Returns to Tenure: Is Specific Human Capital Acquired on the Job?[*]

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Abstract

The paper investigates the impact of including occupation and industry tenure in wage regressions on returns to employer tenure. I find that in contrast to the United States, returns to tenure within an occupation and industry are very low. There appears to be very little wage growth associated with staying in an occupation or industry match once I control for the endogeneity of match durations and wages. I attribute this to the importance of human capital investments - in form of the German apprenticeship system - that happen before fulltime employment starts. This leads to relatively little actual on the job training and skill accumulation for fulltime workers. Furthermore I show that returns are much higher for younger workers, while being relatively stable over time and for different education groups. I also document sharp differences in the tenure profiles for men and for women.

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1 Introduction

Understanding the formation of wages over a worker's lifecycle has traditionally been a central research question in labor economics. One major explanation why wages grow with workers' age is the accumulation of skills and knowledge that enhance productivity. The nature of these skills is of paramount importance for our understanding of the labor market. Classic earnings regressions include total experience and employer tenure as explanatory variables. In these econometric models, the returns to employer tenure appear to be large and this is often taken as evidence that human capital is highly employer specific. This then implies that transferability of human capital is limited and there are rents in a worker-employer match to be shared. Over the last years research has primarily focused on various econometric problems surrounding the endogeneity of the tenure variable (Abraham and Farber 1987; Altonji and Shakotko 1987; Topel 1991; Altonji and Williams 1992; Abowd, Kramarz, and Margolis 1999). More recently however, labor economists began to wonder whether the econometric specification of using firm tenure and total experience as explanatory variables is appropriate. Neal (1995) argued from observations on displaced workers that the correlation between wage growth and employer tenure can be explained by omitted industry experience and Parent (2000) using NLSY and PSID data showed that including industry experience in earnings functions reduces estimated returns to employer tenure by more than 50 percent. Kambourov and Manovskii (2005) and Sullivan (2006) argue that human capital is occupation rather than industry specific. They show that in an earnings regression that includes occupation, industry and employer tenure, employer tenure has close to zero or even negative effect, industry tenure and small and occupation tenure a large effect.

In this paper I explore whether these results for the US labor market hold for the German labor market as well. The large institutional differences between the German and the US labor market (ranging from the importance of Unions, the German apprenticeship system, to the degree of labor market regulation) make it plausible that wage growth over the career of a worker might be significantly different. I show that similarly to the United States, returns to employer tenure disappear (and in fact become slightly negative) once occupation and industry tenure are controlled for. However, while in the US industry tenure returns are much smaller (and in some specifications basically zero) than occupation tenure returns, in Germany the returns to occupation tenure are very small (only about 0.5 to 1.5 percent in 8 years of staying in an occupation compared to about 16 to 20 percent for the United States), while industry tenure has the largest effect on wages (about 3 to 6 percent in 8 years of staying in an industry). This could be a reflection of the fact that most skills are acquired by German workers early in their life in schooling and during apprenticeship training, while American workers learn most skills during on the job training.

I also document how returns to tenure have developed over time and provide evidence that the relationship has remained remarkably stable over the last two decades. I also show how returns to tenure develop over the lifecycle and show that while the impact is relatively large for young workers it becomes persistently lower with age.

In the next section (2) I present the econometric specification employed in this paper and discuss the various sources of endogeneity in such an earnings specification. In section 3 I discuss the data and some of the problems that arise with this. In section 4 I present main results and some interpretations. Section 5 provides some robustness checks

and a sensitivity analysis. In section 6 I explore heterogenous effects in the population. In section 7 I summarize the results and draw some tentative conclusions.

2 Econometric Specification

The empirical specification to estimate the returns to tenure is given by the following wage equation for an individual worker i at employer m, in occupation q, industry j and at time t:

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\begin{aligned}
w_{imqjt} = {} & \beta_1 EmpTen_{imqjt} + \beta_2 OccTen_{imqjt} + \beta_3 IndTen_{imqjt} \\
& + \beta_4 OldEmp_{imqjt} + \beta_3 TotalExp_{imqjt} \\
& + \gamma' X_{imqjt} + \lambda_t + \pi_q + \eta_j + \kappa_{imqjt}
\end{aligned}
\tag{1}
$$

where w_{imqjt} is the log of daily wages, $EmpTen, OccTen, and\ IndTen$ are years of employer tenure (in levels and a squared term), occupation tenure (levels, squared and cubic terms) and industry tenure (also levels, squared and cubic terms). $OldEmp$ is a dummy variable that takes the value 1 if the worker has been with his current employer for at least 1 year. $TotalExp$ is years of total experience (not potential experience). X_{imqjt} is a vector of control variables that include nationality, education, age, age squared, and a constant. λ_t, π_q, η_j are year, occupation and industry fixed effects.

κ_{imqjt} captures unobserved individual characteristics, match specific components and measurement error. For example ability might in part be unobserved, employers might pay different wages, or matches might be of differing quality.

One can thus decompose κ into:

$$\kappa_{imqjt} = \mu_i + \upsilon_{ij} + \theta_{im} + \omega_{iq} + \varepsilon_{it},$$

where μ_i is an individual specific effect (e.g. general ability), υ_{ij} is a individual-industry match specific component, θ_{im} the individual-employer match specific component, ω_{iq} the individual-occupation match specific component. For example a worker might be a talented baker but a very untalented truck driver. In this case his baker specific component would be high while the truck driver component low. The problem is that these match specific effects are likely to be correlated with tenure variables and wages. Suppose the worker starts working as a truck driver, he will realize he is not very productive, earn lower wages and quit early. Then he becomes a baker, where he earns more money and will stay longer. Thus in the longer tenure job wages will be higher, not because he is accumulating more human capital there but because the worker was a more talented baker in the first place and remains longer at this job. Very similar stories can be constructed for the employer worker match component and the industry worker match component. To deal with this source of endogeneity, Altonji and Shakotko (1987) proposed to use deviations from average tenure within a worker employer match as an instrument for current tenure. Suppose a worker stays with an employer for three years and the first observation is at the end of the first period. In the first period Tenure would be 1, in the second 2 and in the third 3. Average tenure for this worker employer match would be two years. In the three periods deviations from this average would be -1, 0, and 1 respectively. These deviations are then used as an instrument for the tenure variable. By construction, the deviations are orthogonal to the employer worker specific match and thus they are a valid instrument. This deals with all match specific errors. If there are time periods, occupations, or industries for which wages and tenure variables are higher (or

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lower), this type of endogeneity will be captured by year, occupation and industry fixed effects.

By construction the instruments for tenure are uncorrelated with the individual specific term μ_i, so that a correlation between μ_i, tenure and wages does not bias the results in the IV specification. Remaining sources of endogeneity are correlations between υ_{ij} and occupation and employer tenure; between θ_{im} and industry and occupation tenure; and between ω_{iq} and employer and industry tenure. Kambourov and Manovskii (2005) argue that these correlations are likely to be weak and will tend to bias the estimated returns to zero.

3 Data

This study uses the factually anonymous IAB Employment Sample IABS (Regional File 1975 - 2001). Data access was provided via a Scientific Use File supplied by the Research Data Centre (FDZ) of the German Federal Employment Agency(BA) at the Institute for Employment Research (IAB). The data is a 2 percent random sample of all social security liable workers (SSLW) in Germany between the years 1975 to 2001. The SSLW represent a very large part of the German labor force but they are not quite representative, since e.g. self employed workers and workers in the public sector (Beamte) are not represented. The data is in panel form that allows me to construct the entire career history of a worker during the sample period.

I limit my analysis to fulltime workers who had their first employment spell in West Germany[1]. For workers who are of age 16 or younger (or not yet born) in 1975, I can use the data to construct precise measures for all tenure and experience variables at any point in time during the sample period. While this is still a very large number of observations, it would restrict my sample to a very young population. The oldest workers would thus be 41 in 2001. This is unfortunate, since an important aspect of this paper is to generate results comparable to the United States, where estimates usually use a population age 20 to 62. In order to deal with this problem, I also generate tenure variables for the older cohorts based on the time I observe them. For example the occupation tenure variable will be correct once a worker switches occupation. Thus I know that for everyone who switched occupation, industry and employer I can precisely measure all tenure variables. For the same reason it is also clear that the tenure variables generated for the entire sample will become more precise for the later years in the sample period. For example, in 1995 there is censoring for all tenure variables higher than 20 years, but this is a very small part in the sample. In my main analysis I use the entire sample, including those observations for which tenure is censored, but only after 1985. Thus tenure is censored at 11 years for the 1985 cohort, 12 years for the 1986 cohort, etc. Figures 1 to 6 document the censoring problem with histograms of the tenure variable of all workers in year 1985 and 1995. In 1985 about 25 percent of workers are recorded as having employer tenure of exactly 11 years and thus are potentially censored. In 1995 only tenure more than 21 years is censored and this is a much smaller fraction of the workforce (about 8 percent).

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[1] For detailed information regarding the data cleaning and definitions such as 'fulltime worker' see the appendix.

Clearly there is a tradeoff between using observations in later periods (and thus having a smaller censoring problem) and having a larger sample. In section 5 I present evidence that the results are very robust to restricting the observations to after 1985 or using other restrictions. The main reasons why my results should not be affected very much by this restriction is that I am focusing on returns to tenure within the first 8 years.

4 Main Results and Interpretation

Table 2 presents estimations of equation (1) using OLS. The first column includes only tenure with the current employer as a tenure variable and is closest to traditional earnings regressions. Note that there is strong wage growth in the first year of staying with an employer (about 4.9 percent) as indicated by the coefficient on the Old Employer Dummy (Job at employer held for more than 1 year). Beyond that employer tenure continues to have a positive effect on wages, although the effect becomes smaller with additional years of tenure (the effect on employer tenure squared is negative). One might be tempted to interpret this a returns to employer specific human capital which is lost in case of a worker leaving an employer. The second column includes tenure in current industry as an explanatory variable. In this specification industry tenure has a moderately strong positive effect on wages (5 years in the same industry would give a return of about 9 percent) and the returns to employer tenure become negative. Including occupation tenure has a similar effect as including industry tenure, although returns to employer tenure remain positive (column 3). Column 4 includes occupation and industry tenure but not employer tenure. Compared to either of these tenure variables alone they both have a smaller effect. Column 5 finally uses all three types of tenure. The main effect of this

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seems that the return on employer tenure becomes negative after the first year, while the returns to occupation and industry tenure are both positive and of very similar magnitude.

Since all of these earnings regressions suffer strong endogeneity problems, I now turn to the IV results. Table 3 estimates the same econometric specifications as Table 2, but all the tenure variables are now instrumented in the way explained in the previous section and the appendix. Since the returns to each tenure component are described by three coefficients (level, squared and cubic terms) this table is not so straightforward to interpret. Table 4 therefore uses the coefficients from the last column of table 2 and 3 to calculate cumulative returns to tenure after 2, 5 and 8 years[2]. First focusing on Germany, Table 4 reveals that going from the OLS to the IV specification lets the returns to occupation become much smaller. For example the returns to staying within the same occupation for 8 years are about 7.7 percent in the OLS, but only 2.1 percent in the IV specification. The returns to industry tenure shrink from 8.5 percent to 3.3 percent. Only the effect on employer tenure remains of similar magnitude, negative 2.6 percent. The decrease in returns to tenure is expected if one believes that particularly good matches between workers and occupation for example lead to longer duration of such matches and higher wages. Since the IV is controlling for this spurious correlation we would expect the effect to decline.

The right part of Table 4 reproduces results from Kambourov and Manovskii (2005). The econometric model, sample restrictions and variable construction closely mirror my own estimations, so the coefficients are directly comparable. First, notice that in the OLS

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[2] Standard errors for these cumulative returns are calculated from the estimated covariance matrix from the regressions, taking the covariance between coefficients into account.

specification the returns to occupation appear much larger for the US than for Germany. This contrast becomes even starker in the IV, where after 8 years the returns are 14 percent for the US but only 1.4 percent in Germany. The returns to tenure are more similar for both countries in the OLS and the IV specification. While for the US the coefficient cannot be distinguished from 0, the much larger sample for Germany allows tight estimation and reveals that the returns to industry tenure are in fact significantly different from the returns to occupation and approximately twice the magnitude with 3.3 percent. Also thanks to the larger sample size the returns to industry tenure in Germany are significantly negative, while indistinguishable from 0 (but also from the result for Germany) for the US.

