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JOB TENURE, WAGES AND TECHNOLOGY: A REASSESSMENT USING MATCHED WORKER-FIRM PANEL DATA

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ABSTRACT

Job Tenure, Wages and Technology: A Reassessment Using Matched Worker-Firm Panel Data*

This Paper presents new estimates of the impact of job tenure on wages using a new French matched worker-firm dataset. We develop an identification strategy that relies on one specific feature of the French labour laws. They stipulate that firms, when firing workers, must include as one of their criteria the number of dependent children of their employees. Our dataset confirms that workers with a relatively large number of dependent children at the entry in the firm are, *ceteris paribus*, less likely to be laid-off and have on average higher job tenure than their co-workers with a relatively small number of dependent children. Within this framework, the relative number of children at entry in the firm represents a plausibly valid instrumental variable for identifying the impact of job tenure on wages. Our new IV estimate of the return to job tenure (3.1% per year) is much larger than the OLS estimate (1%). This result holds true regardless of whether we focus on educated or non-educated workers, men or women. The downward bias which affects OLS estimates suggests that workers who receive relatively high wage offers tend to change firms more rapidly: they tend to have relatively high wages and low job tenure. Regarding trends, our new IV estimator suggests that the returns to job tenure have declined over the 1990s in the industries where the share of educated workers is the largest. The technologies that complement highly-skilled labour seem to drive a decline in the incentive to keep workers over long periods of time and, as a consequence, a decline in the impact of tenure on wages.

JEL Classification: J31, J53 and O33
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1 Introduction

The idea that job seniority has a large effect on wages has been the subject of much controversy in the recent economic literature[1]. At stake is the view that specific human capital is an important ingredient of wage growth and workers' turnover, as well as the assumption that deferred compensation (in the form of rising wages) encourages workers' effort and induces profitable self-selection of heterogenous workers. Whether or not seniority has a large impact on earnings is also very important in assessing the costs of job dislocation and the relevance of public policy targeted at increasing labor market flexibility.

In this paper, we try to shed some light on these issues and provide new estimates of the returns to seniority and of their variations across industries and over time. We use new French matched worker-firm panel data and new identification techniques, relying on some of the unique features of our database and of French institutions.

The basic problem for identifying the returns to job tenure comes from the fact that job tenure, like wage, is an outcome of optimisation by employers and workers. As such, job tenure cannot be considered as an exogenous determinant of wages. Workers with different level of seniority receive different wages, but it does not necessarily mean that seniority affect wages. It may also simply reflect the fact that job tenure and wages are both determined by some similar unobserved factors.

To overcome this problem and identify the true effect of seniority on wages, one possibility is to construct instrumental variables that affect wages only insofar as they affect seniority. When laying workers off, French firms are constrained by labor laws to take into account the number of dependent children of their workers (see article L. 321-1-1 of the French labor laws). One interesting feature of our matched worker-firm dataset is that it makes it possible to rank workers within their firm according to the number of dependent children.

[1] See e.g. Abraham and Farber (1987), Altonji and Shakotko (1987), Topel (1991), Altonji and Williams (1997).

Our dataset confirms that workers with a relatively large number of dependent children are less likely to be laid off and have on average higher job tenure than their co-workers with a relatively small number of dependent children regardless of whether we control for the absolute number of children or not. Assuming that the relative number of children has no direct effect on wages, this variable provides us with a new interesting instrumental variable for identifying the returns to job tenure. The first basic goal of this paper is actually to reevaluate the average returns to job tenure using this new instrument.

The second purpose of this paper is to explore the extent in which returns to job tenure vary across industries and over time. On the one hand, we can plausibly speculate that contemporary technological change is increasing the returns to skills that are acquired on the job, exactly the same way it is increasing the returns to education (see e.g. Katz and Autor, 1999). On the other hand, given that routine tasks are those for which senior workers may have the strongest comparative advantage -they have had time for learning them on the job- and given that the dissemination of new technologies is mostly destroying these routine tasks[2], we can also expect that technological change is decreasing the demand for high-seniority workers and, as a consequence, decreasing the returns to seniority.

