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Working Paper

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ZEW Discussion Papers, No. 09-005

Provided in Cooperation with:
ZEW - Leibniz Centre for European Economic Research

Suggested Citation: Zwick, Thomas (2009) : Why Pay Seniority Wages?, ZEW Discussion Papers, No. 09-005, Zentrum für Europäische Wirtschaftsforschung (ZEW), Mannheim

This Version is available at:
https://hdl.handle.net/10419/27624

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Nontechnical Summary

Why do establishments pay wages that increase with seniority? There are three rivalling theories that can explain this empirical phenomenon – the agency theory, human capital investments and efficiency wage theory. The agency theory stresses that establishments aim at motivating and retaining their employees by paying them a low initial wage and higher wage increases with tenure than their productivity increases. The human capital theory asserts that earnings increase with tenure because productivity increases by training efforts. The efficiency wage theory finally argues that establishments want to motivate their employees by paying them a higher wage than the market wage from the start. These theories lead to different predictions on the characteristics of establishments that offer seniority wages. This paper tries to disentangle the theories by explaining the differences in the steepness of seniority wages between establishments. It shows that establishments with higher than average seniority wages are characterised by a higher qualified work force, works councils and collective bargaining coverage, lower initial wages for entrants, a higher profitability, flexible working time arrangements for senior employees and a large size but no stronger training investments. These findings are in accordance with agency theories and do not support the other theories. The paper introduces an innovative two-step estimation procedure on the basis of representative German linked employer-employee panel data. This makes it possible to first calculate individual seniority wages taking into account that the tenure effect on wage is biased by matching quality. Second, individual seniority wages are aggregated to the establishment level. Finally the seniority wage indicator is explained by a broad spectrum of establishment characteristics.

Nichttechnische Zusammenfassung

Weshalb bezahlen Arbeitgeber Löhne, die mit der Betriebszugehörigkeit steigen? Drei Theorien können dieses empirische Phänomen erklären – die Prinzipal-Agenten Theorie, die Humankapital- sowie die Effizienzlohntheorie. Die Prinzipal-Agenten Theorie betont, dass Arbeitgeber ihre Beschäftigten an sich binden und motivieren wollen indem sie ihnen einen relativ niedrigen Einstiegslohn sowie im Laufe der Betriebszugehörigkeit stärker steigende Löhne bezahlen als dies deren steigende Produktivität rechtfertigen würde. Die Humankapitaltheorie hingegen zeigt, dass die Löhne parallel zur Produktivität der Beschäftigten aufgrund von Weiterbildungsanstrengungen steigen. Die Effizienzlohntheorie schließlich argumentiert, dass Arbeitgeber die Beschäftigten dadurch motivieren, indem sie von Anfang an einen Lohnaufschlag gegenüber dem Marktlohn zahlen. Diese Theorien führen somit zu unterschiedlichen Vorhersagen, welche Betriebe ihren Beschäftigten hohe Senioritätslöhne anbieten sollten. Dieser Beitrag versucht die empirische Relevanz der drei Theorien zu testen, indem er die Unterschiede zwischen Unternehmen innerhalb eines Sektors bezüglich der Höhe der Senioritätslöhne durch betriebliche Charakteristiken erklärt. Er zeigt, dass Arbeitgeber mit überdurchschnittlich hohen Senioritätslöhnen höher qualifizierte Beschäftigte, einen Betriebsrat, eine höheren Gewinn, niedrige Einstiegslöhne und Alterszeit haben sowie an Tarifverhandlungen teilnehmen und größer sind. Ihre Weiterbildungsanstrengungen sind jedoch nur durchschnittlich. Diese Befunde stützen die Prinzipal-Agenten Theorie und sind nicht mit den beiden anderen Theorien kompatibel. In diesem Beitrag wird ein repräsentativer verknüpfter Beschäftigte- Betriebspaneldatensatz sowie ein innovatives zweistufiges Schätzverfahren verwandt. Dies ermöglicht es, zuerst individuelle Senioritätslöhne zu berechnen und hierbei zu berücksichtigen, dass der Einfluss der Betriebszugehörigkeit auf die Löhne durch die Güte der Passgenauigkeit zwischen dem Arbeitgeber und Arbeitnehmer verzerrt sein kann. Im zweiten Schätzschritt werden die individuellen Senioritätslöhne auf das Betriebsniveau aggregiert. Schließlich wird die Abweichung der betrieblichen Senioritätsentlohnung vom Sektordurchschnitt durch eine Reihe von Betriebscharakteristiken erklärt.

Why pay seniority wages?

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January 2009

Abstract

This paper characterises establishments that pay higher seniority wages than their competitors. It tests whether seniority wages are paid on the basis of agency, human capital or efficiency wage considerations. A representative linked employer-employee panel and an innovative two-step estimation strategy are used to first calculate individual seniority wages taking into account that match quality biases tenure effects on wages. Then individual seniority wages are aggregated to the establishment level. Finally, the seniority wage indicator is explained by establishment characteristics. This contribution shows that large, profitable and establishments with a highly qualified workforce pay high seniority wages. Also collective bargaining coverage and works councils have a positive impact and the share of foreigners, training intensity and initial wage levels have a negative correlation with seniority wages. The results support an agency based motivation for seniority wages.

Key-Words: Seniority Wages, Establishment Characteristics, Linked Employer-Employee Data

JEL Codes: J14, J21, J31

[◊] I thank Philipp vom Berge, Wolfgang Buchholz, Christian Göbel, Peter Jacobebbinghaus, Johannes Ludsteck, and Jens Mohrenweiser for helpful comments and the Research Data Centre (FDZ) of the Federal Employment Agency at the Institute for Employment Research for their support with the analysis of the data. The data basis of this publication is the Cross Section Model (version 1) of the Linked Employer-Employee Data of the IAB (LIAB, years 1997-2004). Data access was via guest research spells at FDZ and afterwards via controlled data remote access at FDZ.