The fact that returns to employer tenure are so sensitive to the inclusion of occupation and industry tenure is a strong indicator that human capital might rather be occupation and firm specific than employer specific. This would indicate that losing a job with an employer is not bad and might in fact be positive as long as one stays in the same occupation and industry. On the other hand the degree to which the returns to tenure decrease in the IV specification indicates the severity of the endogeneity bias. Regarding the differences between the US and Germany, the main difference appears to be the much larger returns to occupation tenure in the United States. One potential explanation, and in my view a very likely one, is that in the German labor market most occupational skills are acquired during the apprenticeship period very early in workers careers, before they actually become full time workers. Once a worker has finished his or her apprenticeship, human capital accumulation is comparatively slow. In the United States on the other hand much more training happens while being on the job. Thus workers' human capital grows

relatively quickly at the beginning of working in an occupation. This is reflected by the large returns to occupation tenure in the United States. Note that one has to be careful not to interpret the low coefficient in the IV specification for Germany as an indication that human capital is not occupation specific. The IV specification allows one to focus on wage growth that is associated with tenure growth. If occupation specific skills are accumulated during the apprenticeship period, this means that wages don't grow at the beginning of an occupation, because human capital is already at a high level. However a worker who is displaced from an occupation would still lose the human capital acquired during apprenticeship and might be severely hurt. Section 6 will provide more evidence regarding my interpretation of these results, but before that it is necessary to check for the robustness of the sample definition.

5 Sensitivity Analysis

In section 3 I discussed the problems with estimating returns to tenure in the IABS for older age cohorts. There are various ways to deal with these problems, none of which are quite perfect. Fortunately it turns out that in practice the results are very robust to various sample definitions, so that I conclude the censoring problem to be of minor importance. Table 5 shows how changes in the definition of the sample affect the results. The first three columns reproduce the first three columns of Table 4 as a reference point. The next three columns are generated by using only worker who were either 16 or younger in 1975 (the beginning of the sample period) and workers who changed occupation, industry and employer at least once, since for this group I can generate exact (uncensored) tenure measures. The problem with this however is that the sample is not representative anymore. If for example most occupation switches are workers who are

displaced, then I would have a disproportionately larger fraction of displaced workers among the older workers and overall in this sample. Since we know that displaced workers experience large earnings losses, this would likely increase the raw positive correlation between longer tenure (since displaced workers will have shorter tenure) and wages. In fact this seems to be the case and the second three columns of Table 5 show that the OLS estimates for the returns to industry and occupation tenure are slightly higher.

Furthermore if one of the reasons that workers wages grow little with occupation and industry tenure is that most human capital is already acquired during apprenticeship training, then we would expect workers who start in a new occupation and industry to experience faster wage growth, since they are learning skills from zero. If this is true then including more displaced workers in the sample would also increase the observed wage growth with tenure. This is supported by the fact that in the IV specification the coefficients are slightly larger.

The third group of results in table 5 restricts the sample to workers where tenure is not censored since there year of birth is 1959 or later. The advantage of this is that for all the years of births included, I retain the entire sample and there is no selection based on tenure variables. The disadvantage is that I can only look at a relatively young age cohort (18 to 41) in this way. Furthermore by using all observations for the 1959 and after cohorts between 1975 and 2001, the sample has much more younger workers. Compared to the other two sample restrictions, the returns to occupation tenure are similar in the OLS but even smaller in the IV specification for this group. The returns to industry tenure on the other hand are significantly higher, while the returns to employer tenure are quite a

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bit more negative. I will discuss difference across age cohorts in the next section. The last three columns in Table 4 show result from estimating the model only for observations after 1995. From figures 1 to 6 it is easy to see that censoring should be a much smaller problem in 1995 and later than in 1985. If returns to tenure are concave (bigger effects at the beginning), then censoring at the beginning of tenure spells should lead to an underestimation of returns to tenure. Correspondingly the returns to tenure increase when we focus on observations after 1995 where censoring occurs less frequently. One reason not to focus on this sample so much is that the time period here is quite different from the period US studies look at, making it less comparable. In the end none of the restrictions are perfect solutions, but since the effects remain remarkably constant, never changing more than 2 percentage points, looking at different restrictions gives a sufficient idea of what the basic pattern is. Furthermore since in the next part of the paper I look mainly at comparisons of different groups, it is more important that the restrictions are consistent so that the censoring for each group will have a similar impact.

6 Exploring Heterogeneity

Potentially career paths for workers with different educational attainment might be very different. For example if the apprenticeship system is an important factor in explaining the relatively low returns to occupation tenure in Germany, one might expect to get different results when looking at workers who never did an apprenticeship. Table 6 investigates returns to tenure separately for 3 education groups: (1) No vocational training with schooling less than Abitur; (2) Vocational school (Haupt- or Realschule) and vocational training (apprenticeship); (3) College (Hochschulabschluss or Fachhochschulabschluss). I will focus on the IV results: perhaps surprising, it seems that

for workers in the lowest education group of no vocation training and no higher schooling, returns to occupation and industry tenure are further reduced and only about half the size of the vocational training group. Also the negative effect of employer tenure becomes very small (less than 1 percent after 8 years). It appears that for this group rather than accumulating human capital more while being on the job, there is hardly any increase or decrease in human capital when staying with an occupation, industry or an employer. The second education group has a similar pattern to the overall results, which of course is not surprising given that this group constitutes 65 percent of the overall sample. For the group of college graduates returns to occupation tenure are about twice as large as for the vocational training group, 3 percent after 8 years, while returns to industry are only about half as big, 1.7 percent in 8 years.

So far the analysis has focused entirely on men, mainly to enhance comparability of this study with other studies. Table 7 shows results for women and men. The OLS results look very similar for Women and Men, but looking at the IV results it is striking that women have negative returns to tenure to all three tenure variables. This means that women who remain with the same employer and in the same occupation and industry, actually experience declining wages relative to those women who switch between occupation, industry and employer. Note that because total experience and age is controlled for this does not mean that the actual wages are declining; it is only relative to women moving to other jobs. The magnitude of the effect is that a woman who stays in the same occupation for 8 years relative to a woman who switches occupations has about 2.6 percent lower wages. For industry and employer tenure the effect is negative 1.5 percent and negative 3 percent respectively. This is evidence that wages over the career

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path develop quite differently for women than for men. There are various potential explanations for this: perhaps women are in different occupations and industry that have different career paths than the typical male jobs, but within these industries and occupations there are now gender differences. It could also be that because women have a much lower attachment to the labor market, in face of a bad shock, such as displacement, they just leave the labor force, so that women only switch occupations and industries when they receive very good offers. It will be left for future work to more carefully examine these potential channels.

Figures 7 to 9 plot returns to 2 years of tenure for different years. Each dot in each figure thus represents estimates from a separate regression, where the sample is restricted to observations from that specific year. Figure 7 and 8 show OLS results, while Figure 9 shows the results for IV. Since in earlier years IV turns out to be very imprecise I show the latter graph only for the 1991 to 2001 period. Overall I interpret these figures as revealing a remarkable stable relationship between tenure and wages, both in the OLS and in the IV specification. The dip in Industry Tenure in 1997 corresponds to the year with the highest unemployment rate in Germany over the 1990s (and before). A simple interpretation might be that during a period of tight labor markets, there is less (successful) on the job search and thus less inter industry mobility associated with wage growth.

In Figure 10 returns to tenure are depicted for different age cohorts. Figure 11 zooms into the graph by just showing returns to slightly older workers. Figures 12 to 13 present IV results. Since for the younger age cohorts the precision of the IV specification is very bad, the last two graphs concentrate on older workers. I use three year bins for the IV

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graphs (putting 3 years of age together in one regression). The graphs show how returns to tenure change over the lifecycle of a worker. The figure shows that returns to all three categories of tenure become increasingly smaller (in absolute values) as workers age. While for young workers employer tenure is strongly negative and occupation and industry tenure strongly positive in the OLS specification, all these returns become closer to zero as a workers grows older. If one were to take the OLS on face value, the strong negative coefficient on employer tenure joint with a strong positive coefficient for industry and occupation tenure for young workers would imply that workers who switch employers within an occupation and industry experience strong wage growth. Unfortunately in the IV specification this is less clear, although there is some evidence that for younger workers switching employer and industry while staying in the same occupation might be beneficial. This is consistent with Topel and Ward's (1992) work on the career development of young workers, who show that most of the wage growth of young workers happens with job changes. It is also notable from this graph that until the end of workers' career occupation and industry tenure continue to have a positive effect while employer tenure remains slightly negative both in the OLS and IV specification.

7 Conclusion

The analysis in this paper showed that including occupation and industry tenure has large impacts on the estimated returns for employer tenure in earnings regressions. However while the returns to occupation and industry tenure appear to be economically significant in the OLS specification, when instrumenting for the tenure variables the effect becomes much smaller (about 2 to 4 percent) for men and even negative for women. Comparing the results for men with results from the United States shows that

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returns to occupation tenure are much smaller in Germany. I interpret this as evidence for large investments in human capital on the job in the United States, that result in fast accumulation of human capital, while in Germany most skills are acquired prior to entering the labor market as fulltime workers.

The decomposition in different education groups reveals that the group with the least amount of formal schooling and training is hardly affected by employer, occupation or industry switches, indicating that their skills are highly transferable but probably also that there is little growth in these skills. Wages of college graduates on the other hand respond similarly to occupation and industry switches as do workers who went through formal vocational training (an apprenticeship).

The fact that employer tenure consistently has a negative impact on wages requires a more careful discussion. Since a worker who stays with an employer usually remains in the same occupation and industry, the negative coefficient means that relative to a worker who leaves the firm but stays in the same occupation and industry a worker is doing worse, while he is doing better than workers who switch employer and industry or occupation. Employer switches are mainly happening for two reasons: displacement and on the job search for better positions. Workers who are displaced usually experience large drops in earnings, but this is to a large extent driven by the fact that they are reemployed in a different industry or occupation. Workers who leave because they found a job they prefer, are likely to have higher wages after leaving the employer. If the effect of workers who leave because of on the job search is bigger than the effect of those who are displaced but stay in the same industry and occupation, then returns to employer tenure will be negative, as is shown in the data for Germany.

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9 Appendix - Data

In this section I explain the various steps that were performed to clean the data and put it in a usable format. The guiding principle for these steps was to keep the results comparable to studies from the United States.

In the IABS the unit observation is a spell (employment or unemployment). Such a spell can last from a few days up to a maximum of one year for employment spells or several years for unemployment spells. My first restriction is that I only use workers whose first employment is recorded in West Germany (variable ow_kto = 0). Furthermore since there are a cases where two or more employment spells are recorded for the same period of time, I use only one spell, namely the spell with level=0. This amounts to preferring employment spells to unemployment spells, fulltime spells to part time spells and higher wage spells to lower wage spells. This makes sense in so far as a person who has a part time and a full time job would be full time employed from an economists perspective. Similarly a person who has a job and receives unemployment benefits would still count as someone with a job rather than being unemployed. The cases were spells are duplicates for the same employment with different wages are a very small fraction of the sample and the wage differences are very small.

I define a fulltime employment spell as a spell that belongs to the group of social security jobs (Sozialversicherungspflichtige Beschaeftigte, pers_gr = 1) and where the position on the job is described as full time (stib = 1, 2, 3, or 4). For a few full time employment spells generated this way wage (entgelt) is equal to zero. This is largely due to the fact that these spells are secondary reports (ergaenzte Meldungen). Since this is only due to the reporting mechanism, I assign these spells (fulltime spells with btyp > 1

and btyp <= 7) the wage from the previous spell. The remaining fulltime spells with 0 wage are negligible. I transform wages from spells after 1998 from Euro to DM by multiplying them with 1.95583 and use a consumer price index to generate real wages in prices of 2000.

In order to generate tenure variables, I identify occupation, industry and employer switches for fulltime spells by looking at whether the occupation, industry or employer variable changed from the previous fulltime spell. This means that a person who works in an occupation, becomes unemployed and resumes another fulltime job in the same occupation would not be counted as a occupation switcher, while a person who moves to another fulltime occupation and then back to the first occupation would have 2 occupation switches. Similarly for industry and employer switches.

