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Same educational level, same wage returns? An analysis over time and across occupations in Germany

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ABSTRACT

Analysing wage differentials due to educational investments within occupations can explain the persistent wage inequality in western industrialised countries, such as Germany. This article contributes to the discussion by examining occupation-specific variance in wage returns for men working full-time in Western Germany between 1976 and 2010. We distinguish between three groups: employees with a vocational education and training (VET) degree with an Abitur (a certificate allowing entrance into a German university), with a VET degree but no Abitur, or with a university degree. First, we theoretically argue why wage returns vary within educational levels across occupations. Second, on the assumption that wage return variance will be greater at higher educational levels, we investigate wage return variance patterns for VET and university graduates over time. Estimating a two-stage multilevel model using the Sample of Integrated Labour Market Biographies (SIAB), we show that holding an Abitur increases wage return variance across occupations. Moreover, we find a significantly higher occupation-specific variance in wage returns to education for university graduates than for VET graduates. For the period under examination, we reveal a fluctuating variance in wage returns for VET graduates and a slightly decreasing variance for university graduates.

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Task approach; occupation-specific wage returns to education; occupation-specific variance patterns; German labour market

Introduction

Empirical findings demonstrate that employees with the same level of education earn different wages depending on their occupation (e.g. Haupt 2016) or field of study (Glocker and Storck 2014). From previous research, we know that the combination of education and occupation decisively impacts wage returns and income (Friedrich and Hirtz 2021; Stüber 2016). Nevertheless, systematic patterns of varying wage returns to education, particularly for highly-structured occupations, are underexplored. Only a few studies have deduced empirically testable hypotheses concerning wage return variance within educational levels and across occupations. Furthermore, no attention has yet been paid to the temporal development of wage return variance across occupations.

The present paper¹ contributes to the discussion about occupations and their impact on wage variance. We reveal variance patterns for occupation-specific wage returns to education (i.e. wage returns to education across occupations) depending on educational level and investigate their development over time.

We estimate a two-stage multilevel model for men working full-time in Western Germany between 1976 and 2010. We decided to exclude women from our analysis because, especially at

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 Supplemental data for this article can be accessed [here](#).

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the beginning of our observation period in the late 70s, the majority work(ed) part-time rather than full-time. Hence, even if we included women, it would be a highly selective group, as we are not able to control for working hours and can therefore only analyse full-time employees. Moreover, the gender wage gap illustrates that women's remuneration is systematically different than men's (e.g. Blau and Kahn 2017). We use the high-quality Sample of Integrated Labour Market Biographies (SIAB), which allows for precise investigations at the individual and occupational levels over 34 years.

The impact of occupations and education on wages is well researched (e.g. Haupt 2016), but discussion of the different wage return variance patterns depending on educational level is mostly lacking. We close this gap by showing that variance in occupation-specific wage returns to education differs between educational levels.

The purpose of this paper is twofold. First, we show the occurrence of occupation-specific wage returns and empirically analyse their variance across educational levels. We examine whether vocational education and training (VET) graduates with an Abitur (a certificate allowing entrance into a German university) experience higher wage return variance across occupations than VET graduates without an Abitur, and whether university graduates show a higher variance at all. Comparing variance in wage returns to educational attainment across occupations allows us to identify the educational path connected with higher earnings risks (Hartog 2011). The distinction between a VET graduate with and without an Abitur is particularly interesting because of possible competition within this group for jobs that do not require a university degree.

Second, we investigate patterns of variance in occupation-specific wage returns across educational levels between 1976 and 2010. Since the 1950s, education expansion has effected profound social change, creating a surge in secondary and tertiary education, and considerably altering various facets of work and life (Baker 2009, 2014). Educational expansion increased the supply of high-skilled workers in the labour market and changed work quality and content (Baker 2009, 2014). Technological change has further increased the demand for complex skills linked to analytic and interactive tasks. Both developments have affected wages and probably wage variance, making it rewarding to evaluate time trends. Inspecting occupation-specific variance patterns of wage returns to education over time helps reveal changes that would otherwise be concealed by average wage returns.

The German education system

The German education system is highly stratified and standardised (Allmendinger 1989), and educational certificates are particularly important for labour market placement (Solga and Konietzka 1999). Students are divided into educational tracks very early after elementary school. First, a vocational track entails 10 years of schooling, and the school-leaving certificate does not enable its holders to attend university. Most graduates without an Abitur do not access the labour market directly; rather, they enter the VET system, which is divided into a school-based vocational system, covering mostly health care and nurturing occupations, and a dual training system, which combines in-company training with additional vocational education and represents the VET system's core. About 56% of the population aged over 15 years hold a VET degree (Autorengruppe Bildungsberichterstattung 2018, 277), which represents the medium skill level.

Second, an academic track entails 12 to 13 years of schooling and the Abitur, which serves as a university entrance certificate. About 17% of the population aged over 15 years hold a university or applied university degree (Autorengruppe Bildungsberichterstattung 2018, 277) and are high-skilled. However, not all graduates with an Abitur enrol in university. The proportion of school leavers with an Abitur within the dual VET system rises constantly (2009: 20%; 2016: 29%; BIBB 2018, 132).

Despite this, approximately 17% of Germans older than 15 have not obtained any vocational qualifications nor have they undergone training (Autorengruppe Bildungsberichterstattung 2018, 277); such persons are referred to as unskilled workers.

Returns to education and key developments in the German labour market

A large strand of the literature addresses wage returns to education in Germany (for an overview, see Friedrich and Horn 2018). All studies find that the higher the educational level, the higher the wage returns. On average, VET graduates earn about 20% more than unskilled workers, and university graduates earn about 42% more than VET graduates (*ibid.*). Regarding the development of wage returns to education over time, the literature reports contradictory results. Giesecke and Verwiebe (2008), for instance, find moderately increasing wage returns to education over the years. Boockman and Steiner (2006) reveal a decline in wage returns for Western Germany since 1945.