1 Introduction

One of the major concerns of the empirical literature on seniority wages is to find out whether earnings increase stronger than productivity. This is notoriously difficult because the individual contribution to productivity is usually not measurable. A first branch of the empirical seniority wage literature therefore collects indirect evidence on the consequences of indicators for the steepness of seniority wages on establishment characteristics such as the employment or hiring structure and the average length of tenure (Hutchens, 1989; Bayo-Moriones et al., 2004; Daniel and Heywood, 2008). This vein of the literature usually is based on establishment level data and uses aggregate indicators for the strength of seniority wages and its consequences. A second string of influential contributions aims at disentangling the "pure" tenure effects in individual wage regressions from productivity increases caused for example by training (Altonji and Shakotko, 1987; Topel, 1991). It (has to) assume that the correlation between wages and tenure is homogeneous across firms because these studies are based on individual data that do not include establishment characteristics. Notable exceptions are the contributions by Levine (1993), Margolis (1996), and Abowd et al. (1999) which are based on linked employer-employee data. These papers show that heterogeneity between establishments and cohorts in the returns to seniority is a significant empirical phenomenon. However they hardly characterise those establishments that pay seniority wages or concentrate on few correlations.[1] It therefore seems promising to combine both branches of the literature by first calculating individual seniority wages and then explaining the differences in seniority wages between establishments on this basis by a broad range of indicators that can disentangle the motivation of establishments to pay high seniority wages.

There are at least three rivalling theories that explain increasing wages with seniority - the agency theory, the human capital theory and the efficiency wage theory. These theories imply different motivations to offer seniority wages and characteristics of establishments that offer seniority wages. This paper aims at empirically disentangling the three theories. The agency theory argues that employees are retained and motivated by paying steeper earnings than productivity profiles for those who stay

[1] Levine (1993) interacts the steepness of the seniority profile with time required for training, initial wages and employee turnover.

in the establishment. Employees receive a low initial wage and contribute to a bond during the first years of seniority that is paid back later by wage increases exceeding the productivity increases (Lazear, 1979; Hutchens, 1987). This theory is contested by efficiency wage considerations that claim that some establishments pay higher wages than the market wage for all or selected employees during their entire career in order to motivate and retain them (Akerlof and Katz, 1986) – here besides seniority wages also initial wages are higher than that paid by the average establishment. Finally, the human capital theory stresses that earnings increases with seniority are a consequence of improvements in human capital induced by training (Carmichael, 1983; Hellerstein and Neumark, 1995; Neumark and Taubman, 1995; Mincer and Higuchi, 1998) – as a consequence earnings and productivity profiles have the same steepness and seniority wages are positively correlated with efforts to improve human capital.

This paper offers several contributions to the empirical seniority wage literature. It systematically characterises enterprises that offer a steeper seniority wage profile than other establishments in the same sector. It includes a broader variety of explanatory variables than before based on theoretical hypotheses. This allows a better discrimination between the three main seniority wage theories. In addition to establishment size, initial wages, and training behaviour that have previously been analysed in the seniority wage literature, it for the first time includes indicators for industrial relations, working time flexibility for older employees, establishment profitability, and the workforce qualification structure. In addition, the steepness of establishment seniority wages is calculated on the basis of individual data according to the estimation approach proposed by Topel (1991). In a next step the individual seniority wages are aggregated to the establishment level. This two-step procedure avoids potential biases in the measurement of the seniority earnings profile.

The remainder of this paper has the following structure. The next part discusses in detail the main theories why enterprises pay seniority wages, which kinds of establishments should offer seniority wages according to these theories and the empirical evidence on differences between enterprises with respect to their seniority wage structure. The third part explains the empirical estimation strategy and the fourth part presents the representative linked employer employee panel data set used. The fifth part contains the empirical evidence on the characteristics of establishments that pay steeper seniority wages than the average and the sixth part concludes.

2 Background

According to Lazear (1979, 1981), employers and employees may enter into implicit contracts, whereby workers receive a wage that is less than the value of their marginal product at the beginning of the contract and larger than the value of the marginal product at the end. The employees are indifferent to work for an employer with implicit contracts or an employer that pays wages equal to the marginal product value if the (expected) present value of both earnings paths is equal. The steeper wage path of firms with deferred compensation changes the workers´ incentive structure, however. It induces them to work harder and remain honest with the firm in order to finally reach the pay-back period of the bond. Workers who shirk or steal run the risk of being caught and fired and forgo the higher payments that come at the end of the contract. This change in behaviour efficiently solves the agency problem[2] and makes redundant more costly alternatives such as efficiency wages (i.e. wage mark-ups paid during the entire career) or extensive effort control mechanisms. Deferred compensation or seniority wages therefore increase the value created over the life cycle and probably also the life time wealth for the employee if the employer shares part of the increased value. One condition is however that the employee trusts the employer not to renege on the implicit contract because the employer´s gain to terminating a work relationship midstream is large.

The agency interpretation of seniority wages implies several correlations between the steepness of the tenure wage profile and establishment characteristics. First, Becker and Stigler (1974) and Lazear (1979) predict a negative relation between the returns to seniority and wages of job entrants because employees first have to contribute to a bond that is repaid later. A negative correlation between the steepness of seniority wages and initial wages is an indicator that distinguishes the agency interpretation from a rivalling interpretation: in an efficiency wage model, Akerlof and Katz (1986) argue that younger workers with strong seniority wages should also receive higher wages at the beginning of their careers. Abowd et al. (1999) demonstrate however on the basis of a panel of French individual-firm matched observations collected by INSEE for 1976-1987 that returns to seniority are negatively related to initial pay. Levine (1993) also finds a negative correlation between plant-specific

[2] Agency problems arise when employees reduce the joint surplus because the labour contract leaves leeway (their behaviour is not transparent to the principal because there is asymmetric information, risk, and uncertainty) and the interests of employer and employee are not aligned (Milgrom and Roberts, 1992).

returns to tenure and plant-specific average initial wages. He uses two small cross-section linked employer-employee surveys from the Indianapolis area in the United States and the Atsugi region in Japan. Bronars and Famulari (1997) estimate wage growth differentials across employers. They relate initial wages to current wages taking into account current tenure and find a significant dispersion in wage growth differentials across employers, conditional on worker characteristics. Differences in employer and worker characteristics therefore can account for a large share of the differences in wage growth. The authors use the US Bureau of Labor Statistics´ White Collar Pay Survey entailing 1681 workers in 241 establishments. They differentiate between average wage growth of men and women with different tenure and experience, and they demonstrate that employees with high wage growth had lower initial wages.