To shed some light on these issues, we will analyze whether the returns to job tenure are larger in the sectors with the highest employment share of educated workers at the beginning of the period under consideration (which we interpret as an indicator of the dissemination of the technologies that complement skilled labor). Besides, we will explore whether this link between the returns to job tenure and the employment share of educated workers varies over time. One of the interesting feature of our dataset is indeed that it provides matched worker-firm information over a relatively long period of time (i.e., 1991-2002). The last decade has witnessed dramatic technological change in France, while labor laws remained stable. If contemporary technological change is actually

[2]See e.g. Autor et al. (2003), Maurin and Thesmar (2003).

increasing the degree of substituability between high and low seniority workers, we can plausibly expect a decline in the return to tenure across the last decade, especially in sectors with the highest dissemination of new technologies.

Our main empirical results may be summarized as follows:

(a) our new IV estimate suggests an average return to job tenure of about 3.1% per year. Most interestingly, this new IV estimate is much larger than the estimate obtained with standard OLS specification (1% per year). This result holds true regardless of whether we focus on educated or less educated workers, men or women. Generally speaking, our IV estimates are closer from Topel (1991) or Dustman and Meghir (2003) than from Altonji and Shakotko (1987) or Abraham and Farber (1989).

The downward bias which affects OLS estimates reflects a negative correlation between the unobserved determinants of wages and job tenure. One possible explanation is that workers who tend to receive high-wage offers also tend to change job more often and, as a consequence, are over-represented in the population of low-seniority workers. This explanation is consistent with the fact that the downward biases affecting OLS estimates are more important for the most educated workers, i.e. the most mobile workers and, as a consequence, those whose seniority is the most likely to be correlated with the quality of the job offers.

(b) According to our IV estimation techniques, the average return to job tenure is actually less significant in the industries with highest share of educated workers at the beginning of the period under consideration. Also we observe a decline in the returns to job tenure in these industries over the last decade. The technologies that complement skilled labor seem to be associated with a decline in the incentive to keep workers for long period of time and, as a consequence, seem to be driving a decline in the returns to job tenure.

All in all, we end up with an array of findings suggesting that the average returns to tenure are actually more significant than what standard OLS specifications suggest and that the technologies which complement skilled labor are

driving a decline in the average returns to job tenure in France.

The paper is organized as follows. Section 2 provides an overlook of the litterature. Section 3 presents our matched worker-firm dataset and our econometric models. Section 4 shows the results.

2 Existing Litterature

There is an old literature on estimating the returns to job tenure using standard earnings function. Typical OLS regression finds an average return of about 1%-2% per year depending on the specification.

There exists also a substantial literature which has worried about the biases that may affect simple OLS estimates of returns to job tenure because of the endogeneity of seniority. Job tenure, like the wage, is an outcome of firms' and workers' behaviors, and, as such, cannot be assumed to represent an independant source of wage variation.

Altonji and Shakotko (1987) and Abraham and Farber (1987) argue that the standard OLS estimated returns to tenure are upward biased due to the fact that job tenure depends on the same unobserved individual and job specific variables as wages. To overcome this problem, Abraham and Farber (1987) construct for each worker-job pair an indicator of the completed duration of the match. They add this indicator as a supplementary control variable to capture the effect of the unobserved quality of the match on wages. Altonji and Shakotko (1987) use an instrumental variable (IV) version of this strategy. For each worker-job pair and each year, they construct the deviation of current job tenure from the mean observed job tenure of this specific match. They use this deviation as an instrumental variable for identifying the true effect of job tenure on wages. In both papers, job tenure and wages are assumed to be linear function of the same unobserved individual and match-specific components. It is the reason why the available information on mean tenure or completed tenure make it possible to purge out the effect of the unobserved factors. Both Altonji and Shakotko (1987) and Abraham and Farber (1987) find a substantial reduction in the estimated

effect of job tenure (i.e., about 0.5% per year of job tenure as opposed to the 2% OLS effect).

