Do Wages Rise with Job Seniority?

The Swiss Case

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Abstract

Whether or not seniority has a substantial effect on wages has been the subject of much controversy in the past decade, mainly in the U.S. Several economists have noted that unobserved heterogeneity across individuals and across job matches may produce inconsistent OLS-estimates of the effect of tenure on wages and turnover. Hence, labor economists have put forward two empirical strategies to deal with unobserved heterogeneity: Altonji and Shakotko (1987) use an instrumental variable for tenure, which is uncorrelated with the individual and job-specific component of the error term, but highly correlated with job tenure, whereas Topel's (1991) basic idea is that within-job wage growth combines the returns to general and job-specific experience. These two empirical strategies revealed different returns to seniority and experience for the U.S. labor market. Our goal is, on one hand, to use the different methodologies for the Swiss labor market and, on the other hand, to evaluate the sources of these differences.

Thus, we replicate these methods with Swiss data (Swiss Labor Force Survey, SLFS). In a first step, we estimate returns to tenure and experience with the standard regression method, OLS. Subsequently, we apply the Topel and the Altonji/Shakotko estimator, and use different specifications for each. We find that (i) Topel's approach delivers similar returns to tenure to OLS, i.e. about 8% within ten years of job seniority, while the Altonji/Shakotko method delivers substantially lower returns (4%). (ii) Returns to tenure are minor in Switzerland compared to the U.S.

1 Introduction

The idea that wages rise with job seniority is the foundation of the theory of specific human capital, as well as other commonly accepted theories of compensation. The extent to which tenure affects wages is important for several reasons: First and foremost, the wage-tenure profile gives fundamental insight to the structure of earnings over careers. Second, the wage-tenure profile is a key determinant of the extent to which the earnings power of individuals is tied to specific jobs, and it is important for assessment of the losses suffered by "displaced" workers. Third, evidence that wages rise with job tenure has been used to explain the decline in quit rates with tenure, since the wage growth on the current job lowers the probability that the worker will locate a superior alternative.

In our paper, we first discuss the problem of the empirical identification of returns to tenure. Returns to tenure and experience are expected to be biased when estimated with the traditional regression method, OLS (Ordinary Least Squares). The reason for these distortions lies in the likely correlations between experience, tenure and unobserved individual and job match specific effects. For example, since tenure is simply a function of past quit and layoff decisions, it will be positively correlated with individual characteristics and jobs which lead to lower quit rates and layoffs. These same characteristics are likely to be positively related to worker productivity, and, in competitive labor markets, to wages. For this reason, the traditional regression method (OLS) is likely to overestimate returns to tenure.

To handle these biases, we concentrate on two methodological approaches, which have been widely discussed in the literature on specific human capital, namely the instrumental variables approach proposed by Altonji and Shakotko (1987, hereafter, AS) and the two-stage estimation procedure of Topel (1991). In their paper "Do Wages Rise with Job Seniority?", AS propose to solve the correlation problem between tenure and the components of the error term by using an instrumental variable for tenure, which is uncorrelated with the individual and job-specific component of the error term, but highly correlated with job tenure. Topel's basic idea is that within-job wage growth combines the returns to general and job-specific experience. Thus in a first stage he estimates wage growth within the same job, and in a second stage he makes a cross-sectional comparison of the wages of workers who started new jobs at different points in their careers. This gives an upper bound on the returns to experience

and thus allows separating these two wage growth effects while eliminating the biases that arise with OLS.

However, the two approaches revealed diverse estimates for returns to tenure and experience in the United States. While AS named a wage effect of 6,8% within 10 years with the same employer in their preferred specification (which is only about one fifth of the corresponding OLS estimate!), Topel estimated a tenure effect of 28% within the same period of time. Altonji and Williams (1997, hereafter, AW) responded Topel's article with the replication and re-estimation of Topel's sample, and got substantially different returns. They argued that these differences arise due to mainly two reasons: First, the two methodologies differ in their responsiveness to measurement errors in tenure and second, they are sensitive to different methods that may be used to control for economy-wide trends in wages and inflation.