Further studies have investigated the influence of various occupations on wages (e.g. Bol and Weeden 2015; Groß 2012; Haupt 2016). They show that occupations act as a decisive context for wages and consequently affect returns to education. According to Haupt (2016), income variance across occupations in Germany is closely linked to employees' human capital. Occupational inequalities have increased over time due to changes in human capital investments (Haupt 2016, 206).

Only a few studies have explicitly examined varying wages within levels of education and across occupations in the German labour market. For instance, Glocker and Storck (2014) demonstrate that wages vary widely within educational levels; higher educational levels tend to show higher variance, depending on the field of education. Blien and Van Phan thi (2010) show remarkable variance in wage returns to occupation by analysing 92 occupations in the dual system; for instance, tilers earn 28% more than the average for all occupations, whereas waiters earn 28% less. Further, Friedrich and Hirtz (2021) discover that occupations inherit occupation-specific wage returns; they also reveal diverging variance between VET graduates with and without an Abitur. Considering lifetime income for four different requirement levels, Stüber (2016) reveals that employees with complex specialist requirements, for example, in the information technology sector, are remunerated at a higher rate than employees who also have highly-complex requirements but work in other occupations.

When considering occupation-specific variance wage return patterns over time, factors such as globalisation and related phenomena such as immigration, offshoring, and outsourcing are relevant. Globalisation comprises macrosocial global interconnections, accompanied by various consequences for market economies. Consequently, the immigration of potential workers changes job competition in local labour markets. Germany's workforce comprises about 10% foreign workers. However, empirical investigations do not show negative wage effects due to immigration (D'Amuri et al. 2010). Hence, for Germany, immigration does not seem to have wage return consequences. Within this study's investigation period (i.e. 1976–2010), Germany experienced reunification in 1990, *inter alia*, majorly overturning the existing labour market structures. The literature does not indicate any direct influence on wages in Western Germany. Accordingly, we do not expect that the reunification-induced intra-Germany migration wave significantly influences occupation-specific variance patterns.

Further, globalisation is closely linked to offshoring and consequently impacts wages. Germany operates offshore less frequently because producing high-skilled labour in the home economy has comparative advantages (Lauder, Brown, and Ashton 2008). Amidst globalisation, offshoring is linked to job outsourcing.

Since the early 1990s, Germany has experienced a great rise in outsourcing, accounting for about a 9% increase in wage inequality (Goldschmidt and Schmieder 2017). Nevertheless, the demand for outsourcing in Germany is rather low. However, negative wage effects induced by outsourcing do exist, although they mainly affect low-skilled rather than high-skilled workers (Geishecker, Görg, and Munch 2010).

Educational levels, wages and occupations

Why should wage returns vary by educational level and occupation?

The most prominent approach to explaining the effect of individual educational investments on labour market outcomes is human capital theory (HCT)² (Becker 1964). The canonical HCT premises that pay is proportional to productivity, and companies remunerate employees according to their productivity. Further, the theory assumes that individuals accumulate specific and general human capital during their education. The more time individuals invest in their education, the higher their productivity. Following HCT, we deduce that workers with higher educational levels have invested more in their human capital, are more productive, and therefore earn higher wages than those with lower educational levels.

In addition to the prominent economic labour market theory, we aim to shed light on some theories that address institutional facets that impact wage return variance. Among them, social closure exemplifies occupation's impact on wages. Following this theoretical account, workers organise themselves into groups to monopolise economic advantages for group members. Five mechanisms regulate access to such an exclusive group: educational credentialing, licencing, unionisation, association representation, and voluntary certification (Weeden 2002). For example, Bol and Weeden (2015) identify the substantial explanatory power of occupations, which account for about 26% of the wage variance in Germany. Further, the authors show that credentialing is linked to higher wages (*ibid.*). In terms of wage ranges, Glocker and Storck (2014) reveal a wider range for individuals with tertiary degrees than for VET graduates.

Educational credentialing describes one mechanism of occupational closure to regulate individuals' access to occupations and the realisation of returns to education. Credentials are certificates employees acquire by successfully matriculating through the education system. Credentialism, or assignment to a certain occupation with a corresponding certificate, is rather strict in Germany and is linked to credentials content (Solga and Konietzka 1999). Germany is characterised as an occupational labour market due to its strong VET system, which teaches occupation-specific skills (Gangl 2001). Occupational labour markets seek a strong match between qualifications and job position. Gangl (2001) assumes that in occupational labour markets such as Germany's, outcomes are less prone to change, given the strength of the aforementioned match at the outset of an individual's career.

Why should wage returns vary within an educational level irrespective of occupation?

One strand of the literature considers the wage return risk dimension and specifies compensating wage differentials (Borjas 2008). 'Risk' subsumes working conditions, workplace disamenities, and accident probability. Firms pay risk premiums for hazardous and aggravating work (Villanueva 2007). Another dimension of risk is the uncertainty of achievable wages after education (Hartog 2011; Mazza, Hans, and Hartog 2013). The higher the uncertainty of realising a certain wage with a specific combination of educational level and occupation, the higher the returns are in order to compensate for the risky decision. As a measurement of risk, the wage dispersion within an occupation is connected with varying returns³ (Hartog 2011). For Germany, Bonin et al. (2007) demonstrate that individuals with higher risk preferences select occupations with high earning risks. The literature shows that the relationship between educational level and risk is nonlinear. A higher educational level is not always associated with higher risk (Mazza, Hans, and Hartog 2013). In summary, workers with the same level of education achieve different wage returns, depending on the risk return rate associated with a particular occupation.

