Working Paper No. 71

How Acid are Lemons? Adverse Selection and Signalling for Skilled Labour Market Entrants

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UNIVERSITÄT BERN

Leading House Working Paper No. 71

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The Swiss Leading House on Economics of Education, Firm Behavior and Training Policies is a Research Programme of the Swiss Federal Office for Professional Education and Technology (OPET).

www.economics-of-education.ch

Non-technical Summary

A major incentive for human capital investments is the possibility to signal individual productivity gained by training not only to the present employer but also to the external labour market. There are only few empirical assessments of the capacity to signal the value of professional or occupational training, however. The most important reason for this gap in the literature is that training quality and employee productivity are not easy to measure. More specifically, prior tenure, unobservable ability and the business cycle usually have an unobservable effect on the market value of job applicants after training.

This paper for the first time presents evidence for negative selection and signals for employer changers. It uses the German dual apprenticeship system as an institution that allows us to analyse the value of signals after occupational training. Apprentices do not have prior employment experience and they are relatively homogeneous with respect to their age and schooling background given their occupation. In addition, they attend a highly standardised programme with three certificates at the end that help them to signal practical, theoretical and social skills. Finally, most apprentices start and finish their training programme at the same point in time and therefore cyclical labour demand and supply effects are the same when apprentices select themselves into a training programme and when they hit the labour market.

We distinguish signals and indices for ability from three sources: occupation, previous training employer and individual. There are quality differences between occupations and therefore we only compare apprentices with the same occupation and remove apprentices who work in a different occupation after they finish their apprenticeship from the data set. Employer changers nevertheless are associated with a different relative productivity when the occupational retention rate differs. A lower average productivity of employer changers can be assumed if employer changers are a negatively selected group because training employers know the quality of their apprentices and succeed in retaining their most able apprentices. This paper indeed shows that the higher the occupational retention rate the more negative the selection and therefore the higher the wage loss of employer changers. The same effect on entry wages for job changers is found for another group selectivity index, the retention rate of the training employer – employer changers from a training firm that retains most of their employees experience a higher wage loss. In addition, the size of the

training employer, and works councils seem to be used as signals for training quality and induce a wage bonus for employer changers. A high average apprentice wage seems to function as a signal that is costly to obtain because better paying firms can select the best apprenticeship candidates. Also according to the signalling theory, employer changers with higher schooling levels obtain a higher entry wage as skilled employees. This paper finally develops a measure for relative productivity of apprentices, their relative wage position. We argue that a wage bonus is paid voluntarily by the training firm in order to retain and motivate the most able apprentices. We indeed find that a high wage position leads to a higher chance to stay with the training firm. This again is an argument for negative selection of employer changers. In addition, a high wage position in the training firm also leads to an increase in entry wages of employer changers in the new firm – obviously the (unobservable) wage position is positively correlated with other observable signals such as certificates.

Nicht-technische Zusammenfassung

Ein wichtiger Anreizmechanismus für Humankapitalinvestitionen ist die Möglichkeit, die dabei erworbene Produktivitätserhöhung nicht nur bei dem eigenen Arbeitgeber sondern auch im externen Arbeitsmarkt zu signalisieren. Bisher gibt es allerdings nur wenige empirische Untersuchungen zur Wirkung von Signalen beruflicher Bildung sowie Weiterbildung. Der bedeutendste Grund für diese offensichtliche Literaturlücke ist, dass die Qualität der Humankapitalbildung sowie die individuelle Produktivität nicht leicht messbar sind. Konkret haben vorherige Betriebszugehörigkeit, unbeobachtete Fähigkeiten und der Wirtschaftszyklus üblicherweise einen unbeobachtbaren Effekt auf den Marktwert von Stellenbewerbern nach deren Humankapitalerwerb.

In diesem Beitrag wird zum ersten Mal gezeigt, dass ausbildende Betriebe die besten Auszubildenden an sich binden und somit Betriebswechsler nach der dualen Ausbildung eine geringere durchschnittliche Produktivität aufweisen. Betriebswechsler können ihre individuelle Produktivität aber mit Hilfe von Signalen vermitteln und damit ihren Einstiegslohn positiv beeinflussen. Das deutsche duale Berufsbildungssystem erlaubt es als Institution, den Wert von Signalen und anderen Fähigkeitsindikatoren nach der Ausbildung zu messen. Lehrlinge haben keine vorherige Berufserfahrung und sie sind relativ homogen in Bezug auf ihren Schulhintergrund. Überdies besuchen sie ein standardisiertes Ausbildungsprogramm, das mit drei Zertifikaten abgeschlossen wird, die ihnen helfen, praktische, theoretische und soziale Fähigkeiten zu signalisieren. Außerdem beginnen und beenden die meisten Auszubildenden ihre Ausbildung im gleichen Zeitraum und somit sind zyklische Arbeitsnachfrage und –angebotseffekte zum Zeitpunkt der Wahl des Ausbildungsberufs und bei der Beendigung der Ausbildung gleich.

Wir können Signale und Indikatoren aus drei Quellen unterscheiden: Beruf, ausbildendes Unternehmen und Individuum. Es gibt Qualitätsunterschiede zwischen Berufen und deshalb vergleichen wir nur Lehrlinge mit dem gleichen Beruf, die in diesem auch nach der Ausbildung arbeiten. Arbeitgeberwechsler nach der Ausbildung haben einen mehr oder weniger negativen Gruppenindikator je nach der Übernahmequote in ihrem Beruf. Wir gehen davon aus, dass Betriebswechsler weniger produktiv sind, weil die ausbildenden Unternehmen ihre Auszubildenden kennen und die Besten halten können. Deshalb ist ein Betriebswechsel umso negativer konnotiert, je höher die berufliche Übernahmequote ist. Es

kann in der Tat gezeigt werden, dass die berufliche Übernahmequote einen negativen Effekt auf den Einstiegslohn von Betriebswechslern hat. Der gleiche Effekt kann für die betriebliche Übernahmequote des Ausbildungsunternehmens nachgewiesen werden. Darüber hinaus bedeuten die Größe des Ausbildungsunternehmens und das Vorhandensein von Betriebsräten in diesen Betrieben offensichtlich einen positiven Indikator für die Ausbildungsqualität und induzieren somit einen Lohnaufschlag für Betriebswechsler. Gemäß der Signaltheorie erzielen Betriebswechsler mit einer höheren Schulbildung einen höheren Einstiegslohn. Ein höheres Lohnniveau für Auszubildende scheint ebenso ein teures Signal darzustellen - besser bezahlende Betriebe können ihre Kandidaten besser selektieren.

In diesem Papier wird zudem ein Maß für die relative Produktivität von Auszubildenden entwickelt: ihre relative Lohnposition am Ende der Ausbildung innerhalb eines Betriebs, Jahrs und Berufs. Wir argumentieren, dass der Lohnaufschlag freiwillig vom ausbildenden Unternehmen bezahlt wird, um die besten Auszubildenden an den Betrieb zu binden und zu motivieren. In der Tat finden wir, dass die Auszubildenden mit einer hohen Lohnposition, eine höhere Chance haben, übernommen zu werden. Dies ist wiederum eine wichtige Evidenz für die negative Selektion der Betriebswechsler. Hinzu kommt, dass eine hohe Lohnposition während der Ausbildung zu einem Lohnaufschlag der Betriebswechsler führt – offensichtlich ist die (für den aufnehmenden Betrieb unbeobachtbare) Lohnposition positiv mit anderen beobachtbaren Signalen wie den Zeugnissen des Bewerbers korreliert.

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Adverse Selection and Signalling for Skilled Labour Market Entrants

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February 2012

Key-Words: entry wages, employer change,adverse selection, signalling

JEL-Codes: J24, J31, J62, J63, M52, M53

Abstract

This paper for the first time jointly analyses the consequences of adverse selection, signalling and indices on entry wages of skilled employees. It uses German linked employer employee panel data (LIAB) and introduces a measure for relative productivity of skilled job applicants based on apprenticeship wages. It shows that post-apprenticeship employer changers are a negative selection from the training firms' point of view. Negative selection leads to lower average wages of employer changers in the first skilled job in comparison to stayers. Entry wages of employer changers are specifically reduced by high occupation and training firm retention rates. High apprenticeship wages signal a positive selection of apprenticeship applicants. Works councils and establishment size seem to be indices for good training quality. Finally, positive individual signals such as schooling background affect the skilled entry wages of employer changers positively.