Since we are interested in obtaining representative estimates for the population of workers rather than for the universe of spells, the data is transformed into a format such that for each worker there is one observation per year. For this I pick for each worker in each year the spell that starts before and ends after September 1st. The worker is then assigned the employment status and, if employed, all job characteristics (occupation, industry, wage etc.) of this spell. Occupation tenure for an observation is calculated by summing up the duration of all fulltime employment spells since the last occupation switch (according to the above definition). Industry and employer tenure are constructed in the same manner.

The instrument for occupation tenure is defined as deviations from mean occupation tenure for an occupation worker match:

$$OccTen\_Instrument_{iqt} = OccTen_{iqt} - \frac{1}{T_{iq}} \sum_{t=1}^{T_{iq}} OccTen_{iq}$$

where T_{iq} is the number of (yearly) observations for a worker occupation match. The instruments for the squared and cubic terms are defined as:

$$OccTen^2\_Instrument_{iqt} = OccTen^2{}_{iqt} - \frac{1}{T_{iq}}\sum_{t=1}^{T_{iq}} OccTen^2{}_{iq}$$

$$OccTen^3\_Instrument_{iqt} = OccTen^3{}_{iqt} - \frac{1}{T_{iq}}\sum_{t=1}^{T_{iq}} OccTen^3{}_{iq}$$

For industry and employer tenure and the OldEmployer dummy, the instruments are defined in the same way.

Table 1: Summary Statistics - Means of Variables for different subpopulations

	Men	Women	Male, Age>18, & Year >= 1985	Male, Reliable & Age > 18	Male, Age > 18 & Birthyear >= 1959
Real Wage	164	120	176	161	155
Log of Real Wage	5.04	4.69	5.11	5.01	4.97
Tenure in current Occupation	6.22	5.30	7.82	4.82	4.14
Tenure in current Industry	6.81	5.52	8.61	5.19	4.48
Tenure with current Employer	5.69	4.66	7.05	4.31	3.65
No formal vocational training	.184	.238	0.162	0.181	0.159
Vocational school and vocational training	.648	.619	0.644	0.624	0.635
Abitur; no vocational training	.00557	.00744	0.00645	0.00674	0.00867
Abitur and vocational training	.0195	.0308	0.0256	0.0274	0.0353
College - FH	.0338	.0126	0.0395	0.0343	0.0337
College - Uni	.0394	.0219	0.0495	0.0425	0.0450
Number of Observations	5,757,365	3,055,856	3,577,275	2,765,464	1,502,928

Only fulltime workers

Workers are defined as reliable (in terms of their tenure variables) if they are born after 1959 or had at least one occupation, employer and industry switch.

Table was generated on 21 Mar 2007 at 18:43:25

Table 2: Effect of Tenure on Wages - OLS

	(1)	(2)	(3)	(4)	(5)
	Log of Real Wage	Log of Real Wage	Log of Real Wage	Log of Real Wage	Log of Real Wage
Tenure with current Employer	0.00573***	-0.00313***	0.00111***		-0.00477***
	(0.000184)	(0.000230)	(0.000200)		(0.000234)
Employer Ten^2 x 100	-0.0160***	0.0111***	0.000309		0.0171***
	(0.000849)	(0.00105)	(0.000908)		(0.00106)
Tenure in current Occupation			0.0170***	0.0120***	0.0127***
			(0.000322)	(0.000353)	(0.000356)
Occupation Ten^2 x 100			-0.113***	-0.0906***	-0.0922***
			(0.00318)	(0.00354)	(0.00355)
Occupation Ten^3 x 100			0.00236***	0.00205***	0.00203***
			(0.0000875)	(0.0000975)	(0.0000975)
Tenure in current Industry		0.0192***		0.0119***	0.0133***
		(0.000372)		(0.000395)	(0.000410)
Industry Ten^2 x 100		-0.0916***		-0.0472***	-0.0449***
		(0.00353)		(0.00391)	(0.00394)
Industry Ten^3 x 100		0.00142***		0.000631***	0.000332**
		(0.0000953)		(0.000106)	(0.000106)
Job at employer held for more than 1 year	0.0393***	0.0338***	0.0320***	0.0220***	0.0311***
	(0.000539)	(0.000547)	(0.000538)	(0.000566)	(0.000546)
Total Experience	0.0445***	0.0370***	0.0368***	0.0343***	0.0340***
	(0.000315)	(0.000382)	(0.000362)	(0.000393)	(0.000393)
Total Experience^2	-0.00186***	-0.00150***	-0.00135***	-0.00134***	-0.00132***
	(0.0000274)	(0.0000347)	(0.0000320)	(0.0000355)	(0.0000355)
Total Experience^3 x 100	0.00371***	0.00307***	0.00258***	0.00273***	0.00267***
	(0.0000702)	(0.0000911)	(0.0000831)	(0.0000933)	(0.0000934)
Age	0.0144***	0.0151***	0.0150***	0.0154***	0.0154***
	(0.000270)	(0.000270)	(0.000270)	(0.000270)	(0.000270)
Age squared	-0.000198***	-0.000206***	-0.000206***	-0.000211***	-0.000210***
	(0.00000334)	(0.00000334)	(0.00000335)	(0.00000335)	(0.00000335)
German Nationality	0.0194***	0.0199***	0.0190***	0.0197***	0.0196***
	(0.00124)	(0.00124)	(0.00124)	(0.00124)	(0.00124)
Nationality Missing	-0.0102	-0.0144*	-0.0119*	-0.0131*	-0.0150*
	(0.00598)	(0.00594)	(0.00595)	(0.00593)	(0.00592)
No formal vocational training	-0.0391***	-0.0403***	-0.0396***	-0.0413***	-0.0405***
	(0.00184)	(0.00184)	(0.00184)	(0.00184)	(0.00184)
Vocational school and vocational training	0.124***	0.122***	0.122***	0.120***	0.121***
	(0.00174)	(0.00174)	(0.00174)	(0.00174)	(0.00174)
Abitur; no vocational training	0.194***	0.191***	0.191***	0.189***	0.189***
	(0.00542)	(0.00540)	(0.00540)	(0.00540)	(0.00539)
Abitur and vocational training	0.290***	0.286***	0.286***	0.284***	0.284***
	(0.00256)	(0.00256)	(0.00256)	(0.00256)	(0.00256)
College - FH	0.447***	0.442***	0.442***	0.440***	0.440***
	(0.00235)	(0.00234)	(0.00235)	(0.00235)	(0.00234)
College - Uni	0.553***	0.547***	0.548***	0.545***	0.544***
	(0.00230)	(0.00230)	(0.00230)	(0.00230)	(0.00230)
Constant	4.257***	4.244***	4.247***	4.239***	4.239***
	(0.00792)	(0.00791)	(0.00792)	(0.00791)	(0.00791)
YearFE	1	1	1	1	1
RegionFE	1	1	1	1	1
IndustryFE	1	1	1	1	1
OccupationFE	1	1	1	1	1
r2	.3893285	.3917456	.3906988	.3921284	.3922831
N	5.46e+06	5.46e+06	5.46e+06	5.46e+06	5.46e+06

Significance Levels: * p<.05; ** p<.01; *** p<.001
Sample restricted to: fulltime & age > 18 & year >= 1985
100 percent of data used
Table was generated on 22 Mar 2007 at 05:17:30

Table 3: Effect of Tenure on Wages - IV

	(1)	(2)	(3)	(4)	(5)
	Log of Real Wage	Log of Real Wage	Log of Real Wage	Log of Real Wage	Log of Real Wage
Tenure with current Employer	-0.00222***	-0.00493***	-0.00250***		-0.00483***
	(0.000132)	(0.000166)	(0.000145)		(0.000169)
Employer Ten^2 x 100	0.0144***	0.0185***	0.0139***		0.0179***
	(0.000578)	(0.000724)	(0.000630)		(0.000737)
Tenure in current Occupation			-0.00536***	-0.00414***	-0.00322***
			(0.000287)	(0.000313)	(0.000314)
Occupation Ten^2 x 100			0.0652***	0.0369***	0.0330***
			(0.00274)	(0.00303)	(0.00304)
Occupation Ten^3 x 100			-0.00177***	-0.000873***	-0.000843***
			(0.0000748)	(0.0000828)	(0.0000829)
Tenure in current Industry		-0.00454***		-0.00523***	-0.00298***
		(0.000321)		(0.000341)	(0.000351)
Industry Ten^2 x 100		0.0886***		0.0777***	0.0726***
		(0.00296)		(0.00326)	(0.00328)
Industry Ten^3 x 100		-0.00259***		-0.00205***	-0.00218***
		(0.0000794)		(0.0000879)	(0.0000881)
Job at employer held for more than 1 year	0.00593***	0.0122***	0.00952***	0.00742***	0.0129***
	(0.000613)	(0.000638)	(0.000629)	(0.000607)	(0.000641)
Total Experience	0.0528***	0.0565***	0.0559***	0.0577***	0.0574***
	(0.000251)	(0.000319)	(0.000302)	(0.000332)	(0.000332)
Total Experience^2	-0.00247***	-0.00299***	-0.00280***	-0.00310***	-0.00307***
	(0.0000214)	(0.0000279)	(0.0000261)	(0.0000290)	(0.0000290)
Total Experience^3 x 100	0.00458***	0.00601***	0.00542***	0.00626***	0.00618***
	(0.0000550)	(0.0000724)	(0.0000672)	(0.0000752)	(0.0000752)
Age	0.0166***	0.0169***	0.0167***	0.0170***	0.0169***
	(0.000136)	(0.000136)	(0.000136)	(0.000136)	(0.000136)
Age squared	-0.000207***	-0.000211***	-0.000208***	-0.000212***	-0.000211***
	(0.00000163)	(0.00000164)	(0.00000164)	(0.00000164)	(0.00000164)
German Nationality	0.0214***	0.0214***	0.0212***	0.0215***	0.0214***
	(0.000547)	(0.000547)	(0.000547)	(0.000547)	(0.000547)
Nationality Missing	-0.0262***	-0.0288***	-0.0269***	-0.0267***	-0.0289***
	(0.00308)	(0.00308)	(0.00308)	(0.00308)	(0.00308)
No formal vocational training	-0.0286***	-0.0288***	-0.0283***	-0.0296***	-0.0287***
	(0.000679)	(0.000679)	(0.000679)	(0.000678)	(0.000679)
Vocational school and vocational training	0.137***	0.137***	0.137***	0.137***	0.137***
	(0.000608)	(0.000608)	(0.000609)	(0.000608)	(0.000608)
Abitur; no vocational training	0.202***	0.201***	0.202***	0.200***	0.201***
	(0.00185)	(0.00185)	(0.00185)	(0.00185)	(0.00185)
Abitur and vocational training	0.296***	0.295***	0.296***	0.296***	0.295***
	(0.00102)	(0.00102)	(0.00102)	(0.00102)	(0.00102)
College - FH	0.454***	0.453***	0.453***	0.453***	0.453***
	(0.00105)	(0.00105)	(0.00105)	(0.00105)	(0.00105)
College - Uni	0.555***	0.553***	0.554***	0.554***	0.553***
	(0.000945)	(0.000946)	(0.000948)	(0.000948)	(0.000948)
Constant	4.213***	4.207***	4.212***	4.207***	4.208***
	(0.00350)	(0.00350)	(0.00351)	(0.00351)	(0.00351)
YearFE	1	1	1	1	1
RegionFE	1	1	1	1	1
IndustryFE	1	1	1	1	1
OccupationFE	1	1	1	1	1
r2	.3855429	.3865443	.3854015	.386322	.386405
N	5.46e+06	5.46e+06	5.46e+06	5.46e+06	5.46e+06

Significance Levels: * p<.05; ** p<.01; *** p<.001
Sample restricted to: fulltime & age > 18 & year >= 1985
100 percent of data used
Altonji Shakotko Instrumental Variables
Table was generated on 22 Mar 2007 at 05:18:06