The other main rivalling explanation for increasing wages with tenure besides the efficiency wage theory is that they might be completely driven by (specific) human capital investments that lead to higher productivity (Carmichael, 1983; Hu, 2003). According to this theory greater training efforts imply a steeper seniority profile on the job and returns to experience according to the human capital theory (Mincer and Higuchi, 1988). The problem is that it is not easy to empirically disentangle tenure and training effects on wages because productivity increases associated with training investments are hard to measure and agency related deferred compensation might only apply for certain jobs or enterprises (Hutchens, 1989). The results presented by the empirical literature that tries to find out whether wage increases with seniority are caused by human capital increases or agency considerations are not consistent so far. On the basis of the waves 1976-1984 of the Michigan Panel Survey of Income Dynamics, Brown (1989) shows for example that within-firm wage growth is correlated to years of training necessary to do the job. He finds no additional effects of tenure on wages and high returns to specific training. Brown concludes that seniority wages are no indicators of agency problems. Barth (1989) uses a very similar indicator for the required level of on-the-job training but finds that firms in which employees have jobs that require a relatively high level of on the job training pay a lower seniority premium. Levine (1993) first calculates enterprise-specific returns to tenure by interacting individual tenure (and tenure squared) with plant identifiers in an individual wage equation. In a second estimation step, he tests whether establishments with high average returns to tenure have higher training incidence in specific and/or general human capital according to the human capital theory. Levine finds a negative correlation between

seniority wages and four out of five training indicators. Both papers therefore support the agency interpretation of wage increases by tenure. Lazear and Moore (1984) compare the steepness of age-earnings profiles between self-employed and salary workers taking into account on-the-job training. On the basis of the US Current Population Survey for 1978 they come to the conclusion that under some strong assumptions most of the increase in wealth across occupations that is associated with steeper wage profiles reflects incentives and not on-the-job training.

Another indicator that allows us to distinguish between the agency and the human capital interpretation of seniority wages is establishment size. One might assume that larger firms have a stronger agency problem than smaller firms because the employees are not so easy to control and the individual contribution to the establishment performance is not readily measurable (Booth and Frank, 1996). Using separate individual Mincer equations for three establishment size classes, Hashimoto and Raisian (1985) find that in Japan the largest firms indeed pay the highest rewards for seniority and the smallest firms the lowest. They use the Japanese Basic Survey of Wage Structure for 1980. For the United States by contrast, they stress that the highest seniority wage mark-ups are paid by the smallest firms. The evidence is based on the 1979 Current Population Survey (CPS). Hu (2003) on the other hand shows on the basis of pooled Mincer regressions from four waves of the Benefits Supplement to the US CPS between 1979 and 1993 that wage-tenure profiles are steepest for the largest firms and flattest for the smallest firms. She explains these differences by a higher propensity of larger firms to invest in firm specific human capital, however. The empirical evidence on the relation between the steepness of seniority wages and firm size is therefore contradictory so far.

This paper tests several additional hypotheses on the correlation between the qualification structure, industrial relations, and exports that might empirically support the agency interpretation of seniority wages. The first hypothesis is related to the qualification structure of enterprises: it pays more to motivate and retain employees if they are higher educated because they usually have more discretion in their activities and an increase in their effort usually has a bigger impact on establishment performance. In addition, tying employees to the employer might be more important for higher qualified employees. They frequently have higher rates of planned mobility between firms in the process of building an optimal career path (Sicherman, 1990). This means that establishments with higher qualified employees should use seniority wages

more frequently in order to solve their agency problem. According to the human capital hypothesis higher educated employees invest a higher proportion of their earnings capacity into the development of their human capital. This might also lead to stronger tenure-earnings profiles (Heckman et al., 1998). In order to separate both hypotheses therefore besides the education level also training has to be accounted for – the agency interpretation does not predict a positive correlation between training and seniority wages.

The next hypotheses are related to industrial relations. Works councils try to protect employees with higher seniority by making it more costly to dismiss these employees. They hereby reduce dismissals and voluntary quits and increase the tenure of employees (Backes-Gellner et al., 1997). Works councils therefore make the commitment of an establishment more credible to keep their employees and pay higher wages in the future (Bayo-Moriones et al., 2004). They are also safeguards against employer opportunism because employers might be tempted to dismiss workers half way before they have received the full compensation for the bond they have paid in the first tenure years (Lazear, 1981). Especially with regard to dismissals, works councils have a rather strong position, implying that employment protection in Germany has a strong collective component (Backes-Gellner et al., 1997) - prior consultation with the works council is a prerequisite of the validity of any dismissal (§§102-3, Works Constitution Act). According to §1 of the Dismissal Protection Act of 1969, dismissals must not be "socially unwarranted". This means that they must be justified in terms of either the conduct of the individual employee or the operational requirements of the enterprise. An additional argument for a positive impact of works councils on the tenure-earnings profile may be that works councils are dominated by insiders with high job tenure and that their effect is concentrated on their constituency (Boockmann and Hagen, 2003). Addison et al. (forthcoming) find however that the wage effects induced by works councils are higher for those groups with wage disadvantages (females, low qualified or foreigners). These groups usually are under-represented in the constituency of works councils, however.

Unions might be especially attuned to the desires of senior workers – they are dominated by incumbents on the expense of labour market or job entrants (Freeman and Medoff, 1984). Kuhn and Robert (1989) show in their two-worker union model that in order to extract the maximum rent from the firm, a union should support a wage profile that favours senior workers over junior workers independent of their distributional

preferences. Topel (1991) indeed finds that cumulative returns to tenure for union members are larger and rising relative to non-members. Freeman and Medoff (1984) note however that unions lead to a flatter wage profile, although the total compensation differential increases with seniority (a result, they find disturbing, p. 131). Booth and Frank (1996) argue on the basis of the British Household Panel Survey (wave 1991) that unions with a formal seniority wage scale have a steeper experience earnings profile than non-union establishments. This is not the case for unions without an incremental wage scale. In Germany, there are almost no formal seniority wage rules in collective bargaining contracts, however (Bispinck, 2006) and therefore higher seniority wages in establishments with collective bargaining and works councils might be an indicator to solve the agency problem by integrating the interests of unions and works councils.

