0.20	-1.76	-0.01	-0.14
Lower secondary school	-0.21	-2.74	-0.22	-7.14
Entrance exam for university of applied sciences	0.11	0.86	0.25	4.21
High-school diploma	0.02	0.14	0.12	2.35
Without school-leaving certificate	-0.36	-1.13	-0.39	-3.04
Without professional degree	-0.67	-3.32	-0.33	-3.94
Dual apprenticeship	-0.14	-0.76	0.07	0.87

to be continued...

...Table B.5 continued

	Coeff.	**t-value**	**Coeff.**	**t-value**
Master craftsman	0.40	1.87	0.50	5.91
University of applied sciences	0.21	0.93	0.48	5.70
University	0.45	2.70	0.61	1.42
Unemployment	-0.02	-0.25	0.01	0.21
Computer	0.52	7.41	0.63	22.70
Temporary work	-0.19	-1.71	-0.09	-1.74
Good economic situation	-0.15	-2.34	-0.11	-4.26
Overtime work	0.35	4.76	0.24	8.22
Profit-sharing	0.21	1.92	0.08	1.62
Incentive wage	0.21	2.43	0.15	4.84
East Germany	0.20	2.26	0.18	5.21
Constant	-0.06	-0.27	-0.45	-4.72
N	2,289		14,521	
Pseudo R^2	0.18		0.19	

Source: BiBB-IAB 1998/99, own calculations.

Table B.6. Estimation results for the propensity score

Parameters		Estimates	z-values
Training intensity in 1991		1.26	5.29
Bargaining agreement		1.84	3.03
Modern job		0.18	3.42
Lower secondary school		0.29	1.91
Intermediate secondary school		0.29	1.92
Entrance examination for university of applied sciences		0.30	1.91
High-school diploma		0.23	1.43
Full-time vocational school		0.01	0.07
Dual apprenticeship		0.19	2.58
Master craftsman		0.23	2.61
University of applied sciences		0.21	2.00
University		0.10	0.90
Professional experience		0.05	0.72
Company tenure		0.35	5.02
Unemployment		-0.00	-0.11
Computer work station		0.36	7.59
Temporary work		-0.24	-2.52
Paid overtime		-0.03	-0.76
Working hours		0.34	4.34
Overqualified		-0.03	-0.69
Profit-sharing		0.04	0.59
Incentive wage		0.13	3.04
Good economic situation		-0.02	-0.43
Children		0.08	2.00
Not married		0.01	0.12
Handicapped		0.01	0.10
Constant		-3.37	-11.52
Number of Observation	7,417		
LR χ^2 (72)	1987.10		

Dummy variables are included for size of firm, professional status, federal state, and economic sector. Instruments included are: technical restructuring, organisational restructuring, three measures of personnel restructuring (hiring of additional workers, downsizing, and hiring of temporary workers), a dummy variable indicating whether workers are employed in a modern job, and sectoral shares of firms by employment size that include continuous training in their collective bargaining agreement.

Fig. B.1. Training participation by age group

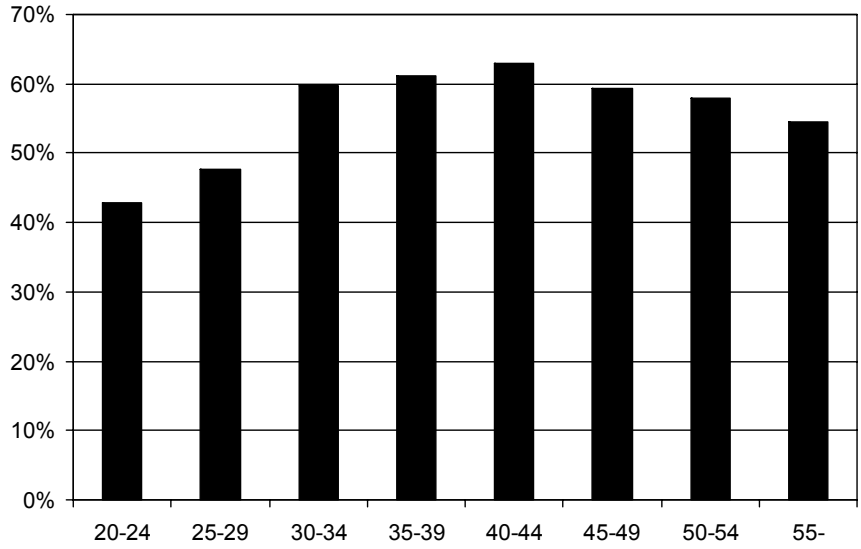


Table B.7. Selection into training (probit)