Table 4: Returns to Tenure

	Germany			United States		
Panel A: OLS						
	2 years	*5 years*	*8 years*	*2 years*	*5 years*	*8 years*
Occupation	0.02953	0.05986	0.07678	0.0750	0.1666	0.2321
SE	*0.00056*	*0.00104*	*0.00123*	*0.0078*	*0.0172*	*0.0237*
Industry	0.02751	0.06045	0.08468	0.0279	0.0695	0.1098
SE	*0.00067*	*0.00128*	*0.00156*	*0.0080*	*0.0169*	*0.0228*
Employer	-0.00878	-0.01943	-0.02707	0.0012	-0.0083	-0.0151
SE	*0.00040*	*0.00088*	*0.00121*	*0.0012*	*0.0145*	*0.0164*
Panel B: IV						
	2 years	*5 years*	*8 years*	*2 years*	*5 years*	*8 years*
Occupation	0.00435	0.01221	0.02089	0.0496	0.1069	0.1418
SE	*0.00050*	*0.00092*	*0.00106*	*0.0065*	*0.0145*	*0.0204*
Industry	0.00541	0.01774	0.03319	0.0045	0.0132	0.0204
SE	*0.00057*	*0.00106*	*0.00125*	*0.0067*	*0.0141*	*0.0191*
Employer	-0.00844	-0.01859	-0.02575	-0.0003	0.0023	0.0060
SE	*0.00030*	*0.00065*	*0.00089*	*0.0093*	*0.0124*	*0.0163*

The estimates for Germany are own calculations where the sample is restricted to fulltime male workers older than 18 and from 1985 onwards. The United States estimates are taken from Kambourov and Manovskii (2005), Table 2 (the two digit Panel). The data for this is from the PSID from the 1981 - 1992 period for workers aged 18 to 64.
100 percent of data used
Table was generated on 17 Mar 2007 at 19:37:48

Table 5: Returns to Tenure - Different Sample Restrictions

	men & fulltime & age > 18 & year >=1985			men & fulltime & uncensored & age > 18			men & fulltime & age > 18 & birthyear >= 1959			men & fulltime & age > 18 & year >=1995		
Panel A: OLS												
	2 years	*5 years*	*8 years*	*2 years*	*5 years*	*8 years*	*2 years*	*5 years*	*8 years*	*2 years*	*5 years*	*8 years*
Occupation	0.02953	0.05986	0.07678	0.03358	0.06517	0.07948	0.03393	0.06010	0.06465	0.03673	0.07428	0.09491
SE	*0.00056*	*0.00104*	*0.00123*	*0.00070*	*0.00124*	*0.00147*	*0.00105*	*0.00180*	*0.00210*	0.00094	0.00176	0.00207
Industry	0.02751	0.06045	0.08468	0.02815	0.06149	0.08503	0.03474	0.07624	0.10632	0.02815	0.06146	0.08558
SE	*0.00067*	*0.00128*	*0.00156*	*0.00081*	*0.00151*	*0.00186*	*0.00121*	*0.00214*	*0.00256*	0.00106	0.00200	0.00242
Employer	-0.00878	-0.01943	-0.02707	-0.01462	-0.03204	-0.04403	-0.02282	-0.04976	-0.06796	-0.00975	-0.02181	-0.03077
SE	*0.00040*	*0.00088*	*0.00121*	*0.00061*	*0.00130*	*0.00175*	*0.00088*	*0.00182*	*0.00238*	0.00060	0.00132	0.00181
Panel B: IV												
	2 years	*5 years*	*8 years*	*2 years*	*5 years*	*8 years*	*2 years*	*5 years*	*8 years*	*2 years*	*5 years*	*8 years*
Occupation	0.00435	0.01221	0.02089	0.00383	0.00945	0.01438	-0.00261	-0.00433	-0.00450	0.01377	0.03162	0.04618
SE	*0.00050*	*0.00092*	*0.00106*	*0.00070*	*0.00125*	*0.00143*	*0.00112*	*0.00194*	*0.00218*	0.00073	0.00135	0.00156
Industry	0.00541	0.01774	0.03319	0.00761	0.02036	0.03301	-0.00136	0.00610	0.01936	0.00796	0.02391	0.04272
SE	*0.00057*	*0.00106*	*0.00125*	*0.00077*	*0.00142*	*0.00168*	*0.00124*	*0.00221*	*0.00254*	0.00080	0.00149	0.00175
Employer	-0.00844	-0.01859	-0.02575	-0.01799	-0.03969	-0.05504	-0.03043	-0.06680	-0.09205	-0.00641	-0.01427	-0.02003
SE	*0.00030*	*0.00065*	*0.00089*	*0.00052*	*0.00111*	*0.00149*	*0.00080*	*0.00168*	*0.00220*	0.00041	0.00091	0.00125

100 percent of data used
Table was generated on 17 Mar 2007 at 19:37:48

Table 6: Returns to Tenure - Different Education Groups

	No Vocational Training			Vocational School and Vocational Training			College (Uni or FH)		
Panel A: OLS									
	2 years	*5 years*	*8 years*	*2 years*	*5 years*	*8 years*	*2 years*	*5 years*	*8 years*
Occupation	0.02742	0.05485	0.06921	0.02665	0.05468	0.07106	0.02292	0.04369	0.05205
SE	*0.00129*	*0.00236*	*0.00275*	*0.00066*	*0.00123*	*0.00146*	*0.00138*	*0.00256*	*0.00302*
Industry	0.02526	0.05561	0.07778	0.02771	0.06061	0.08464	0.01759	0.03629	0.04719
SE	*0.00163*	*0.00310*	*0.00378*	*0.00079*	*0.00151*	*0.00184*	*0.00153*	*0.00286*	*0.00340*
Employer	-0.00151	-0.00297	-0.00349	-0.00748	-0.01670	-0.02351	-0.01213	-0.02669	-0.03687
SE	*0.00099*	*0.00214*	*0.00292*	*0.00048*	*0.00104*	*0.00143*	*0.00083*	*0.00180*	*0.00246*
Panel B: IV									
	2 years	*5 years*	*8 years*	*2 years*	*5 years*	*8 years*	*2 years*	*5 years*	*8 years*
Occupation	0.00032	0.00415	0.01057	0.00474	0.01284	0.02140	0.01296	0.02560	0.03193
SE	*0.00124*	*0.00228*	*0.00261*	*0.00058*	*0.00107*	*0.00124*	*0.00133*	*0.00243*	*0.00281*
Industry	-0.00016	0.00507	0.01463	0.00575	0.01826	0.03367	0.00515	0.01203	0.01769
SE	*0.00147*	*0.00277*	*0.00329*	*0.00066*	*0.00125*	*0.00147*	*0.00148*	*0.00274*	*0.00321*
Employer	-0.00329	-0.00673	-0.00839	-0.00842	-0.01863	-0.02594	-0.00935	-0.02044	-0.02801
SE	*0.00077*	*0.00167*	*0.00228*	*0.00035*	*0.00075*	*0.00103*	*0.00080*	*0.00173*	*0.00235*

100 percent of data used

Sample is restricted to male fulltime workers after 1985

Table was generated on 17 Mar 2007 at 19:37:48

Table 7: Returns to Tenure - Comparing Gender

	Men			Women		
Panel A: OLS						
	2 years	*5 years*	*8 years*	*2 years*	*5 years*	*8 years*
Occupation	0.02953	0.05986	0.07678	0.03168	0.06269	0.07793
SE	*0.00056*	*0.00104*	*0.00123*	*0.00129*	*0.00238*	*0.00286*
Industry	0.02751	0.06045	0.08468	0.02709	0.06140	0.08785
SE	*0.00067*	*0.00128*	*0.00156*	*0.00143*	*0.00267*	*0.00326*
Employer	-0.00878	-0.01943	-0.02707	-0.00995	-0.02215	-0.03105
SE	*0.00040*	*0.00088*	*0.00121*	*0.00093*	*0.00201*	*0.00275*
Panel B: IV						
	2 years	*5 years*	*8 years*	*2 years*	*5 years*	*8 years*
Occupation	0.00435	0.01221	0.02089	-0.01395	-0.02448	-0.02572
SE	*0.00050*	*0.00092*	*0.00106*	*0.00113*	*0.00206*	*0.00235*
Industry	0.00541	0.01774	0.03319	-0.01717	-0.02417	-0.01539
SE	*0.00057*	*0.00106*	*0.00125*	*0.00124*	*0.00228*	*0.00267*
Employer	-0.00844	-0.01859	-0.02575	-0.00993	-0.02207	-0.03089
SE	*0.00030*	*0.00065*	*0.00089*	*0.00066*	*0.00143*	*0.00194*

The sample is restricted to fulltime workers older than 18 and from 1985 onwards.
100 percent of data used
Table was generated on 17 Mar 2007 at 19:37:48

Figure 1: Histogram Employer Tenure – Year: 1985

Percent

Tenure with current Employer
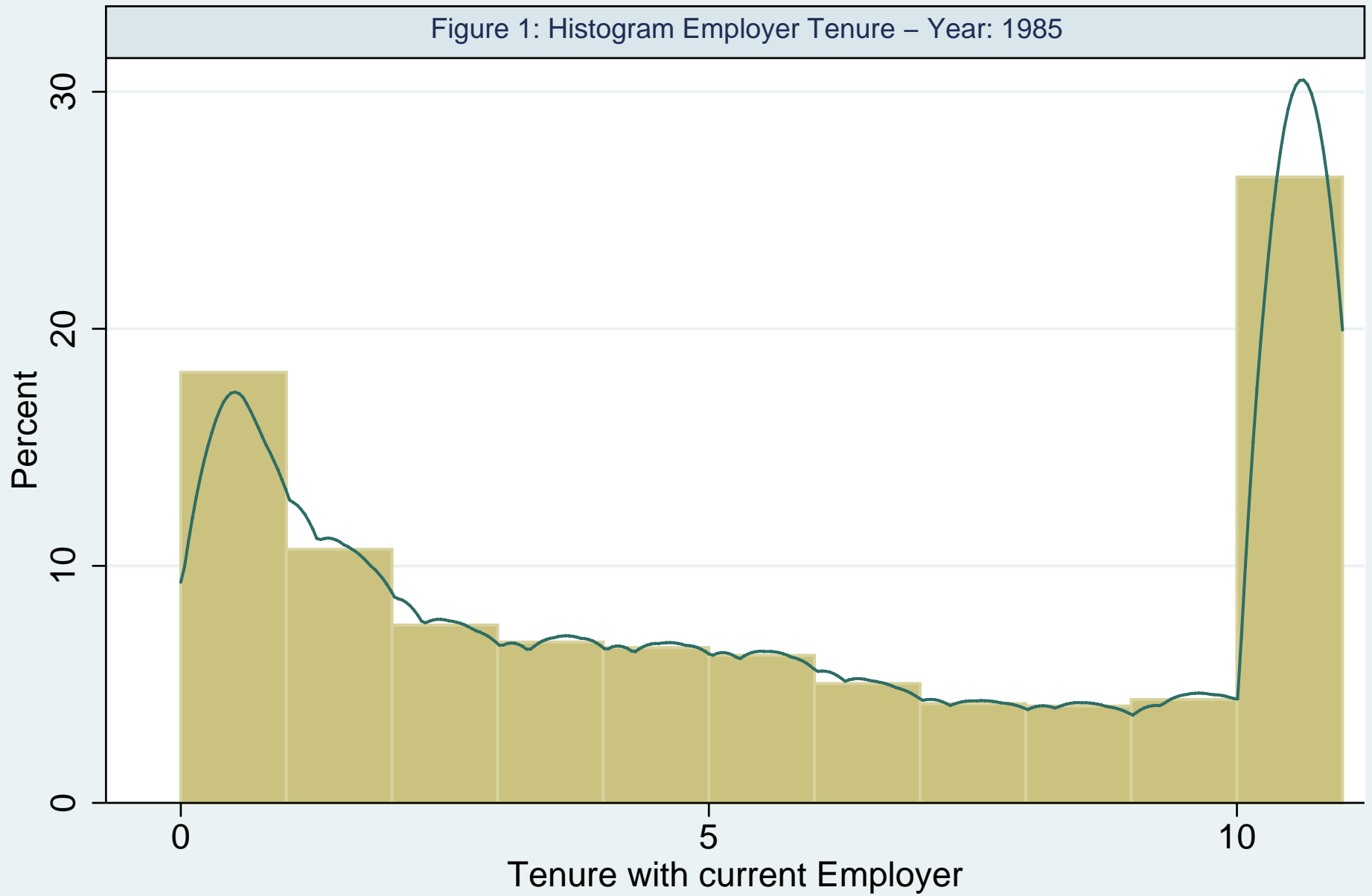
Figure was generated on 22 Mar 2007 at 12:43:51