[♣] Corresponding author, E-mail: robert.wagner@bwl.lmu.de, address: LMU, Munich School of Management, Ludwigstr. 28/RG, D-80539 Munich. We use data provided by the Forschungsdatenzentrum der BA am IAB (FDZ), Nuremberg. The data basis of this publication is the LIAB longitudinal (version 2) sample of the IAB (years 1993-2007). We thank Uschi Backes-Gellner, Christian Dustmann, Edward Lazear, Jens Mohrenweiser, Paul Ryan, Uta Schönberg, and Till von Wachter for helpful comments. Data access was provided via guest research spells at FDZ and afterwards via controlled data remote access at the FDZ.

1 Introduction

Since the seminal work by Akerlof (1970) and Spence (1973), the effects of adverse selection and signalling on the labour market have been at the centre of fruitful research. Although there is a large theoretical literature on how firms tackle adverse selection and signals from job applicants, surprisingly little is known about the empirical effects and importance of adverse selection and signals (Behrenz, 2001; Hu and Taber, 2011). The first reason for this gap in the literature is that individual ability and productivity are not easy to measure and therefore the selectivity of employer changers can be only rarely captured empirically (Schönberg, 2007). The second reason is that for the assessment of the role of signals and ability indices, the labour market history of employer changers has to be known including the characteristics of previous employers. This information again is not available in most data sets and usually the researcher has less information than the new employer for the determination of entry wages of employer changers (Gibbons and Katz, 1991, p. 377/378). In this paper, we propose a measure for relative ability and show that employer changers indeed are a negatively selected group. Then we use qualification, previous employer and individual signals in order assess their relative importance for entry wages of employer changers. We concentrate on skilled employees in their first skilled job immediately after graduation from their apprenticeship qualification. This concentration on a homogeneous group has the advantage that productivity differences between employer changers that usually cannot be controlled for such as for example previous tenure, experience, cyclical labour market effects and training content do not differ or can be taken into account.

The German apprenticeship system is the main entry route for school leavers into the labour market (Ryan, 2001). It is the backbone of the German skilled labour market – more than half of the working age population obtains its highest professional degree from the apprenticeship system and an additional ten percent has a double degree from the apprenticeship system and an academic study or a professional master degree (BMBF, 2010). According to Acemoglu and Pischke (1998), training firms use the apprenticeship period for screening and try to retain the most capable apprentices. This implies that employer changers are a negatively selected group whose average productivity level is lower than that of those who stay at the employer providing their apprenticeship training.

Therefore, firms hiring from the negatively selected group of employer changers after apprenticeship graduation might compensate the higher risk of drawing a "lemon" by offering lower wages (Akerlof, 1970; Greenwald, 1986). Signals of employer changers that credibly indicate high productivity are one possibility to reduce the group adverse selection problem and individually increase entry wages (Spence, 1973). Signals have to be "expensive", i.e. they can be easier obtained by more able people than less able people. Another option to assess more and less able apprenticeship candidates is to look for indices of training quality. So far, there is very little evidence whether employer changers indeed are a negatively selected group and whether hiring firms perceive and react to group and individual signals or indices.

This is therefore the first paper that provides evidence on adverse selection and signals of employer changers for a large and important group of employees. We use the willingness to pay a bonus for apprentices at the end of apprenticeship training as a measure for their productivity in comparison to their peer group in the same occupation and at the same employer. Furthermore, we analyse the effect of (occupation and training firm) and individual signals generated during apprenticeship training on post-apprenticeship wages of recently graduated employer changers. We use linked employer-employee panel data to separate the measurement of individual traits, occupational and training firm characteristics. We look at a homogeneous sample of apprenticeship graduates who immediately come from school and immediately start to work after graduation in a skilled position in their occupation. This strategy allows us to draw causal inferences about the importance of signals and indices for job applicants in a negatively selected group.

The remainder of this paper is structured as follows. Section 2 provides an overview on adverse selection as well as signalling and connects the findings with the German apprenticeship system. Section 3 presents an analytical framework on signals of employer switchers after apprenticeship training. Section 4 explains our estimation strategy. The next section describes the data and analyses differences between movers and stayers after apprenticeship training. In Section 6, we present our findings. Section 7 discusses some robustness checks for the selectivity of the employer change decision. The paper ends with a conclusion in Section 8.

2 Adverse selection, signals and indices in the German apprenticeship system

Adverse selection

An apprenticeship contract between an apprentice and an employer is set up for a fixed training period (§ 11 Vocational Training Act), ranging from two up to three and a half years depending on the occupation. The apprenticeship legally terminates at the day after the final exam and none of the parties has legal claims to extend the employment relationship (§21 Vocational Training Act). This implies that training firms can get rid of their former apprentices at no costs. In addition, employer movers either receive no offer to remain in the training firm as skilled workers or they receive a take-over offer but wish to leave the training firm voluntarily. The wage disadvantage of employer changers induced by the adverse selection risk therefore only reduces the willingness to change employers of those who actually received an offer to stay with their training firm (Greenwald, 1986). More than 30% of apprenticeship graduateswho remain in the labour market[1]immediately separate from their training firm to work in other companies (BMBF, 2010).

Acemoglu & Pischke (1998) argue that training firms use the training period for screening.These firms know by the end of apprenticeship training the productivity (ability) levels of their apprentices. As "the value of a worker to a firm is an increasing function of the information it has about the worker's general training" (Katz & Ziderman, 1990, p. 1149), screening during training creates a substantial informational advantage for the training firm[2]. This informational advantage implies two interrelated consequences. First, if training firms can distinguish between more and less able apprentices,theymight try to retain only the most capable graduates (Greenwald, 1986; Mohrenweiser et al., 2010). Second, outside firms hiring from the pool of firm changers after apprenticeship may face an adverse selection problem (Acemoglu & Pischke, 1998).

If training firms use their informational advantage and succeed in retaining mainly high ability graduates, "the stream of job-changers should be composed disproportionately of less able workers" (Greenwald, 1986, p. 325). In this case, hiring firms anticipate that

[1] More than 70% of all apprenticeship graduates remain in the labour market and work in a full or part-time position (Beicht & Ulrich, 2008).

[2] Because of the high degree of standardisation in the apprenticeship system, information asymmetry between training and outside firms is mainly caused by unobservable individual characteristics of the apprenticeship graduate and the training firm instead of the training content (Acemoglu & Pischke, 1998).

training firms use their informational advantage and consider movers as having a high risk to be "lemons" (Akerlof, 1970). They compensate their risk of drawing a lemon by offering lower entry wages for employer changers.

There is only very little evidence on the extent and the effects of adverse selection of employer changers when previous employers have superior knowledge on unobservable employee characteristics. One example comes from the New Orleans slave market in the 19th century. The authors indirectly identify the degree of adverse selection by an examination of relative prices of slaves from different regions of origin. Their estimates indicate that slaves brought to market have been on average substantially less productive than the slave population in general (Greenwald and Glasspiegel, 1983). Foster and Rosenzweig (1993) compare the piece-rate (actual productivity) and time-rate wages (employers´ perceptions of productivity) of casual workers in the Philippines. They also find that there is adverse selection of employer changers. Schönberg (2007) demonstrates on the basis of test scores for the Armed Forces Qualification Test (AFQT) – which is a measure for basic literacy and numeric skills – that employer movers are a negative selection.

The empirical literature on mover-stayer wage differentials of apprenticeship graduates in Germany is not conclusive. Earlier studies suggest higher post-apprenticeship wages for movers. Harhoff & Kane (1997) explain the wage advantage of movers by assuming that only the most capable graduates in the industry change the employer. Euwals & Winkelmann (2004) find that the higher wages of movers are driven by those movers who change to a larger firm. These contributions do not take into account the potential endogeneity of the moving decision, however. They cannot distinguish between separations caused by quits implying an improved career or firm match (Jovanovic, 1979; Neal, 1999) and layoffs that usually lead to a wage penalty (McLaughlin, 1991).[3]

The majority of studies examining the mover-stayer wage differential of apprenticeship graduates however finds lower entry wages for employer movers and explains the result by adverse selection (Acemoglu & Pischke, 1998; Dustmann et al., 1997; Bougheas & Georgellis, 2004). The studies by von Wachter& Bender (2006) and Göggel & Zwick (2009) show that taking into account the endogeneity of the separation decision increases the mover-stayer wage differential. They estimate a local average treatment effect

[3] In terms of the apprenticeship system, a quit equals a situation where an apprenticeship graduate receives a take-over offer of the training firm but leaves nevertheless. A layoff can be seen as a situation where the training firm does not offer to take over the apprenticeship graduate.

for sub-groups of apprenticeship graduates who move because of (mainly) exogenous reasons.