Endogenous Variables	**Training**	**External Training**	**Internal Training**
Identifying variables			
Technical restructuring	0.32***	0.31***	0.23***
	(0.04)	(0.04)	(0.03)
Organisational restructuring	0.17***	0.10**	0.27***
	(0.05)	(0.05)	(0.04)
Education and vocational training			
School attainment			
Without school-leaving certificate	-0.02	-0.23**	0.10
	(0.11)	(0.11)	(0.10)
Lower secondary school	-0.07*	-0.12***	-0.01
	(0.04)	(0.04)	(0.04)
Entrance examination for	0.10	0.16**	-0.07
university of applied sciences	(0.07)	(0.07)	(0.06)
High-school diploma	-0.11*	-0.03	-0.09
	(0.07)	(0.07)	(0.06)
Professional education			
Without professional degree	-0.14	-0.29***	-0.15
	(0.10)	(0.11)	(0.10)

to be continued...

...Table B.7 continued

Endogenous Variables	**Training**	**External Training**	**Internal Training**
Apprenticeship	0.04	0.03	-0.07
	(0.10)	(0.10)	(0.09)
Master craftsman	0.29***	0.28**	-0.07
	(0.11)	(0.11)	(0.10)
University of applied sciences	0.29**	0.30**	-0.06
	(0.12)	(0.12)	(0.11)
University	0.25*	0.24*	-0.13
	(0.13)	(0.13)	(0.12)
Professional career			
Professional experience	0.00	0.00	-0.00
	(0.01)	(0.01)	(0.01)
Professional experience^2	-0.00*	-0.00	-0.00
	(0.00)	(0.00)	(0.00)
Company tenure	0.04***	0.04***	0.01**
	(0.01)	(0.01)	(0.01)
Company tenure^2	-0.00***	-0.00***	-0.00*
	(0.00)	(0.00)	(0.00)
Unemployment	0.05	0.00	0.02
	(0.04)	(0.04)	(0.04)
Professional status			
Skilled blue-collar worker	0.17***	0.29***	0.10*
	(0.05)	(0.06)	(0.05)
Assistant foreman	0.41***	0.40***	0.41***
	(0.09)	(0.09)	(0.09)
Master/Foreman	0.34***	0.57***	0.04
	(0.10)	(0.10)	(0.10)
Unskilled white-collar worker	0.10	0.21*	-0.12
	(0.10)	(0.11)	(0.11)
White-collar worker with simple tasks	0.13	0.14	0.02
	(0.08)	(0.09)	(0.09)
White-collar worker with difficult tasks	0.39***	0.49***	0.23***
	(0.07)	(0.07)	(0.07)
High-skilled white-collar worker	0.58***	0.77***	0.17**
	(0.07)	(0.07)	(0.07)
Executive white-collar worker	0.47***	0.64***	0.01
	(0.10)	(0.10)	(0.09)
Civil servant in clerical grade	0.35***	0.51***	0.30***
	(0.10)	(0.10)	(0.09)
Civil servant in higher service	0.78***	0.88***	0.20*
	(0.13)	(0.12)	(0.11)
Civil servant in senior service	0.98***	1.16***	0.01
	(0.18)	(0.17)	(0.13)
Workplace characteristics			
Computer work station	0.29***	0.29***	0.24***
	(0.04)	(0.04)	(0.04)

to be continued...