Figure 2: Histogram Employer Tenure – Year: 1995
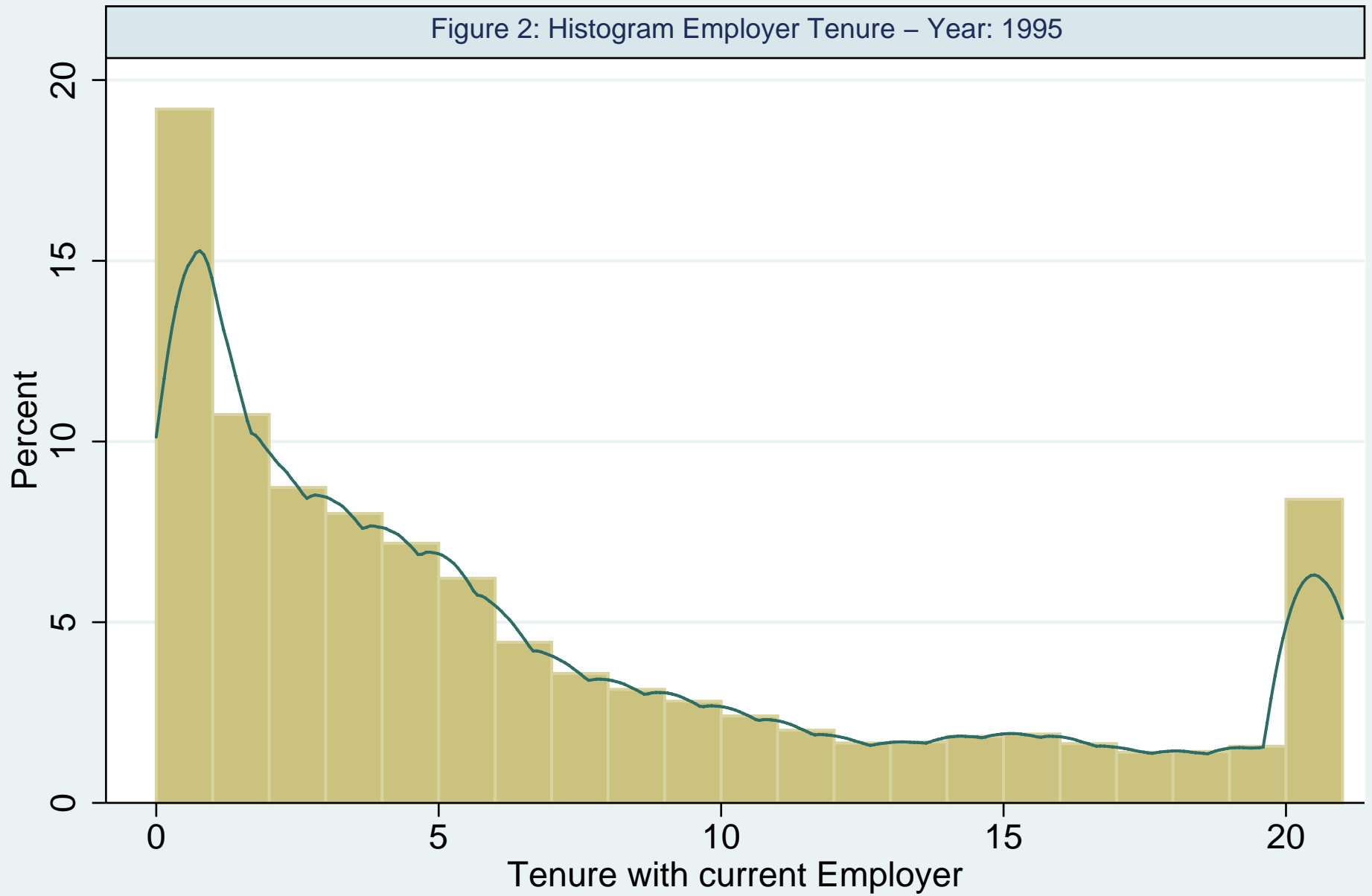
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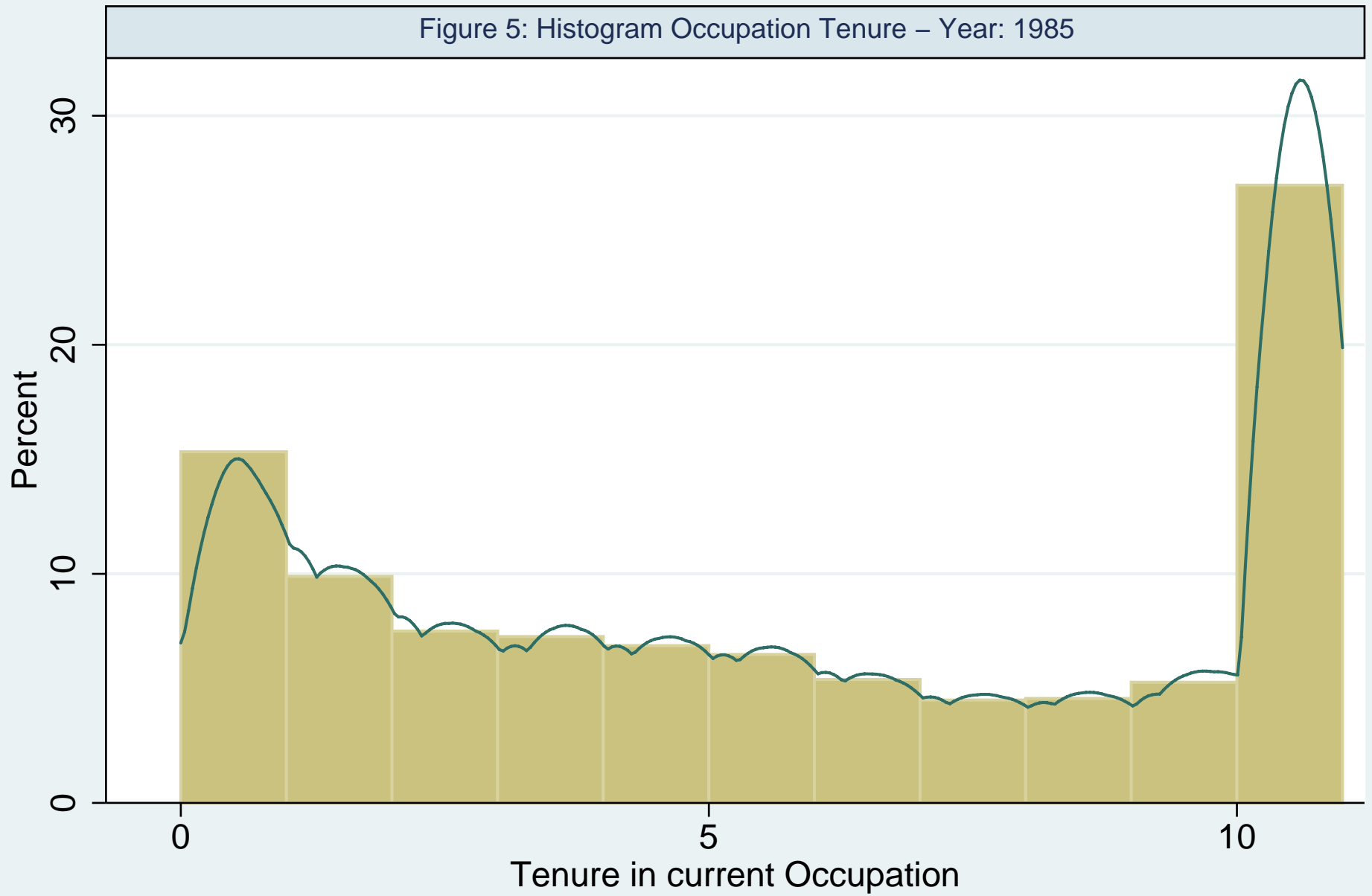
Figure 3: Histogram Industry Tenure – Year: 1985
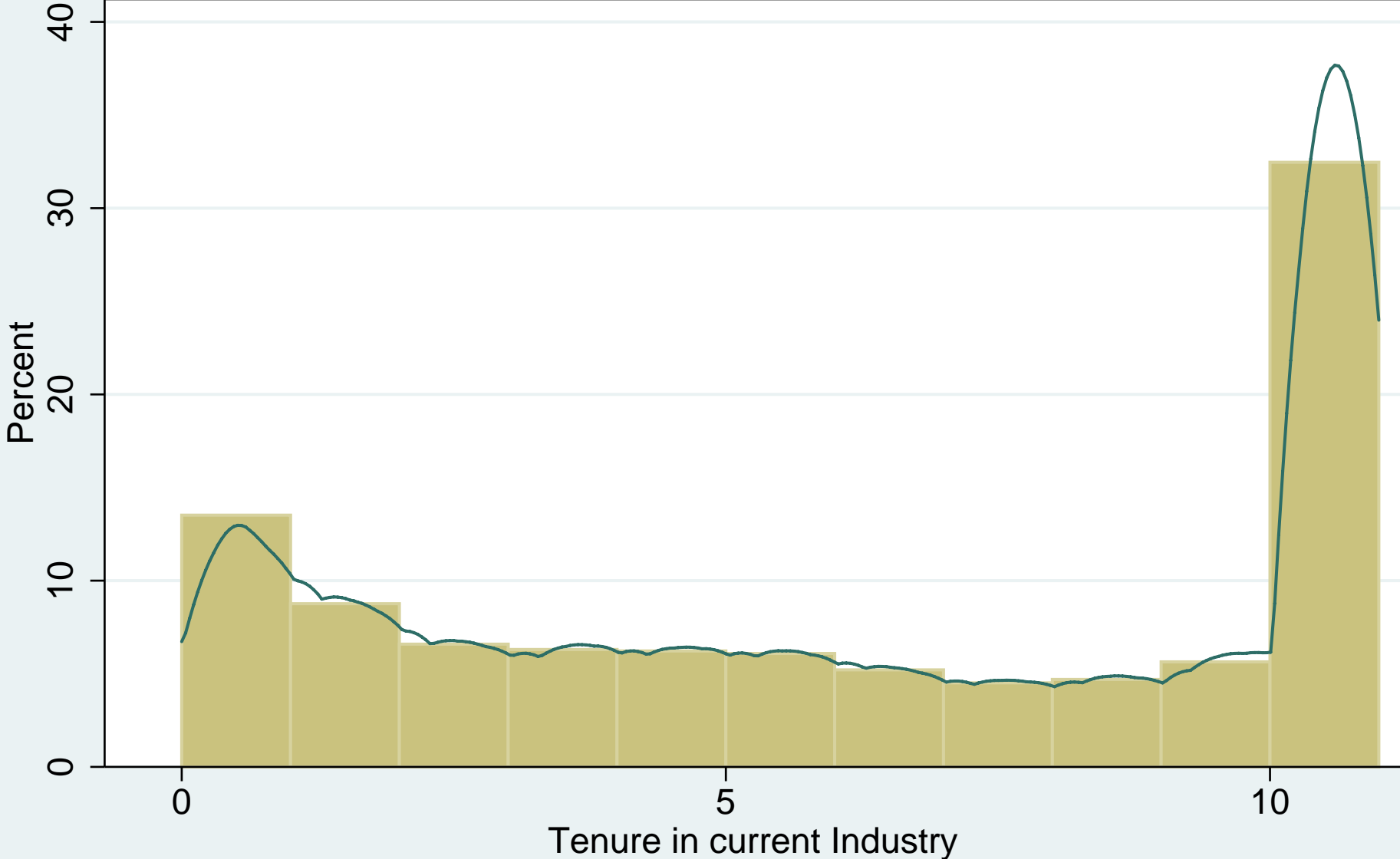