A further hypothesis in the same vein is that more profitable establishments might share profits by using seniority wages or rewarding their stayers by higher wage increases than other establishments. This correlation might also be expected in efficiency wage models. It therefore only allows the discrimination between agency considerations and human capital models.

A final hypothesis that allows us to differentiate between the three theories is the option to offer part-time employment specifically for older employees (*Altersteilzeit*). Establishments that pay higher seniority wages as a consequence of an increase in productivity induced by human capital investments or efficiency wages should not have an incentive to allow older workers to work less hours if he or she wishes to do so. In the case of an agency induced seniority wage profile entailing higher wages than productivity, employers are quite willing to let employees work less when they are older because this saves part of the difference between productivity and wages. In addition, we know that older employees frequently prefer to work part-time when they get older because they have to take care for a sick relative or because their own health condition is then less affected by demanding work conditions (OECD, 2006, p. 77). Establishments that pay wages according to productivity such as in the human capital theory or according to efficiency wage considerations should be interested in getting the full working potential from their older employees.

Summing up, the following correlations between establishment characteristics and the strength of the seniority earnings profile should be found if establishments pay seniority wages motivated by agency considerations: high seniority wages should be positively correlated with establishment size, profitability, the qualification level of

employees, and the presence of works councils, collective bargaining coverage as well as part-time working time arrangements specifically for senior employees. Finally, there should be no positive correlation between seniority wages and continuing training intensity and a negative correlation with initial wages.

The empirical papers mentioned so far do not systematically explain the correlation between establishment characteristics and the steepness of the wage seniority pattern. Some contributions however try to find support for the agency version of seniority wages on the establishment or job level using aggregate indicators for seniority wages. Bayo-Moriones et al. (2004) use cross-section survey data from the Spanish manufacturing industry dating from 1997 and including more than 700 establishments with more than 50 employees. The dependent dummy variable equals one if seniority is an important determinant for wage setting. They find some support for the agency theory because the self-assessed importance of seniority wages is negatively correlated with explicit monetary incentives and monitoring. Correlations with a strong union coverage, strong export share, wages above the sector level or establishment size are insignificant, however.

Hutchens (1986 and 1987) also finds indirect support for the agency theory. Both papers do not look at establishments but at individual jobs. The first paper shows that jobs in which only a small share of recently hired workers are over age 55 in relation to the share of all workers that are over age 55 are characterised by mandatory retirement, a pension, long tenure, and high wages per hour for older employees. The second paper, which is also based on a cross section of the National Longitudinal Survey of older males and the Dictionary of Occupational Titles also shows that a repetition of tasks variable has positive correlations with mandatory retirement, pension, tenure, and wages of older employees and a negative correlation with the share of recently hired older workers.

Barth (1997) estimates individual Mincer equations including firm fixed effects and then analyses which average firm characteristics influence the fixed wage effect. On the basis of the cross sectional Norwegian Survey of Organizations and Employees (that on average reports wages for less than five employees per firm), he finds some support for the agency theory because piece rate workers have negligible returns to seniority while workers with less direct financial incentives enjoy returns to seniority.

Hellerstein and Neumark (1995, 2004) and Hellerstein et al. (1999) pursue another estimation strategy – they measure the impact of different groups of workers on

productivity and wages in order to avoid the measurement problem of individual productivity impacts. Hellerstein and Neumark (1995) analyse the impact of young, middle aged and older employees in the occupation categories unskilled, academics, engineers, and technicians on productivity and labour costs. On the basis of Israel´s Central Bureau of Statistics (CBS) data from 1988, they do not find significant differences between the wage and productivity profile and tentatively argue that the wage increases are close to the productivity increases and therefore supportive of the human capital model. Their profiles are measured rather imprecisely, however. Hellerstein et al. (1999) compare in non-linear estimations the productivity impact of prime-aged workers with the impact of older workers with their differences in relative wages. They use a US linked employer-employee data set for 1989 from the Census of Population and the Longitudinal Research Database. They find that productivity and earnings rise at the same rate over the life cycle for both groups of workers. Hellerstein and Neumark (2004) use a similar estimation approach on the basis of the large and representative US 1990 Decennial Employer-Employee Dataset. They find that the estimated relative wage profile is steeper than the relative productivity profile, consistent with models of deferred wages.

Most papers mentioned so far use indicators for seniority wages that do not disentangle the effect of tenure and matching quality. This might bias the seniority wage effects measured because employees with a better job match tend to stay longer with their employers (Altonji and Shakotko, 1987; Topel, 1991). The only exception is a paper by Abowd et al. (1999) that uses French linked employer-employee data (the *Déclarations Annuelles des Salaires* from 1976-1987). They show that the estimated returns to seniority decrease when a firm-specific intercept and a firm specific seniority wage slope are included in individual wage equations. In addition, the estimated standard deviation of the seniority wage slopes is at least three times as large as the mean of the coefficient (see also Margolis, 1996). This means that there is a lot of variance to explain between individual seniority-wage patterns. Abowd et al. (1999) do not attempt to characterise the differences between the enterprises, however.

3 Estimation Strategy

A string of papers shows that seniority wages can be split into wage increases induced by increases in matching quality and the seniority effect on wages (Altonji and

Shakotko, 1987; Topel, 1991; Dustmann and Pereira, 2008; Orlowski and Riphahn, 2008; Zwick, 2008). Employees with a better match between their skills and those demanded stay longer with their employer, have a higher productivity and earn more. However these employees frequently had high earnings already when they entered the job. This means that the seniority variable might be endogeneous in the wage equation. One way to avoid biases in estimations is to instrument seniority (and experience) by their deviations from the individual means (Altonji and Shakotko, 1987; Dustmann and Pereira, 2008). An alternative is to measure wage growth of stayers instead of wage levels and separate the tenure and experience effect on wages increases (Topel, 1991).