...Table B.7 continued

Endogenous Variables	**Training**	**External Training**	**Internal Training**
Temporary work	-0.27***	-0.23***	-0.21***
	(0.08)	(0.08)	(0.08)
Overtime	0.16***	0.13***	0.15***
	(0.04)	(0.04)	(0.04)
Incentive wage	0.17***	0.05***	0.19***
	(0.04)	(0.06)	(0.04)
Individual characteristics			
Children	0.13***	0.10***	0.10***
	(0.03)	(0.03)	(0.03)
Foreigner	-0.27***	-0.26***	-0.10
	(0.08)	(0.08)	(0.07)
Firm size			
1-4	0.05	0.14*	-0.24***
	(0.07)	(0.08)	(0.08)
5-9	0.02	0.11*	-0.17***
	(0.06)	(0.06)	(0.06)
50-99	0.02	-0.04	0.05
	(0.05)	(0.05)	(0.05)
100-499	0.06	0.01	0.14***
	(0.04)	(0.05)	(0.04)
500-999	0.19***	0.18***	0.17***
	(0.06)	(0.07)	(0.06)
1,000 and above	0.11**	0.03	0.15***
	(0.05)	(0.05)	(0.05)
Number of Observations	9,723	9,723	9,723
LR χ^2	2708.27	3149.59	1356.47
Pseudo R^2	0.27	0.33	0.12

Remarks: Between brackets are the heterogeneity robust standard errors. Also included: 13 dummies for job content, 46 dummies for economic sector and 11 dummies for the federal state.
Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table B.8. Descriptive statistics of the estimated propensity score

	Percentiles	**Smallest**		
1%	0.0099	0.0012		
5%	0.0241	0.0017		
10%	0.0374	0.0026	Obs	7,417
25%	0.0799	0.0026	Sum of Wgt.	
50%	0.2181		Mean	0.2824
		Largest	Std. Dev.	0.2267
75%	0.4526	0.9133		
90%	0.6308	0.9143	Variance	0.0514
95%	0.7106	0.9187	Skewness	0.6676
99%	0.8161	0.9453	Kurtosis	2.3065

Table B.9. Correlations between types of training and income

	Trade Fair	**Lecture**	**Spec. Litera-ture**	**On-the-Job**	**Quality Circle**	**Special Tasks**	**Semi-nars/ Courses**	**Income**
Trade fair	1.00							
Lecture	0.41	1.00						
Specialist literature	0.41	0.49	1.00					
On-the-job	0.06	0.11	0.11	1.00				
Quality circle	0.13	0.20	0.21	0.16	1.00			
Special tasks	0.16	0.24	0.24	0.19	0.17	1.00		
Courses and seminars	0.26	0.50	0.36	0.12	0.28	0.24	1.00	
Income	0.31	0.38	0.38	0.03	0.19	0.19	0.31	1.00

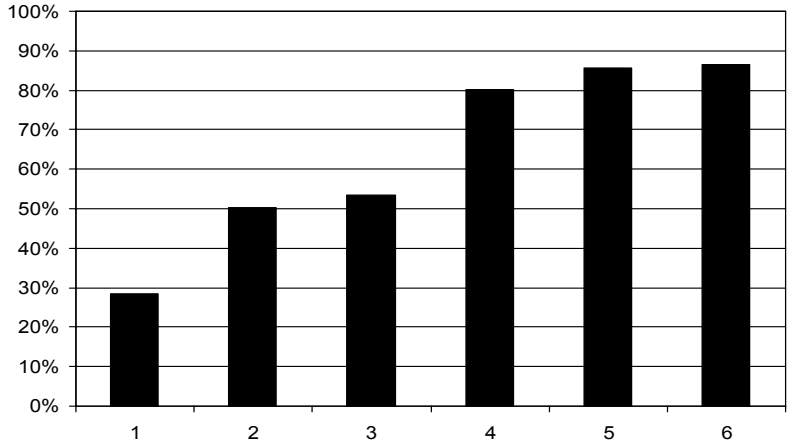
Remark: Correlations are all significant at 5% level.
Source: BiBB-IAB 1998/99, own calculations.

Table B.10. Rotated component matrix[a] of factor analysis: Types of training

Factor	**Factor value**	**Variables**	**Factor loadings**[b]
1: External training	2.54	Trade fair	0.78 (-0.22)
		Lecture	0.81 (-0.01)
		Specialist literature	0.76 (-0.00)
		Courses and seminars	0.61 (0.20)
2: Internal training	1.07	On-the-job	0.81 (-0.19)
		Quality circle	0.55 (0.14)
		Special tasks	0.53 (0.19)

Notes: [a] The factors have been rotated by promax.
[b] In the brackets, you find the factor loading of the factor not chosen.
Source: BiBB-IAB 1998/99, own calculations.