To sum up, the claim that employer changers at the end of apprenticeship are a negatively selected group is so far based on a comparison between the entry wages of employer stayers and movers and therefore rather indirect. This paper chooses a more direct approach. It measures the differences in productivity of apprenticeship graduates based on earnings bonuses training employers voluntarily pay to some of their apprentices. We can show on the basis of this relative productivity measure that employers indeed succeed in retaining their most able apprentices. In addition to the analysis of adverse selection of employer changers, we add evidence for the effectiveness of signals on entry wages.

Signals and indices

The apprenticeship system and most of the training occupations have a long tradition in Germany. In addition, there are strict legal training regulations (*Ausbildungsordnung*) that are enforced by independent institutions such as the chambers of industry and commerce or the chambers of craft (*Handwerkskammer, Industrie- und Handelskammer*). Training regulations define the minimum requirements on vocational training in Germany. There is variation with regard to the execution of training contents in training firms[4]. State-authorised institutions such as chambers guarantee transparent basic skills acquired in specific occupations. This means that most companies hiring from the pool of employer movers directly after apprenticeship either have own training experience or they have at least realistic expectations about the average productivity levels obtained in different occupations.

The analytical framework on signalling and indices in the next part of this paper discriminates between occupation, training firm and individual signals and indices. Besides information on the average productivity of apprenticeship graduates from an occupation or a training firm, the German apprenticeship system also provides signals for differences in individual performance – a crucial prerequisite for signals to reduce the adverse selection

[4] Empirical evidence shows that there are differences in training investment within the dual system. Wenzelmann et al. (2009) show that the total costs for apprenticeship training significantly increase with firm size and are higher in manufacturing than services. Mohrenweiser & Zwick (2009) support this argument by showing that a higher share of apprentices relative to unskilled workers in manufacturing occupations has a negative effect on a company's gross profit.

risk (Spence, 1973). The main signalling source in the apprenticeship system is credible certificates (Acemoglu & Pischke, 2000). These certificates serve as a valid signal for individual qualifications an apprenticeship graduate gained during training in addition to the group signals. The apprentice can present three certificates after graduation. These feature grades from poor to excellent and have considerable variation (Wydra-Sommaggio et al. 2010). First, the reference from the employer during the apprenticeship training refers so social and work-related skills, second, the certificate from the chamber of industry and commerce or chamber of craftsrefers to the practical skills, and the certificate from the vocational college refers to the theoretical occupational skills. At least the certificates from the chambers and the professional schools are valid signals[5] because their acquisition is expensive and the certification institutions are credible, state-authorised and neutral (Akerlof, 1970). These institutions have the legal mission to provide nationally comparable, transparent and independent assessments without own economic interests.

It is striking that the previous empirical literature on signalsin the labour market mainly concentrates on school education level and tenure, experience or continuing training in the previous employment (Behrenz, 2001). In this paper, we pursue a completely different approach. We argue that we have a homogeneous sample with respect to cohort, previous tenure, experience and training as well as the timing of labour market entry. Apprenticeship graduates in one occupation who switch the employer all have the same tenure, experience and documented basic occupational training contents. They all start their career at the same point in time and they apply for a new job at the same point in time because their apprenticeship contract ends in the same week (the final examination day at the chamber of commerce or chamber of craft that is comparable for all regions in Germany). This means that we do not have to take into account secular trends and cyclical cohort effects at the start or the end of the previous employment when we control for the year of graduation. Many papers have shown that booms or recessions leave temporary and permanent scars for entry wage in first skilled jobs and have selection effects (Kahn, 2010). These cyclical effects in addition affect job applicants with different signals and schooling credentials differently (Oreopoulos et al., 2008). This might mean that the business cycle influences entry wages of apprenticeship graduates differently by occupation. In addition, all work

[5] Seibert & Solga (2005) and Wydra-Somaggio et al. (2010) show that apprenticeship certificates from the chambers are valid signals for the labour market. They find a positive correlation between the grades and entry wages of apprenticeship graduates

related productivity differences between applicants have to come from human capital investments during the apprenticeship period because apprentices usually did not engage in economic activities before. This means that mainly observable signals such as information on the occupation (occupational retention rate) and information on the training employer (apprentice retention rate, industrial relations, size, sector and apprentice wage level) as well as individual information (age, gender or school qualification[6]) drive entry wages of employer changers.

Signals allow hiring firms to differentiate between high and low ability workers (Spence, 1973). The firms' perception of the uncertainty in hiring a new worker and therefore the assessment of the risk involved is driven by "observable characteristics and attributes of the individual" (Spence, 1973, p. 357). This means that the hiring firm determines the wage of newly hired apprenticeship graduates based on a bundle of observable signals and indices for a given job. This paper shows that employer movers who are able to send credible positive signals and indices can reduce the information asymmetry and partly offset the wage disadvantage from the group adverse selection risk.

3 An analytical framework on signals and indices of employer movers after apprenticeship

The following analytical framework explains the wage determination of hiring firms for apprenticeship graduates trained in other firms. It identifies individual signals and indices that potentially reverse negative earnings effects from being part of an adversely selected group. The framework allows us to deduct hypotheses about potential signals and indices that affect entry wages of apprenticeship graduates who switch their employer[7]. Let p be the probability of hiring a low ability worker and $1-p$ is the probability of hiring a high ability worker. The productivity per worker is given by $y = \alpha h$, where α is average group productivity in an occupation and h the individual deviation of an apprenticeship graduate from α. The variable $h = 1$ stands for low ability workers and $h > 1$ for high ability workers. As we are interested in the wage determination of an apprenticeship graduate who immediately changes the employer, let α be the average productivity of an apprenticeship graduate in a

[6] Unfortunately, we cannot include grades from the final school examinations. Therefore we have to assume that differences in the school levels are more important than differences in school grades.

[7] The notation as well as the basic idea of our analytical framework is adopted from Acemoglu & Pischke (1998 and 2000).

given occupation. In a perfect Bayesian equilibrium, hiring firms choose a wage level *w* that leads to zero expected profits π_0:

$$\pi_0 = p(\alpha - w) + (1-p)(\alpha h - w) = 0 \qquad (1)$$

or

$$w = \alpha p + \alpha h(1-p). \qquad (2)$$

Equation 2 shows that the wage offer in a given occupation equals the expected productivity of the hired apprenticeship graduates based on the average occupational human capital, individual productivity and the adverse selection risk.

The hiring firm needs additional information on occupational *k* and training firm *n* specific adverse selection risk in addition to the individual ability level *h* for every hired worker *i.* Apprenticeship graduates therefore can send credible signals and indices about *p* and *h – α* is given by occupation. Assuming that hiring firms perceive and react to these signals and indices, we can add the following elements to equation 2:

$$w_{ikn} = \alpha_k p_{kn} + \alpha_k h_i (1 - p_{kn}). \qquad (3)$$

In equation 3, w_{ikn} is the wage of person *i* in occupation *k* from company *n.* The variable α_k is the expected productivity of every apprenticeship graduate in occupation *k*. The variable *h* is the ability of worker *i* and p_{kn} is the group risk to be of low ability. The occupation and training firm group characteristics are independent and therefore low ability probability p_{kn} can be thought of having the following functional form:

$$p_{kn} = v p_k + (1-v) p_n. \qquad (4)$$

The weight of the information on p_n is indicated by (1-*v)* and the weight for the information on p_k by *v*. The differentiation between information about both group identification signals training occupation and training firm is important because we a-priori do not know which part of *p* can be observed (better) by the hiring firm. The better the hiring firm can observe one of the two components, the higher the weight of the components p_k and p_n in p_{kn}.

