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Heterogeneous Wage Effects of Apprenticeship Training

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Abstract

Relatively small average wage effects of employer and occupation changes after apprenticeship training mask large differences between occupation groups and apprentices with different schooling backgrounds. Employer and occupation changers in industrial occupations enjoy large wage advantages, whereas apprentices in commerce and trading occupations, as well as in construction and crafts occupations, face wage losses from an occupation change. Differences between the firms that provide the apprenticeship training are found to be small or insignificant. This paper reconciles differences between previous findings by comparing and replicating their empirical estimation strategies. It demonstrates that selectivity in occupations and changes, unobserved heterogeneity between occupations, and sample selection matter.

JEL Codes: J24; J31; M53

Key-Words: Wage mark-up, occupations

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I. Introduction

The quality of apprenticeship training is a recurring and hotly debated topic in the literature. Heckman, Roselius and Smith, for example, assert that the "completion of an apprenticeship […] often conveys more information about the tenacity of the trainee and his or her ability to finish a task than it does about the quality of the skills obtained". They conclude from the perceived poor quality of apprenticeship training in Germany that the "apprenticeship program may contribute to diminished options in later life" (Heckman *et al*., 1994, p. 99). On the contrary, Korpi and Mertens (2003, p. 612) write that "the proportion of truly firm specific skills acquired during a German apprenticeship is rather low in relation to the transferable skills obtained".

An important reason for these differences in the perception of the apprenticeship system might be that the training in some apprenticeship occupations is of high quality and provides useful skills for the labour market, whereas the training in other occupations is of low quality and offers poor earnings prospects. Soskice (1994) argues that the German apprenticeship system can be split into two groups. According to his seminal paper, the first group consists of high-quality apprenticeship programmes typically provided by large firms in industry and commerce. Apprentices in these economic sectors enjoy high retention rates, and low wage losses when they have to change their employer or occupation because the skills acquired during their apprenticeship are transferable and have a high value on the labour market. Soskice (1994) stresses that most of those who pass through the second group of apprenticeships – low-quality and relatively basic apprenticeships mainly provided by the crafts and construction sector – have weaker qualification backgrounds. He argues that these apprentices accept low wages and employment as semi-skilled employees in other firms if they are not retained by their training firms, because their alternative would be unemployment.

In Soskice's mainly conceptual paper, several empirical contributions are used to examine differences between earnings capacities of apprentices in different economic sectors in order to see whether his analysis can be supported. The results of these studies are not conclusive, however. Some papers find clear differences between training firms, others conclude that all apprenticeship occupations offer comparable earning opportunities. We argue that the differences in the findings can be explained by differences in the empirical approaches of the studies. More specifically, most papers only look at the impact of employer characteristics on wages in skilled jobs after the end of the apprenticeship training. We demonstrate that, besides employer characteristics, occupational and individual characteristics play important roles in the earnings potential provided by an apprenticeship. In addition, we show that not all relevant quality indicators of apprenticeships have been studied empirically so far. Finally, we find sizeable changes in the results when differences in wages during the apprenticeship period, unobserved heterogeneity between changers and stayers, and the endogeneity of the decision to change employer or occupation are included.

The reminder of this paper is organised as follows: Section 2 gives a brief survey of the literature and some theoretical considerations on the relationship between wages of stayers and changers after apprenticeship training and the quality of apprenticeship training. We describe our estimation strategy in Section 3, and the data and some descriptive statistics in Section 4. Results are discussed in Section 5 and Section 6 concludes.

II. Background

Most papers that empirically investigate differences in the quality of apprenticeship training look at wage differences between stayers and changers of employer or occupation. A change of employer or occupation highlights the transferability of skills acquired during the apprenticeship to the labour market. Besides revealing the market value of occupations, it is of key interest for the attractiveness of occupations, i.e. whether there is a wage penalty for

changing employer or occupation after the apprenticeship. The average retention rate after apprenticeship training in Germany is relatively stable at around 65% (Franz and Zimmermann, 2002; Mohrenweiser and Backes-Gellner, 2010; Seibert and Kleinert, 2009). About 30% of apprentices change occupation within one year after the end of apprenticeship training (Clark and Fahr, 2001), and about 25% find a new employer within one month (Seibert and Kleinert, 2009).

The wage penalty for changers in comparison to stayers gives us an insight into the specificity and transferability of skills obtained during apprenticeship training. If the apprenticeship provides mainly general (bundles of) human capital or the specific labour market for the skill bundle is large, apprentices should not face wage disadvantages when they change employer or occupation directly after their training. However, if most of the training is firm-specific, wage disadvantages can arise, as other firms are not willing to pay the same skilled wage for new employees who changed from another employer (Lazear, 2009; Gathmann and Schönberg, 2010).

Although the curricula and the training quality of all occupations are agreed on by the social partners, and set and monitored by the Federal Institute of Vocational Education and Training (BIBB) and by local Chambers of Commerce, there are large differences in the quality of occupations. Two examples of how strongly occupations differ in Germany are the popular occupations *Mechatroniker* (a combination of industrial mechanic and electrician) and hairdresser. *Mechatroniker* learn during their three-and-a-half apprenticeship years how to combine mechanic, electric and electronic parts in complex systems such as robotics in industrial production. They also maintain, check and adjust these systems. The salary ranges from €760–940 per month. The share of apprentices with a university entrance diploma (*Abitur*) is 24% and the share of apprentices with lower secondary education (*Hauptschule*) is 6%. Hairdressers learn in three years how to wash, cut, dye and dress the hair of their clients. The salary ranges from €210–540. The share of apprentices with a university entrance

diploma is 3%, and the share with lower secondary education is 61%. There are also about 40 occupations for which the apprenticeship period lasts only two years, such as ice-cream maker, bicycle assembler or picture laboratory assistant. However, these relatively basic occupations have not been chosen very extensively until now.[1] The size of the specific labour market for the skills learnt in different occupations also differs, e.g. it is much larger for hospitality occupations than for car mechanics, and both occupations are chosen with about the same frequency. This renders the human capital more specific in some occupations than in others (Lazear, 2009).