The main aim of this paper is to compare the two alternative methodologies with a data set covering a time period during which only moderate economy wide wage growth occurred. With this property, remaining differences between the methodologies must have other causes than different detrending approaches. Our results indicate that there are substantial differences between the AS and Topel approach. While Topel's approach produces an estimate of the return to tenure of about 8 percent after 10 years, estimates based on the AS approach are at most one half of this figure. These differences are robust to a number of different ways of dealing with economy wide wage growth. Our findings thus suggest that the main reason for differences between the two most important ways of measuring returns to tenure is due to measurement error in tenure.

The paper is organized as follows: Section 2 presents the different empirical methodologies that have been suggested to measure returns to tenure. Section 3 describes the Swiss data set. The regression results are presented in section 4. Our main findings will be summarized in section 5.

2 Methodological Background

2.1 The Basic Wage Model

Most studies investigating returns to tenure, including AS, Topel and AW, work with the basic wage model

(1) $$W_{ijt}=\beta_0 t+\beta_1 X_{ijt}+\beta_2 T_{ijt}+\varepsilon_{ijt}$$

where W_{ijt} denotes the log real wage of person i in job j in period t, X_{ijt} is total labor market experience, and T_{ijt} is tenure with the current employer. Parameters β_1 and β_2 represent average returns to experience and tenure, respectively, and are the parameters of interest in this paper. The equation abstracts from a set of control variables, and from nonlinear terms in experience and tenure.

The error term is decomposed as

(2) $$\varepsilon_{ijt}=\mu_i+\theta_{ij}+\eta_{ijt}+u_{it},$$

where μ_i is a fixed individual specific error component, θ_{ij} is a fixed job match specific error component, η_{ijt} is a time varying job match specific component, and u_{it} is the sum of measurement errors in the wage and a person specific error component that affects wages of all employees. AS, Topel and AW all ignore u_{it} because it is unlikely to be related to turnover behavior. Topel argues that η_{ijt} is unlikely to influence his analysis if it is a random walk and shows that the data are consistent with that. In our study, we mainly rely on these findings and concentrate on the individual and the job match specific error components.

The key parameters of interest are β_0, β_1 and β_2, where β_1 is the partial effect of an additional year of experience on the wage, and β_2 is the partial effect of tenure. The parameter β_0 is an economy wide trend in real wages. Many studies have used OLS to estimate these parameters, and they consistently find large returns to tenure. AS and Topel find that using OLS, the wage effect of tenure within ten years is about 30% and 35% respectively.

However, using OLS to estimate these parameters is inappropriate because of the likely correlation between experience and tenure with the unobserved heterogeneity (individual and job match specific). Tenure and experience are likely to be correlated with the components of the error term because of several reasons:

- Tenure is likely to be a negative function of past layoff and quit decisions; the lower personal productivity is (the lower μ_i), the shorter tends to be the time with the same employer. This likely behavior will lead to an upward bias in estimating returns to tenure with OLS.

- Matching and search models (Burdett, 1978) imply that job shopping over a career will induce a positive correlation between experience and the unobserved job match component, θ_{ij} (experienced workers had more time to locate a good job).

- The correlation between tenure and θ_{ij} is ambiguous. On the one hand, workers will be less likely to quit high wage jobs, inducing that the correlation is positive. On the other hand, voluntary job changes will lead to low tenure values and therefore induce this relationship to be negative. Thus it is difficult to sign the effect of this correlation on the estimation results for returns to tenure.

2.2 Altonji and Shakotko's Instrumental Variables Estimator

Altonji and Shakotko's general wage model differs only slightly from the general wage model. The authors propose an instrumental variable to address the problems of individual and job match heterogeneity in the wage model. They specify the principal instrumental variable as the *deviation of tenure from its mean* for the sample observation *on a given job match,* $D\tilde{T}_{ijt}=T_{ijt}-\overline{T}_{ijt}$. This variable is *uncorrelated by construction* with both the individual specific error component of the wage equation and the permanent job match component. Abstracting from η_{ijt}, this variable is a valid instrument because it is orthogonal to the job match specific and personal error components. AS refer to this estimator as the IV1 estimator. They get estimated returns to tenure, which are only about one fifth of what they would get with OLS. However, there are different possible sources of biases in the IV1 estimator:

- The likely positive correlation between experience and the job match specific error

component θ_{ij} leads to a positive bias in β_1^{IV1}, and therefore to a negative bias in estimating returns to tenure (β_2^{IV1}).