The first estimation step in this paper is to estimate individual seniority wages according to the procedure proposed by Topel (1991). His original approach however constrains all firms to reward seniority in the same manner and precludes the possibility that firms might strategically use different levels of initial earnings and rates of earnings growth to motivate and retain individuals with particular combinations of productive capacities (Margolis, 1995). The measured tenure coefficient therefore is a weighted average of firm-specific returns and may deviate from the true average returns if we allow for differences between establishments. The first step is based on individual seniority profiles and therefore gives us the opportunity to discriminate between individuals with higher and lower observed seniority profiles by using the individual deviations from the predicted average increase in wages. In a second estimation step these deviations from the average seniority wages are therefore aggregated to the enterprise level and hereby identify establishments with steep and flat seniority wage profiles. Finally, the characteristics of the establishments that have a relatively steep seniority wage profile in comparison to the average establishment in the sector can be explained by various establishment characteristics. Here deviations from the sector and year means are used for all variables in order to control for the ease to monitor effort (Hutchens, 1989) and to capture macro-economic shocks that have an impact on all wages.

As indicated above, Topel (1991) argues that tenure is endogeneous in an earnings regression. In order to separate the tenure and the experience effect, first the growth of real wages Δw in year t is estimated only for those workers i who stay with the same employer by the main characteristics that change over time – tenure Δt and experience Δe – (and their squares, triples, and quadruples)[3]:

[3] Results are roughly the same if we de-trend wages using year dummies in order to remove the

$$\Delta w_{it} = \alpha_1 \Delta t_{it} + \alpha_2 \Delta t_{it}^2 + \alpha_3 \Delta t_{it}^3 + \alpha_4 \Delta t_{it}^4 + \beta_1 \Delta e_{it}^2 + \beta_2 \Delta e_{it}^3 + \beta_3 \Delta e_{it}^4 + \varepsilon_{it} \quad (1)$$

From the estimates of equation (1), the cumulated predicted average wage increase since the present job began is calculated for every employee taking into account individual experience and tenure. Please notice that one cannot distinguish yet between the linear tenure and experience effect but only observe their combined effect in the coefficient α_1 because both measures increase by one from year to year for those who stay in the same firm.

The average predicted wage increase in the present job – given the current tenure and experience – is then deducted from the current wage in order to obtain the predicted wage at the beginning of the present job at $t=0$: $w_0 = w_i - \Delta \hat{w}_i$.[4] In the next estimation step, w_0 is explained by the experience at the beginning of the current job e_0 and a vector F of further individual and enterprise characteristics:

$$w_{0i} = \beta_0 e_{0i} + \delta' F_i + \zeta_i \quad (2)$$

The unbiased wage increase induced by seniority is calculated by deducting the experience effect on the initial wage level β_0 in equation (2) from the joint linear seniority and experience effect α_1 in equation (1).[5]

Having obtained the unbiased individual seniority wage profiles, the steepness of the establishment seniority wages is calculated. For this, the error terms of equation (1) are taken (i.e. the positive or negative deviations from the average predicted wage increase $\hat{\varepsilon}_{it}$). This captures the individual deviation from the average wage increase for stayers taking individual experience and tenure into account. Then the individual residuals are aggregated to the average residuals on the establishment level $\sum_j \hat{\varepsilon}_{i \in j}$ for every year. In a last step, the deviations of the yearly average enterprise residual from the sector and year average $d_{jt} = \hat{\varepsilon}_{it} - \sum_i \hat{\varepsilon}_{it \in j}$ are calculated.[6] It is therefore possible that if some

effects of secular wage growth.

[4] We have to estimate the initial wage because it lies outside of our observation period for employees with long seniority.

[5] The second estimation step might bias the measured tenure effect downwards because job matches are heterogeneous and upwards because individuals are heterogeneous (Williams, 2004). In order to avoid these biases, Topel (1991) proposes to instrument initial experience with current experience in the second stage. In a robustness check, initial experience in equation (2) is instrumented accordingly.

[6] Please note that this estimation procedure does not automatically lead to a negative relation between individual initial wages and the individual seniority wages (Neumark and Taubman, 1995). The initial

employees in one enterprise earn more and some employees earn less than the average seniority wage in the sector and year, the aggregate deviation of the establishment is zero. As a robustness check besides the deviation from the sector and year mean, also a dummy is calculated. This dummy is one if the establishment pays higher seniority wage mark-ups than the sector average and zero otherwise.

In order to characterise the establishments with high and low seniority wages, the aggregate deviation from the sector and year mean in year t, d_{jt} is taken as the endogeneous variable. It is explained by a vector G including the establishment characteristics identified in the previous section:

$$d_{jt} = \phi' G_{jt} + \varphi_{jt} . \tag{3}$$

All variables are taken as deviations from the sector and year average.

One of the explanatory variables is initial wages of the employees. This variable is obtained by aggregating the predicted individual initial wages w_0 from equation (2) to the establishment level and taking the deviations from sector and year averages.

4 Data

In order to characterise establishments that pay strong seniority wages in Germany, this paper uses the waves 1997-2004 of the linked employer-employee data set of the *Institut für Arbeitsmarkt- und Berufsforschung* (LIAB). The so-called cross section version of this panel data set is chosen, which means that we have one observation per year (on June 30th) for virtually all employees in the establishments observed (see Jacobebbinghaus, 2008 for details). On the establishment level, the LIAB uses the representative survey data of the IAB establishment panel. This panel entails questions on value added, industrial relations, sector, average employee characteristics and expectations of the managers. The establishment data are linked by the means of a common identifier to the employee information. The individual level uses official data of the IAB employment register. Yearly information on wages, qualification, gender, tenure, experience, and age can therefore be linked to the employer data. Altogether the LIAB covers almost 7 Mio. employees and more than 8,500 establishments.

The data provide daily earnings at the survey date. These wages are deflated by the official wage inflation data from the Federal Statistical Office. About 8% of the

wages are calculated by deducting the average predicted wage increase since the start of the topical job from the observed wage. The individual deviation from the average seniority wage ε_i is therefore not included in this estimation step.

observations have censored wages on the social contribution ceiling (only the ceiling value is reported in the data set and not the true earnings). Those censored wages are multiply imputed (compare Gartner, 2005) by defining 20 cells for different gender, qualification (five groups), and nationality. For each cell censored wage Tobit regressions are estimated separately including the covariates tenure, tenure square, age, sector (16 dummies), an East Germany dummy, and three dummies for the qualification level. Also tenure and experience are censored. For employees in West Germany experience and tenure are known since January 1st 1970 and for East Germany the variables are known since January 1st 1990. This means that between 16% (1997) and 7% (2001) of the West German and between 46% (1997) and 28% (2001) of the East German employees have censored values. We account for censoring by also multiply imputing the censored values. The calculated imputed values for wages, experience and tenure might lead to excess variance in time differences and therefore only the first imputed value of several censored values in a row is taken. For the following values the same (inflation corrected) wage is taken instead of a separately calculated imputed wage and for tenure and seniority, one year is added to the base value. In order to check the robustness of the results, all regressions have also been executed without any observations with censored values for wages, tenure, and experience. The results were qualitatively the same and led to slightly higher estimated seniority wages (results available on request).