Wage consequences of employer changes

The first line of the empirical literature on heterogeneity in the German apprenticeship system looks at the wage consequences of employer changes. Most papers find positive or insignificant wage effects (Dustmann *et al*., 1997; Harhoff and Kane, 1997; Acemoglu and Pischke, 1998; Werwatz, 2002; Bougheas and Georgellis, 2004; Euwals and Winkelmann, 2004). In addition, wage losses are larger for apprentices trained in industrial firms (Werwatz, 2002), apprentices changing to smaller firms and apprentices not changing immediately after training (Harhoff and Kane, 1997; Bougheas and Georgellis, 2004; Euwals and Winkelmann, 2004).

All papers mentioned in this section do not include indicators for occupations. This is a problem because both occupation and employer characteristics have an impact on wages and the variables may be correlated. More attractive employers offer more attractive occupations, higher apprenticeship wages and attract more able apprenticeship applicants (Soskice, 1994). Therefore, it is not clear whether the differences between employers are mainly the result of differences between the occupations these firms offer, or, for example, the background of the training participants. In addition, the papers mentioned partly use wage data long after entry

[1] Further information can be found at http://berufenet.arbeitsagentur.de

into the skilled labour market.[2] On one hand, this incurs the risk that unobservable labour market characteristics after the apprenticeship period have an impact on the results (Burtless, 1994); on the other, it has the advantage that long run-effects might be captured.

Wage consequences of occupation changes

The second line of empirical research concentrates on the wage effects of occupation changes. Occupations are closely related to tasks and, therefore, the quality of jobs for former apprentices may be mainly determined by occupations rather than the characteristics of the employer (Kambourov and Manovskii, 2009; Poletaev and Robinson, 2008). The literature that concentrates on occupation changes, however, faces the problem that there are, for example, 15 different occupations in electronics that might have very similar skill demands, whereas other occupations do not have close substitutes. Therefore, it seems almost impossible to find an indicator for the closeness of occupations with different names (Clark and Fahr, 2001).[3] We adopt a pragmatic solution to differentiate changes between the first- and second-digit levels of the occupational code. We assume that changes between occupations with occupational code on the broad first-digit level, for example between codes 1 and 2 go further than changes on the finer second-digit level, for example between codes 11 and 12.

[2] Harhoff and Kane (1997) only use employees with at least five years' experience, Werwatz (2002) includes observations with, on average, 15 years' experience, and Acemoglu and Pischke (1998) observe employees with, on average, between 14 and 20 years in the labour market.

[3] Gathmann and Schönberg (2010) calculate the distance between occupations based on tasks performed in the occupations. Geel and Backes-Gellner (2009) determine the specificity of skills in different occupations by aggregating weighted required skill portfolios. We do not have information on tasks or required skills in our data set, however, and therefore have to assume that the occupational code is a sufficiently precise indicator of the closeness of occupations.

Empirical papers usually find small positive or negative wage effects of occupation changes (Clark and Fahr, 2001; Fitzenberger and Spitz, 2004). The wage penalty is larger for displaced occupation changers and changers into occupations that are less similar (Clark and Fahr, 2001).

Endogeneity of changing decision and occupation choice

Employer and occupation changers are not a random sample, and, therefore, endogeneity might bias the results of wage regressions (Ryan, 2001). The main source of endogeneity is the decision to choose a certain employer and occupation after school and after completing the apprenticeship training. Most contributions try to solve the endogeneity problem by using instrumental variables.[4] Some papers distinguish between (an indicator for) voluntary and involuntary changes (Clark and Fahr, 2001; Bougheas and Georgellis, 2004), arguing that the closure of an enterprise or mass lay-offs can be taken as indicators for an involuntary employer change.[5]

Our contribution is closest to Dustmann *et al*. (1997) and Euwals and Winkelmann (2004). Both papers include employer and occupation information, they take into account the endogeneity of employer changes and include information on apprenticeship wages and skilled wages.

[4] Typical instruments used are whether the employee was drafted to military service after the apprenticeship or differences in the time period between joining the firm as an apprentice and the firm failure (Acemoglu and Pischke, 1998; Dustmann and Meghir, 2005; Fitzenberger and Spitz, 2004; Fersterer *et al*., 2007).

[5] The contributions use the disappearance of the firm indicator as a sign for the closure of an enterprise. This might be problematic because a firm indicator might also cease to exist because the firm restructures itself or is bought by another firm without stopping operations.

III. Estimation strategy

We aimed to estimate the wage impact of changing employer or occupation directly after apprenticeship training. To do this, we reduced the impact of selectivity and unobservable differences between changers and stayers by using a number of estimation measures that go beyond the available evidence. First, we concentrated on a homogeneous sample – apprentices just before the end of their apprenticeship training and at the beginning of their first job.[6] This means that all individuals had neither tenure nor experience.[7] We only took those employees with gaps between the apprenticeship and the first job of less than 30 days because, by definition, apprentices who stay with the same firm after completing their apprenticeship period do not have a long gap between apprenticeship and first skilled employment.[8] In addition, we compared the differences between changers and stayers for three wage indicators: the wage during apprenticeship, the first skilled wage and the wage mark-up between the last apprenticeship spell and the first skilled employment.

[6] Dustmann *et al*. (1997) and Euwals and Winkelmann (2004) use the version of the IABS until 1995. This version does not include exact notifications of when apprentices finished their apprenticeship period. Therefore, the last apprenticeship spell might entail wages for skilled jobs for more than 20% of the observations. The authors, therefore, have to use the wage information from the first year after finishing the apprenticeship training. Hereby they capture heterogeneity in tenure in the first skilled job. In addition, they include observations with long unemployment or out of labour force spells between apprenticeship and skilled job, e.g. those who served in the army or did their civil service before starting their first skilled job.