- There are problems in measuring tenure. This might arise with OLS too, but the importance on the estimations is likely to be greater with AS, because the variance of measurement error is larger in the instrument for tenure than in raw tenure[1].

2.3 Topel's Two-Stage Estimation Procedure

Topel estimates returns to tenure with an alternative two-stage method. First, he estimates the wage growth for employees within the same job. With this strategy, he is able to eliminate the biases that arise because of the individual and the job match specific error terms, because these terms are constant within the same job. In a second stage, he divides the effect of tenure and experience on wages. Topel subtracts the wage effect per year (using the coefficients from the first stage), such that he obtains the wage level at the beginning of a job. He uses this wage to identify the effect of experience on wages when a job begins.

Real Wage Growth within the Same Job

With the information on years within the same job, it is easy to see if the employees have changed their job. For the employees who stayed with the same employer over the years considered (stayers), one can compute within-job wage growth as follows:

(3) $$W_{ijt} - W_{ijt-1} = \beta_1 + \beta_2 + \varepsilon_{ijt} - \varepsilon_{ijt-1}$$

With this method, the individual and the job match specific effect are eliminated. Since there's always one year between two periods, one can say that $\Delta X = \Delta T = 1$. Therefore, wage growth $(W_{ijt} - W_{ijt-1})$ is the sum of returns to general and job specific human capital accumulation, and thus reflects the sum of returns to tenure and experience. In a second step, Topel regresses wage growth on a constant, and gets a consistent estimator of wage growth

[1] See Griliches (1979) or Griliches and Hausman (1986) for a theoretical illustration.

($\beta_1 + \beta_2$), if the estimator ($\varepsilon_{jjt} - \varepsilon_{ijt-1}$) has an average value of zero. In addition, he includes higher order terms of tenure and experience and changes in dummy variables[2].

Estimated Returns to Experience and Job Tenure

The second stage of the Topel estimation separates the effects on wage growth of an additional year of job tenure (β_1) and labor market experience (β_2) respectively.

With $X = X_0 + T$, model (1) can be rewritten as:

(4) $$W = X_0\beta_1 + TB + \varepsilon$$

where T = number of years within the same job (tenure) and $B = \beta_1 + \beta_2$. The first term on the right side of the equation represents the wage at the beginning of the job, whereas the second term describes the wage effect of accumulated general and firm-specific human capital within the same job.

Equation (4) and the wage differentials from (3) lead us to:

(5) $$W - T\hat{B} = X_0\beta_1 + \varepsilon$$

where $\hat{B} = \overline{(\beta_1 + \beta_2)}$ is the consistent estimator from the first stage. Equation (5) describes the relationship between the estimated wage at the beginning of the job and the valuation of the employee's previous experience. With subtraction from the first estimator, a lower bound of the wage effect of job tenure can be identified.

Topel's model relies on the assumption that both the job match specific and the individual error terms are constant over time and thus disappear when the equation is expressed in wage differentials. If experience is uncorrelated with job match or individual heterogeneity, the Topel estimator of returns to tenure and experience is unbiased.

[2] For example: if an employee gets married in one year, in this year the variable "dmarried" has a value of one, otherwise a value of zero.

2.4 Differences and Problems of the Approaches

AS, Topel and AW used substantially the same sample of U.S. data collected in the Panel Study of Income Dynamics (PSID). All calculations were made for the years between 1968 and 1981. Only white male employees, aged between 18 and 65, were included. Table 1 gives a short overview of the results of Topel's and AS's estimations:

TABLE 1: ESTIMATED RETURNS TO TENURE WITHIN 10 YEARS FOR THE DIFFERENT METHODOLOGICAL APPROACHES (LOG WAGE INCREASE)*

	OLS	AS – Method (IV1)	Topel's Method (2 - step estimator)
Altonji/Shakotko (1987)	0.263	0.066	
Topel (1991)	0.300		0.246

*: The results displayed in this table apply to the preferred estimations of the authors.