Another approach to explaining wage differences within educational levels is the task approach (Autor 2013; Autor, Levy, and Murnane 2003; Acemoglu and Autor 2011), which is an extension of skill-biased technological change. Autor, Levy, and Murnane (2003) conceptualised a model distinguishing five different tasks: routine cognitive, routine manual, non-routine manual, analytic, and

interactive. Computers and other technologies substitute routine cognitive and routine manual tasks, but complement analytic and interactive tasks, and do not affect non-routine manual tasks. Hence, technological change induces a decrease in the demand and remuneration for routine cognitive and routine manual tasks, but increases demand and remuneration for analytic and interactive tasks. Demand and wages for non-routine manual tasks are not affected. Numerous studies have shown that task composition influences wages (Antonczyk, DeLeire, and Fitzenberger 2018). For instance, changes in task content and the offshoring of tasks impact employment structure and account for job polarisation (Goos, Manning, and Salomons 2014). Bachmann, Cim, and Green (2019) underpin the impact of tasks on wages in Germany by proving that high occupational routine task intensity comes with wage penalties. Further studies show that the tasks performed vary within and between occupations (Autor and Handel 2013). In short, tasks influence wages and vary considerably within educational levels and occupations. This variance again results in varying wage returns. The assumption of task specificity in occupations, leading to varying wage returns, emphasises the task approach's relevance to our study.

Based on our theoretical considerations, we conclude that returns to education vary within educational levels, irrespective of occupation. Concentrating on the task approach, we put forward an argument explaining why variance in returns to education across occupations differs by educational level. To that end, we offer our hypotheses.

Deriving hypotheses for occupation-specific variance patterns at different educational levels

A key assumption of the task approach is that 'workers of a given skill level can perform a variety of tasks and change the set of tasks that they perform in response to changes in labour market conditions and technology' (Acemoglu and Autor 2011, 1045). High-skilled workers are more productive than medium-skilled workers, and both are more productive than low-skilled workers, especially in performing analytic and interactive tasks. High-skilled workers have a comparative advantage and are more likely to perform these tasks (Autor 2013), earning higher wage premiums. These premiums widen the distribution of wage returns for workers upwards. Additionally, many substitution possibilities exist between different educational levels (Acemoglu and Autor 2011). The mismatch between educational achievement and educational requirements comes with wage penalties, widening the distribution of wage returns downwards. We presume that wage return variance differs between VET graduates with and without an Abitur. During their additional years of schooling, graduates with an Abitur acquire further human capital, especially general skills (Schneider 2008), enhancing their capabilities in terms of performing analytic and interactive tasks. Following this argument, VET graduates with an Abitur have comparative advantages in performing these tasks, compared to VET graduates without an Abitur. Hence, Hypothesis 1 (H1): Workers with a VET degree and an Abitur experience higher occupation-specific wage return variance than workers with a VET degree but no Abitur.

Besides the differences between workers with and without an Abitur, we expect university graduates' wage return variance to be even higher. University graduates are especially productive in performing analytic and interactive tasks, and can serve as substitutes for less educated employees (Welch 1979), which widens their wage distribution both upwards and downwards. Hence, Hypothesis 2 (H2): University graduates' occupation-specific wage return variance is higher than that of VET graduates, both with and without an Abitur.

Technological change leads to polarised demand for and remuneration of skills. For analytic, interactive, and non-routine manual tasks, demand and remuneration rise, whereas they decline for routine manual and routine cognitive tasks (e.g. Goos, Manning, and Salomons 2009). Spitz-Oener (2006) shows that for Germany, 'occupations have experienced a shift toward analytical and interactive activities and away from cognitive and manual routine tasks' (263). More recently, Bachmann, Cim, and Green (2019) point to a notable decrease in routine-intensive tasks in Germany since the

1970s. Dengler and Matthes (2018) calculate the probability of substitution using the share of routine tasks for various occupations. According to their measure, all occupations have the potential for substitution due to technological change, but complex specialists and highly-complex occupations are less affected than specialist and unskilled occupations.

Educational expansion has increased the supply of high-skilled workers in the German labour market, changed work content, and promoted task substitution (Baker 2009, 2014). We assume that the relationship between the supply and demand of high-skilled workers differs across occupations (Zika et al. 2015). For example, due to recruitment problems in some occupations, medium-skilled workers might be upskilled to take over interactive and analytic tasks, and receive higher wages. Substituted workers will end up performing more routine tasks and earn lower wages or leave the labour market. Hence, Hypothesis 3a (H3a): The variance in occupation-specific wage returns to education shows a rising trend for VET graduates (with and without an Abitur) over time.

A growing demand for high-skilled workers, promoted by technological change and changing work content, favours analytic and interactive tasks, and entails wage increases. Hence, task diversity diminishes for high-skilled workers because they are increasingly taking over analytic and interactive tasks. In particular, occupations where the supply of high-skilled workers has caught up with demand are affected. This development leads to the adjustment of wage returns for tertiary degrees and narrows the distribution of wage returns for high-skilled workers at the upper end. Hence, Hypothesis 3b (H3b): The variance in occupation-specific wage returns to education for university graduates shows a declining trend over time.

Despite changes in task structure and the supply of skilled employees, globalisation and associated phenomena (immigration, offshoring, and outsourcing) are also plausible influencing factors for wage return variance. Given its complexity, it is not possible within the scope of our research to derive the net effect of globalisation on wage inequality. However, the effect of globalisation should be kept in mind when inspecting developments over time.

Method

We apply a hierarchical multilevel model (e.g. Langer 2010; Rabe-Hesketh and Skrondal 2012) by analysing employees nested in occupations for each year between 1976 and 2010. We use two levels of analysis: individuals, i , at the first level and occupations, j , as contexts at the second level. We specify all our models with an unstructured covariance matrix and cluster-robust standard errors for occupations. The following model steps adhere to the general practice of a multilevel analysis (Langer 2010).