Fig. B.2. Training participation by qualification group



1: Without Professional Degree
2: Full-Time Vocational School
3: Dual Apprenticeship
4: Master Craftsman
5: University of Applied Sciences
6: University

C Further Tables and Figures for Chapter 4

Table C.1. Used variables in chapter 4

Variable	Share/ Average	Notes
School attainment		
Without school-leaving certificate	2.01%	
Lower secondary school	36.45%	
Intermediate secondary school	35.56%	Reference category
Entrance to university of applied sciences	7.24%	
High-school diploma	18.73%	
Vocational training		
Without professional degree	10.15%	
Full-time vocational school	2.22%	Several years of professional training in school; reference category
Dual apprenticeship	59.30%	Several years of professional training in school and on-the-job
Master craftsman	10.46%	
University of applied sciences	6.42%	
University	10.66%	
Training		
Courses and seminars	43.86%	Participation in courses and seminars during the last 5 years
Courses and seminars before 1997	16.77%	Participation in courses and seminars before 1997
Professional career		
Professional experience	21.02	Years from first job until today
Company tenure	11.76	Years from starting to work for a company until today
Unemployment	30.37%	Dummy = 1 if a person was ever employed, otherwise 0
Professional status		
Unskilled blue-collar worker	11.90%	Worker without professional degree
Skilled blue-collar worker	18.53%	Worker with degree from dual apprenticeship system or full-time vocational school; reference category
Assistant foreman	2.52%	
Master/Foreman	2.18%	
Unskilled white-collar worker	3.68%	
White-collar worker with simple tasks	8.35%	

to be continued...

...Table C.1 continued

Variable	Share/ Average	Notes
White-collar worker with difficult tasks	18.57%	
High-skilled white-collar worker	19.50%	
Executive white-collar worker	5.53%	
Job change	69.40%	
Job change after training	11.26%	Dummy = 1 if there is job change after training, dummy = 0 if there is training and no job change after
Training	23.54%	Dummy = 1 if training takes place before possible job change; dummy = 0 if there is no training
Job change (1984-1994)	63.91%	Job change between 1984 and 1994
Job change after 1994	22.64%	
Training before 1997	16.77%	
Occupational change	32.90%	
Occupational change after training	5.80%	
Task change	28.86%	
Task change after training	9.22%	
Number of employers		5 categories: 1, 2, 3, 4, 5 or more
Task change after training	9.22%	
Occupational change (health)	1.81%	Occupational change for health reasons
Occupational change (family)	2.64%	Occupational change for family reasons
Firm failure	14.72%	
Workplace characteristics		
Computer work station	54.59%	Work routine includes using the computer
Temporary work	7.77%	
Overtime	78.50%	Dummy = 1 if a person works overtime, otherwise 0
Profit-sharing	7.64%	
Incentive wage	19.13%	
Working hours	4.14	
Job content		13 categories: training, procurement, testing, organisation, marketing, developing, manufacturing, negotiating, supervising, research, repairing, counselling, monitoring
Individual characteristics		
Children	45.39%	Dummy = 1 if a person has at least one child, otherwise 0
Child < 6 years	14.92%	Dummy = 1 if a person has at least one child below 6 years, otherwise 0
Child 6 to 17 years	28.94%	Dummy = 1 if a person has at least one child above 6 and below 17 years, otherwise 0
Child > 18 years	10.84%	Dummy = 1 if a person has at least one child above 18 years, otherwise 0
Foreigner	5.43%	Dummy = 1 if a person does not have German nationality, otherwise 0
Not married	8.42%	
Female	32.24%	
Handicapped	3.78%	
Partner employed	38.51%	
Size of household		3 categories: 2, 3 or 4 household members
Identifying variables		
Technical restructuring	24.68%	

to be continued...