Only employees who work full time are included because we do not know the working hours of those working part time. In the tradition of Topel (1991), only employees aged 18-60 are included in order to avoid strong selectivity at the age fringes. We exclude the East German employees because their experience and tenure information is heavily censored and wage increases are dominated by the quick catch-up process between East and West German wages in the 1990s. We also exclude employees in public enterprises because they receive an automatic seniority bonus in the observation period and employers are not free to decide on the steepness of the seniority bonus. Apprentices are excluded because they have a strong wage increase after completing their apprenticeship. Finally, employees whose wages increased or decreased by more than 200% from year to year are excluded.

5 Why do employers pay high seniority wages?

First the individual seniority wages are estimated analogously to the approach by Topel (1991). The average tenure/experience effect of an additional year at the same employer calculated according to equation (1) is about 11% in our sample (compare Table 1). This effect is comparable to that found by Counch (2003) for Germany on the basis of the German Socio-Economic Panel (GSOEP) data for 1984-1992. It lies between the effect found by Lefranc (2003) and Counch (2003) for the USA (about 12% for 1981/1984-1992) and France (about 5% for 1990-1997).[7] The effect of initial experience on the predicted initial wage according to equation (2) found in a weighted OLS regression is about 6% (see Table 2). This means that initial experience β_0 in equation (2) accounts for about half of the linear seniority and experience wage effect α_1. This share of initial experience on seniority wages is comparable to that found by Lefranc (2003) for France but smaller than that for the USA. After deducting the initial experience effect from the combined seniority and experience effect, we obtain a seniority wage premium per annum of about 4%. This effect is lower than that of comparable studies by Counch (2003) but higher than that by Orlowski and Riphahn (2008) also on the basis of the GSOEP for 2002-2006. The seniority wages presented here for Germany are higher than in comparable estimations for France and the USA – seniority wages are measured at around 1-2% (Lefranc, 2003), see the lower part of Table 2 for the estimated cumulative returns to job tenure.[8]

It therefore seems that wages increase with seniority within an enterprise in Germany and that this increase is comparable or even higher than that in the USA, UK or France. This corresponds with what the OECD (2005) concludes on the basis of cross section analyses without taking selectivity issues into account and what Counch (2003) finds in a comparison between Germany and the USA and Dustmann and Pereira (2008) in a comparison between Germany and the UK.

Not all establishments might use deferred payments and therefore we should allow for differences in the wage-seniority profile across establishments instead of looking at averages (Hutchens, 1986, Abowd et al., 1999). In the next step therefore the residuals from the individual wage increase equation for stayers (1) are aggregated to

[7] The results derived by Topel (1991) for the USA 1968-1983 are not comparable because he uses average hourly wages instead of the exact hourly wages at the estimation point in time. Lefranc (2003) also demonstrates that the estimation period plays a pervasive role in the calculations (repeating the estimation by Topel for the period 1981-1992 reduces the average coefficient from about 12% to 4%).

[8] If the initial experience variable is instrumented by current experience, this reduces the estimated

the establishment level and deviations from the sector and year means are constructed. This indicator has mean zero and variance 0.02. It is used as the dependent variable in a weighted ordinary least square equation with five qualification share indicators, training intensity, initial wage levels, an export dummy, the share of foreigners in the firm and dummies indicating whether there is a works council or whether the establishment is profitable plus year, size and sector dummies as explanatory variables. These variables are all included as deviations from the sector and year means (besides the year, size and sector dummies). As several observations of one establishment are used from different years, the estimation is performed using clustering by establishment (Moulton, 1990).

First, several simple correlations are presented in order to get a rough picture of how the deviation from the sector mean in seniority wages is correlated with our main explanatory variables (compare Appendix Tables A2). The investment and consumption goods sector, the banking and insurance industry, and the rest category "other services" (for example personal services) pay higher seniority wages than the other sectors. Especially low seniority wages are paid in the sectors agriculture and forestry, hospitality, and education and training. According to our hypotheses, we find that large and more profitable enterprises, enterprises with highly qualified employees and enterprises controlled by works councils and collective bargaining contracts pay higher seniority wages. Contrary to the hypotheses derived from the agency interpretation of seniority wages, the simple cross correlations indicate that enterprises with higher seniority wages also train more and pay higher initial wages.

Finally, the full model is estimated including all explanatory variables (compare Table 3). In a weighted OLS regression the deviation of the seniority wage in an enterprise from the sector and year average is explained. As a robustness check, a Probit regression is estimated. A dummy that equals one if the enterprise pays higher seniority wages than the sector average is used as the dependent variable. In both regressions clustering of establishments and heterogeneity in the variances are taken into account and all variables are estimated in deviations from the sector and year means.

The multivariate regressions show analogously to the previous correlation results that larger enterprises and enterprises with higher qualified employees, works councils and collective bargaining agreements pay higher seniority wages. Enterprises with a high share of foreigners pay less seniority wages. The covariates "initial pay" and "training intensity" interestingly change their sign after including the other explanatory

initial experience coefficient β_0 from about 6% to about 4% in equation (2).

variables. Training is now negatively correlated with the steepness of seniority wages. This finding is according to the results by Levine (1993) and Barth (1997) for the US and Japan but in contrast to the results described by Hu (2003).[9] Establishments with steep seniority wages pay lower initial wages. This is also found by Levine (1993) and Neumark and Taubman (1995). These results suggest that enterprises mainly pay seniority wages on the basis of agency considerations.