In an other influential paper, Topel (1991) takes a different approach. Firstly, he uses the average within-job wage growth of workers who do not change jobs (stayers) as an unbiased estimated of the total wage growth due to both labor market experience and job tenure. He assumes that biases that could arise from endogenous selection in the subsample of stayers can be neglected. This first stage provides Topel with an estimate of the wage that workers receive when they got hired. By regressing this estimated wage at the start of the job on an indicator of the labor market experience at the start of the job, he gets what he interprets as an upward bound of the impact of labor market experience on wages. The difference between the first-stage and second-stage estimates provides him with a lower bound for true return to tenure of about 2.5% per year. All in all, Topel argues that there exists a substantial return to job tenure.

One issue in Topel's analysis is his assuming that the wage dynamics of stayers provide an unbiased evaluation of the wage dynamics for all workers had they changed jobs or not. This assumption does not allow for the possibility that workers change jobs for reasons related to wage.

Altonji and Williams (1997) revisit the question and argue that Topel's use of lagged wages with a current measure of job tenure (due to the design of the PSID) results in an upward bias in the return to tenure in his sample. They conclude from their analysis that the return to tenure is about 1% per year, i.e. substantially smaller than Topel's finding.

As emphasized by Farber (1999), the assumptions under which Altonji and Williams or Abraham and Farber estimators are valid remain not perfectly clear. Controlling for current tenure, the completed or mean tenure depends plausibly on factors that also determine the current wage and this may cause some biases. Besides it is not clear why job tenure should be a linear function of the unobserved determinant of wages and why the difference between observed tenure and complete tenure should purge the endogenous unobserved effects

out. Assume for instance that (a) quits occur when current wages are lower than a given exogenous threshold, (b) the unobserved determinant of current wages affect tenure only insofar as they affect quits. In such a case, job tenure is clearly a highly non-linear function of any unobserved determinant of wages.

Buchinski et al. (2002) have recently tried to address these issues by estimating jointly a participation equation, a job mobility equation and a wage equation. Using the PSID and assuming a normal distribution for the joint distribution of their residuals, they find returns to job tenure which are significantly higher than Altonji and Williams (1997) and almost as high as Topel (1991).

Another approach to evaluating returns to tenure relies on examining the wage dynamics of workers who change jobs for reasons exogenous to their own decisions or to the decisions of employers with regard to their wages or performances. Addison and Portugal (1989) present an analysis of data from the January 1984 Displaced Workers Survey which finds that earnings losses are larger for workers with more pre-displacement tenure. Farber (1999) presents similar evidence using the DWS from 1984 to 1996 suggesting a return to tenure of about 1.2% per year. Using the DWS from 1984 to 1986, Gibbons and Katz (1991) present an analysis of workers who are displaced due to plant closing. The idea is that the other displaced workers may be selected by their employers on the basis of relatively poor performance (or relatively high pay). To avoid the bias that may arise from endogenous selection, the idea is to focus on a sample of more exogenous job losers. Gibbons and Katz (1991) report similar links between wage losses and pre-displacement tenure across the different categories of job losers.

One issue with focusing on plant closure is that workers who are still employed in a plant when this plant closes represent a plausibly endogenously selected population. Put differently, plant closing is a long process and one may speculate that the population of workers at the end of the process is not representative of the population at the beginning (see Pfann, 2002).

In a recent paper on German data, Dustman and Meghir (2003) circumvent the problem by assuming that workers cannot predict a closure if the closure is more than a year away and by defining displaced workers as workers who are in the firm one year before the closure. Assuming that age affects the probability of finding a post displacement job, but not the level of the wage offer, they are able to identify the return to experience and the return to sector tenure. From there, using a two-step approach in the spirit of Topel (1991), they can recover the return to seniority. They find very significant average return to tenure (from 2% for skilled workers to 3.5% for unskilled workers). Of course, the most debatable assumption in Dustman and Meghir (2003) is their exclusion restriction. If the impact of age on labor force participation reflects the impact of family situation (as suggested by the authors), it is not very clear why it should not also affect the intensity of job search and, as a consequence, the quality of the available job offers.