Equation 3 shows that w_{ikn} – ceteris paribus – increases with individual ability h_i and decreases with the adverse selection risk p_{kn} for a given occupation k and training firm n. The prerequisite for h_i and p_{kn} to affect the wage w_{ikn} is that the hiring firm has credible information about them or in other words that movers generate credible signals on h_i and p_{kn}. Therefore, we propose the following three hypotheses on entry wages of employer changers after apprenticeship:

The entry wage of skilled employees who immediately move to another employer after their apprenticeship training

H1: increases with positive individual signals and indices $h_{i.}$

H2: decreases with the adverse selection risk induced from occupation information $p_{k.}$

H3: decreases with the adverse selection risk induced from training firm information $p_{n.}$

4 Empirical Strategy

We argue that differences between wages for apprentices in their last apprenticeship year, controlling for employer, occupation and year, are indices for productivity differences of apprentices and therefore can be used as a measure for adverse selection of employer changers. There are a couple of institutional reasons for this argument and we add some empirical evidence for our claim. The first institutional reason is that firms under collective bargaining agreements (almost 90% of the apprentices work for employers with collective bargaining or oriented at collective bargaining, Schönfeld et al., 2010) are forced to pay a fixed (minimum) wage for all employees irrespective of their occupation according to § 17 of the Vocational Training Act (*BBiG*). Apprentices´ wages are in addition controlled by the chambers of commerce or crafts. In practice, this collectively agreed apprenticeship wage constitutes a minimum wage, increases with every apprenticeship year and is well-known because as it is published by chambers of commerce and unions.

In addition to this focal minimum wage, employers may grant selected (or all) apprentices a bonus (Ryan et al., 2010, Ryan, 2011). The voluntary bonuses frequently are based on good school grades or performance assessments and they can be interpreted as efficiency wages with the goal to reduce quits of highly productive apprentices the training enterprise would like to retain (Yellen, 1984). Quits of apprentices after graduation might be a consequence of disutility experienced by apprentices during apprenticeship (Acemoglu &

Pischke, 1998). Examples for disutility are apprentices not getting along with their colleagues or supervisor or apprentices who wish to move to a different city for family reasons. When the employer cannot observe the individual disutility value (Acemoglu & Pischke, 1998), a bonus for the higher productive apprentices might be an attempt to reduce quits induced by disutility specifically for this group of apprentices.

The absolute wage bonus training firms grant at the end of the apprenticeship training is low but the relative wage bonus may be a strong commitment for higher wage increases and a good job prospect after the end of the apprenticeship period[8] or may be perceived as a gift by the apprentice because they are well aware of the bonus (Akerlof, 1982). This means that in training firms where (some) apprentices receive bonus pay, high-ability apprentices should earn more than low-ability apprentices and therefore the wage position at the end of apprenticeship training in comparison to other apprentices in the same occupation and training firm is a credible signal for ability. The apprenticeship wage information obviously is unknown to the hiring firm after the apprenticeship is completed, however. But it may be correlated with other individual signals such as examination grades in the occupational school or the chambers of commerce/crafts we cannot observe in this data set.

The basic experimental idea to measure the effect of signals and indices generated during apprenticeship training on post-apprenticeship wages of movers, is to estimate the average treatment effect of occupational, training firm and individual characteristics fixing other factors. Yet, it is not clear which signals and indices are perceived as credible by hiring firms and therefore lead to higher individual wages (Weiss, 1995). In this paper, we include information on the occupational productivity levels α_k, information about the adverse selection risk from the training occupation p_k and the training employer p_n, further information on training quality and apprentice selectivity in the training employer, and individual characteristics h_i. The value of these signals and indices is discussed now.

Hiring firms have expectations about the average occupational productivity levels (Spence, 1973) because apprenticeship training curricula are highly standardised[9] and most employers who hire skilled job entrants from other training firms train themselves.

[8] Mohrenweiser et al. (2010) show that there is a positive correlation between the relative wage position in the training firm at the end of the apprenticeship period and the entry wage in the first skilled employment.

[9] Legal training regulations specify the training content and define occupational skill standards (§5 Vocational Training Act).

Occupations differ with regard to the required skill levels and the schooling background of the apprentices. Therefore, we regard occupational labour markets as separated, always include controls for occupations and only include skilled job entrants who do not change their 2-digit occupation immediately after the apprenticeship training. An indicator for productivity of job changers given their productivity p_k is the occupational retention rate. When hiring firms assume adverse selection of training firms, they might perceive high occupational retention rates as a signal for strong adverse selection in an occupation. In addition, the experience with previous employer changers in occupations with high retention rates might be especially negative when indeed employer changers are a negatively selected group (Soskice, 1994). Therefore, high occupational retention rates should be negatively related with entry wages of employer changers.

Hiring firms might also have information about the training firm of their job applicants. Training firms differ with respect to the quality of their apprenticeship training and selectivity of their retained apprentices. In order to reach a higher skill level of apprentices than in comparable firms, a major part of the training has to be performed in expensive apprenticeship workshops. This leads to higher training investments (Büchel & Neubäumer, 2001). Empirical evidence shows that there are large differences in training investments by training enterprises given an occupation (Mohrenweiser & Zwick, 2009). Therefore, training firms with a high training effort should provide higher skills than firms with low training efforts. The training quality is a typical experience good and many firms might induce the quality of apprentices from previously hired skilled employees from this training firm. Large training firms frequently have the means and scale advantages to provide high quality training. They also might have better opportunities to select the most able applicants because school graduates first apply in large and well-known training enterprises (Soskice, 1994). In addition, it is more probable that other firms know or have had (positive) experiences with apprenticeship graduates from large training firms. We therefore assume that the entry wage of an employer changer is positively correlated with the size of the training enterprise.

Works councils and unions have a positive influence on training quality because they regard themselves as champions of the interests of apprentices (Kriechel et al., 2011). They ensure that the content and the process of training meets the formal training regulations and have the right to call for a replacement of training personnel who neglect their duties.

Thus, training quality may be positively affected by works councils because it is more likely that negligence of such duties goes undetected in firms without works councils. Dustmann & Schönberg (2009) find that collective bargaining coverage increases participation in training and we therefore might assume that also unions have a positive impact on apprenticeship quality. Kriechel et al. (2011) accordingly find higher net investments in apprenticeship training in enterprises with works councils and collective bargaining agreements. These – usually easily observable – institutions of industrial relations in the training firm therefore also should be a positive indicator for the quality of employer changers.

We already argued that the retention rate of the training firm provides additional information on the extent of possible adverse selection of apprentices. The retention rate should be negatively correlated with entry wages, accordingly. Finally, a high average apprenticeship wage (given the occupation) is a signal of training quality and selectivity of the training firm for apprenticeship applicants. Higher training wages mean that the training firm voluntary pays more than the focal wage (usually the collectively bargained wage level). This attracts on average apprentices with higher ability, increases training investment costs and therefore should increase entry wages of employer changers from firms with high apprenticeship wages.

Observable individual characteristics such as age, educational background, as well as the grades of the apprenticeship exam serve as signals for the hiring firm and drive entry wages of employer stayers and movers (Acemoglu & Pischke, 1998; Göggel & Zwick, 2009; Wydra-Somaggio et al., 2010). Relatively old job applicants might signal problems in school because they had to repeat a class or needed additional schooling in an occupational school after general school before they were deemed able to start with their apprenticeship (*Übergangssystem*). We therefore would expect a negative correlation between the entry wage and the age of the employer changer. Graduates from all school types can apply for apprenticeships. In some occupation groups such as commerce and banking, mainly graduates from grammar school (*Abitur*) get an apprenticeship, in craft and construction occupations, most apprentices have a lower secondary education. Therefore the positive signal of a higher school degree such as grammar school has different weights in occupations.

The institutional rules of the apprenticeship system in Germany described above and the transparent certification rules suggest that hiring firms might be able to assess the

relative individual ability of applicants quit realistically. This does not mean, however that the different sources of information do not provide "signals or indicators" because the individual match of the employer changer and the new job is unknown and might differ between employers hiring two employer changers with the same observable characteristics. Whether hiring firms have to systematically correct the entry wages of their switching skilled job entrants in order to adapt them to their true productivity can only be detected by analysing the wage development in the first years of the first skilled job. This is beyond the scope of this paper, however.