[7] Differences in tenure or experience frequently drive wage differences between changers and stayers (Von Wachter and Bender, 2006; Poletaev and Robinson, 2008; Gathmann and Schönberg, 2010).

[8] The only exception might be military quitters who return to their training employer (Acemoglu and Pischke, 1998). Therefore, we excluded apprentices who first served in the army or other community services directly after their apprenticeship before returning to the labour market because these relatively long employment gaps of at least 12 months might lead to wage reductions.

We included the wage during the apprenticeship and the wage mark-up between apprenticeship and first skilled job, and, therefore, were able to capture unobserved heterogeneity in productive ability, as well as training quality and intensity between changers and stayers who manifest themselves during the apprenticeship training (Winkelmann, 1996; Euwals and Winkelmann, 2004; Von Wachter and Bender, 2006). Wages for apprentices are usually set by collective bargaining at the sectoral level according to §17 of the German Apprenticeship Law (BBiG) – this means that apprentices in the 26 economic sectors should earn the same wage irrespective of their occupation. In addition, a company has to pay an appropriate wage when it is not covered by collective bargaining. A wage is appropriate, if it is at most 20% below the collective bargaining rate. The chambers of commerce and the chambers of crafts control whether the wages in training contracts are within that range. However, there is some leeway for individual wage setting, even for employers with collective bargaining: First, enterprises are free to voluntarily pay a wage mark-up. Second, there are usually regional differences in the more than 500 wage contracts concerning apprentices (mainly between East and West Germany, but also for smaller regions). Third, collective bargaining agreements might include different earnings level options for apprentices and firms might attribute their apprentices differently to these levels – there are indications that works councils, for example, use their bargaining power to attribute apprentices to higher earnings levels, see Addison *et al*. (2010).[9] If it is mainly apprentices with negative unobservable characteristics or in firms with negative characteristics who change employer, this should already be detectable in lower wages during the apprenticeship (Ryan, 2001) – therefore, the wage mark-up is more informative than simple comparisons of the first skilled wage.

The estimation procedures described so far allowed us to avoid unobserved time-invariant heterogeneity and selectivity in occupations. However, the decision of staying or changing to

[9] For further details, see Bundesministerium für Bildung und Forschung (2010) pp. 272–277.

another employer or occupation still might be endogeneous. In addition to differences in the quality of apprenticeships, the economic situation of the enterprise offering the apprenticeship also might be decisive. Former apprentices might be forced to change their employer, for example, because the firm is in economic hardship and, consequently, reduces the number of apprentices retained. According to the literature on displaced workers, we argue that the true effect of changing employer can only be measured for those who have to change jobs involuntarily. However, usually, it cannot be measured, whether an employee changes employer voluntarily or not. Therefore, mass lay-offs preceding employer change are taken as an indicator for an involuntary change (Jacobson *et al*., 1993; Bender *et al*., 2002). More precisely, we define enterprise reducing employment in the last half a year of an apprenticeship by more than 30% as an instrument for the stay/change decision.[10] This means that we have to assume the mass lay-off assumption is innocuous in the wage mark-up equation. We argue that the apprenticeship wage half a year before the end of the apprenticeship is not affected by lay-offs occurring up to half a year later, and skilled wages in other enterprises are also not affected by the mass-lay off.

Finally, besides obtaining unbiased wage estimates, the main purpose of this paper is to differentiate between certain apprenticeship quality indicators. Indicators relating to the size and sector of the training firm or the first skilled job employer frequently have been used in the empirical literature. In addition to that, we introduced the school qualification of the apprentice, training in East or West Germany, and three homogeneous occupation groups as quality indicators. Therefore, we differentiated between:

[10] Dustmann *et al*. (1997) use the percentage of firms that close down in the respective year on a two-digit industry level as an instrument in the selectivity term. This means, however, that the instrument is on a higher aggregation level than the instrumented variables and not as closely related to the observation as instruments that directly apply to the individual employee. Dustmann and Meghir (2005) use firm closure information from an additional data file. Unfortunately, we do not have this information.

- wage effect of a change between employers,
- wage effect of a change between occupations. We distinguished between all occupation changes and those who change to an occupation that has a different number on the broad first level of the occupation classification,
- wage effect of an employer or occupation change from a smaller firm during training to a larger employer for the first skilled job,
- wage effect of a change from the manufacturing to the service sector,
- wage effect for changers with university entrance diploma (*Abitur*),
- wage effect for changers trained in East Germany,
- wage effect for changers in three selected homogeneous occupation groups.

Our three occupation groups have been defined on the basis of the following considerations (Mohrenweiser and Zwick, 2009):[11] commerce and trading occupations provide the apprentices with relatively general human capital such as communication and ICT skills that are widely used. Also, the mixture of skills demanded from skilled employees in these occupation groups seems to be rather similar. In industrial occupations such as electronics, ICT, chemicals and metal-working, it takes some time until proficiency is achieved. Most apprenticeships take three-and-a-half years instead of three years, and they are intellectually more demanding than most other occupation training. In addition, it seems probable that additional experience after the completion of the apprenticeship training is necessary to reach full productivity. This means that the specificity of the skills learnt might be high. An additional argument for the high specificity of these occupations is that they are frequently new or recently adopted to the rapid technological change in these fields. Lazear (2009) argues that new skills might be more specific than traditional skills. Finally, skilled employees in industrial occupations are hard to find. This implies that training firms have relatively high retention rates, invest in apprenticeship training and offer attractive internal

[11] We exclude other occupations from this analysis because they are very heterogeneous.

labour markets (Zwick and Schröder, 2001). In our last occupation group (crafts and construction occupations), although the skills learnt might be general, the skill mix demanded might differ between enterprises. A typical example is the change from a small craft bakery to an industrial bakery after the apprenticeship. The quality of these apprenticeships and the intellectual level demanded might be low because the employers only provide their apprentices with the basic skills necessary for their specific job in order to save investment costs. Apprenticeships usually take three years and most applicants have a weaker qualification background than in the other occupation groups (Soskice, 1994).