3 Data

The data in this study come from the recent annual Labor Force Surveys (LFS) conducted by the French national statistical office (INSEE) between 1991 and 2001. The survey takes place in March of every year. The survey samples are representative of the population aged 15 and up. The sampling fraction is approximately 1/300. The following standard information is compiled for each interviewee: education, age, labor market status (in employment, unemployment, not in the labor force), industry, job tenure. We also have an information on whether the worker wants to change job and (if yes) whether this is because s/he expects to be soon laid off. Further, we have an information on the family situation of each worker. In particular, we know the number and the age of the dependent children in his/her household.

Using the information on the seniority of the worker and the age of his/her children, we can evaluate the number of dependent children when s/he got hired by his/her current firm. For instance, a ten-years seniority worker with a five-

years old child is a worker who had no dependent children when s/he got hired by his/her current firm.

Regarding wages, we have information on actual net monthly earnings and on the corresponding number of hours worked. Respondents are asked to state their actual wage for the month prior to the survey - or the latest month of regular activity if the previous month was too atypical. The study focuses on hourly wages. Generally speaking, we find qualitatively similar results when we focus on monthly-earnings rather than hourly wages and this is the reason why we do not report the monthly-earning regressions. Notice that our wage measure refers to the same month as our job tenure measure[3].

One interesting characteristics of the LFS is that workers are asked their firms' identification number (SIREN). This information is collected and captured in several stages (for more details, see appendix A). The information is available for about 80% of the workers surveyed. As it turns out, about 45% of the private-sector workers surveyed in a typical LFS have at least one co-worker surveyed in the same LFS and about 20% have four co-workers or more in the same survey (see table A1). This feature of the LFS makes possible to construct large samples of workers with detailed information on one or more other workers in the same firm. In this paper we will mostly focus on the sample of respondents who are less than 50 years old, who are employed in the private sector, for whom we know the SIREN identification number of the firm and who have at least one co-worker in the sample. The size of this sample is 71,698 when we focus on male respondents and 48,500 when we focus on women. Table A2 provides some basics statistics of the sample.

Another interesting feature of the LFS is that only one third of the sample is renewed each year. One can thus track the career of portion of the sample for 2 or 3 years. In this paper, we have extracted from the main sample a subsample of about 40,260 workers who are surveyed two years consecutively t and $t + 1$.

[3]The American studies that are regarded as authoritative used the PSID where job tenure refers to the date of the survey whereas the wage measure is annual earnings in the previous calendar year. When there is a job change, all measures of earnings are mixture of the old and the new compensation (see Altonji&Williams, 1997).

About 5% are employed at t and unemployed at $t + 1$, but were not willing to find another job at t or were willing to find another job only because they were expecting to be laid off. We will interpret this subsample as a subsample of involuntary job losers.

3.0.1 Instrumental variables

Regarding instrumental variables, we will use a variable describing workers' family situation at the entry in the firm relative to the family situation of their co-workers at the entry in the firm.

The rationale for using this variable as an instrument comes from the fact that French labor laws stipulate that firms -when laying workers off- must take into account the family situation of their employees. The Article L 321-1-1 of the French Code du Travail stipulates that (a) the employer must negotiate with workers' representatives the criteria that are used for determining who is laid off when some layoffs are decided and (b) these criteria should take into account the number of dependent children of the worker, whether the worker is a single parent, his/her seniority within the firm, the age of the worker, whether the worker has handicaps that make it more difficult to find another job. The employer must take these criteria into account regardless of the number of layoffs.

Among the compulsory criteria (number of dependent children, age, seniority, handicaps) the number of dependent children is the only one that does not correspond to a personal characteristic of the worker and, in this sense, it is a priori the most exogenous one, .i.e. the least correlated with the unobserved abilities which may affect wages. It is the reason why we will focus on this specific criterium to construct our instrument.