5 Data and sample characteristics

We use the second longitudinal version of the Linked-Employer-Employee (LIAB) data of the Institute of Employment Research in Nuremberg (IAB). This data set includes the information described above to measure the effect of training signals on skilled entry wages after apprenticeship. Based on a unique employer identification number, the data combine employer survey panel data with employee data from social security registration. The employer survey includes information on establishment size, sector, industrial relations, and employee structure. Employee data comprise information about daily wages, age, sex, nationality, schooling and professional education degree, and occupation (Jacobebbinghaus & Alda, 2007). Based on an employee identification number and the panel structure of the LIAB data, it is possible to observe a worker's professional career, starting with apprenticeship training. This implies that information about when, where and in which occupation the worker was trained, and whether he or she changed the employer or occupation afterwards, is available on a day to day basis. On average, more than 90% of the employees in each firm can be identified in the data. We use the waves 2000-2002 of the LIAB as a quasi-pooled data set because every apprentice graduates only once.[10]

An important fact that has to be taken into account for the determination of entry wages of employer changers is the timing of the separation from the training firm. It is important to control whether the separation happens immediately after graduation or some time afterwards. Harhoff & Kane (1997) and Bougheas & Georgellis (2004) show that direct

[10] In addition, the longitudinal LIAB data set entails establishments that responded to all employer surveys in the period 2000-2002 and therefore not many additional training establishments can be captured when additional years are added.

movers have different wage expectations than movers with some tenure in the training firm after graduation. Additional occupational human capital obtained after apprenticeship training leads to an upward-bias of the estimates. As shown by Kambourov & Manovskii (2009), occupational skill specificity positively influences wages. The additional occupational human capital acquired after training would artificially increase the wage effect of signals and indicators generated during training. A long time span between graduation and the first skilled job could also be an indicator for unemployment, and thus for a loss of human capital, however. A long unemployment spell would negatively affect post-apprenticeship wages and bias the effect of credible signals downwards (Gibbons & Katz, 1991). As a consequence, we only use skilled employees with a maximal time span of 30 days between the end of apprenticeship training and the first skilled job.

Variable	*All*	*Stayer*	*Mover*
Individual Characteristics			
Age	21.06	21.10	21.01
Female	36.62%	34.36%	38.93%
Grammar school	14.11%	18.30%	10.01%
Western Germany	63.02%	78.56%	47.21%
Occupation field[11]			
Commercial & Trade	36.01%	38.14%	33.85%
Manufacturing	23.65%	29.16%	18.03%
Crafts & Construction	32.18%	27.73%	36.72%
Other	8.16%	4.98%	11.39%
Training establishment size			
≤249	23.20%	34.42%	44.09%
250-999	30.88%	40.35%	37.34%
≥1000	45.92%	25.23%	18.57%
Number of observations	59,749	30,138	29,611

Table 1: Descriptive sample statistics

In addition, we restrict the employee sample to those who have finished an apprenticeship during the years 2000 and 2002, took training which lasted at least 24 months, ended between January and September (the usual examination period) and are younger than 25 years old when they graduate. Also observations of apprentices with earnings above the upper earnings limit in the statutory pension fund (less than 140€ per day in western Germany and around 120€ a day in eastern Germany) and below the marginal part-time income threshold (a little less than 11 € per day) have been deleted. A

[11] Based on the differentiation proposed by Mohrenweiser & Zwick (2009), the occupation groups “commerce and trading”, “industry”, and “crafts and constructions” are shown separately.

descriptive overview about the number of training firms and apprentices is provided in Appendix Table A1. The number of observations is almost balanced across the three years and the total number of apprentices at the end of apprenticeship training is 59,749. In our data, around 79% of all apprenticeship graduates start their first full-time employment immediately after graduation.

Table 1 shows descriptive sample statistics on training firm and apprentice characteristics for the total number of observations as well as on subsamples for employer movers and stayers. Table 1 reveals that apprentices who are male, have the highest schooling degree (grammar school) and work in western Germany have a higher probability to stay in their training firm. The shares of stayers are higher in commercial and trade as well as manufacturing occupations and lower in crafts and construction occupations (this is also found by Mohrenweiser & Zwick, 2009). The share of stayers also increases with the size of the training firm.

Table 2 shows daily wages and average wage variation at the end as well as one and two years before the end of apprenticeship training for different groups. Wages in each group increase with apprenticeship tenure. Furthermore, average wage variation is by far smaller one and two years before the end of apprenticeship training than at the end of apprenticeship training. Wages at the end of apprenticeship training have an average standard deviation of roughly 10% (also compare Mohrenweiser et al., 2010)[12]. Almost 96% of all apprentices at the end of their apprenticeship training do not receive exactly the same wage as the other apprentices in the same firm, occupation and year. The average standard deviation two years before the end of apprenticeship training is just around 5%. We interpret this increase in wage variation as evidence for our hypothesis that firm vary wages in order to retain able apprentices – on the one hand ability can be revealed only gradually and on the other hand the wage differentiation has the largest impact just before the decision whether to leave the firm after apprenticeship training or not.

We therefore have sufficient wage variation that can identify productivity differences of apprentices coming from the same training firm in a certain year and occupation. The LIAB data contain daily wages, calculated by dividing the recorded gross wage of a social security

[12] We find only small differences in the wage spread at the end of apprenticeship training for firms with and without collective bargaining agreement. We find significant differences between establishments with and without a works council, however. These differences can be explained by establishment size effects as shown in Table 2.

record by the duration of the spell. Therefore, the wage variable includes performance based bonus pays.

	Two years before end of apprenticeship training	*One year before end of apprenticeship training*	*End of apprenticeship training*
Variable	Mean daily wage *(Wage variation[13])*	Mean daily wage *(Wage variation)*	Mean daily wage *(Wage variation)*
Overall average	20.56 €	24.60 €	29.21 €
	(1.14 €)	*(1.33 €)*	*(3.64 €)*
Occupation			
Commercial & Trade	21.43 €	25.33 €	30.65 €
	(1.08 €)	*(1.23 €)*	*(4.30 €)*
Manufacturing	22.48 €	25.92 €	29.61 €
	(1.23 €)	*(1.44 €)*	*(3.92 €)*
Crafts & Constructions	18.99 €	23.53 €	27.93 €
	(1.19 €)	*(1.43 €)*	*(2.96 €)*
Other	16.40 €	20.27 €	24.68 €
	(0.92 €)	*(1.08 €)*	*(2.69 €)*
Training establishment size			
≤249	17.36 €	21.12 €	24.55 €
	(1.00 €)	*(1.11 €)*	*(2.21 €)*
250-999	20.41 €	24.56 €	28.78 €
	(1.15 €)	*(1.25 €)*	*(2.96 €)*
≥1000	21.99 €	26.19 €	31.76 €
	(1.18 €)	*(1.55 €)*	*(4.62 €)*

Table 2: Apprenticeship wages and wage variation at the 2-digit occupational level in a firm/year cell

We rank the apprentices according to their wage position at the end of their apprenticeship training.[14] We calculate a relative wage rank r_{ikjt} based on equation (5), where R_{ijkt} is the wage rank of apprentice *i* in occupation *k*, in company *j,* at time *t* and N_{jkt} is the number of ranks (or the number of apprentices) in occupation *k*, in company *j* at time *t* (Pfeifer & Schneck, 2012):[15]

$$r_{ikjt} = \frac{R_{ijkt}}{N_{jkt}+1}. \qquad (5)$$

Equation (5) only makes sense if we observe training firms with more than one apprentice in one occupation. The focus on training firms with more than one apprenticeship graduate per occupation *per annum* reduces the number of observations. Tables A2 and A3 show how the

[13] Average wage variation means standard deviation in the same establishment, 2-digit occupation and year at the end of apprenticeship training.

[14] Also compare the similar approach by Kroch & Sjoblom (1994) who rank employees by their education in their cohort.

[15] Apprentices with the lowest wage have the lowest rank one. When two apprentices get the same wage, they share a rank.

sample size develops for apprenticeship graduates and training firms when we only use establishments with more than one apprentice in each occupation/year cell and then reduce the observations to those employees who immediately work in full time after graduation, change their employer but do not change their occupation after graduation. About 20% of the apprenticeship graduates in our sample change their employer and about 80% of the employer changers stay in their training occupation[16].

According to our assumption that training firms should only retain the most capable apprentices, the stayers should – on average – have higher relative wage ranks than movers. We find no significant differences in relative wage ranks between movers and stayers when we compare all movers with all stayers. However, Table 3 shows the relative wage ranks for movers and stayers for firms with different training firm retention rates.[17] There is a stable relative wage rank for stayers, whereas the relative wage rank of movers decreases with the retention rate. Except for retention rates below 40%, the differences between movers and stayers are significant at the 1% level. The findings in Table 3 therefore are in accordance with our expectations: The higher the retention rate of the training firm, the higher the negative selection in the group of movers.