Our distinction between the occupation groups is supported by the argument that the more specific the skill requirements of an occupation compared to the labour market in general, the smaller is the probability that workers change occupations after completion of apprenticeship training (Geel *et al*., 2010; Geel and Backes-Gellner, 2009; Gathmann and Schönberg, 2010). Apprentices in more specific occupations are stuck because a change of occupation would reduce the value of their specific skill set. Indeed, our occupation groups do differ with respect to the share of employer and occupation changers (see Table 1[12]) – in the commerce and trading occupations and in the construction and craft occupations changing employer and/or occupation is more common than in industrial occupations. Note that comparison of wage consequences of occupation changes between our three occupation groups might be problematic because the proximity of occupations might differ between these groups.

Table 1 about here

To sum up, for apprentices in commerce and trading occupations, we expect a positive wage impact of employer changes because they work in an environment that supports changes, acquire relatively general human capital and require relatively low investment by the

[12] The shares of changers in our table are lower than those presented in the literature because we include only changers between the end of the apprenticeship period and the first skilled job, and, in addition, restrict our sample to those without long interruption spells between the apprenticeship period and skilled job.

training firms (Mohrenweiser and Zwick, 2009). For apprentices in industrial occupations, a change is likely to incur a wage loss because employers might see changers as a negative selection and the human capital acquired is more specific. In addition, high apprenticeship training costs induce employers to keep their (best) apprentices. An argument against this hypothesis is that a degree in these occupations is a signal for relatively high intellectual capability and tenacity in comparison to other occupation groups. Changers in crafts and construction occupations should face wage reductions because the training quality is low, training contents are frequently specific and other employers are not willing to take changers without wage concessions because an apprenticeship in these occupations is regarded as low quality (Soskice, 1994).

Apprentices with a university entrance diploma are likely to be privileged and enjoy a higher training quality (Soskice, 1994). It is well known that many of these apprentices choose the apprenticeship qualification in Germany as a risk avoidance strategy (Pilz, 2009). As a consequence, they obtain better apprenticeship training and get favourable treatment by enterprises interested in attracting them after the end of their apprenticeship period. Apprentices in East Germany are likely to encounter a stronger wage reduction because they face a worse external labour market situation with higher unemployment rates for skilled employees than their West German colleagues.

The preceding discussion leads us to the following hypotheses:

1. The wage mark-ups are larger for changers from qualitatively higher apprenticeship occupations such as industrial occupations.
2. Changers in occupations with a high share of changers, such as commerce and trading, enjoy higher wage mark-ups.
3. Changers in occupations with relatively specific training contents, such as industrial occupations or crafts and construction, face wage markdowns.
4. Changes into occupations that are less similar lead to a larger wage reduction.

5. Changers with a university entry diploma, and changers from a smaller to a larger enterprise enjoy wage mark-ups. Changers from manufacturing into services and in East Germany face wage markdowns.
6. Involuntary changes lead to higher wage markdown.

The literature review does not allow us to derive hypotheses on the size of the average impact of an employer or occupation change. Our econometric specification is a log-linear ordinary least squares (OLS) estimation and has the following form:

$$Y_i = \alpha + \beta' X_i + \gamma' V_i + \varepsilon_i, \qquad (1)$$

where Y_i is the individual wage or wage mark-up (in logs), X is a change of employer or change of occupation dummy or an interaction term of this dummy with the groups of individuals, employers or occupations described above, V is a vector of individual and firm-specific control variables.

We performed a couple of robustness checks that allow comparison of our results to those presented in the literature. First, we ran a pooled OLS estimation that includes all wage observations in the first skilled job until two years after the beginning of the first skilled job (as long as the job was not changed). In order to get rid of unobservable time-invariant heterogeneity, such as work motivation or ability, we also took into account individual fixed effects.[13] These are individual wage observations half a year, a year, and one-and-a-half years before the end of the apprenticeship training, and half a year, a year, one-and-a-half years, and two years after the first skilled job starts. Together with the information on the wage at the

[13] Von Wachter and Bender (2006) and Dustmann *et al.* (1997) present firm fixed effects regressions. This is conceptually different because it wipes out only unobserved heterogeneity between firms, which affects all apprentices irrespective of their occupation. In addition, they only can use firms with more than one apprentice, which dramatically reduces their sample because a large share of the firms only employs one apprentice.

end of the apprenticeship training and at the start of the first skilled job, we have maximally nine wage observations per person and can include a fixed effect δ_i into our wage equation:

$$Y_{it} = \alpha + \beta' X_{it} + \gamma' V_{it} + \delta_i + \varepsilon_{it}. \quad (2)$$

Finally, we took into account the possible endogeneity of changing after the apprenticeship training. We assumed that the chance that somebody involuntarily changed the employer is much higher if a mass lay-off[14] took place in the last year of the apprenticeship. We showed that the mass lay-off indicator is a valid instrument: mass lay-offs are not correlated with the average ability of apprentice cohorts but induced by unexpected changes in labour demand. They are highly correlated with an apprentice's propensity to change the employer or the occupation, however (Von Wachter and Bender, 2006).

IV. Data

We used a 2% sample of official register data from the years 1993 to 2003[15] of all employees subject to social insurance in the period 1975–2004 (IABS 1975–2004) (see Drews, 2007 for details). We constructed a subsample of individuals moving from apprenticeship to their first employment and exploited the so-called employment and benefits history with spell information for each individual in the sample. For the wage mark-up version, we observed the end of the apprenticeship training and the start of the first skilled job for every individual only once. This created a sample of repeated cross-sections.