Let us first consider AS's estimations. With the standard estimation method, they get a value for the wage effect within ten years with the same employer of 0.263. This means that an employee who is on the same job since this time period would take a wage loss of about 30% ($e^{0.263}$ - 1) of his income if his job ended exogenously, or if he decided to quit. When AS run the estimations with their alternative method, they display a wage growth effect from tenure of 6.8% ($e^{0.066}$ - 1) in 10 years on the same job, which is only about one fifth of what was computed with OLS. These results imply that a large part of the differences to OLS is caused by the strong correlation between wages and tenure (or that with the IV1 approach, one can eliminate the mentioned biases). The small returns to tenure with AS's approach are accompanied by greater returns to general experience, namely 31.7% in the first ten years on the same job when computed with OLS or 48.2% with the IV1 procedure. This might be explained by the correlation between experience and tenure (a downward bias in tenure leads to an upward bias in experience). Thus, with the IV1 method, AS assign most of the wage growth to general experience, and only a modest part to tenure.

The contrary is the case with Topel's results. He estimates a wage effect of tenure of about 28% for 10 years with the same employer, which is little below his OLS estimation result (35%). Altonji and Williams get substantially smaller returns to tenure, namely about 11%, when they replicate the sample and re-estimate Topel's procedure.

These different results raise the question which method yields the better estimations. AW stress that there are mainly two reasons, which might explain the divergent messages and which will be discussed in the following subsections:[3]

- different methods in controlling for economy wide time trends and changes in sample composition,
- measurement errors in tenure.

Different Methods to Control for Economy Wide Trends in Wages and Changes in Sample Composition

There are two different ways of dealing with economy wide growth in real wages. The first method suggests to control for average wage growth *within* the sample as shown in equation (1). This procedure has been applied by AS. Topel deflates nominal wages using the Murphy-Welch (1987) index, which nets out both real aggregate wage growth and changes in the price level. This means that he uses information from *outside* the sample to control for aggregate wage growth. There are two problems with the "time trend" approach:

- Time is not statistically exogenous in panel data. With rising experience, job match quality (θ_{ij}) rises with time (persons with high market experience have had more time to locate a good job). In this situation, treating time as exogenous might lead to an overstatement of temporal wage growth and thus to a downward bias in returns to seniority.
- Time may be correlated with the mean of μ_i: Household heads with better unobserved characteristics μ_i are likely to respond more often to the survey. Thus, sample attrition leads to an increase in average μ_i with time, again causing a downward bias in returns to seniority.

[3] We concentrate on these two explanations. Further possible causes for unequal results are the functional form and the inconsistent timing of the tenure and earnings measures. Both Topel and AS showed that the functional form doesn't influence the results substantially; this is in line with our findings. In the PSID data, most variables refer to the survey date, while the wage measure is annual earnings divided by annual hours in the previous calendar year. This possibility doesn't apply to our data set, because all variables refer to the survey year.

AW use different treatments of the time trend to check the influence on the estimators of returns to tenure; they conclude that the use of the Murphy-Welch wage index to detrend real wages (used by Topel) has little effect on the OLS estimates (they are persistent at 0.27 within 10 years of job tenure). The same outcome applies to the Topel estimator; here the coefficients of returns to tenure range between 0.22 (year dummies) and 0.25 (deflated wages). The effect of the use of different time trends is substantial to the IV1 approach; here AW observe a large upward change in the estimator for returns to tenure when deflating the wage data using the Murphy-Welch index (0.246) compared to the results which arise from treating time as exogenous using year dummies (0.093). So the net result of using deflated wage data is to move the Topel estimator closer to OLS and the IV1 estimator closer to both the Topel and OLS estimates.