In the first step of our empirical analysis, we estimate the random intercept-only model (R-I-O-M), using the following equation:

$$(1a) \text{ Level1 : } Y_{ij} = \beta_{0j} + r_{ij}$$

$$(1b) \text{ Level2 : } \beta_{0j} = \gamma_{00} + u_{0j}$$

Eq. 1a depicts wages (Y_{ij}) within occupations. β_{0j} is the intercept, which varies only in the context j . r_{ij} subsumes the residual of the value from Y_{ij} of an individual i nested in the context j . Eq. 1b shows the measurement of the context-specific intercept. γ_{00} represents the constant of the regression (i.e. the average intercept for all j). u_{0j} defines the random component of occupations, which measures the deviation of the intercept in context j from the average intercept γ_{00} . By estimating random effects, we examine the share of income variance potentially explained by occupation. The intraclass correlation (ICC) coefficient measures the variance component explained by the higher level (i.e. the second level).

In the second step, we estimate a random intercept model (R-I-M) to compute wage variance under control for Level 1 variables (i.e. the educational level and a set of control variables at the

individual level). We calculate the impact of the Level 1 variables as fixed effects and the intercepts as random effects. This step uses the following equation:

$$(2a) \text{ Level1 : } Y_{ij} = \beta_{0j} + \delta_{10}W_{i.} + r_{ij}$$

$$(2b) \text{ Level1 : } \beta_{0j} = \gamma_{00} + u_{0j}$$

The additional term $\delta_{10}W_{i.}$ subsumes control variables at the first level (i.e. individual level) that do not vary at the occupational level.

In the third step of our analysis, we estimate a random-intercept, random-slope model (R-I-R-S-M). We augment our model by measuring the variance of the selected Level 1 variables and their covariance across Level 2. In other words, we allow the slopes to vary according to occupation. This step uses the following equation:

$$(3a) \text{ Level1 : } Y_{ij} = \beta_{0j} + \beta_{1j}X_{ij} + \delta_{10}W_{i.} + r_{ij}$$

$$(3b) \text{ Level2 : } \beta_{1j} = \gamma_{10} + u_{1j}$$

Eq. 3a contains the entity $\beta_{1j}X_{ij}$, which typifies the context-specific slopes for the individual predictors X_{ij} nested in occupations j . β_{1j} varies for all occupations j , so we determine an inherent slope for each occupation.

In the last step of our analysis, we fit the core element of our analysis, the intercept-as-outcome model (I-as-O-M). This step uses the following equation:

$$(4a) \text{ Level1 : } Y_{ij} = \beta_{0j} + \beta_{1j}X_{ij} + \delta_{10}W_{i.} + r_{ij}$$

$$(4b) \text{ Level2 : } \beta_{0j} = \gamma_{00} + \gamma_{01}Z_j + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + u_{1j}$$

Eq. 4b extends Eq. 3b with $\gamma_{01}Z_j$, which measures the effect of the control variables Z_j at Level 2 (i.e. occupational characteristics) on the variance of the intercepts across occupations j . The average slope γ_{10} of X for all contexts and its deviation from the average contextual slope (i.e. u_{1j}) are used to measure β_{1j} .

I-as-O-M provides the statistical variance of an individual characteristic's context-specific slopes ($\text{Var}(\beta_{1j}|X_i)$). We use this value to judge the variance in wage returns across occupations. Further, the model allows for the estimation of occupation-specific returns to education, enabling us to assess variance patterns between occupations.

We are aware of potential bias due to unobserved heterogeneity at the individual and occupational levels because we cannot control for correlations between unobservable and observable factors. Nevertheless, we are interested in revealing the overall variance patterns, instead of quantifying exact wage returns.

Data and variables

We used the SIAB from 1975 to 2010. The data set is a weakly anonymised 2% random sample of the Integrated Employment Biographies (IEB) from the Institute for Employment Research (vom Berge, König, and Seth 2013). The administrative data match our analyses very well because of their reliable measurement of wages and the large number of cases, allowing for a multilevel analysis. A limitation is that the data include only employees who are subjected to social security contributions. Hence, the data do not cover self-employed or civil servants.

To obtain a comparable sample, we constrained our analyses to male employees older than 18 years working full-time in Western Germany. We excluded 1975 from the sample due to the small number of cases in the individual birth cohorts (Bender 1996, 21–22). These sample restrictions leave us with 209,000 to 248,000 observations per year.

The dependent variable of our analyses is the individual deflated gross monthly wage (base year: 2010), including special payments, as reported for the 30th of June in the respective year. Since the information on wages in the SIAB is truncated at the social security contribution limit, we imputed the corresponding cases, according to Gartner (2005). Without imputation, our results are considerably biased downwards because the truncation artificially compresses the wage distribution. Even with imputation, we tend to underestimate high wages and, thus, the estimated variance.

Our main independent variable is educational level. We distinguished four levels of education representing the different tracks of the educational system: no degree (unskilled), VET without an Abitur (VET1), VET with an Abitur (VET2), and an (applied) university degree as higher education (HE). In order to reduce missing information, we imputed our educational variable, following the well-established first imputation procedure (IP1), according to Fitzenberger, Osikominu, and Robert (2005).

Occupations serve as the context for our study. To operationalise the occupational level, we used the three-digit level corresponding to the 1988 German occupational classification (Klassifikation der Berufe, KldB 1988). All three-digit occupations were too small (less than 20 observations per year) to provide reliable information and were therefore mapped to similar occupations (Table A1.1 in the Appendix), resulting in 275 occupations for our estimations. To check the robustness of our analyses, we excluded occupations with less than ten observations per educational level in four observation years (1980, 1990, 2000, and 2010). The results (available upon request) do not differ significantly from those presented here.

In our models, we controlled for several individual and occupational variables. We used nationality⁴ (as a proxy for labour market immigration), the labour market entry cohort, tenure, occupational experience (and their respective squares), an interaction of educational level with occupational experience, employees having more than one job, the duration of unemployment, firm size, branch, and region on the individual level (i.e. Level 1). At the occupational level (i.e. Level 2), we used the share of employees with at least a VET1 and a university degree, respectively, to account for an occupation's educational structure, as well as the displacement of unskilled employees and VET degree holders. Further, we included the share of women per occupation to represent women's increasing labour market participation. Finally, a dummy variable controls for occupational licencing, and the composition-cleaned wage per occupation accounts for closure (see Table A1.2 for detailed information about the Level 2 control variables).