[14] According to the literature, we define a mass lay-off as a reduction in employment in one firm larger than 30% of the labour force within one year. Von Wachter and Bender (2006) use deviations from the average retention rate of the training firm as an instrument for involuntary employer change. We cannot construct the retention rate in our data, however, because we observe only a sample of the employees in each firm.

[15] Until the year 1992, firms did not have to report a change in the status of employees from apprentice to full-time employee if they stayed with their training firm (see Dustmann *et al.* 1997).

The full data set entails almost 25 million spells. When we reduced the sample to the spells in the years 1993–2003 and the main employment spells that take at least two days, the number of spells was little more than 12 million. When we focused on full-time employed individuals aged 16–25 and additionally eliminated those employees with either a university degree or an occupational degree that cannot be obtained through a dual vocational training (mostly full-time school-based training), as well as employment spells in the agriculture and public sector, the number of employment spells was reduced to a little more than 1.1 million. Our interest lies in the wage difference between apprentices who remain with their training firm and/or occupation (stayers) and those changing to another employer and/or occupation (changers). We know the precise end of the apprenticeship and the precise start of the first skilled job and the related wages. We know the daily wage of the last spell before the end of the apprenticeship training and the first daily wage when working in a skilled job for 53,312 employees. Finally, we used a trimmed sample where observations in the first and the 99th wage mark-up percentile were dropped.

Estimations on the basis of the IABS are usually subject to the problem that wages are censored at the social benefit contribution ceiling, and that experience and tenure are censored. We considered job starters with relatively low wages, and, therefore, these data problems do not affect our estimations. We took into account wage inflation for all wage observations.

At the firm level, information on the size of the training firm (during apprenticeship) and the employing firm (during the first skilled job) as well as the economic sector of the employing and training firm were used as control variables. At the individual level, age, sex and nationality were used as controls (see Table A.1 for details on variables).

Please note that we observed the employer at the firm level. This means that a change from one firm to another within a conglomerate of firms cannot be identified (Euwals and Winkelmann, 2004). Nevertheless, specific skills acquired might also be lost when changing

between firms within a conglomerate. Descriptive statistics of our variables can be found in Table A.2.

V. Results

Main results

Our first estimation results are displayed in Table 2. We found a significant negative wage impact of an employer change of about 3% on the first skilled wage (see column "first skilled job" in Table 2). The employer changers have a strong wage disadvantage of about 5% at the end of their apprenticeship period in comparison to the average occupation wage (compare column "apprenticeship" in Table 2). As a consequence, the true effect of changing employer is 1% and significantly positive (see column "mark-up").[16] The negative wage coefficients reported in the literature for employer changers might, therefore, be a statistical artefact when the lower wages of the changers during the apprenticeship training are not controlled . We also found that those employees who were paid poorly during their apprenticeship period have a stronger inclination to change employer.

Table 2 about here

Those who change their occupation directly after their apprenticeship training suffer a small but significant wage mark-up disadvantage of about 1% (row one in Table 3). Occupation changers also have lower wages at the end of their apprenticeship training. Those who change to another occupation in the broader first occupation classification level suffer a slightly smaller wage disadvantage (-0.004 instead of -0.01). This evidence is not consistent with our hypothesis 4 and with the evidence in Clark and Fahr (2001), and Geel and Backes-Gellner (2009). They found higher wage disadvantages for those who changed to a different

[16] Please note that the coefficients between the columns do not precisely add up because we used different sets of covariates controlling for firm characteristics during apprenticeship training when the apprenticeship wage is explained and for firm characteristics after the apprenticeship training when the first skilled wage is explained.

occupation (first-digit level).[17] A comparison of the financial consequences of employer and occupation change indicates that occupations might be more human capital-specific than employers, at least for skilled job starters.

Table 3 about here

The wage advantage of employer changers with university entrance exams is particularly large. This group is, according to our hypothesis 5, treated especially favourably by prospective employers because it has the attractive outside option of obtaining an academic degree. In accordance with hypothesis 5, we found that changers from a smaller to a larger enterprise profit from this decision; the difference is not significant, however. In the other subgroups, employer or occupation changers do not have different wage mark-ups in comparison to stayers (compare Table 3). Those who change sectors from manufacturing to services have lower initial wages in their first skilled job. As their wages also were lower during their apprenticeship training, there is no difference in their wage mark-up. According to hypothesis 5, East German occupation and employer changers also suffer wage disadvantages – their wage mark-up is not significantly different from those who do not change, however.

Grouping apprenticeships into our homogeneous occupation subgroups, we found the following interesting pattern: in industrial occupations, employer and occupation changers enjoy a significantly positive wage mark-up of around 4%. In trading and commerce occupations, employer changers also have a small but significant positive wage mark-up and occupation changers face a significant loss in the wage mark-up of almost 4%. In craft and construction occupations, wage mark-up losses for occupation and employer changers are small and only weakly significant. An interpretation of these findings is that, according to hypothesis 3, the specificity of training contents in trading and commerce occupations is

[17] The difference again might be driven by the fact that Clark and Fahr (2001) only look at differences in the skilled wages – we also found a larger wage disadvantage in skilled wages for this group.

relatively low. Therefore, firms with apprentices in trading and commerce occupations are not willing to invest much in apprenticeship training because their apprentices could leave the training firm without a cost. As a consequence, the productivity of employees with this occupational background in other occupations is low and an occupation change is, therefore, correlated with a wage disadvantage. In addition, a change of employer is relatively widespread in trading and commerce – employers seem, according to hypothesis 2, to be willing to hire apprentices from other training firms without a wage reduction.[18] In industrial occupations, the successful completion of the apprenticeship is a positive signal for capability. So employer and occupation changers might, according to hypothesis 1, profit from this positive signal. In addition, skilled employees with these qualifications are traditionally in short supply (Zwick and Schröder, 2001). Both effects seem to dominate the negative wage effects implied by a relatively high specificity of these occupations. In craft and construction occupations, the relatively low quality of the occupation and their high specificity seem to lead to disadvantages of occupation and employer changers.