Training firm retention rate	Stayer	Mover	Difference
<40%	0.507	0.499	0.008
40% - 60%	0.510	0.486	0.024***
60% - 80%	0.507	0.473	0.034***
>80%	0.506	0.430	0.076***
Number of observations			

Table 3: Relative wage ranks of movers and stayers
(*** p<0.01)

In the next step, we perform a multivariate Probit regression in order to verify whether the relative wage rank has a significant effect on the probability to leave the training firm:

$$P(y_{ijt} = 1|X) = \Phi(\beta_0 + \beta_1 r_{ikjt} + \beta'_2 O_{it} + \beta'_3 F_{it} + \beta'_4 I_{it} + \beta'_5 T + u_{ikjt}). \quad (6)$$

We control for additional occupational, training firm and individual characteristics. According to adverse selection theory, we expect a negative effect of the relative wage rank in the last

[16] Note that the descriptive statistics from Table 1 only marginally change after the new sample restrictions.
[17] The retention rates are calculated by training firm per year.

apprenticeship spell on the probability to leave the training firm when holding other determinants for an employer change constant. The dependent variable in equation (6), y_{ijt} equals one if the apprenticeship graduate leaves the training firm after graduation (otherwise y=0) and r_{ikjt} is the relative wage rank calculated according to equation (5). Vector O_{it} includes the dummies for 2-digit occupations, vector F_{it} captures training firm characteristics such as establishment size, sector, presence of a works council, unionisation as well as the region. Vector I_{it} summarises individual characteristics such as age, educational background and sex. Vector T includes time dummies. According to the negative selection of employer movers, we find a highly significant negative correlation between the relative wage rank and the probability of leaving the training firms, see Appendix Table A4. This means that the higher the relative wage rank of an apprentice at the end of apprenticeship training, the lower – on average – is the probability of leaving the training firm. Marginal effects indicate that an increase in the relative wage rank from 0.5 to 0.75 induces a decrease in the average probability of separating from the training firm – ceteris paribus – by approximately 2.35 points.

6 Results

First, we verify whether our data produce similar wage differences between employer stayers and movers directly after apprenticeship training as previous empirical studies and test whether the relative wage rank at the end of apprenticeship training has an effect on post-apprenticeship wages. We conduct a simple entry wage regression including employer movers and stayers:

$$lwage_{it} = \beta_0 + \beta_1{}' Ind_{it} + \beta_2{}' Occ_{it} + \beta_3' Firm_{it} + \beta_4' Rank_{it} + \beta_5' Time + \beta_5' M_{it} + \varepsilon_{it}. \qquad (7)$$

The variable $lwage_{it}$ is the log of the individual wage in the first skilled job. Vector Ind_{it} summarises the individual characteristics age, sex, region and schooling background. Vector Occ_{it} is the occupation on the 2-digit level, $Firm_{it}$ are training firm characteristics such as establishment size, retention rate, presence of a works council, collective wage agreement and sector, $Rank_{it}$ is the relative wage rank in the training firm and M_{it} is a dummy indicating a separation from the training firm.

We find lower wages for employer movers of more than 4% that can be attributed to the negative selection of this employee group, see Appendix Table A5. This wage reduction is comparable to that found by other relevant studies (von Wachter & Bender, 2006; Göggel & Zwick, 2009). We find a positive effect of the relative wage rank at the end of the apprenticeship period on post-apprenticeship wages. All other coefficients remain stable when the wage rank is added. If the relative wage rank increases – ceteris paribus – by 0.25, the average entry wage increases by 0.8%. Therefore, the relative wage rank at the end of the apprenticeship training seems to be a valid predictor for apprentice's capabilities on the skilled labour market. Apprentices obviously can take the voluntary bonus from the end of apprenticeship to their new skilled job and employers are willing to offer higher skilled entry wages to those who already earned more during apprenticeship training.

Now we analyse whether signals and indices generated during apprenticeship training help to reduce the negative consequences of the adverse selection risk andaffect post-apprenticeship wages of employer changers. We therefore restrict our sample to employer movers for the rest of the paper. The sample reduction allows us to get rid of unobserved heterogeneity between movers and stayers. Based on our analytical framework in section 2, a hiring firm determines wages based on information about the average human capital per occupation (α_k), the probability of being of low ability (p_{kn}) and the individual ability level (h_i).

Table 4 shows descriptive statistics for the apprenticeship graduates who change employer, come from an establishment with more than one apprenticeship graduate and obtain a skilled job within 30 days in their trained occupation analogously to Table 1.

The most complex ability index to operationalise is the risk of drawing a lemon p_{kn}, as we a priori cannot say which relevant information the hiring firm has. Our first adverse selection indicator is the average retention rates of apprentices in their occupation and retention rates in the training firm. We assume that training firm retention rates per year might not be as well known as the occupation retention rates. Training firms might not reveal it to the public when they are not able to take over their usual share of apprentices. In addition, enterprise take-over rates might be stronger affected by cyclical effects than occupation retention rates and therefore previous experience with employer changers might be misleading.

Equation (8) summarises our regression model for the entry wages of employer movers after their apprenticeship:

$$lwage_{it} = \beta_0 + \beta_1{}' Ind_{it} + \beta_2{}' OccRate_{it} + \beta_3' Firm_{it} + \beta_4' Occ_{it} + \beta_5' Time_{it} + \beta_6' Rank_{it} + \varepsilon_{it}. \quad (8)$$

Here, $lwage_{it}$ is the log of the individual wage in the first skilled job. Vector Ind_{it} summarises the individual characteristics age, sex, region and schooling background, $OccRate_{it}$ is the occupational retention rate, $Firm_{it}$ are training firm characteristics such as establishment size, retention rate, presence of a works council, collective wage agreement, sector, and the average apprentice wage level given the occupation *dafwl*, $Rank_{it}$ is the relative wage rank in the training firm at the end of apprenticeship training. Finally, Occ_{it} is a vector for training occupations at the 2-digit level, and $Time_{it}$ are the three year dummies.

Variable	*Mean first full-time employment after graduation*
Wage in first job	68.61 € (*S.D. 16.04*)
Unionisation	94.21%
Works council	91.98%
Age	21.07 (*S.D. 1.59*)
Female	47.77%
Grammar school	19.26%
Occupation	
Commercial & Trade	53.09%
Manufacturing	16.61%
Crafts & Constructions	23.03%
Other	7.28%
Training establishment size	
<9	5.51%
10-49	4.75%
50-99	8.18%
100-249	14.87%
250-499	15.43%
500-999	24.50%
1000-4999	11.15%
5000-7499	8.87%
>7500	6.74%
Number of observations	4,092

Table 4: Descriptive statistics on employer changers

Table 5 shows the regression output for five different model specifications. In Model 1, we only include individual signals and indices which are not directly related to

apprenticeship training quality. We find that the entry wages of females are lower. According to our hypotheses, a grammar school degree and employment in western Germany leads to significantly higher entry wages. Being older than the average apprenticeship graduate has no influence on wages. Therefore the fact that some job applicants do not get an apprenticeship immediately after their school graduation or that they have to repeat a school grade obviously has no consequences for the entry wage of employer changers. These results remain remarkably stable when we add additional controls.

In Model 2, we include the relative wage rank in the training firm. For the sample of employer changers, we find a positive albeit insignificant effect of the relative wage rank on wages in the first skilled job. It is quite improbable that the new employer knows the relative wage rank of job applicants during their apprenticeship period. This might reduce the value of the signal for example in comparison to the final examination grades in the vocational college and chambers of crafts and of industry and commerce that unfortunately are not included in our data set[18].