Specifically, we will evaluate for each worker the rank within his/her firm according to the number of dependent children in his/her household at the entry in the current firm. We will focus on the relative number of children at the entry in the firm rather than on the current relative number of children, because the current number of children is plausibly a consequence of the quality

of the current job-worker match[4] and, as such, less exogenous. Dividing this rank variable by its mean value within the firm, we obtain a normalized rank variable which is by construction uncorrelated with the number of co-workers and with the size of the firm. This normalized rank variable will be used as our basic instrument for identifying the effect of seniority on wages. As shown below, these instruments are correlated with involuntary job loss and job tenure, even after controlling for the absolute number of children. Appendix B proposes a very simple model of job mobility and wage formation which may justify our identifying strategy.

4 Results

Holding workers' education, experience and number of children constant, Table 1 shows that the relative number of children at the entry in the firm z has a significant negative effect on the probability of being laid off and a significant positive impact on job tenure. These results are the same regardless of whether we control for firm size or not. These findings are consistent with the French institutional context and confirm that z is a potentially valid instrument for identifying the effect of job tenure on wages.

Model (3) in table 2 shows the results of the basic OLS regression of wages on workers' seniority and basic characteristics (education, experience and number of children). According to this model, the return to job tenure is about 1.1% per year[5]. This finding is consistent with typical OLS estimates of the average return to job tenure in France (see e.g. Goux and Maurin, 1994).

Model (4) shows the results of our basic IV regression. Most interestingly, the IV estimated average return to job tenure is significantly larger than the OLS estimate, namely 3.1% per year. The downward bias which affects OLS estimates suggest that high-seniority workers have on average lower wage potential than low-seniority workers. One plausible interpretation is that workers

[4] Some parents may plausibly wait for good, stable jobs before having children.

[5] We find exactly the same OLS results when we use the whole LFS sample rather than the sample of workers with at least one co-worker.

who receive relatively high-wage offers tend to change firm more rapidly than workers with low wage offers: they tend to have (ceteris paribus) higher wage and less job tenure.

Models (5) and (6) show the OLS and IV results for the subsample of high-school dropouts while models (7) and (8) focus on high-school graduates. In both cases, the IV estimates are larger than the OLS estimates. The downward bias which affects OLS estimates is, however, larger for educated workers than for non-educated ones. This result suggests that the correlation between job tenure and the quality of wage offers is stronger for educated workers than non-educated workers, which is consistent with the fact that job mobility is more often voluntary for educated workers than for non-educated workers.

4.1 Robustness

Holding the absolute number of children constant, the relative number of children of any given worker is correlated with the distribution of the absolute number of children in his/her firm. Given that the absolute number of children is correlated with age, the distribution of the absolute number of children at the entry in a firm is plausibly correlated with the distribution of workers' age at the entry in this firm. Hence, our identification strategy relies upon the assumption that the unobserved components of firms' wage policies are not correlated with the distributions of age at the entry. To test this hypothesis and probe the robustness of our results, we have replicated our analysis using the average age at the entry of co-workers as a supplementary control variable (Table A3). Comfortingly, this variable has a negligible effect on wages and the basic diagnosis are the same regardless of whether we use it as a control variable or not. We have also replicated our analysis on the sample of women ($N = 48,500$). Comfortingly the OLS estimate are very similar for women and men (Table 2b). The IV estimates are also much larger than the OLS estimates. The IV estimates are however somewhat less well estimated in the women case.

4.2 Seniority biased technological change

As argued by Farber (1999), an appropriate estimate of the returns to job tenure measures the compensation structure used by firms to discourage voluntary turnover and achieve appropriate performance from their workers. Such an interpretation suggests that the relationship between tenure and earning is not a market-determined constant, but is likely to vary across firms with different technologies[6].