5.2 Robustness checks

In order to obtain comparable results to those derived in the previous literature, we also reported the coefficients for employer and occupation change in a pooled OLS regression for the wage observations in the first two years of the first skilled job. Please note that the coefficients obtained in the pooled OLS regressions are very similar to those obtained in the regressions using the first skilled wage (compare the first column in Table 4). The coefficients are, in general, higher and more significant in the pooled version, however. This might be an indication for an overestimation of losses in previous papers that used wage information from a considerable time after the first skilled job started. Here, labour market effects might have an impact or long-term wage effects of changing might be different from short-term effects.

[18] The relatively high negative impact of an occupation change in commerce and trading in comparison to the other occupation groups might, however, be a consequence of occupations being less similar in this group.

Table 4 about here

We eliminated unobserved time-invariant heterogeneity between employer and/or occupation stayers and changers by applying fixed effects regressions. These results are very similar to those of the wage mark-up regressions, but have a larger and higher significant coefficient in absolute terms (see column 2 in Table 4). This again points at the possibility that long-run effects are larger than short-run effects and labour market influences later in the career bias the results.

5.3 Instrumental variable regressions

The wage mark-up results in Tables 2 and 3 take into account financial disadvantages or advantages of changers during the apprenticeship training that are indicators of unobserved heterogeneity between both groups. Endogeneity of employer or occupation changing still remains a problem because we cannot assume that changing is random, and selectivity can be fully captured by controlling the wage level during the apprenticeship training period. Therefore, we first explain in two probit estimations the probability that an apprentice changes his or her occupation or employer. We include the covariates used in the wage equation plus a dummy variable indicating whether the number of employees decreased by more than 30% during the last half a year of the apprenticeship. The mass lay-off variable has high explanatory power. Durbin-Wu-Hausman tests and Hausman tests indicate that employer and occupation changing are endogeneous in the wage mark-up estimation and our mass lay-off indicator is a valid instrument to control for endogeneity (see Table 5).[19] If we use the predicted change probability in the instrumental variables (IV) estimation, the wage mark-up for employer changers increases to 0.82 and the mark-up for occupation changers decreases to -0.80 (see Table 6). Both coefficients lose significance, however. As indicated previously, we cannot compare the coefficients in the IV and the OLS regressions because the IV coefficients

[19] Tentative apprenticeship wage and wage mark-up regressions confirm that the mass lay-off indicator is not significant.

apply for the specific group of apprentices who changed their employer or occupation because their firm suffered a mass lay-off. We can conclude, however, that changing employer after the apprenticeship training has a higher wage advantage when the former employer was in economic trouble, and, therefore, that the employer change is not attributable to individual characteristics of the former apprentice. Changing the occupation in such a situation might lead to a higher wage disadvantage because the occupation change has been involuntary and the alternative jobs entail losses in human capital.

Tables 5 and 6 about here

VI. Conclusions

This paper tests several important hypotheses on differences in the quality of apprenticeship training in Germany. Small wage advantages for those who change their employer directly after the apprenticeship training are indicators that the German dual apprenticeship training system provides, on average, generally usable human capital. We found small average wage losses for occupation changers that might be a consequence of the loss of specific human capital.

The small average effects mask large differences between occupation groups, however. For apprentices in industrial occupations (more specifically in metal working, electronics, IT and chemical industry occupations), changing employers and occupations is associated with a positive wage mark-up. The changers might profit from the positive signal a degree in these relatively demanding occupations conveys, and from chronic skilled labour market shortages in these occupations. Changers in crafts and construction occupations suffer from small wage disadvantages in comparison to stayers. These losses might be the consequence of low quality of apprenticeships and their relatively high specificity. For commercial and trade occupations the picture is mixed. Employer changers gain in comparison to stayers and occupation changers lose. The reason for this pattern might be that the apprenticeship contents are

relatively general and changes between employers are relatively common, but the quality of the apprenticeships is not that high.

By comparing the results of the wage mark-up with wages in the last apprenticeship spell and the first skilled employment, we demonstrate that analyses that do not take into account differences in apprenticeship wages obtain biased results. This is caused by lower wages of changers already occurring during their apprenticeship period. In the literature this effect is frequently controlled by using fixed effects regressions. Fixed effects regressions are problematic, however, because they use wage observations some time before and after the start of the first skilled job. We showed that including observations before and after the beginning of the first skilled job leads to (potentially biased) higher and more significant findings. Taking into account selectivity in changing by using an instrumental variables approach, leads to an increase in the coefficients. Involuntary employer changers, therefore, seem to profit more, and involuntary occupation changers lose more than the average changer.

This paper reconciles contradictory results in the literature by replicating and comparing the differences in empirical approaches. Additionally, it shows that differences in apprenticeship quality are usually small between economic sectors of the training firm or their size and location. These differences have been the centre of interest in previous literature. Large differences are only found between homogeneous occupation groups and the qualification backgrounds of apprentices. Such distinctions are proposed in this paper for the first time.

We account for the employer characteristics of economic sector and size. It seems important, however, to compare the impact of other employer characteristics, such as industrial relations, profits or business strategy on apprenticeship quality, which have not been analysed so far. We assume that, analogously to the large differences in occupation groups, certain employers offer better earnings prospects for apprentices who come from other training firms or change their occupation. The exploitation of linked employer–

employee data that include the relevant employer information for this purpose is a promising field for further research on this topic.

VII. Literature

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Tables

Table 1: Share of changers by occupation groups, directly after apprenticeship training

Occupation group	Share of employer changers	Share of occupation changers
Trading	17.3	12.6
Industrial	10.9	7.8
Crafts, construction	14.7	9.6
Average (including other occupations)	15.9	13.1

Data Source: IABS scientific usefile 1993–2003, complete sample.