A higher occupational retention rate has a large and significantly negative effect on post-apprenticeship wages of firm changers (Model 3). The occupation retention rate therefore signals the strength of adverse selection of employer changers and employers adapt their entry wage offers accordingly. In Model 4, we substitute the occupational retention rate by information about the training firm. The average apprentice wage level of the training firm shows a significantly positive effect ofhigh economic relevance. This means that the employment in a well paying training firm signals a high individual ability and a high training quality. The estimates on different levels of training firm retention rate have no wage effects. One reason for the absence of effects may be that the retention rates of training firms are not easy to observe for other employers. In contrast, training in larger firms leads to a wage bonus, probably because larger firms are associated with higher training quality and higher selectivity. Works councils are probably also seen as guarantors

[18] In an additional specification, we use the relative wage rank per occupation and year as a predictor for individual ability instead of the relative wage rank per firm, occupation and year. We find significant positive effects of the professional wage rank on entry wages. This might imply that the occupational wage rank at the end of apprenticeship training signals the productivity rank of apprentices in their occupational labour market and is easier to assess for new employers than the specific wage rank of the applicant in the training employer. In specifications with the relative wage rank per occupation, the effect of the presence of works councils becomes insignificant whereas all other factors – including education and average apprenticeship wage level in the training firm – remain robust.

of a high quality in apprenticeship training and therefore have a positive wage impact – in contrast to unions and the training regulations in collective wage bargains.

Model 5 presents the results for our full specification. Our findings support hypothesis 1: individual capability signalled by grammar school increases post-apprenticeship wages. Another predictor for post-apprenticeship wages for employer changers is the occupational retention rate and the adverse selection risk implied by it. Furthermore, the training reputation and selectivity of the training firm, measured by the average apprenticeship wage, the presence of works councils[19] and establishment size has a positive effect on wages in the first skilled job. Therefore, our findings support hypotheses 2 and 3 as well.

[19] We also checked whether the dummy for the presence of works council is an additional dummy for establishment size because incidence of works councils is highly correlated with the number of employees. However, the works council dummy remains positive and significant when we use a finer differentiation of the establishment size (<9, 10-49, 50-99, 100-249, 250-499, 500-999, 1000-4999, 5000-7500 and>7500) as well as the linear establishment size as explanatory variables. This suggests that the presence of a works council in the training firm has a genuine impact on training quality in addition to the size effect.

Log(Wage first skilled job)	(1)	(2)	(3)	(4)	(5)
Indices and Individual Signals					
Female	-0.033***	-0.034***	-0.033***	-0.027***	-0.028***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Age deviation from	0.001	0.001	0.001	0.000	0.000
occupational mean	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Grammar school	0.032**	0.031**	0.032**	0.032**	0.031**
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Western Germany	0.165***	0.165***	0.165***	0.151***	0.151***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Relative apprenticeship wage		0.020			0.017
rank		(0.017)			(0.016)
Training Employer Signals					
Average apprentice wage level♦				0.005***	0.005***
				(0.001)	(0.001)
Retention rate training firm (Ref.-Cat.: <40%)					
40% - 60%				-0.017	-0.017
				(0.013)	(0.013)
60% - 80%				-0.014	-0.014
				(0.018)	(0.018)
Works council				0.046**	0.046**
				(0.023)	(0.023)
Collective wage bargaining				0.032	0.032
				(0.024)	(0.024)
Training establishment size (Ref.-Cat.: ≤249)					
250-999				0.014	0.015
				(0.019)	(0.018)
≥1000				0.076***	0.076***
				(0.020)	(0.020)
Occupation Signals					
Retention rate occupation (Ref.-Cat.: <40%)					
40% - 60%			-0.087*		-0.154***
			(0.051)		(0.056)
>60%			-0.581***		-0.598***
			(0.045)		(0.044)
Constant	3.821***	3.816***	3.909***	3.825***	3.974***
	(0.051)	(0.051)	(0.047)	(0.054)	(0.048)
14 sector dummies	Yes	Yes	Yes	Yes	Yes
2 year dummies	Yes	Yes	Yes	Yes	Yes
64 occupation dummies	Yes	Yes	Yes	Yes	Yes
R-squared	46.05%	46.08%	46.05%	47.76%	47.78%
Observations	4,035	4,035	4,035	4,035	4,035

Table 5: Dependent variable: Log wage in the first job

Standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

♦ Wages measured as deviations from 2-digit occupational means

All specifications with robust standard errors, standard errors clustered by training firms

7 Robustness Checks

One shortcoming of the LIAB data set is that we do not know whether the employer change after the apprenticeship training is voluntary or not. An apprentice cannot easily signal whether he or she is a good choice just because he or she is a quitter instead of having been laid off. It is not allowed to explicitly mention in the employer reference at the end of the apprenticeship whether the apprentice received a take-over offer or not. Hence, it is not possible to distinguish between quits and lay-offs for a potential new employer. This is a problem if unobservable characteristics of apprenticeship graduates who quit are different from those who are laid off and if the same characteristics also drive entry wages as well as the value of the observable signals. One example for this correlation could be that training enterprises choose less favourable formulations in their reference letter for those employees who do not get a retention offer (although they are legally bound not to use explicitly negative formulations).

Gibbons and Katz (1991) derive evidence for the hypothesis that job loss from a plant closure does not provide a negative signal in contrast to a lay-off. Von Wachter & Bender (2006) accordingly show that the wage impact of apprentices changing the employer is over-estimated if we cannot control whether the apprentice was laid-off or quit. They use the training firms' internal variation in the retention rate of apprentices as an instrument for the employer changing dummy. Von Wachter and Bender accordingly measure the local average treatment effect (LATE) for a group of workers who moved because their training firms' retention rate was lower than its average.[20]

We implement this approach in our estimation strategy in order to test the robustness of our estimates in the previous section. As we focus on the group of employer movers, we do not have an employer changer dummy and therefore cannot apply an instrumental variable approach to take into account the endogeneity of the decision to leave the training firm. Instead, we define a sub-sample of exogenous movers to measure the LATE

[20] Göggel & Zwick (2009) argue that a mass lay-off during the last half a year in the apprenticeship also can be used as an instrument for an employer change. This instrument indeed highly correlates with the likelihood of an involuntary employer change and arguably has no relationship to graduates' innate abilities. They define a "mass lay-off as a reduction in employment in one establishment larger than 30 percent of the labour force within one year" (Göggel & Zwick, 2009, p. 15). Unfortunately only 160 observations are left in our sample even if we reduce the mass lay-off definition to a labour force-reduction of more than 20 percent. The results are therefore not very reliable and we do not display them here.

of signals and indices generated during apprenticeship training on skilled entry wages. 3,042 employer movers after their apprenticeship training left a training firm whose retention rate in the year of the separation was lower than its average retention rate during all three years covered by our sample.

Table 6 shows the estimates for equation (8) on the basis of the new sub-sample. The coefficient for the average wage level of the training firm remains highly significant. The effects of the occupation retention rate are also still significant and the training firm retention rate now also has a significantly negative coefficient. A large training firm implies a wage bonus in the first skilled job. Also a higher schooling grade has a positive influence on entry wages. The results in Table 6 therefore show that most of our central findings in Section 6 are robust to a reduction of the sample to apprentices for whom the probability that they had to change their employer involuntarily is high.

Log(Wage first job)	
Indices and Individual Signals	
Female	-0.037***
	(0.009)
Age deviation from	-0.002
occupational mean	(0.003)
Grammar school	0.035***
	(0.013)
Western Germany	0.157***
	(0.020)
Relative apprenticeship wage	0.003
Rank	(0.016)
Training Employer Signals	
Average apprentice wage level♦	0.005***
	(0.001)
Retention rate training firm (Ref.-Cat.: <40%)	
40% - 60%	-0.024*
	(0.013)
60% - 80%	-0.023
	(0.019)
Works council	0.044
	(0.030)
Collective wage bargaining	0.009
	(0.034)
Training establishment size (Ref.-Cat.: ≤249)	
250-999	0.020
	(0.019)
≥1000	0.078***
	(0.020)
Occupation Signals	
Retention rate occupation (Ref.-Cat.: <40%)	
40% - 60%	-0.181***
	(0.062)
>60%	-0.203**
	(0.081)
Constant	4.149***
	(0.061)
14 sector dummies	Yes
2 year dummies	Yes
Occupation dummies	Yes
R-squared	47.22%
Observations	3,042

Table 6: Dependent variable: Log wage in the first job
Sample employer movers from training firms with retention rate less than average
Standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1)
♦ Wages measured as deviations from 2-digit occupational means
All specifications with robust standard errors, standard errors clustered by training firms

8 Discussion

This paper shows that employer changers at the end of apprenticeship training are an adversely selected group and face an entry wage disadvantage in their first skilled job as a consequence. It also shows however that there are many occupational, employer and individual signals and indices that have an impact on entry wages of employer changers. These signals and signals are on the one hand consequences of institutional rules that imply credible institutions for certification of different abilities. In addition, the new employer usually has experience with employer changers in previous years or realistic ideas on the capabilities of apprenticeship graduates with different characteristics. The functioning of these signals and indices may be an important reason why apprenticeship training still is an attractive venue for school leavers to obtain occupational skills. A considerable share of apprenticeship graduates leaves the training enterprises and faces the consequences of being a member of a negatively selected group (Akerlof, 1970) – being able to signal individual ability therefore is an important condition for high ability apprenticeship applicants to find investments in apprenticeships worthwhile (Foster & Rosenzweig, 1993; Acemoglu & Pischke, 2000). Wage variation based on individual, occupational and training firm characteristics may also be a consequence of the fact that potential employers of apprenticeship graduates can offer wages contingent on performance and usually first offer fixed-term contracts for skilled entrants to the labour market. Performance pay and fixed term contracts reduce the negative financial consequences of over-paying an unexpectedly bad draw from the group of available candidates or of being overly optimistic about the match quality between the candidate and the new job (Greenwald, 1986).