Insight into varying wage returns to education

Share and wage variance by educational level

The composition of the workforce in Western Germany changed between 1976 and 2010. Figure 1 depicts the development trajectory of our sample of men older than 18 years working full-time. The share of unskilled workers decreased from approximately 24% (1976) to 9% (2010). Workers with a VET1 degree dominate the period, with a share of over 66%, but since the early 1990s, their share has declined steadily. The number of workers with a VET2 and a university degree increased, respectively. Starting with about 1% in 1976, VET2 degree holders rose to 7% in 2010, and the proportion of employees with a university degree rose from 2% to 12%.

Between 1976 and 2010, real wages by educational level increased to varying degrees: tertiary degree holders' average wages rose between 1976 and 2010, from about 3,300 Euro to 4,300 Euro, while VET graduates' wages increased from about 2,600 Euro to 3,100 Euro, and unskilled labourers' wages rose from 2,100 Euro to 2,500 Euro. Despite absolute wage differentials and their

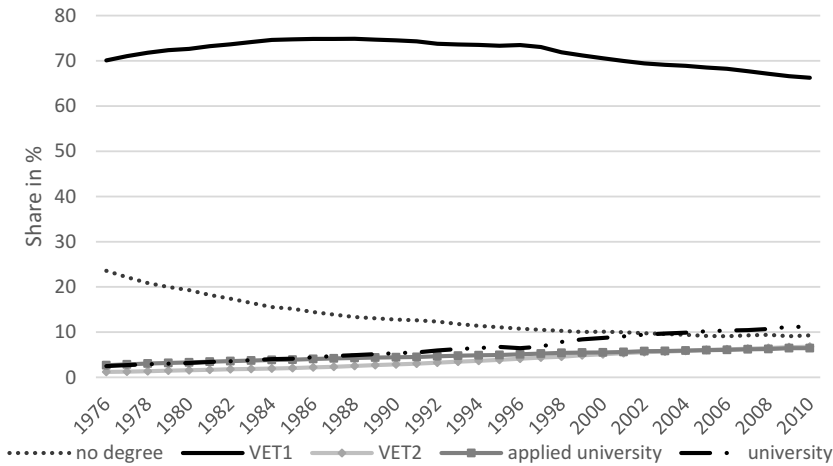


Figure 1. The share of levels of education.

Source: SIAB V7510. Population: West-German full-time male employees.

development over time, our study focuses on variance in wage returns within educational levels. Hence, we examined these variances descriptively. Figure 2 plots the upper (75%) and lower (25%) wage quartiles, as well as the median (50% quartile) for each educational level. Juxtaposing educational levels, one can distinguish three tendencies: First, unskilled workers and workers with a VET1 degree experienced medium wage variance in 1976. Over time, the differences between their wages grew steadily. Second, workers with a VET2 degree have experienced high wage variation since the

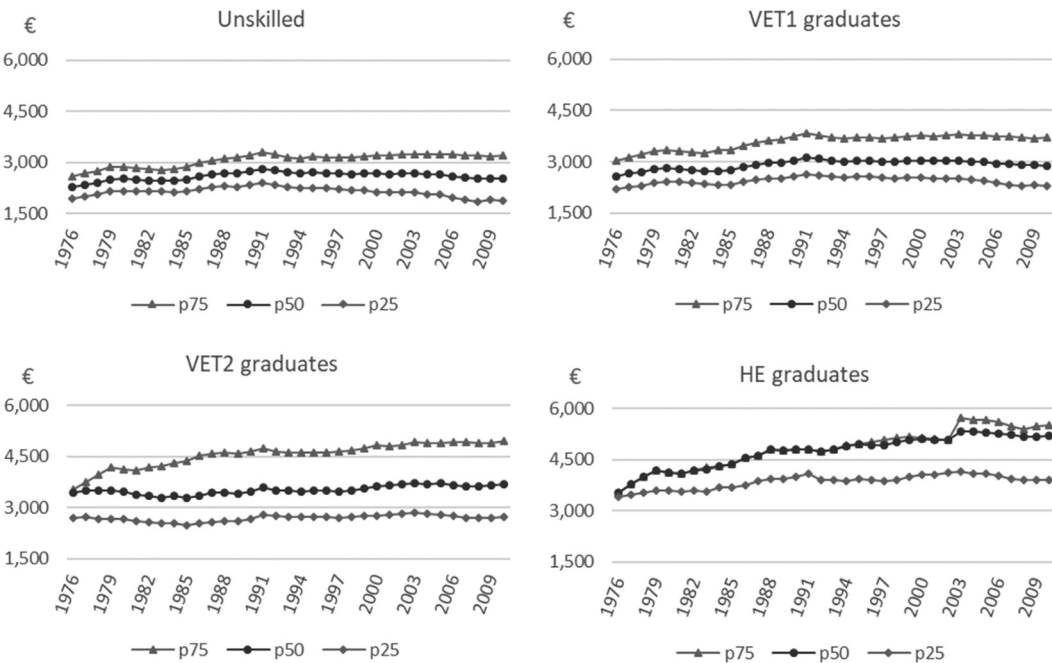


Figure 2. Dispersion of deflated gross monthly wages in € by level of education.

Source: SIAB V7510. Population: West-German full-time male employees.

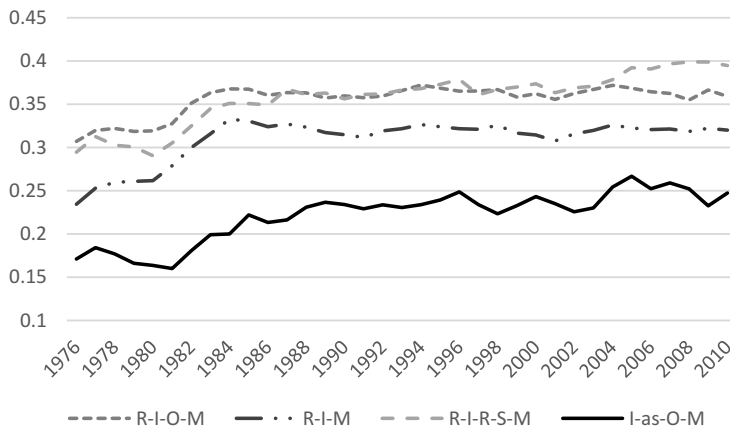


Figure 3. Intra-Class-Correlation coefficients (ICC).