Figure was generated on 22 Mar 2007 at 12:43:32
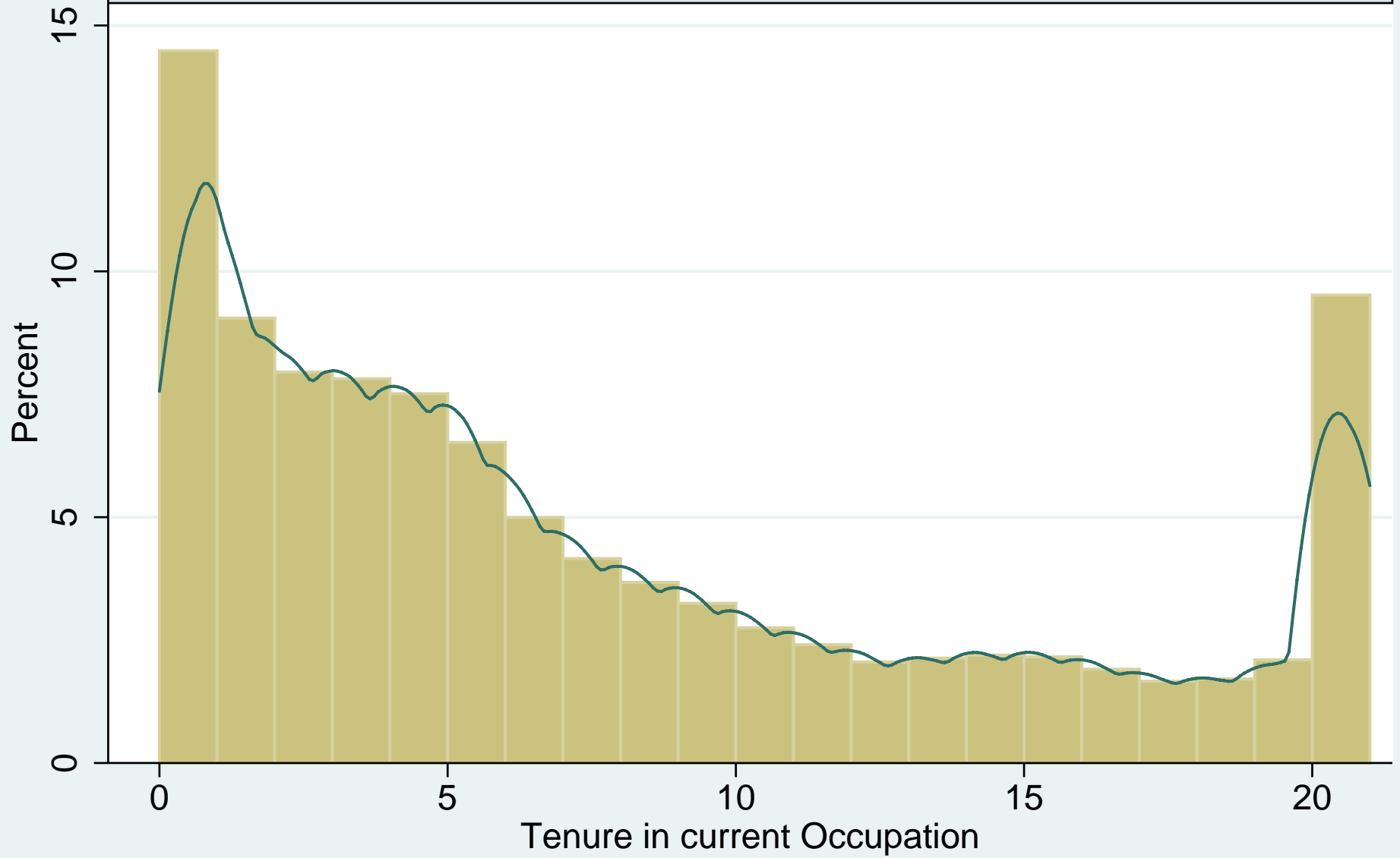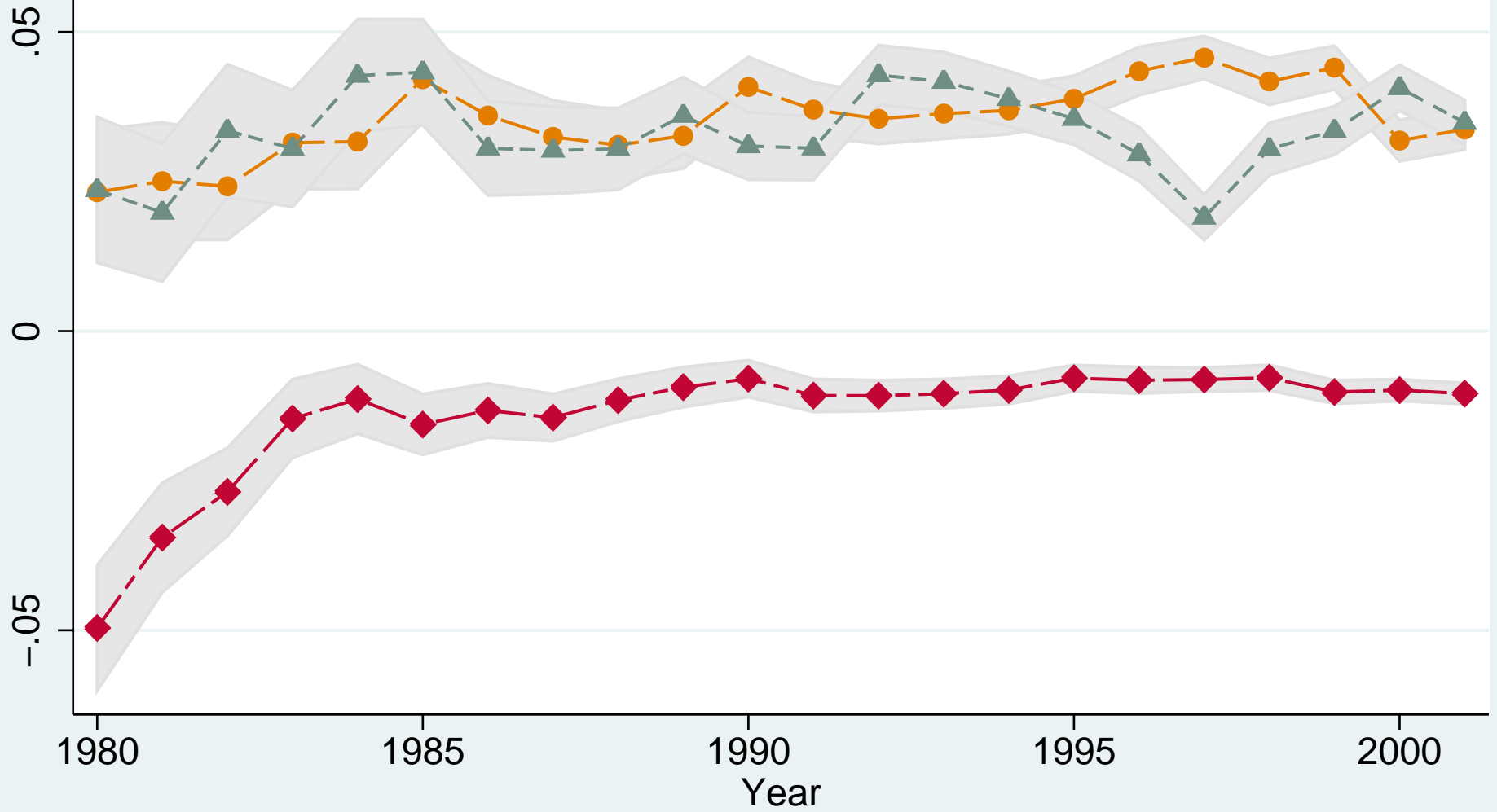
Figure 4: Histogram Industry Tenure – Year: 1995
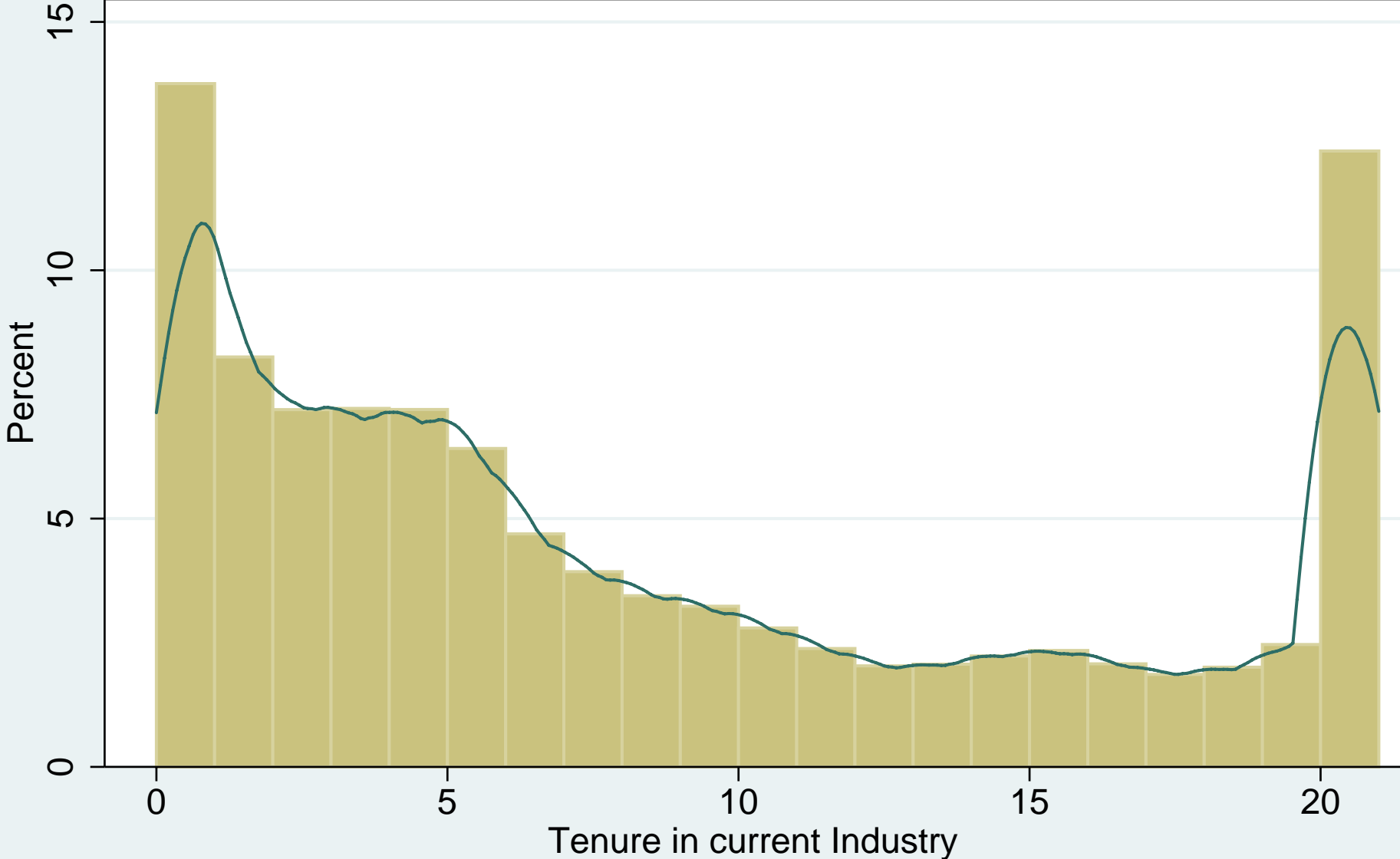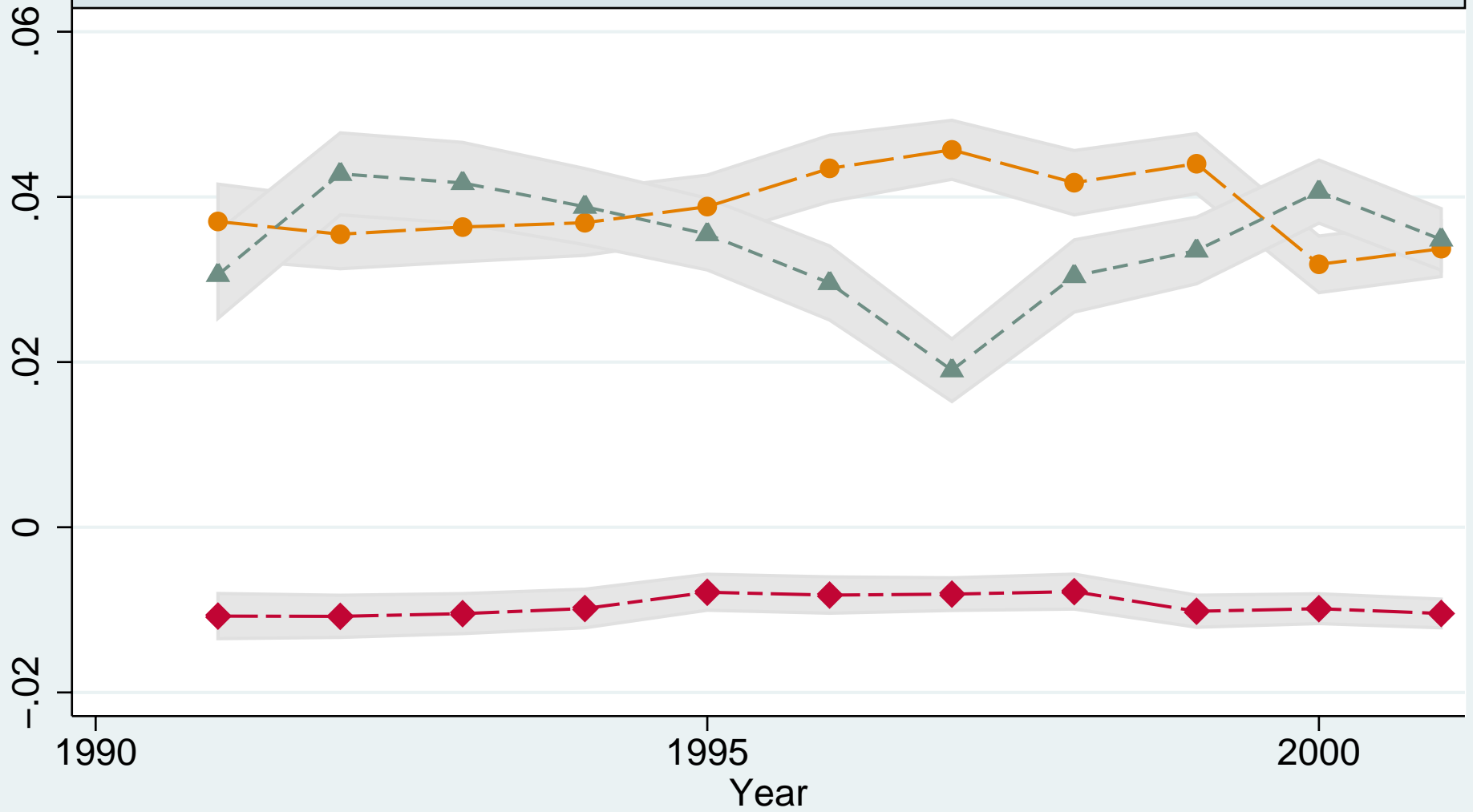
Figure was generated on 22 Mar 2007 at 12:44:37