Our focus group is large and it is the backbone of the German economy (Soskice, 1994). The concentration on young employees without previous work experience and a fixed training programme with transparent and legally monitored minimum standards allows us to abstract from potentially unobservable third factors such as previous experience or tenure, cohort, continuing training efforts or business cycle effects. Differences between entry wages of employer movers therefore can mainly be attributed to observable occupation, training firm and individual characteristics. In addition, the apprenticeship system provides transparent, observable and certified (minimum) skills.

We propose to use the relative wage rank of an apprenticeship graduate in the training firm (given occupation and graduation year) as a measure for relative individual productivity during apprenticeship. We argue that a high wage rank is the consequence of voluntary wage bonuses for apprentices. The wage bonus is paid for more able apprentices in order to give them a feed-back on their productive value to the training firm and increase the probability that the apprentices with high wage bonuses stay after the end of their apprenticeship. Based on the relative wage rank we show that employer movers, compared to stayers, are indeed a negatively selected group from the training firms' point of view and apprentices with a wage bonus have a higher probability to stay in their training firm. In accordance with prior literature, we find that there is an average wage penalty for employer changers that can be explained by adverse selection of the better informed training firms when they decide which apprenticeship graduate to retain.

In addition, we assess the suitability of potential signals and indicators that reduce the information asymmetry between post-apprenticeship employer changers and hiring firms given training firms use adverse selection. We identify generally available indices for a negative selection of groups of apprentices – occupational and training enterprise retention rate as the main drivers of entry wages. The higher the retention rate the higher is the risk that the employer changers are "lemons". Accordingly, employer changers in occupations with high retention rates experience an entry wage disadvantage in comparison to employer changers in other occupations. The same applies for apprentices coming from training firms with high retention rates. The average apprenticeship wage level in training firms can be used as a signal for selectivity of apprenticeship applicants and the training quality provided and therefore also leads to higher wage offers for employer switchers. Additional training quality indicators such as training establishment size and the presence of works councils in the training enterprise have the expected positive impact on skilled entry wages. Individual signals such as schooling background also have the expected impact on entry wages. Our signal for relative individual productivity in the training firm – the relative wage rank at the end of the apprenticeship training – is only valid in parsimonious specifications. This does not necessarily mean that apprentices cannot signal individual ability acquired during the apprenticeship training, however. Unfortunately, we do not observe the grades from chambers of commerce and trade, chambers of craft, and vocational college exams. Exam grades are a more direct and easier accessible signal for hiring firms than the wage position

during apprenticeship training and they are most likely closely correlated with each other (Wydra-Sommagio et al., 2010). We conclude that employer changers suffer from wage reductions when they belong to especially adversely selected groups, they can signal individual productivity and training quality however and accordingly reduce their wage disadvantage when they have a higher than average productivity.

In a robustness check, we take into account that our sample of employer changers consists of quitting and laid off apprenticeship graduates. We reduce the sample to those employer changers who with a high probability changed their employer involuntary because their training firm had a lower than average retention rate in their graduation year. The signs of the signals remain intact in the smaller sample.

The structure of the LIAB data allows us to control for training firm characteristics only. We therefore cannot include characteristics of the hiring firms and have to interpret the labour market value of the signals without taking into account differences between training and hiring firms.[21] Another shortcoming of our analysis is the reduction of our sample to firms with more than one apprentice per year and 2-digit occupation for the construction of our individual productivity measure. The observable enterprise and employee characteristics however only marginally change after reducing the sample to firms with more than one apprentice.

Our focus on the entry wage of employer changers does not allow us to evaluate whether the separation from the training firm is efficient or not. Von Wachter & Bender (2006) show that the wage gap between movers and stayers vanishes within the first five years after graduation. This finding suggests that movers are not necessarily a negative selection for hiring firms – in this case, we would expect a permanent wage penalty for a negatively selected group. Instead, movers can be a negative selection from the training firms' point of view but not for the hiring firm. In this case, separations improve the employer-employee match (Jovanovic, 1979; McLaughlin, 1991; Neal, 1999). To analyse whether movers are indeed a negative selection from the training firms' point of view but not for the hiring firm, further research has to compare the wage developments during the first years in the new firm, with the wage development of stayers. If transitions are efficient, movers should have a steeper wage profile than stayers in the first years as skilled workers.

[21] Euwals &Winkelmann (2004) show for instance that the difference in size between training and hiring employer has a positive effect on post-apprenticeship wages of movers.

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Appendix

Year	*Number of training firms*	*Number of apprentices at the end of training*	*Number of apprenticeship graduates with full-time skilled employment*
2000	3,842	19,701	16,824
2001	3,667	20,371	16,061
2002	3,436	19,677	14,204
Total	***10,945***	***59,749***	***47,089***

Table A1: Data computation

	Number of training firms with more than 1 apprentice per occupation and year	*Numberofapprentices in firms with more than one apprentice per occupation and year*
2000	1,507	11,483
2001	1,492	11,919
2002	1,323	10,426
Total	***4,322***	***33,828***

Table A2: Sample size for training firms with more than one apprentice in 2-digit occupation per year

	Number of graduates in a full-time position from an establishment with more than one graduate	*Number of apprentices in a full-time position who change employer*	*Number of graduates in a full-time position who change employerand keep occupation*
2000	8,667	1,788	1,458
2001	8,708	1,792	1,392
2002	7,587	1,546	1,235
Total	***24,962***	***5,126***	***4,089***

Table A3: Data computation for graduates in first full-time job

y=pr(mover)=33.82%	Marginal Fixed Effects	Mean
Relative wage rank	-0.100***	0.499
	(0.011)	
Female	-0.016**	33.90%
	(0.007)	
Age deviation from	-0.004**	-0.109
occupational mean	(0.002)	
Grammar school	-0.002	18.87%
	(0.009)	
Western Germany	-0.020***	77.71%
	(0.007)	
2establishment size dummies	Yes	
2 dummies for industrial relations	Yes	
14 sector dummies	Yes	
64 occupation dummies	Yes	
2 year dummies	Yes	
Observations	32,822	

Table A4: Regression output for equation (6)
Standard errors in parentheses. (*** p<0.01, ** p<0.05)
Table A2 shows that we have 33,828 apprentices in firms with more than one apprentice at the end of apprenticeship training. We lose 1,006 observations by missing values in the firm data.

ln(wagefirst_job)	(1)	(2)
Employerchange	-0.041***	-0.041***
	(0.004)	(0.004)
Relative wage rank		0.032***
at the end of training		(0.005)
Female	-0.028***	-0.028***
	(0.003)	(0.003)
Age deviation from	0.004***	0.004***
occupational mean	(0.001)	(0.001)
Grammar school	0.019***	0.019***
	(0.004)	(0.004)
Western Germany	0.185***	0.185***
	(0.003)	(0.003)
Constant	3.608***	3.584***
	(0.011)	(0.012)
2establishment size dummies	Yes	Yes
64 occupation dummies	Yes	Yes
Industrial relations	Yes	Yes
14 sector dummies	Yes	Yes
2 retention rate dummies	Yes	Yes
2 year dummies	Yes	Yes
R-squared	51.44%	51.50%
Observations	26,263	26,263

Table A5: Regression output for equation (7)
Standard errors in parentheses. (*** p<0.01)
Both specifications with robust standard errors.