Source: SIAB V7510. Population: West-German full-time male employees.

1980s, with the rise in the variance remaining flat. Third, workers with a university degree were similarly paid in 1976, whereas in 2010, their remuneration became more heterogeneous. Surprisingly, for university graduates, the upper quartile and the median were almost identical over 25 years, until 2002, and they still lie very close to each other. A possible reason for this is the truncation of the data. Presumably, our imputation is not capable of imputing extremely high wages, so our wage distribution is compressed, especially for university graduates, who are more likely to earn wages above the social security contribution limit.

Overall, the above descriptive results reveal changes in the proportions associated with the educational levels and buttress the assumption of varying wage returns within an educational level over time. To understand whether unadjusted wage variance is determined by differentiating wage returns across occupations, we proceed with our multivariate analyses.

Before we investigate variance in occupation-specific wage returns to education and test our hypotheses, we sketch the results of our model development. In the first step, we aim to discover whether occupations act as determining factors of wages in our sample. Figure 3 shows the ICC for our model. The ICC of the R-I-O-M shows that occupations explain between 30% and 40% of the wage variance.

In the next step of our model development, we add the individual predictor variables and release the occupations' intercepts. The ICC changed only slightly compared to the R-I-O-M (Figure 3). The estimated wage returns to education (Table A2.1) are not surprising; VET2 graduates yield higher returns than VET1 graduates, whereas HE graduates earn the highest returns.

The next model step (R-I-R-S-M) releases not only the occupations' intercepts, but also the slopes for the educational levels, namely VET1, VET2, and HE. Again, considering the ICC first, we observed a considerable reduction of approximately 25% to 30% (Figure 3). Wage returns to education (Table A2.1) were equal to that of the R-I-M. To illustrate the released slopes, we present the results for occupation-specific wage returns in Figure A2.1. On the x-axis, the occupations are ordered according to their KldB88 code, with agricultural and manufacturing occupations on the left and technical and service occupations on the right. The black line illustrates the regression coefficient (γ_{10}) and represents the average wage return. Comparing the different educational levels' occupation-specific wage returns, we observe different variance patterns. HE graduates' occupation-specific wages spread more around the average than those of VET1 and VET2 graduates, a finding we will discuss further in our final model, the I-as-O-M.

The last step of our model development is to include occupation-level control variables. The ICC diminishes further to approximately 15%–25%. Again, the wage returns hardly differ from those of

the previous models. Since the I-as-O-M, as our data analysis' core element, covers the broadest range of control variables, we will also briefly consider their effects (Table A2.1). Most coefficients are significant, which is unsurprising. For example, the larger the firm, the more the employees earn, and the longer the unemployment duration, the smaller the wage returns. It might be striking that European Union foreigners earn higher wages, on average, than German employees. However, the coefficient was relatively small. Further, only employees working in agriculture and mining earn higher wages than manufacturing employees, and those working in teaching and education are subjected to the highest wage penalties. Lastly, when inspecting the variables at the occupational level, we find a slightly positive correlation with wages for VET1 and HE graduates, and occupational licencing. In contrast, we find lower wage returns in occupations with a higher proportion of women. In the next section, we discuss occupation-specific wage returns in more detail.

Occupation-specific wage return variance patterns

In this section, we provide a general overview of the occupation-specific wage return variance patterns, calculated using the I-as-O-M. We form intervals where 95% of the occupation-specific slopes are expected to lie (estimated as the variance of occupation-specific slopes multiplied by ± 1.96 ; Rabe-Hesketh and Skrondal 2012, 198 f.). The intervals represent the range of occupation-specific wage returns to education (Figure 4). VET1 graduates' occupation-specific wage returns lie within the range of -0.05 and 0.17 in 2010, meaning that in some occupations, VET1 graduates earn 5% less than unskilled workers (i.e. reference category), whereas in other occupations, they earn 17% more than unskilled workers, on average. In comparison, the range for employees with a VET2 degree is between 2% and 27%. Between 1976 and 2010, VET2 graduates constantly generated higher wage returns than both unskilled workers and VET1 employees. University graduates achieve the highest wage premiums, with 22% (marked as a grey dot in Figure 4). Between 1976 and 2010, the average wage returns to education slightly decreased for VET1 graduates (9% to 6%), more or less stagnated for VET2 graduates (14% to 13%), and increased for HE graduates (18% to 22%).

To further illustrate the variance spreads for each educational level, we plot the predicted occupation-specific wage returns for 1980 and 2010 (Figure A2.2a-c). VET1 graduates generated, on average, 9% higher wages than unskilled employees in 1980 (Figure A2.2a), and university graduates generated, on average, 19% (Figure A2.2 c). The average returns for VET2 graduates lie between those of VET1 graduates and university degree holders. In Figure A2.2a-c, each dot in the scatter plot represents an occupation-specific wage return (i.e. β_{1j}). The further apart the dots lie, the higher the deviation from the average wage return.

We assumed that wage returns would vary more for VET2 than for VET1 graduates (H1). As expected, the occupation-specific wage patterns for VET1 and VET2 graduates (Figure A2.2a-b) differ from each other. In 2010, *good examiners* with a VET2 degree earned 31% more than unskilled examiners, whereas *motor vehicle drivers* earned 3% less (Figure A2.2b). VET1 degree holders with the highest returns earn only 21% more (*brokers, property managers*), but those with the lowest returns earn 12% less (*other water transport occupations*) (Figure A2.2a; for the year 2010). These outliers support the well-known finding that employees without an Abitur have lower wage returns. The outliers' total distances illustrate the differences in the variance in occupation-specific wage returns for VET1 and VET2 graduates. Specifically, for VET2 graduates, the gap is 38 percentage points, but for VET1 graduates, it is only 33 percentage points.