Figure 5: Histogram Occupation Tenure – Year: 1985

Percent

Tenure in current Occupation

Figure was generated on 22 Mar 2007 at 12:42:48

Figure 6: Histogram Occupation Tenure – Year: 1995

Figure was generated on 22 Mar 2007 at 12:44:16

Figure 7: Returns to tenure over time – OLS

Occupation Tenure
Industry Tenure
Employer Tenure

The figure plots estimated returns to 2 years of tenure on log of real daily wage
Sample restricted to: fulltime & male & age <= 62 & age >= 18
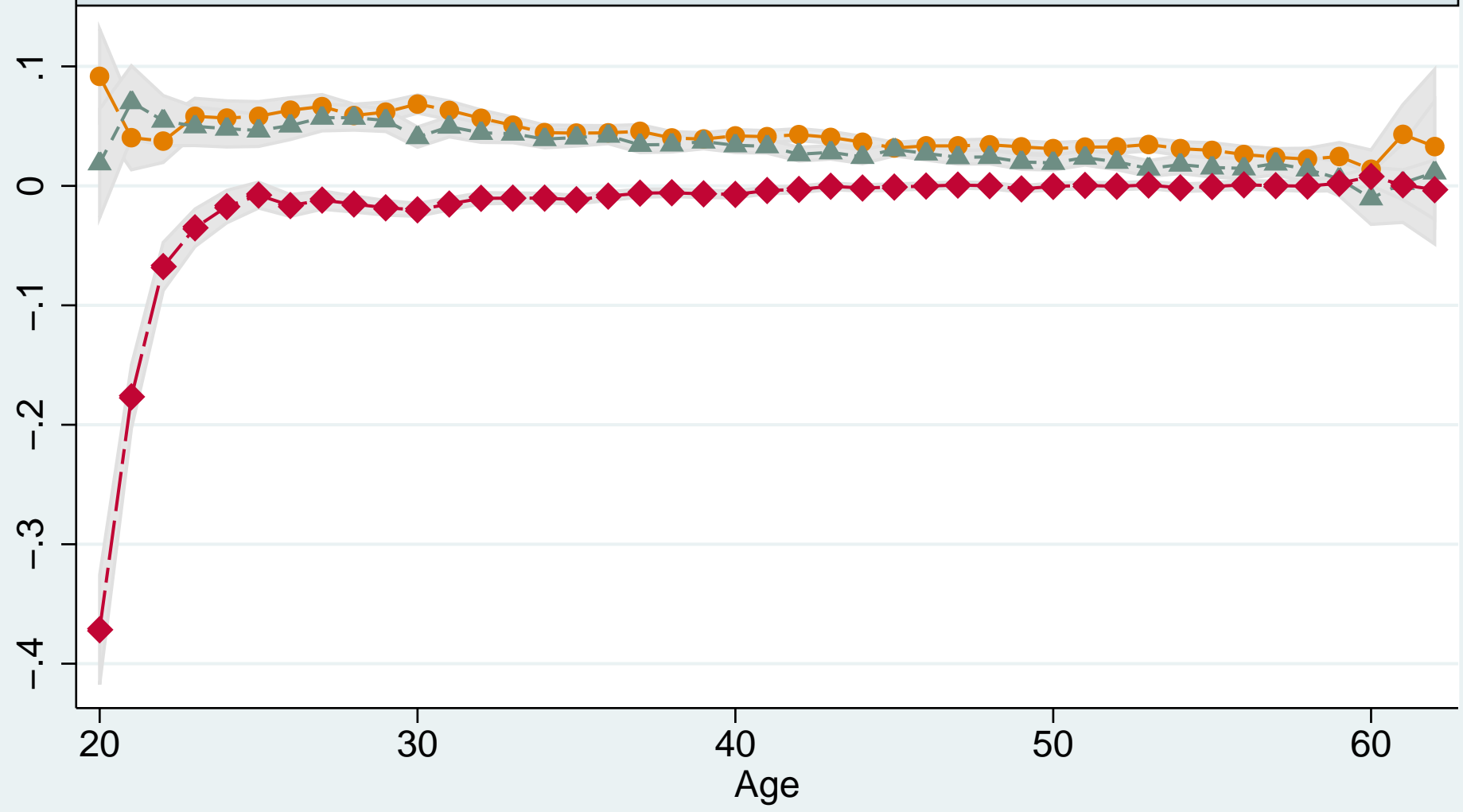100 percent of data used
Figure was generated on 22 Mar 2007 at 12:52:01

Figure 8: Returns to tenure over time – OLS

Occupation Tenure
Industry Tenure
Employer Tenure

The figure plots estimated returns to 2 years of tenure on log of real daily wage
Sample restricted to: fulltime & male & age <= 62 & age >= 18
100 percent of data used
Figure was generated on 22 Mar 2007 at 14:40:59

Figure 9: Returns to tenure over time – IV
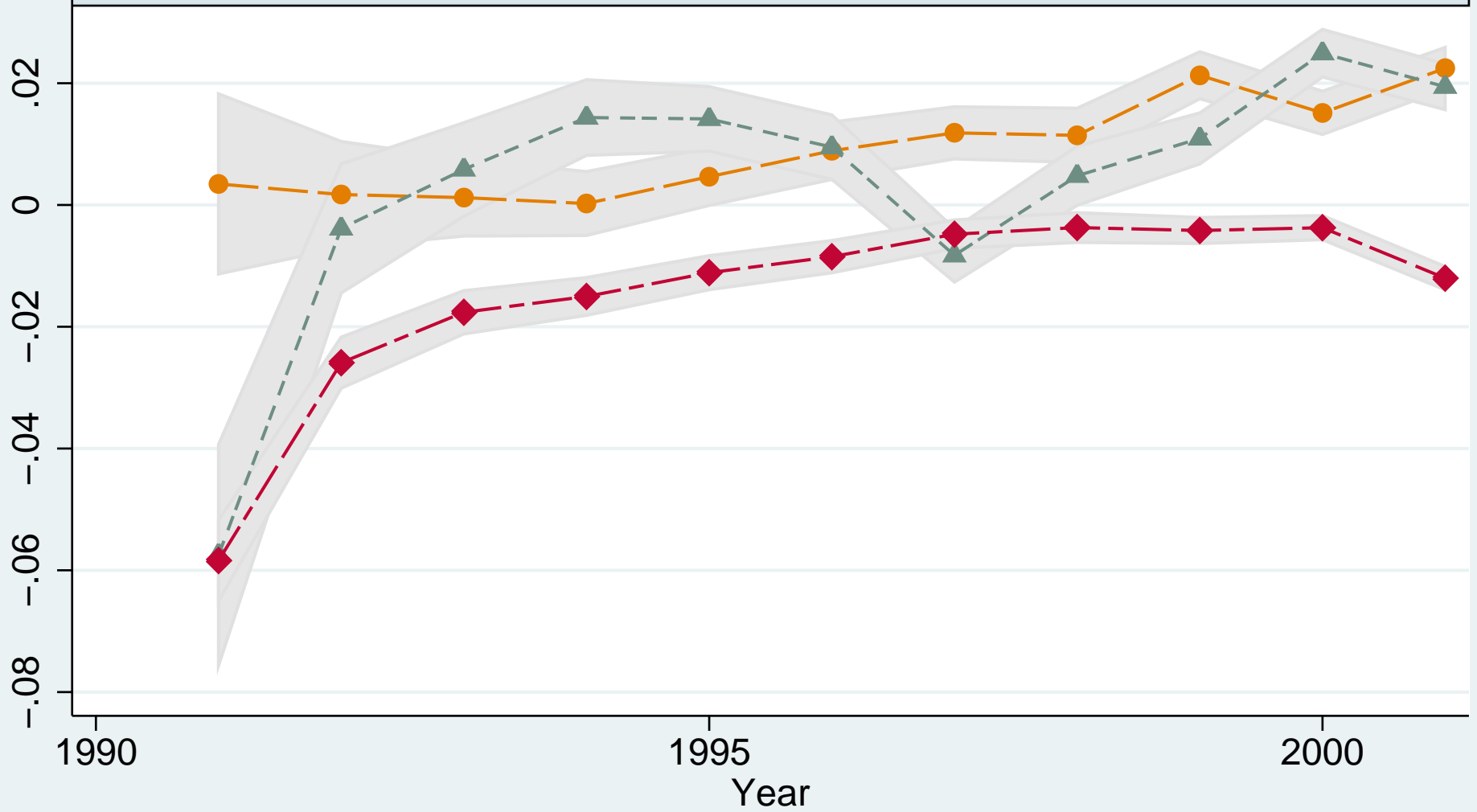
Occupation Tenure
Industry Tenure
Employer Tenure

The figure plots estimated returns to 2 years of tenure on log of real daily wage
Sample restricted to: fulltime & male & age <= 62 & age >= 18
100 percent of data used
Figure was generated on 22 Mar 2007 at 14:44:44