More specifically, technologies may vary with respect to the quantity of productive skills that can be acquired on the job. But they may also vary with respect to the degree in which the (transferable) skills that can be found on the labor market are easy to substitute for the (specific) skills that are acquired on the job. Generally speaking, the incentive to reduce voluntary turnover and to offer steeply sloped earning profiles increases when (a) workers acquire a lot of new skills on the job and when (b) low-seniority workers cannot be easily substituted for high-seniority ones.

Given this fact, contemporary technological change may plausibly have two opposit effects on the compensation structure used by employers. Its first potential effect is throught destruction of routine tasks (Autor et al. 2003, Maurin and Thesmar, 2003). Given that routine tasks are those for which high-seniority workers may have a significant comparative advantage (they have had time to learn them on then job), technological progress plausibly makes low-seniority workers easier to substitute for high-seniority ones. As a consequence, turnover may become less costly to the firms and the link between seniority and wages may weaken[7].

On the other hand, technological change plausibly increases the productivity of the skills that are acquired on the job exactly the same way it increases the productivity of the skills that are acquired at school (Katz and Autor, 1999). As a consequence, it may also increase the incentive to reduce voluntary

[6] Margolis (1996) provides a detailed description of the huge variations in earning profiles across firms.

[7] Givord and Maurin (2002) find that the recent increase in involuntary turnover in France is more pronounced in sectors with the highest proportion of new technologies' users.

turnover. In this section we are going to examine empirically how these two effects combine.

To begin with, Table 3 provides an analysis of the returns to job tenure when one allows these returns to vary across sectors. We distinguish sectors according to the employment share of high-school graduates at the beginning of the period (i.e. 1991). The question is whether the returns to job tenure depend on the presence of technologies that complement skilled labor[8]. Model (16) provides IV estimates showing that the returns to job tenure are less significant in the sectors with the highest share of educated workers. According to model (18) and (20), this result holds true regardless of whether we focus on educated or non-educated workers. As discussed above, one possible interpretation is that new technologies are destroying the very tasks for which job tenure provides a comparative advantage, which reduces the incentive to keep workers for long period of time.

Regarding the estimated effect of tenure and its variation across sectors, the comparison of models (16), (18) and (20) with models (15), (17) and (19) shows that the downward bias which affects OLS is larger in "low-tech" sector, i.e. sectors with the lowest proportion of educated workers. This finding suggests the concentration of high-wage workers in low-tenure jobs is relatively more important in "low-tech" than in "high-tech" sectors. One plausible explanation is that the flows of voluntary job mobility go mostly from "low-tech" to "high-tech" sectors.

To probe the robustness of these results, Table 4 provides an analysis of the variation in the average return to seniority over time. Model (22) provides an IV analysis showing that the differences between the returns to job tenure in low-tech and high-tech sectors tend to increase over time. Specifically, the returns to tenure are becoming increasingly larger in the low-tech sectors, i.e.

[8]The mean employment share of high-school gradute is 0.28 and the standard deviation is 0.17. Using the recent survey on Working Conditions (conducted in 1998 as a supplement of the French LFS), we have checked that the employment share of high-school graduates is highly correlated with the employment share of internet users (the correlation coefficient is 0.70) or with the employment share of R&D workers (0.63). More details can be found in Givord and Maurin (2003).

the sectors with the lowest share of educated workers. These results confirm that the diffusion of technologies that complement skilled workers is driving a decline in the average return to tenure. Models (24) and (26) suggest that this trend is significant for non-educated workers only. The impact of new technologies on the distribution of tasks across senior and junior workers would be more significant for non-educated workers than for educated workers. Assuming that new technologies affect the returns to job tenure mostly through destroying routine tasks, this last finding plausibly reflects that routine tasks are mostly allocated to non-educated workers.