Table 2: OLS regression explaining individual log wage or log wage mark-up

	Apprenticeship		First skilled job		Mark-up	
	Coeff.	S. D.	Coeff.	S. D.	Coeff.	S. D.
Employer change	-0.047 ***	(0.003)	-0.029 ***	(0.003)	0.010 ***	(0.003)
Age	-0.096 ***	(0.017)	0.042 ***	(0.014)	0.106 ***	(0.001)
Age^2	0.003 ***	(0.000)	-0.001	(0.000)	-0.003 ***	(0.000)
Sex	-0.013 ***	(0.003)	-0.097 ***	(0.003)	-0.074 ***	(0.004)
Nationality	0.030 ***	(0.005)	0.035 ***	(0.004)	0.003	(0.006)
Eight firm size dummies apprenticeship	Yes		No		Yes	
Eight firm size dummies skilled employment	No		Yes		Yes	
Nine sector dummies apprenticeship	Yes		No		Yes	
Nine sector dummies skilled employment	No		Yes		Yes	
Constant	-0.025 ***	(0.005)	3.211 ***	(0.152)	-0.171	(0.182)
N	50,699		50,699		50,699	
Adj. R^2	0.098		0.116		0.019	

Data Source: IABS scientific usefile, waves 1993–2003.

Notes: Year dummies included, standard errors in brackets, significance levels: *: 10%, **: 5%, ***: 1%.

Table 3: OLS regressions explaining individual log wages or log wage mark-up

	Apprenticeship		First skilled job		Mark-up	
	Coeff.	S.D.	Coeff.	S.D.	Coeff.	S.D.
Occupation change	-0.022 ***	(0.004)	-0.034 ***	(0.003)	-0.011 ***	(0.003)
Occupation change – 1	-0.036 ***	(0.004)	-0.040 ***	(0.003)	-0.004	(0.004)
Employer change X manufacturing into services	-0.156 ***	(0.009)	-0.136 ***	(0.007)	0.031 *	(0.020)
Occupation change X manufacturing into services	-0.142 ***	(0.011)	-0.139 ***	(0.009)	0.020	(0.014)
Employer change X change into larger enterprise	0.002	(0.004)	0.017 ***	(0.004)	0.012	(0.008)
Occupation change X change into larger enterprise	-0.019 ***	(0.006)	-0.016 ***	(0.005)	-0.002 ***	(0.007)
Employer change X university entrance diploma	0.006	(0.009)	0.057 ***	(0.008)	0.049 ***	(0.010)
Occupation change X university entrance diploma	0.021 *	(0.013)	0.050 ***	(0.011)	0.019	(0.012)
Employer change X East Germany	-0.277 ***	(0.008)	-0.252 ***	(0.006)	0.004	(0.008)
Occupation change X East Germany	-0.251 ***	(0.009)	-0.254 ***	(0.007)	-0.015 *	(0.009)
Employer change X commerce and trading	-0.006	(0.005)	0.020 ***	(0.004)	0.009 **	(0.005)
Employer change X	-0.057 ***	(0.006)	-0.004	(0.005)	0.041 ***	(0.006)

industrial occupations						
Employer change X crafts and construction	-0.071 ***	(0.007)	-0.082 ***	(0.005)	-0.012 *	(0.007)
Occupation change X commerce and trading	0.016 ***	(0.006)	-0.023 ***	(0.005)	-0.038 ***	(0.006)
Occupation change X industrial occupations	-0.003	(0.005)	0.036 ***	(0.005)	0.036 ***	(0.006)
Occupation change X crafts and construction	-0.046 ***	(0.008)	-0.072 ***	(0.007)	-0.016 *	(0.009)

Data source and significance levels: see Table 1.

Notes: Covariates (besides employer change) and other notes as in regressions in Table 1, every single line shows a separate regression besides joint estimations using three occupation dummy interaction.

Table 4: Pooled OLS and fixed effects regressions explaining individual log wages

	Pooled OLS		Fixed effects	
	Coeff.	S.D.	Coeff.	S.D.
Employer change	-0.082 ***	(0.002)	0.005 ***	(0.001)
Occupation change	-0.089 ***	(0.002)	-0.006 ***	(0.001)
Occupation change - 1	-0.098 ***	(0.003)	-0.006 ***	(0.004)

Data source and significance levels: see Table 1

Notes: Standard errors in brackets. Individual cluster effects are added in pooled OLS regressions. Covariates in OLS regressions: age, sex, nationality, size and sector of first skilled employer, year dummies; covariates in FE regression are the same except sex and nationality.

Table 5: Probit regressions explaining individual probability to change the employer or the occupation at the end of the apprenticeship period

Variable	Employer change		Occupation change	
Mass lay-off in last half a year of apprenticeship period	0.593***		0.157***	
Age	0.014***		0.022***	
Sex	0.165***		-0.008	
Nationality	-0.022		0.003	
Eight firm size dummies apprenticeship	Yes		Yes	
Eight firm size dummies skilled employment	Yes		Yes	
Nine sector dummies apprenticeship	Yes		Yes	
Nine sector dummies skilled employment	Yes		Yes	
Year dummies	Yes		Yes	
Constant	-1.684***		-2.187***	
Pseudo R^2	0.08		0.08	
N	41892		41892	
Wu-Hausman F test[1]	F(1,41891) = 3.940**	(0.047)	F(141891) = 3.684*	(0.055)
Durbin-Wu-Hausman chi-square test [1]	Chi-sq(1) =3.945**	(0.047)	Chi-sq(1) =3.688*	(0.055)

Data source and significance levels: see Table 1.

Notes: [1] p-values in brackets.