Further, for VET2 graduates, more occupations have a high deviation from the average return, compared to VET1 graduates. The predicted occupation-specific wage returns for VET1 graduates cluster more around the average wage return. The finding of a higher variance of wage returns for VET2 graduates is also confirmed by the wage return range. Figure 4 shows that from 1976 to 2010, VET2 graduates had a larger range of wage returns than VET1 graduates. In 2010, the range for the intervals where 95% of the random slopes are expected to lie is 29 percentage points for VET2 graduates and only 22 percentage points for VET1 graduates. Given our results, we confirm H1, which

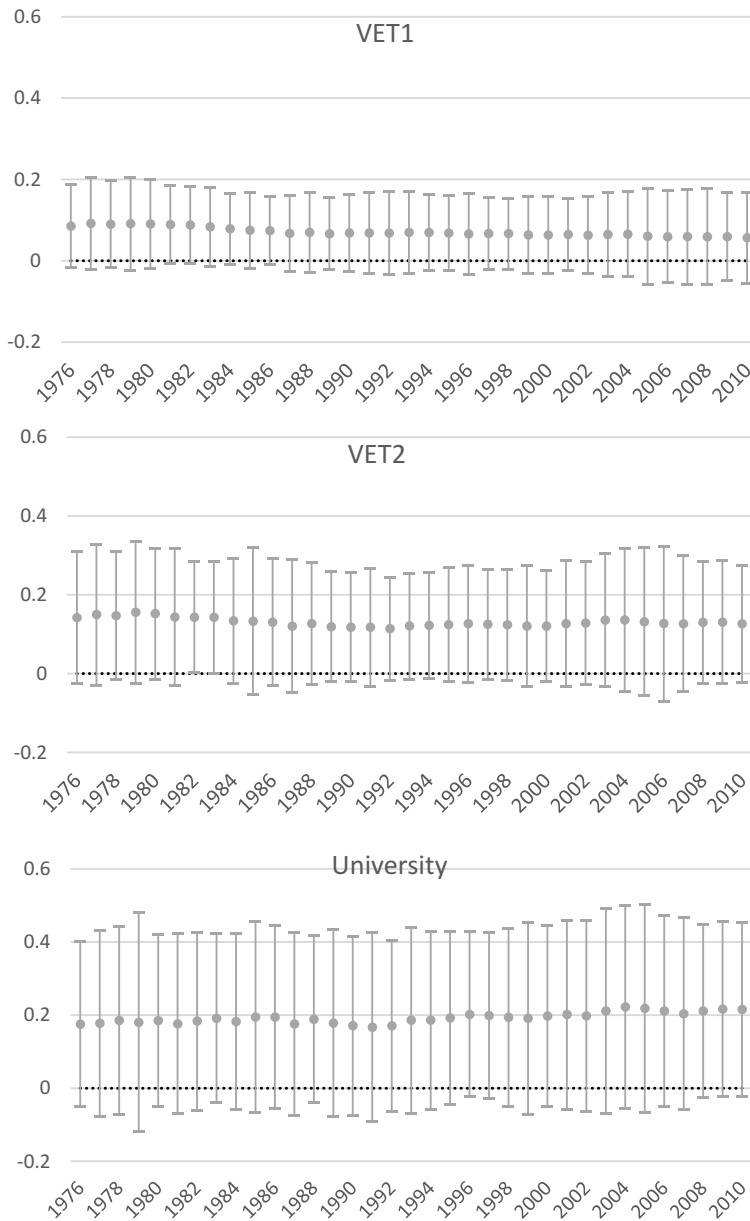


Figure 4. Range of wage returns compared to unskilled calculated by the I-as-O-M.

Source: SIAB V7510. Population: West-German full-time male employees.

Note: All coefficients are highly significant at the 5% level.

states that employees with a VET degree and an Abitur have higher wage return variance across occupations, compared to workers with a VET degree but no Abitur. The additional human capital that graduates with an Abitur acquire through further schooling results in wider wage return ranges. VET graduates with an Abitur appear to have a comparative advantage due to their advanced abilities with respect to performing analytic and interactive tasks, resulting in higher variance across occupations.

Considering the variance across occupations, we expect stronger occupation-specific wage return variance for university graduates, compared to VET1 and VET2 degree holders (H2). The predicted

occupation-specific returns cluster less around the average returns for university degree holders, compared to VET1 and VET2 graduates (Figure A2.2a-c). For instance, an extreme VET1 outlier at the top is *brokers, property managers*, who achieved a return of about 21% in 2010, which is about 154 percentage points higher than the average for all VET1 graduates (i.e. 6%) (Figure A2.2a). *Other water transport occupations* is an extreme VET1 outlier at the bottom, with a wage penalty of 12%. For university degree holders, we detect an even wider wage return variance across occupations, ranging in 2010, for particular occupations, from -7% (i.e. *motor vehicle drivers*) to 45% (i.e. *good examiners*) (Figure A2.2 c). The wage return ranges between 1976 and 2010 (Figure 4) support these results. We find that university degree holders have wider ranges than VET1 and VET2 graduates. University graduates' wage return range spread from 0.02% to 45% in 2010 and is the largest, in comparison to VET1 and VET2 degree holders. We therefore confirm our hypothesis (H2) that the wage return variance across occupations is higher for university graduates. These findings indicate the following. On the one hand, high-skilled workers earn higher wage premiums due to their comparative advantages with regard to performing analytic and interactive tasks. On the other hand, their wage premiums are mitigated if they act as substitutes for medium-skilled workers. Figures A2.2 c and 4 illustrate that HE graduates do not always earn wage premiums commensurate to their degree and may even earn lower wage returns than unskilled workers, for example, when they work as *motor vehicle drivers*.