Measurement Error in Tenure

Topel specifies measurement errors in tenure in the AS sample as one of the leading factors to the differences in conclusions of the two articles. He argues that tenure is often measured in intervals of several years, such that year-to-year changes in recorded job tenure often don't have the theoretical value of one. Topel reports that the estimated effect of tenure on wages rises substantially when he uses the IV1 estimator with his corrected tenure measure.

AW state that AS were aware of the problems with measuring tenure. They found that eliminating the effects of bracketing of tenure values in the early years and unusual changes in tenure or smoothing the tenure variable increased their basic estimate from 0.067 to 0.084. They concluded that the measurement error is important, but not substantial, to their conclusions. Thus, the magnitude of the results seems to stay the same, in the sense that AS do not find very large wage effects from tenure. One could argue that if there's a problem in measuring tenure, it is the same, no matter which estimation method is implemented. All the same, as we discussed before, the changes in the variance of the error term when different methods are used has a larger impact on AS's results, because overall variance is greater than with the other approaches (see Griliches, 1979 or Griliches and Hausman, 1986).

The main problem with previous research on the differences between the AS and Topel approach is that during the sample period (1968-1981) both, aggregate real wage growth and inflation were substantial. In contrast, we address the differences between the AS and the

Topel approach based on a time period where both, aggregate real wage growth and inflation were negligible compared to the United Stats. Thus, we eliminate the first important source of different estimates in the returns to tenure. This allows examining the empirical relevance of "measurement error in tenure" explanation.

3 The Data

We applied the different methodological proposals to the *Swiss Labor Force Survey* (SLFS, Schweizerische Arbeitskräfteerhebung). For reasons of comparability to the U.S. studies by AS, Topel and AW, we included only male employees which are aged between 18 and 65. Our survey includes observations for the period of time between 1991 and 1998. One property of our sample which is different to the PSID sample is that our panel is a *rotating panel*, which means that every person is in the survey during five following years, while the sample used by AS, Topel and AW observes only people who were in the sample during the whole time from 1968 until 1981. This property of our sample is important for the considerations made before: The fact that our panel is rotating leads to the presumption that the problem of the correlation between time and experience or tenure is minor in our sample than in the PSID data set.

The second important advantage of using this dataset is that during the time period under consideration the economy-wide growth in wages was very low. From 1991 to 1998 nominal wages for men in Switzerland only grew by a yearly average of 2.5%. This compares very favorably to the 8% wage growth from 1968 to 1983 in the U.S. labor market. Moreover, real wages of Swiss men only grew by an average of 0.4% in our sample. Therefore, the control of the economy-wide trend will only be of minor importance compared to the PSID sample used by AS and Topel. This is particularly the case for the years after 1995 with an average growth of nominal wages of 0.9% and real wages of 0.1% respectively. The development of real wages, nominal wages and consumer prices is shown in Table 2.

TABLE 2: CONSUMER PRICE INFLATION, NOMINAL AND REAL WAGE GROWTH FOR MEN IN SWITZERLAND, 1991-1998

	1991	1992	1993	1994	1995	1996	1997	1998
Consumer price inflation	5.9%	4.0%	3.3%	0.9%	1.8%	0.8%	0.5%	0.0%
Nominal wage growth (men)	7.1%	4.9%	2.6%	1.5%	1.1%	1.2%	0.4%	0.8%
Real wage growth (men)	1.9%	1.5%	-0.8%	0.4%	-0.4%	0.4%	0.0%	0.4%

Source: Swiss Federal Office of Statistics (1999), Swiss Statistical Yearbook 2000, Neue Zürcher Zeitung Verlag, Zürich; own calculations.

In the empirical part, we will utilize the low wage growth property of our sample and run regressions for different detrending procedures.