...Table C.1 continued

Variable	Share/ Average	Notes
Organisational restructuring	15.77%	
Restructuring	2.33	Number of restructuring measures (1997/98)
Need for training	1.13	Number of areas with a subjective need for training
Instrument1	9.05	Share of firms, where training is part of the collective agreement (industrial level)
Employer characteristics		
Size of firm		7 categories: number of employees is 1-4, 5-9, 10-49 (reference category), 50-99, 100-499, 500-999, 1000 and more
East Germany	19.80%	
Economic sector		47 categories
Trade sector	12.30%	
Industrial sector	25.80%	
Private household sector	0.36%	
Public service sector	26.95%	
Handcraft sector	17.45%	
Agricultural sector	1.34%	
Good economic situation	80.82%	Dummy = 1 if the company is in a good economic situation, otherwise 0

Table C.2. First stage: Probit model for participation in training

Variable	Coeff.	Std. err.
Training in 1991	0.42**	0.18
Individual characteristics		
More than two previous employers	0.11***	0.03
Professional experience	0.03***	0.01
Professional experience (squared)	-0.00***	0.00
Unemployment	0.10***	0.03
Age	0.00	0.01
Lower secondary school	-0.16***	0.04
Entrance to university for applied sciences	-0.07	0.07
High-school diploma	0.01	0.06
Without school-leaving certificate	-0.10	0.11
Without professional degree	-0.22***	0.05
University for applied sciences	-0.04	0.07
University	-0.07	0.07
Other controls		
Not married, East Germany, household size (3), sex, children, full-time vocational school, master craftsman, temporary work, computer work station, size of firm (6), white-collar worker, economic sectors (4), overtime, profit-sharing, incentive wage, working hours, partner employed, occupational change (2), restructuring, need for training.		
Intercept	-2.59***	0.18
Observations	12,578	
Log-likelihood	-4981.65	
$\chi^2_{(41)}$	1042.04	

In parentheses are the number of dummies included.
Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table C.3. First stage: Probit model for employer change. Children between 6 and 17 and employed dummy for partner as instruments

Variable	Coeff.	Std. err.
Partner employed	-0.23*	0.12
Child 6 to 17 years	0.12	0.09
Individual characteristics		
More than two previous employers	0.14	0.09
Professional experience	-0.02	0.02
Professional experience (squared)	0.00	0.00
Company tenure	-0.38***	0.08
Company tenure (squared)	-0.03**	0.01
Unemployment	0.37***	0.08
Age	0.01	0.01
Lower secondary school	0.04	0.10
Entrance to university of applied sciences	-0.18	0.14
High-school diploma	0.09	0.12
Without school-leaving certificate	-0.01	0.25
Without professional degree	-0.08	0.16
University of applied sciences	-0.07	0.15
University	-0.23*	0.14
Other Controls		
Not married, foreigner, handicapped, East Germany, household size (3), sex, children, full-time vocational school, master craftsman, temporary work, computer work station, size of firm (6), white-collar worker, economic sectors (47), overtime, profit-sharing, incentive wage, working hours, partner employed, occupational change (2), firm failure, restructuring, need for training.		
Intercept	0.88	0.63
Observations	5,026	
Log-likelihood	-868.11	
$\chi^2_{(87)}$	775.61	

In parentheses are the number of dummies included.
Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table C.4. Non-participants in training: Correlation between job change and wages

Variable	Coeff.	Std. err.
Job Change after 1994	0.00	0.01
Individual characteristics		
More than two previous employers	0.04***	0.01
Professional experience	0.01***	0.00
Professional experience (squared)	0.00***	0.00
Company tenure	0.01***	0.00
Company tenure (squared)	0.00	0.00
Unemployment	-0.05***	0.01
Age	0.01***	0.00
Lower secondary school	-0.03***	0.01
Entrance to university of a0pplied sciences	0.08***	0.02
High-school diploma	0.06***	0.02
Without school-leaving certificate	0.01	0.02
Without professional degree	-0.09***	0.01
University of applied sciences	0.13***	0.02
University	0.24***	0.02
Other Controls		
Not married, foreigner, handicapped, East Germany, household size (3), sex, children, full-time vocational school, master craftsman, temporary work, computer work station, size of firm (6), professional position (2), economic sectors (47), overtime, profit-sharing, incentive wage, working hours, occupational change (2).		
Intercept	7.54***	0.08
Observations	9,305	
R^2	0.42	
$F_{(86,9218)}$	69.37	

In parentheses are the number of dummies included.
Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table C.5. First stage: Probit model for employer change. Children between 6 and 17 and employed dummy for partner as instruments