Finally only the observations from year 2002 are used (compare Table 4). This reduction of the sample tests whether the results are robust if only single observations from every establishment are used. In addition, the dummy "part-time employment for older employees" can be included because it is only asked in the year 2002. This dummy variable has the value one if the establishment specifically offers part-time employment for employees who are older than 50 years of age. The results are very similar to those obtained from the sample covering several years. In addition, the part-time employment variable for older employees is positively correlated with the strength of the seniority wages. This also supports the notion of seniority wages being mainly driven by agency considerations.

6 Conclusions

This paper explains why establishments pay higher seniority wages. It identifies establishment characteristics that allow discrimination between the three main theories for seniority wages – the agency theory, the human capital theory and the efficiency wage theory. According to Lazear´s (1979, 1981) agency theory (and contrary to the human capital theory), establishments with steeper seniority wages do not have higher training efforts. Also according to the agency theory and against the efficiency wage theory, establishments with higher than average seniority wages, offer lower initial wages for job entrants. Additional evidence for the agency interpretation of seniority wages is provided by a positive correlation between the qualification of employees and seniority wages: Higher qualified employees have more discretion in their activities and frequently build their career on voluntary job switches. This means that long-term financial incentives are particularly effective. Works councils are potent guarantors that the establishment does not renege on its promise to repay the bond financed by the

[9] Daniel and Heywood (2008) find that while indicators for deferred compensation are strongly negatively related to the share of older employees hired, training indicators have a much weaker correlation.

employees in their early career stages. This helps the establishment to credibly promise a life long wage profile that is steeper than the productivity profile. It is also found that establishments with collective bargaining pay steeper seniority wages - unions increase the tenure of employees and they are particularly interested in improving the situation of the core employees (those with long tenure). Larger establishments have more problems to monitor employees and provide explicit incentives because the individual performance is more difficult to measure – they therefore also rely more often on the implicit seniority wage incentive contracts. In addition, more profitable establishments frequently have stronger seniority wages because this is an efficient way to motivate and retain employees by sharing profits with their employees. Finally, establishments with higher seniority wages more frequently offer part-time employment for older employees, another fact that only can be explained by agency considerations.

This paper therefore provides evidence that establishments with high seniority wages in Germany use a wage pattern that gives employees a wage level below their marginal productivity during the first years of their tenure and grants them a wage higher than their labour productivity after some time in the establishment. This interpretation is supported by the finding that establishments with higher seniority wages than the sector average hire less older employees and have a longer average tenure in Germany (Zwick, 2008).

This paper includes a broader range of variables to characterise enterprises that offer steeper seniority wage profiles than the literature so far. It also uses an innovative two step procedure and a large and representative linked employer-employee panel data in order to properly calculate individual seniority wages before aggregating them to the enterprise level. Nevertheless this paper can only offer indirect indicators for steeper wage profiles than productivity profiles because direct measures for productivity are not available.

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Table 1: Yearly wage growth for employees staying in the establishment, dependent variable: ln(yearly real wage change), West-German males

	OLS regression	
	Coef.	Std. Dev.
Δ experience and seniority	0.115***	0.001
Δ seniority^2*100	-0.218***	0.003
Δ seniority^3*1000	0.081***	0.001
Δ seniority^4*10000	-0.010***	0.000
Δ experience^2*100	-0.621***	0.006
Δ experience^3*1000	0.211***	0.002
Δ experience^4*10000	-0.027***	0.000
Number of observations	5305623	
R^2	0.02	

Source: LIAB Cross Section Version, Waves 1998-2004

Table 2: Explanation of job entry wages, dependent variable: estimated real wage at tenure = 0, West Germany

	Weighted OLS regression		IV regression	
	Coef.	Std. Dev.	Coef.	Std. Dev.
Experience at job start	0.056***	0.000	0.035***	0.000
Secondary education without professional degree	-0.040***	0.001	-0.042***	0.001
Secondary education with professional degree	-0.068***	0.001	-0.069***	0.001
Tertiary education with professional degree	0.295***	0.000	0.240***	0.002
University of Applied Sciences	0.504***	0.002	0.540***	0.002
University	0.656***	0.001	0.666***	0.001
Foreigner	0.005***	0.001	-0.009***	0.001
Dummy 1999	0.027***	0.001	0.032***	0.001
Dummy 2000	0.029***	0.001	0.040***	0.001
Dummy 2001	0.038***	0.001	0.063***	0.001
Dummy 2002	0.064***	0.001	0.097***	0.001
Dummy 2003	0.112***	0.001	0.146***	0.002
Constant	3.206***	0.001	3.149***	3.203
Number of observations	4809951		4809951	
R^2	0.34		0.30	

Estimated Cumulative Return to Job Tenure (OLS regression)

	5 years	10 years	15 years
West Germany 1998-2003	0.23	0.40	0.56
Topel (1991) for USA 1968-1983	0.18	0.25	0.28
Lefranc (2003) for USA 1981-1992	0.06	0.11	0.15
Lefranc (2003) for France 1990-1997	0.08	0.15	0.20

Comment: Weights are the inverse of standard variance of job entry wages.

Source: LIAB Cross Section Version, Waves 1998-2004.

Table 3: Determinants of establishments with higher seniority wages than the sector average, West Germany 1998-2004

	Weighted OLS regression		Probit regression	
	Coef.	Std. Dev.	Coef.	Std. Dev.
Share secondary education without prof. qual.	-0.003 *	0.002	-0.218***	0.020
Share secondary education with prof. qual.	0.001	0.002	-0.037***	0.014
Share tertiary education with prof. qual.	0.013 ***	0.005	0.199***	0.039
Share polytechnics	0.030 ***	0.006	0.242***	0.047
Share university	0.022 ***	0.004	0.369***	0.035
Share foreigner	-0.020 ***	0.003	-0.198***	0.029
Works council	0.007 ***	0.001	0.062***	0.009
Positive profit situation	0.009 ***	0.001	0.027***	0.010
Collective Bargaining	0.005 ***	0.001	0.007	0.008
Continuing training	-0.002	0.006	-0.012	0.009
Entry wages	-0.003 *	0.001	-0.019	0.014
Establishment size 1-20	-0.005 ***	0.002	-0.049***	0.010
Establishment size 21-100	-0.003 ***	0.000	-0.053***	0.008
Establishment size 501-2000	0.003 ***	0.000	0.059***	0.012
Establishment size >2000	0.006 ***	0.001	0.184***	0.023
Number of Observations	27370		31901	
(Pseudo)R^2	0.06		0.04	

Comments: dependent variables: deviation from average sector seniority wage (OLS) and dummy = 1 if above average sector seniority wage (Probit), regressions, clustered by establishment number and heterogeneity robust standard error, weights are the inverse of standard variance of seniority wage deviations in OLS, marginal effects in Probit, regressions include a constant, year dummies and 16 sector dummies.