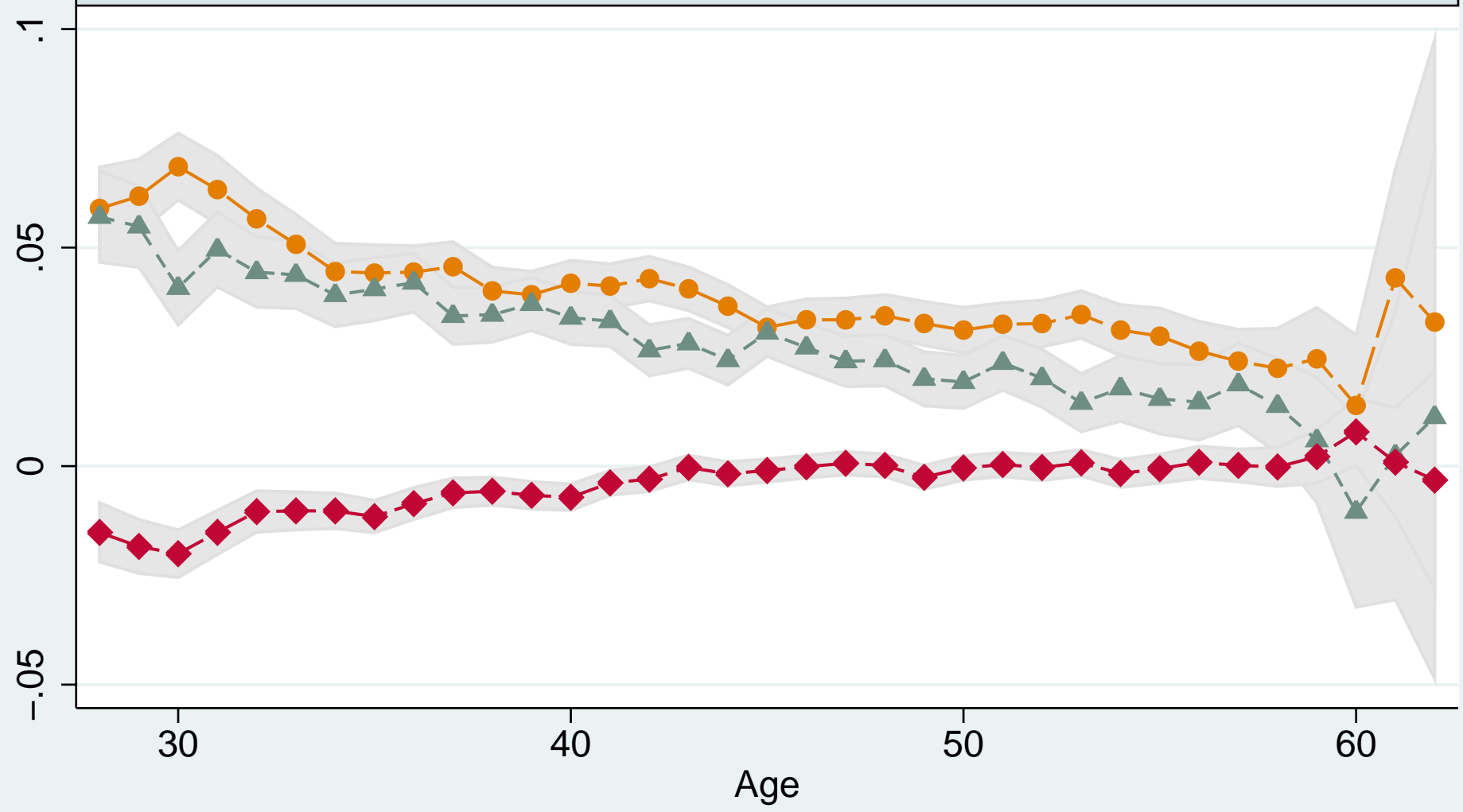Figure 10: Returns to tenure at different years of age – OLS

Occupation Tenure
Industry Tenure
Employer Tenure

The figure plots estimated returns to 2 years of tenure on log of real daily wage
Sample restricted to: fulltime & male & year >= 1985
100 percent of data used
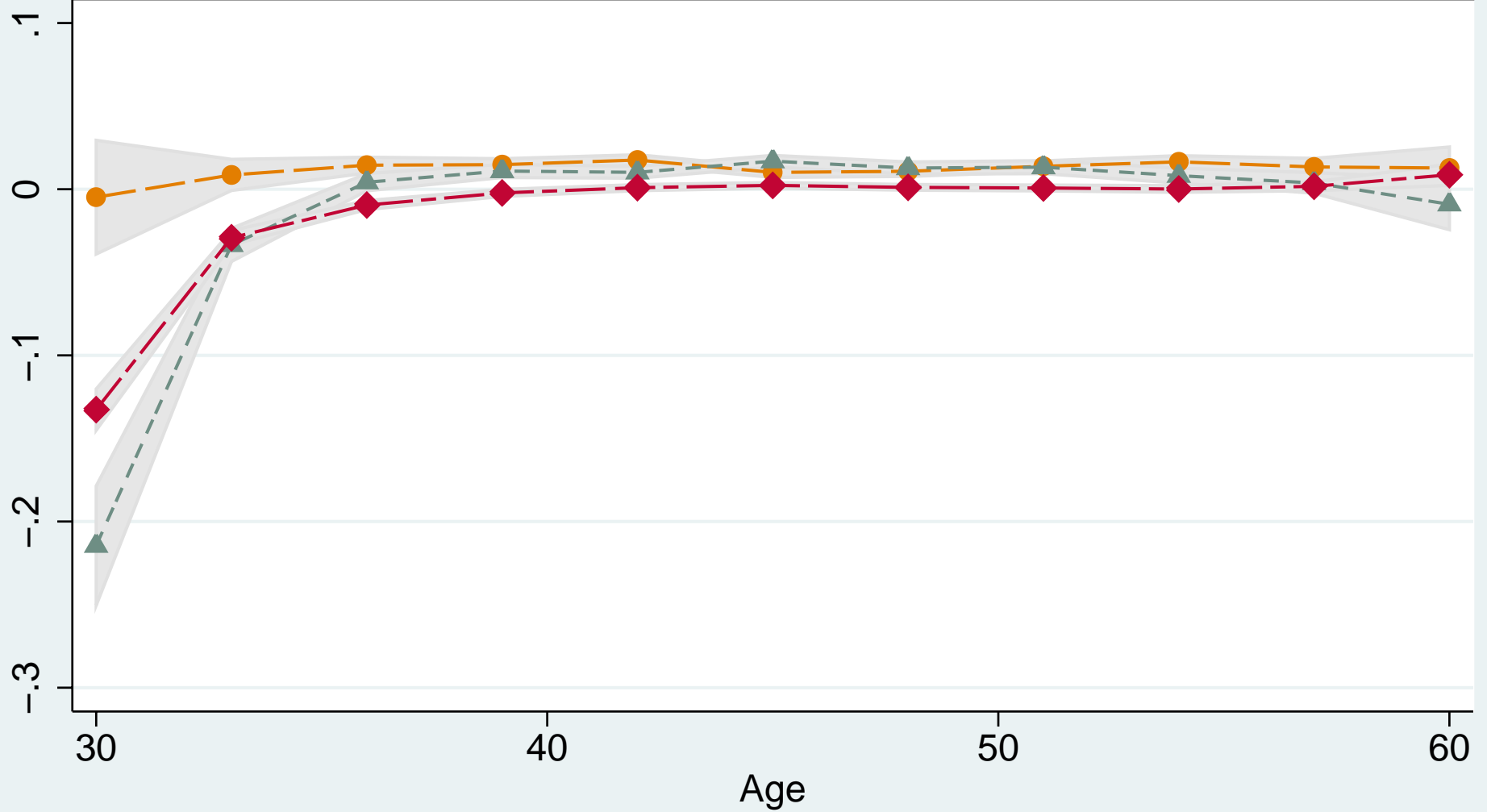Figure was generated on 22 Mar 2007 at 13:25:43

Figure 11: Returns to tenure at different years of age – OLS

Occupation Tenure
Industry Tenure
Employer Tenure

The figure plots estimated returns to 2 years of tenure on log of real daily wage
Sample restricted to: fulltime & male & year >= 1985
100 percent of data used
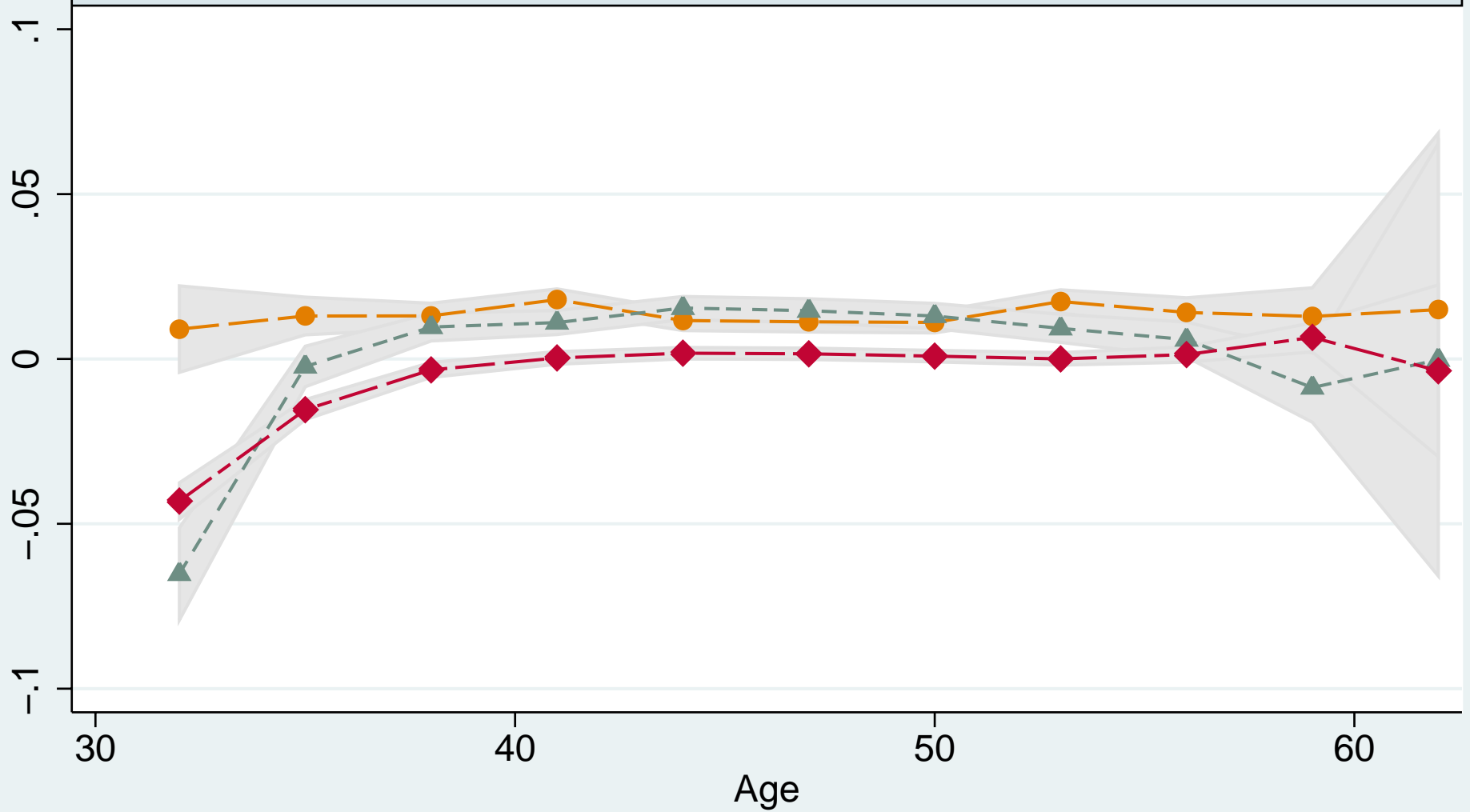Figure was generated on 22 Mar 2007 at 13:33:34

Figure 12: Returns to tenure at different years of age – IV

Occupation Tenure
Industry Tenure
Employer Tenure

The figure plots estimated returns to 2 years of tenure on log of real daily wage
Sample restricted to: fulltime & male & year >= 1985
100 percent of data used
Figure was generated on 22 Mar 2007 at 15:48:32

Figure 13: Returns to tenure at different years of age – IV

Occupation Tenure
Industry Tenure
Employer Tenure

The figure plots estimated returns to 2 years of tenure on log of real daily wage
Sample restricted to: fulltime & male & year >= 1985
100 percent of data used
Figure was generated on 22 Mar 2007 at 15:53:14