Variable	Coeff.	Std. err.
Partner employed	0.33***	0.11
Child 6 to 17 years	-0.45***	0.13
Individual characteristics		
More than two previous employers	1.09***	0.09
Professional experience	0.24***	0.02
Professional experience (squared)	-0.01***	0.00
Company tenure	1.76***	0.11
Company tenure (squared)	-0.47***	0.02
Unemployment	0.49***	0.08
Age	0.02*	0.01
Lower secondary school	0.08	0.09
Entrance to university of applied sciences	0.18	0.16
High-school diploma	-0.05	0.13
Without school-leaving certificate	-0.39*	0.22
Without professional degree	-0.31***	0.10
University of applied sciences	-0.09	0.19
University	-0.02	0.17
Other Controls		
Not married, foreigner, handicapped, East Germany, household size (3), sex, children, full-time vocational school, master craftsman, temporary work, computer work station, size of firm (6), white-collar worker, economic sectors (47), overtime, profit-sharing, incentive wage, working hours, occupational change (2).		
Intercept	-0.60	0.47
Observations	10,723	
Log-likelihood	-904.77	
$\chi^2_{(87)}$	893.68	

In parentheses are the number of dummies included.
Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Table C.6. Non-participants in training: IV estimates of the effect of job change on wages

Variable	Coeff.	Std. err.
Job Change after 1994	-0.01	0.01
Individual characteristics		
More than two previous employers	0.04***	0.01
Professional experience	0.01***	0.00
Professional experience (squared)	0.00***	0.00
Company tenure	0.01***	0.00
Company tenure (squared)	0.00	0.00
Unemployment	-0.05***	0.01
Age	0.01***	0.00
Lower secondary school	-0.03***	0.01
Entrance to university for applied sciences	0.08***	0.02
High-school diploma	0.06***	0.02
Without school-leaving certificate	0.01	0.02
Without professional degree	-0.09***	0.01
University for applied sciences	0.13***	0.02
University	0.24***	0.02
Other Controls		
Not married, foreigner, handicapped, East Germany, household size (3), sex, children, full-time vocational school, master craftsman, temporary work, computer Work station, size of firm (6), professional position (2), economic sectors (47), overtime, profit-sharing, incentive wage, working hours, occupational change (2).		
Intercept	7.55***	0.08
Observations	9,305	
R^2	0.42	
$F_{(86,9218)}$	69.38	

In parentheses are the number of dummies included.
Significance levels: $*$: 10% $**$: 5% $***$: 1%.

D Further Tables and Figures for Chapter 5

Table D.1. Means and standard deviations

Variable	Mean	Std. Dev.	Observations
Wage (in logs)	2.90	0.17	406
Value added (in logs)	-3.19	0.47	382
Training	0.03	0.02	406
Capital (in logs)	-3.49	0.84	364
Investments (in logs)	-5.17	0.85	385
Labour (in logs)	-3.51	1.05	385
Job change	0.10	0.03	406
High skilled	0.24	0.14	406
Women	0.44	0.21	406
East	0.03	0.01	406
Tenure 0-4	0.35	0.09	406
Tenure 5-9	0.22	0.04	406
Tenure 10-14	0.13	0.03	406
Tenure 15-19	0.08	0.02	406
Tenure 20-29	0.13	0.05	406
Tenure 30-39	0.05	0.02	406
Tenure 40-51	0.01	0.01	406
Age 17-20	0.01	0.01	406
Age 21-25	0.07	0.02	406
Age 26-30	0.12	0.02	406
Age 31-35	0.15	0.02	406
Age 36-40	0.16	0.02	406
Age 41-50	0.27	0.03	406
Age 51-65	0.22	0.04	406