To get a short overview of our data set, Table 3 summarizes the properties of the most important variables in our sample:

TABLE 3: DESCRIPTIVE STATISTICS

	Full Data Set (N = 25'236)		Stayers (1st Stage Topel) (N = 12'252)	
	Mean	Standard Deviation	Mean	Standard Deviation
Real Hourly Wage (CHF)	43.15	27.18	43.54	20.57
Yearly Real Wage	79'447	46'443	81'367	34'107
Ln of Real Hourly Wage	3.67	0.40	3.69	0.38
ΔReal Wage			0.014	0.205
Tenure	10.16	9.54	11.75	9.50
Experience	19.28	12.05	20.45	11.90
Age	39.34	10.94	40.41	10.74

Starting with the full data set, se see that the real hourly wage during the observation period was 43.15 Swiss Francs, which corresponds to 31.4 US$[4] within this time frame. The yearly wage is nearly 80'000 Swiss Francs (57'776 US$, respectively). There is a large dispersion over individuals in the wage data, which is reflected in the corresponding standard deviations.

The mean worker in our sample has been on the same job (tenure) since a bit more than a decade, which is quite close to the observations on the U.S. labor market (Topel displays mean tenure of 9.978 years for the PSID sample from 1968 to 1983). The workers display a mean labor market experience of twice as much, i.e. more than 19 years, which is also in line with the U.S. observations. The mean age of the workers is 39 years. Comparing these data with the reduced sample which displays only stayers (the sample we need for the Topel's first stage estimations), we see that real wages are about the same, but display a smaller standard deviation. This can be explained by the fact that the jobs at the lower/upper bound of the wage dispersion are less persistent (for example due to job shopping). As expected, stayers are more

[4] Source: Swiss National Bank, monthly data; own calculations

experienced and older (and naturally have higher tenure) than the workers of the overall sample.

The regressions were run with more than 25'000 observations (10'700 job matches) for OLS and the second stage of Topel, 20'830 (8'400 job matches) for the AS method, while in Topel's first stage (stayers) we used about 12'000 observations (6'470 job matches).

4 Estimation Results

In this section we first present results on the returns to tenure for Swiss male workers based on the AS and the Topel approach. Second, we examine the relevance of using different methods of dealing with economy wide wage growth. Finally, we present estimates based on a time period where controlling for economy wide wage growth is, essentially, irrelevant.

TABLE 4: RETURNS TO TENURE WITHIN 10 YEARS (DEPENDENT: LOG WAGES)

	Nominal wages with year dummies (AS's approach)	Detrended wages (Topel's approach)
OLS	0.075	0.075
Altonji/Shakotko	0.033	
Topel		0.078

Table 4 shows the returns to tenure based on the three main approaches suggested in the literature[5]. OLS estimates suggest that the return to firm specific capital is 7.8 % (=exp(.075)-1) within the first 10 years. Results based on the AS approach show that returns to seniority are 3.3 %. This finding is in line with the hypothesis that the ordinary least squares approach leads to an overestimation of the returns to tenure because the OLS error term and seniority are positively correlated. In contrast, Table 4 indicates that the returns to tenure within the first 10 years based on Topel's approach are 8.1 %. This replicates the finding that the AS estimator and the Topel estimator produce widely dispersed estimates of the returns to

[5] All estimates control for standard controls used in wage regressions as well as for nonlinear tenure and experience profiles (detailed results available from the authors).

specific capital. The surprising finding in Table 4 is that Topel estimates and OLS estimates are of the same order of magnitude. On one hand, this may suggest that omitted variable bias in the OLS estimator is less strong than previously hypothesized. On the other hand, this may be due to the fact that measurement error in tenure may bias OLS estimates downward more strongly than Topel estimates[6].

TABLE 5: RETURNS TO TENURE WITHIN 10 YEARS (DEPENDENT: LOG WAGES)

	Nominal wages with year dummies (AS's approach)	Detrended wages (Topel's approach)
Altonji/Shakotko		0.024
Topel	0.075	

Table 5 addresses the question whether it is possible to align the AS and Topel estimates by interchanging the method of dealing with economy wide wage growth. We report results based on the AS estimator based on wage data which were deflated using the consumer price index (Topel's preferred approach)[7]. Second, we present Topel estimates using nominal wages with year dummies (AS preferred approach). Table 5 suggests that none of the differences in the estimated returns to tenure can be assigned to the different treatments of aggregate wage growth. Returns to tenure based on the AS approach using Topel's detrending method are 2.4 %. Topel returns based on AS's detrending method are 7.8 % within 10 years. This suggests that the main cause of the differences in the two estimates is due to the estimation procedure.