Table 6: Instrumental variable regressions explaining individual log wage mark-up between apprenticeship and first skilled wage

	IV Wage Mark-up Employer Change		IV Wage Mark-up Occupation Change	
	Coeff.	Std. Dev.	Coeff.	Std. Dev.
Change	0.082 **	(0.032)	-0.080	(0.118)
Age	0.101 ***	(0.019)	0.099 ***	(0.019)
Age^2	-0.002 ***	(0.000)	-0.002 ***	(0.000)
Sex	-0.073 ***	(0.003)	-0.076 ***	(0.004)
Nationality	0.003	(0.006)	0.006	(0.006)
Constant	-0.198	(0.201)	-0.174	(0.204)
Observations	41892		41892	
Adj. R^2	0.018		0.018	

Data source and significance levels: see Table 1

Notes: All regressions include eight firm size apprenticeship dummies, eight firm size skilled employment dummies, nine sector dummies and year dummies.

Table A.1: Variable Definition

Variable	Definition
Dependent variables	
Wage first job	Log wage at the beginning of the first skilled job
Wage apprenticeship	Log wage at the end of the apprenticeship period
Wage mark-up	Log wage mark-up between apprenticeship and first skilled wage
Variables of interest	
Employer	Dummy equals 1 if individual changed employer after apprenticeship
Occupation	Dummy equals 1 if individual changed occupation
Occupation – 1	Dummy equals 1 if individual changed occupation at the first occupational level
Occupation dummies	Dummy for commerce and trading occupations, industrial occupations and crafts/construction occupations
Explanatory variables	
Age	Age of individual at time of first skilled employment
Sex	Dummy equals 1 if individual is female
Nationality	Dummy equals 1 if individual has foreign nationality
University entrance diploma	Dummy equals 1 if individual has a university entrance diploma (*Abitur*)
Unemployment	Dummy equals 1 if individual was registered unemployed after apprenticeship
Firm size apprentice	Size of the training firm, eight dummies for 1–9, 10–49, 50–99, 100–

	249, 250–499, 500–999, 1000–4999, 5000+ employees
Firm size employee	Size of firm in first skilled job, eight dummies
Firm sector dummies	Nine dummies for: water and power, manufacturing, construction, trading, traffic and communication, finance, hospitality and restaurants, rent and lease, services
Y1994 to Y2003	Year dummies for 1994–2003, reference year: 1993

Table A.2: Summary statistics in absolute values: dependent variables

Variable	Mean	Std. Dev.	Min	Max
Employer change	0.190	(0.301)	0	1
Occupation change	0.160	(0.367)	0	1
Occupation change -1	0.141	(0.348)	0	1
Commercial trading	0.084	(0.277)	0	1
Employer change X change from manufacturing into services	0.023	(0.149)	0	1
Occupation change X change manufacturing into services	0.016	(0.130)	0	1
Employer change X change into larger enterprise	0.089	(0.286)	0	1
Occupation change X change into larger enterprise	0.098	(0.298)	0	1
Employer change X university entrance diploma	0.013	(0.113)	0	1
Occupation change X university entrance diploma	0.010	(0.098)	0	1
Employer change X East Germany	0.087	(0.282)	0	1
Occupation change X East Germany	0.071	(0.258)	0	1
Employer change X commercial trading occupations	0.063	(0.243)	0	1
Employer change X metal working occupations	0.018	(0.135)	0	1
Employer change X crafts and construction occupations	0.031	(0.173)	0	1
Occupation change X commercial trading occupations	0.046	(0.209)	0	1
Occupation change X industrial occupations	0.020	(0.144)	0	1
Occupation change X crafts and construction occupations	0.020	(0.141)	0	1

Data source: Sample drawn from IABS scientific usefile, waves 1993–2003.

Table A.3: Summary statistics in absolute values: covariates

Variable	Mean	Std. Dev.	Min	Max
Trading and commerce	0.364	(0.500)	0	1
Industrial occupations	0.255	(0.227)	0	1
Crafts, construction	0.209	(0.133)	0	1
Age	20.958	(1.703)	16	25
Sex	0.410	(0.492)	0	1
Nationality	0.068	(0.251)	0	1
University entrance diploma	0.041	(0.199)	0	1
Unemployment	0.002	(0.042)	0	1
East Germany	0.159	(0.365)	0	1
Firm size app.* <10	0.177	(0.382)	0	1
Firm size app. 10–49	0.285	(0.452)	0	1
Firm size app. 50–99	0.112	(0.315)	0	1
Firm size app. 100–249	0.142	(0.349)	0	1
Firm size app. 250–499	0.097	(0.296)	0	1
Firm size app. 500–999	0.078	(0.269)	0	1
Firm size app. 1000–4999	0.084	(0.277)	0	1
Firm size app. >5000	0.024	(0.154)	0	1
Firm size emp. <10	0.185	(0.388)	0	1
Firm size emp. 10–49	0.293	(0.455)	0	1
Firm size emp. 50–99	0.112	(0.315)	0	1
Firm size emp. 100–249	0.138	(0.345)	0	1

Firm size emp. 250–499	0.093	(0.290)	0	1
Firm size emp. 500–999	0.073	(0.260)	0	1
Firm size emp. 1000–4999	0.081	(0.273)	0	1
Firm size emp. >5000	0.024	(0.154)	0	1
Water and power	0.015	(0.121)	0	1
Manufacturing	0.359	(0.480)	0	1
Construction	0.131	(0.337)	0	1
Trading	0.206	(0.404)	0	1
Traffic and communication	0.038	(0.192)	0	1
Finance	0.119	(0.323)	0	1
Hotels and restaurants	0.013	(0.111)	0	1
Rent and lease	0.082	(0.275)	0	1
Services	0.038	(0.192)	0	1
Number of observations	30,642			

Data source: see Table A2, notes: * app. means employer during last spell of apprenticeship, ** emp. means employer during first skilled job.