Table D.2. Training intensity by economic sector

Sector	Training (in %)
Education and teaching	0.07
Activities connected with banking and insurance industry	0.06
Health care, veterinary medicine, and welfare	0.06
Insurance industry	0.06
Banking sector	0.06
Lobbies, churchly and other religious unions	0.05
Data handling and databases	0.05
Manufacture of office machines and data-handling equipment	0.05
Civil service, defence, social insurance	0.05
Research and development	0.04
Aviation	0.04
Energy supply	0.04
Coking plant and petroleum processing	0.03
Chemical industry	0.03
Water supply	0.03
Broadcast, television, and communications engineering	0.03
Services mainly for establishments	0.03
Manufacture of electricity production and allocation equipment	0.03
Premises and housing	0.03
Telecommunications	0.03
Culture, sport, and entertainment	0.03
Manufacture of automobiles and automobile particles	0.03
Other vehicle construction	0.03
Medical technology, measurement, control technology, optics	0.02
Other services	0.02
Extraterritorial organisations and statutory corporations	0.02
Engineering	0.02
Extraction of crude oil and natural gasoline and services connected with it	0.02
Forestry	0.02
Automobile trade, maintenance and mending of automobiles, petrol station	0.02
Tobacco processing	0.02
Land transport, transport via pipelines	0.02
Metal production and machining	0.02
Commerce intermediation and wholesale	0.02
Publisher and print trade, duplication of played Sound storage medium, picture and record carrier	0.02
Waste, sewage, and other disposal	0.02

to be continued...

...Table D.2 continued

Sector	Training (in %)
Coal mining, extraction of turf	0.02
Auxiliary activities and additional businesses for traffic, traffic intermediation	0.02
Manufacture of vulcanised rubber and plastic goods	0.02
Retail, mending	0.02
Manufacture of metal products	0.02
Glass trade, ceramics, processing of stones and earthen	0.02
Paper trade	0.01
Construction	0.01
Wood trade	0.01
Textile processing	0.01
Extraction of stones and earthen, other mining	0.01
Navy	0.01
Agriculture and hunting	0.01
Clothing trade	0.01
Manufacture of furniture, jewelry, musical instruments, pieces of sports equipment, and other manufactures	0.01
Renting of chattels without operating staff	0.01
Hotel and restaurant industry	0.01
Nutrition trade	0.01
Recycling	0.01
Private households	0.01
Leather trade	0.01
Fishery and fish farming	0.00

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ECONOMIC SECTORS	
Activities connected with banking and insurance industry	Kredit- und Versicherungshilfsgewerbe
Agriculture and hunting	Landwirtschaft und Jagd
Automobile trade, maintenance and mending of automobiles, petrol station	Kraftfahrzeughandel; Reparatur von Kraftfahrzeugen; Tankstellen
Auxiliary activities and additional businesses for traffic, traffic intermediation	Hilfs- und Nebentätigkeit für den Verkehr u.Ä.
Aviation	Luftfahrt
Banking sector	Kreditgewerbe
Broadcast, television, and communications engineering	Rundfunk-, Fernseh- und Nachrichtentechnik
Chemical industry	Chemische Industrie
Civil service, defence, social insurance	Öffentliche Verwaltung, Verteidigung, Sozialversicherung
Clothing trade	Bekleidungsgewerbe
Coal mining, extraction of turf	Kohlebergbau, Torfgewinnung
Coking plant and petroleum processing	Kokerei, Mineralölverarbeitung, Herstellung von Brutstoffen
Commerce intermediation and wholesale	Handelsvermittlung und Großhandel (ohne Handel mit Kraftfahrzeugen)
Construction	Baugewerbe
Culture, sport, and entertainment	Kultur, Sport und Unterhaltung
Data handling and databases	Datenverarbeitung und Datenbanken
Education and teacing	Erziehung und Unterricht
Energy supply	Energieversorgung
Engineering	Maschinenbau
Extraction of crude oil and natural gasoline and services connected with it	Gewinnung von Erdöl und Erdgas; Erbringung damit verbundener Dienstleistungen
Extraction of stones and earthen, other mining	Erzbergbau, Gewinnung von Steinen und Erden, sonstiger Bergbau