Source: LIAB Cross Section Version, Waves 1998-2004

Table 4: Determinants of establishments with higher seniority wages than the sector average, West Germany 2002

	Weighted OLS regression		Probit regression	
	Coef.	Std. Dev.	Coef.	Std. Dev.
Part time for older employees	0.006***	0.001	0.095***	0.017
Share secondary education without prof. qual.	-0.006	0.004	-0.175***	0.043
Share secondary education with prof. qual.	-0.004	0.004	-0.009	0.030
Share tertiary education with prof. qual.	-0.001	0.013	0.279***	0.080
Share polytechnics	0.024**	0.009	0.270***	0.100
Share university	0.020*	0.010	0.324***	0.071
Share foreigner	-0.023***	0.007	-0.223***	0.060
Positive profit situation	0.013***	0.002	0.056***	0.021
Works council	0.006***	0.001	0.076***	0.020
Collective Bargaining	0.004***	0.002	0.025	0.018
Continuing training	0.002	0.002	-0.269***	0.018
Entry wages	0.001	0.003	0.015	0.029
Establishment size 1-20	-0.003***	0.001	-0.062***	0.063
Establishment size 21-100	-0.001	0.001	-0.055***	0.019
Establishment size 501-2000	0.002*	0.001	0.046*	0.027
Establishment size >2000	0.008***	0.001	0.116**	0.055
Number of Observations	6049		6750	
(Pseudo)R^2	0.07		0.07	

Comments: dependent variables: deviation from average sector seniority wage (OLS) and dummy = 1 if above average sector seniority wage (Probit), regressions, clustered by establishment number and heterogeneity robust standard error, weights are the inverse of standard variance of seniority wage deviations in OLS, marginal effects in Probit, regressions include a constant, year dummies and 16 sector dummies.

Source: LIAB Cross Section Version, Wave 2002

Appendix Table 1: Descriptive statistics of variables used

Variable	Average Value	Description
Seniority	11.08	Years of seniority, imputed
Experience	16.54	Years of experience, imputed
Experience at job start	5.90	Years of experience in current job at seniority equals zero
Wage	4.56	log wage, imputed
Secondary education without professional qualification	0.16	Dummy, 1=highest school education secondary education without professional qualification, 0=otherwise
Secondary education with professional qualification.	0.62	Dummy, 1=highest school education secondary education with professional qualification, 0=otherwise
Tertiary education without professional qualification (reference)	0.01	Dummy, 1=highest school education tertiary education without professional qualification, 0=otherwise
Tertiary education with professional qualification	0.05	Dummy, 1=highest school education tertiary education with professional qualification, 0=otherwise
Polytechnics	0.05	Dummy, 1=highest school education university of applied sciences, 0=otherwise
University	0.07	Dummy, 1=highest school education university, 0=otherwise
Foreigner	0.10	Dummy, 1=foreigner, 0=German
Works council	0.91	Dummy, 1= works council present, 0=otherwise
Profit situation	0.28	Dummy, 1=profit situation better than that at competitors, 0=otherwise
Average employee age	40.31	Average age of employees
Collective bargaining	0.91	Dummy,1=bargaining yes, 0=otherwise
Training	0.90	Dummy, 1=training offered, 0=otherwise
Part-time for older workers (for 2002 only)	0.83	Dummy, 1=part-time offered, 0=otherwise

Appendix Table 2a: Correlations between establishment size and seniority wages, West Germany

	Coef.	Std. Dev.
Establishment size 1-20	-0.013 ***	0.000
Establishment size 21-100	-0.007 ***	0.000
Establishment size 501-2000	0.006 ***	0.000
Establishment size >2000	0.013 ***	0.000
Number of Observations	6520865	
Adj. R^2	0.08	

Comments: separate OLS regressions clustered by establishment number and heterogeneity robust standard errors. Regressions include a constant, year dummies, five firm size dummies, and 16 sector dummies.

Appendix Table 2b: Correlations between establishment sector and seniority wages, West Germany

	Coef.	Std. Dev.
Agriculture and Forestry	-0.013 ***	0.000
Mining and energy	0.001 ***	0.000
Basic goods	0.000 ***	0.000
Investment goods	0.002 ***	0.000
Consumption goods	0.004 ***	0.000
Construction	0.014 ***	0.000
Trade	-0.008 ***	0.000
Traffic and Communication	-0.002 ***	0.000
Banking and Credit	0.014 ***	0.000
Insurance	-0.016 ***	0.000
Hotels, restaurants, private services	-0.001 ***	0.000
Education and publishing	0.003 ***	0.000
Health services	0.013 ***	0.000
Business services	-0.010 ***	0.000
Other services	-0.001 ***	0.000
Number of Observations	6520865	
R^2	0.10	

Note: reference sector is food processing.

Appendix Table 2c: Correlations between qualification and seniority wages, West Germany

	Coef.	Std. Dev.
Secondary education without prof. qual.	-0.004 ***	0.000
Secondary education with prof. qual.	-0.001 ***	0.000
Tertiary education with prof. qual.	0.008 ***	0.000
Polytechnics	0.008 ***	0.000
University	0.008 ***	
Number of Observations	6520865	
Adj. R^2	0.02	

Note: reference is tertiary education without professional qualification

Appendix Table 2d: Correlations between establishment characteristics and seniority wages, West Germany

	Coef.	Std. Dev.
Training dummy	0.002 ***	0.000
Initial wage level	0.000 ***	0.000
Collective bargaining dummy	0.012 ***	0.000
Good profit situation dummy	0.008 ***	0.000
Export dummy	0.004 ***	0.000
Works council	0.014 ***	0.000

Note: all regressions have been performed separately; all regressions have 6520865 observations and an adjusted R^2 below 0.01.

Source: LIAB Cross Section Version, Waves 1998-2004