We address temporal differences by considering between-occupation wage return variance patterns. We expected that variance across occupations for VET graduates both with and without an Abitur would rise over time (H3a). Comparing the patterns for 1980 and 2010, as shown in Figure A2.2a, we see that outliers above the average wage return essentially vanish and that the occupation-specific wage returns cluster more around the average wage return. For VET2 graduates, we observed more occupations providing no returns to education in 2010, compared to 1980. However, overall, there were less visible changes in the occupation-specific wage return patterns between 1980 and 2010 (Figure A2.2b). The wage return ranges (Figure 4) for VET1 and VET2 graduates show that the variance spread for the late 70s and the 2000s are equal, meaning that the occupation-specific wage return range remains stable over time. The marked drop in the lower bound of the wage return ranges for VET1 degree holders after 2005 is striking. This drop implies higher possible penalties for VET1 graduates. This finding points to polarisation and corroborates the theoretical assumption that demand and remuneration for low-skilled workers increase, whereas medium-skilled workers' wage returns shrink over time (i.e. VET graduates). Altogether, the findings contradict our hypothesis (H3a) that for VET1 and VET2 graduates, wage return variance rises over time. Nevertheless, the wage return ranges for VET1 and VET2 graduates were subject to fluctuations between 1976 and 2010. The demand for interactive and analytic tasks does not seem to exaggerate the supply of high-skilled workers, with medium-skilled workers compensating for recruitment problems, in general.

We further expected to find declining variance across occupations for university graduates (H3b). The occupation-specific wage return patterns buttress these findings. The scatterplots for 1980 and 2010, shown in Figure A2.2 c, reveal that occupation-specific wage returns spread more around the average wage return in 2010 than in 1980, which is particularly evident for service occupations (shown on the right-hand side of the scale). University degree holders' wage return ranges (Figure 4) fluctuate considerably, but increase slightly over time. Given our empirical findings, we discard H3b. Hence, the rising demand for non-routine tasks due to technological change probably does not narrow high-skilled workers' wage return distribution, as they take over more analytic and interactive tasks.

Conclusion

This study assesses variance in wage returns to education within a certain educational level and across occupations among men working full-time in Western Germany between 1976 and 2010.

First, we show that between-occupation wage return variance is higher for VET2 graduates than for VET1 degree holders, and that university graduates experience higher variance than both types of vocational degree holders. Our findings indicate that educational attainment does not pay off equally for all occupations. In particular, in high-skilled occupations, it is crucial for employees to exploit their earning potential. Further, our results demonstrate that despite credentialism and the importance Germany places on occupational certification, previous schooling affects remuneration, especially for VET degree holders. Combining an Abitur with a VET degree could be a rewarding strategy to improve earning potential. We assume that VET2 employees' comparative advantage in performing analytic and interactive tasks attracts both higher occupation-specific wage returns and higher variance.

Second, we note a fluctuating wage return variance for VET degree holders and a slightly increasing variance for university graduates. According to our analyses, technological change and the concomitant rising demand for analytic and interactive tasks have not influenced occupation-specific wage return variance. However, particular occupation-specific wage returns change over time. For example, VET1 graduates' lower range of occupation-specific wage returns drops markedly below zero after 2005. Hence, the risk that investments in education will not amortise in some occupations is rising for VET1 graduates over time. Consequently, the more occupations do not pay returns for education, the more devastating a problem the VET system will have in terms of attracting young talent. From a socio-political perspective, compensation for (risky) educational investments is of fundamental importance. Further research should investigate how the revealed patterns of occupation-specific wage returns relate to individuals' changing assignment to different jobs. Inspecting how occupation-specific wage return variance patterns change due to VET graduates working in a broader spectrum of occupations or due to the influx of HE graduates in the course of educational expansion might be a fruitful research approach.

However, our study has some limitations. For example, we cannot control for the match between current job and training occupation and field of study, respectively. The fact that employees who work in a mismatched occupation suffer wage penalties (Bol et al. 2019) suggests that mismatch is the driving force behind diverging occupation-specific wage returns. Even university graduates are subject to wage penalties, where occupational mismatch effects are likely. Since the data lack information on skills and interests, we are also unable to scrutinise employees' self-selection. Additionally, examining the concrete mechanisms driving wage return variance within an educational level, such as occupational specificity or tasks, proves to be a promising agenda for future studies.

Further, we excluded self-employed persons, part-time employees, East Germans, and women from our sample. We encourage other researchers to repeat our analysis, drawing on recent data for women to reveal the variance in their occupation-specific wage returns. A comparison with men's occupation-specific wage return variance would deepen the understanding of the gender wage gap.

Finally, we do not address globalisation empirically. We are aware of the potential impact of globalisation and associated trends such as immigration, offshoring, and outsourcing on varying returns to education, and these should be considered in future studies.

Overall, our study highlights the importance of occupations and their impact on varying returns for educational attainment. The extent of the variance significantly influences whether educational investments pay off. Our findings underpin realistic assumptions about future earnings, for which possible variation in wage returns needs to be taken into account. Depending on risk aversion, individuals might choose occupations with lower variance and more stable risk return rates. Hence, information about wage return variance across occupations is valuable for career decisions and should be included in career guidance.

Notes

1. This study uses the weakly anonymous Sample of Integrated Labour Market Biographies (1976–2010). Data access was provided via on-site use at the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB). Subsequently, remote data access was provided.
2. For a critical review of the orthodox human capital approach, see Brown, Lauder, and Cheung (2020).
3. This effect remains stable when controlling for unobserved heterogeneity (Mazza, Hans, and Hartog 2013).
4. We are fully aware that nationality might not be an exact indicator of immigration, but it can serve as approximation. D'Amuri et al. (2010) discuss the problem of equating nationality and immigration. Due to data constraints and for lack of a better proxy, we decided to use nationality regardless (D'Amuri 2010).

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No potential conflict of interest was reported by the author(s).

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