Extraterritorial organisations and statutory corporations	Ausländische Organisationen und Körperschaften
Fishery and fish farming	Fischerei und Fischzucht
Forestry	Forstwirtschaft
Glass trade, ceramics, processing of stones and earthen	Glasgewerbe, Keramik, Verarbeitung von Steinen und Erden
Health care, veterinary medicine, and welfare	Gesundheits-, Veterinär- und Sozialwesen
Hotels and restaurant industry	Gastgewerbe
Insurance industry	Versicherungsgewerbe
Land transport, transport via pipelines	Landverkehr; Transport in Rohrfernleitungen
Leather trade	Ledergewerbe
Lobbies, churchly and other religous unions	Interessenvertretungen, kirchliche und religiöse Vereinigungen
Manufacture of automobiles and automobile particles	Herstellung von Kraftwagen und Kraftwagenteilen
Manufacture of electricity production and allocation equipment	Herstellung von Geräten der Elektrizitätserzeugung, -Verteilung u.ä.
Manufacture of furniture, jewellery, musical instruments, etc.	Herstellung von Möbeln, Schmuck, Musikinstrumenten usw.
Manufacture of metal products	Metallerzeugung und -Bearbeitung, Herstellung von Metallerzeugnissen
Manufacture of office machines and data-handling equipment	Herstellung von Büromaschinen, Datenverarbeitungsgeräten und -einrichtungen
Manufacture of vulcanised rubber and plastic goods	Herstellung von Gummi- und Kunststoffwaren
Medical technology, measurement, control technology, optics	Medizin-, Mess-, Steuer- und Regelungstechnik; Optik
Metal production and machining	Herstellung von Metallerzeugnissen
Navy	Schifffahrt
Nutrition trade	Ernährungsgewerbe
Other services	Sonstige Dienstleister
Paper trade	Papiergewerbe
Pieces of sports equipment	Herstellung von Sportgeräten
Premises and housing	Grundstücks- und Wohnungswesen
Private households	Privathaushalte
Publisher and print trade, duplication of played	Verlags-, Druckgewerbe, Vervielfältigung
Recycling	Recycling
Renting of chattels without operating staff	Vermietung beweglicher Sachen ohne Bedienungspersonal
Research and development	Forschung und Entwicklung
Retail, mending	Einzelhandel (ohne Kraftfahrzeuge); Reparatur von Gebrauchsgütern
Services mainly for establishments	Dienstleister überwiegend für Unternehmen

Sound storage medium, picture and record carrier	Herstellung von Tonträgern
Telecommunications	Nachrichtenübermittlung
Textile processing	Textilgewerbe
Tobacco processing	Tabakverarbeitung
Vehicle construction	Fahrzeugbau
Waste, sewage, and other disposal	Erbringung von Entsorgungsleistungen
Water supply	Wasserversorgung
Wood trade	Holzgewerbe (ohne Herstellung von Möbeln)
TRAINING	
Internship	Praktikum
Lecture	Fachvortrag
Quality circle	Qualitätszirkel
Specialist Literature	Fachliteratur
Trade fair	Fachmesse
SCHOOL ATTAINMENT	
Without school-leaving certificate	Ohne Abschluss
Lower secondary school	Hauptschule
Intermediate secondary school	Realschule
Entrance examination for university of applied sciences	Fachhochschulreife
High-school diploma	Abitur
VOCATIONAL TRAINING	
Without professional degree	Ohne Ausbildung
Full-time vocational school	Berufsfachschule
Apprenticeship	Lehre
Master craftsman	Meister
University for applied sciences	Fachhochschule
University	Universität
PROFESSIONAL STATUS	
Unskilled blue-collar worker	Angelernter Arbeiter
Skilled blue-collar worker	Facharbeiter
Assistant foreman	Vorarbeiter
Master/foreman	Meister
Unskilled white-collar worker	Ausführender Angestellter
White-collar worker with simple tasks	Angestellter mit einfacher Tätigkeit
White-collar worker with difficult tasks	Angestellter, der schwierige Aufgaben nach allgemeiner Anweisung selbständig erledigt
High-skilled white-collar worker	Angestellter, der selbständige Leistungen in verantwortungsvoller Tätigkeit erbringt oder begrenzte Verantwortung für die Tätigkeit anderer trägt

Executive white-collar worker	Angestellter mit umfassenden Führungsaufgaben und Entscheidungsbefugnissen
Civil servant in clerical grade	Beamter im einfachen oder mittleren Dienst
Civil servant in higher service	Beamter im gehobenen Dienst
Civil servant in senior service	Beamter im höheren Dienst

COUNTRY ABBREVIATIONS

A	Austria
B	Belgium
D	Germany
DK	Denmark
E	Spain
I	Italy
F	France
FIN	Finland
GR	Greece
IRL	Ireland
L	Luxembourg
NL	The Netherlands
P	Portugal
S	Sweden
UK	United Kingdom
EU15	European Union (15 countries)

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