[6] The literature concerned with the causal effects of education on wages provides an interesting parallel to our finding that the OLS estimator does not perform so "badly". In the "returns to education" literature, the expectation is also that OLS leads to an upward bias in the effect of education on wages because individuals with higher unobserved productivity choose higher education. However, when Angrist and Krueger (1991) address ability bias using instruments for education, they find that the OLS estimator of returns to education is lower than the IV estimator for education. The interpretation put forward by Ashenfelter and Rouse (1998) is that ability bias and attenuation bias have offsetting effects on the OLS estimator.

[7] We do not account for aggregate real wage growth because it was essentially zero in the observation period.

TABLE 6: SENSITIVITY ANALYSIS: A PERIOD WITH NO WAGE GROWTH

	Nominal wages, no time trend (1995-1998)
Altonji/Shakotko	0.039
Topel	0.081

Table 6 presents the results of a sensitivity analysis, in which estimated returns to 10 years of tenure are based on a sample period where controlling for aggregate real wage growth is not essential. In the period from 1995-1998, real wages grew on average by 0.1 % per year and consumer price inflation was 0.7 % per year. We applied the AS and Topel's approach to nominal wages without controlling for time. *The advantage of this last approach is that it is neither necessary to develop an index nor is it necessary to assume statistical exogeneity of time*. We find that there are substantial differences in the returns to 10 years of tenure between the two estimation methods.

After we have ruled out the other possibilities, the *last remaining explaining factor for the substantially different results appears to be the problem of measuring errors in tenure*. As we have discussed before, the different methods reveal different overall variance in tenure and thus lead to unequal estimations.

5 Conclusions

The question of whether or not wages rise with job seniority is of practical as well as theoretical importance. From an employee/employer point of view, the wage-tenure profile gives valuable insight into the structure of earnings over careers. The wage-tenure profile determines to what degree the earnings power of an employee is linked to a specific job, and it is important for valuation of the losses suffered by "displaced" workers.

The problem of measuring returns to tenure has been widely discussed in the last decade, especially in the U.S. There are two well-known approaches to deal with unobserved heterogeneity, which, in general, tell different stories about the extent to which wages rise with job tenure. The first method was proposed by Altonji and Shakotko (1987), where an

attempt was made to solve the correlation problem between tenure and the components of the error term. AS use an instrumental variable for tenure, which is uncorrelated with the individual and job-specific component of the error term, but highly correlated with job tenure. Topel's (1991) basic idea is that within-job wage growth combines the returns to general and job-specific experience. He estimates returns to tenure with a two-stage-procedure.

These two approaches yielded disparate estimates for returns to tenure in the United States, which prompted the debate on which strategy yields better estimates. While AS named a wage effect of 6,8% within 10 years with the same employer in their preferred specification (which is only about one fifth of the corresponding OLS estimate!), Topel estimated a tenure effect of 28% within the same period of time. Altonji and Williams (1997) specify several reasons for these diverging results. The most important ones are measurement errors in tenure and the difficulty to control for economy-wide trends in wages and inflation.

We can rule out the latter argument because real wage changes and inflation were very low during the observation period. We use several approaches to detrend nominal wages to test this assumption. First, we run our regressions with deflated wages, then use nominal wages with year dummies, and finally run the regressions with nominal wages for a time period where inflation was very close to zero (1995 to 1998).

Our results are in accordance with the experiences in the U.S. in the sense that with Topel's method, we get substantially higher returns to tenure than with the AS approach. Topel's estimation results imply that a Swiss employee gets a wage increase of about 8% after 10 years with the same employer, compared to his wage at the beginning of the job. The estimation results are substantially smaller when AS's approach is used; they assign only between 2.4% and 4% (depending on the detrending convention) to this effect.

Thus, our results suggest that with using the advantageous properties of our data set, we can rule out one of the two main reasons why the estimators of the two approaches differ, namely the different detrending procedures. The remaining differences in the results we found might therefore be ascribed to measuring problems in tenure, which should be addressed in further research in this area.

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