5 Conclusion

French firms, when laying workers off, have to take into account the number of dependent children of their employees. Using a unique French dataset with information on the family situation of a representative sample of workers and co-workers, we confirm that workers with a relatively large number of dependent children are less likely to be laid off and have - ceteris paribus - higher job tenure than their co-workers with a relatively small number of dependent children. Given these facts, the variable measuring the relative number of children provides us with a potentially interesting new instrumental variable for identifying the impact of job tenure on wages. Our new IV estimate of the return to job tenure (3.1% per year) is much larger than the OLS estimate (1.1 %). Also, it is significantly larger in the industries with the lowest share of educated workers and the differences across sectors tend to increase over time. We interpret these variations in the returns to tenure across sectors and over time as reflecting the emergence of a new seniority-biased technological change. The technologies that complement skilled labor seem to drive a decline in the incentive to keep workers over long period of time and, as a consequence, a decline in the impact of job tenure on wages.

This paper focuses on the average returns to tenure and on their distribution across industries. The identification of other aspects of the distribution of

returns to tenure would require supplementary instrumental variables. Further researches are needed to better explore how the marginal returns to tenure vary with age and also with tenure itself.

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Appendix A

Employer identification

During the interview, the LFS respondents furnish the actual address of the establishment where they work and its SIREN identification number (they know it by looking at their pay slip). The data are entered into a computer and assembled at a national computing center for collation with the official national business register (SIRENE). In nearly 60% of the cases, the information gathered from the respondents offers an instant straightforward match with single establishment in the official register. For all these cases, the national center extracts the relevant information on the employer from SIRENE and it is this information that is used to enhance the final LFS file. In other words, the information on establishments and firms that appears in the final file (including industry and SIRET number) is taken from the legal register, not from survey respondents.

In about 20% of cases, the information obtained from the respondent matches two possible establishments in the SIRENE register. Typically, they are establishments of the same firm, but with nearby or identical adresses. For these occurences, the coding center list the two possible responses and it is up to the INSEE survey local manager to choose the most likely one. Here as well,

the employer information incorporated into the survey file is derived from the official register, not from statements of the surveyed workers.

In the 20% or so remaining cases, the address given by the respondent is incorrect or incomplete, preventing an identification of the employer establishment. In such instances, the information on firms' industry and size included in the survey file is the information reported by respondents.

It should be pointed out that the LFS annual codings in year t take into account the codings in year $t-1$. Consequently, when the official register suggests two alternative codes in year $t-1$ (i.e., in 20% of cases) and when two identical options reoccur in year t, the INSEE survey local manager checks whether the choices in both year are consistent. This procedure offers additional protection against the spurious mobility that could be construed from the coding of problematic responses.

Appendix B

Wages, seniority and mobility: the model and the econometric strategy

This section proposes a simple illustrative model that captures the key concepts and identification problems. Consider worker i at date t and denote,

$w_{it} \equiv$ the (log) wage paid to the worker by the current firm ,

$w_{it}^{A} \equiv$ the best alternative (log) wage available to the worker,

$w_{it}^{0} \equiv$the (log) wage that the worker received when s/he got hired by the current firm,

$Q_{it} \equiv$ a dummy indicating whether the worker experiences a voluntary firm change between t and $t+1$.

$F_{it} \equiv$ a dummy indicating whether the worker experiences an unvoluntary firm change between t and $t+1$.

With these notations, we assume the following very simple model of wage determination and mobility decision,

$w_{it} = w_{it}^{0} + \alpha s_{it} + \epsilon_{it}$,

$w_{it}^{A} = \beta X_{it} + \gamma \exp_{it} + \nu_{it}$,

$Q_{it} = (w^{A}_{it} - w_{it-1} > 0)$ and $F_{it} = (\theta Z_{it} + \eta_{it} > 0)$,

where s_{it} is the seniority of the worker and $\exp_{it}$ the labor market experience of the worker. The X_{it} represents observed variables that affect the quality of the job offers received by i, typically his/her education. Since the family situation is a plausible determinant of the job search quality, these variables plausibly include the number of dependent children. The Z_{it} represents observed variables that determine the layoff probability of worker i.

The α parameter describes the average wage growth within firms while ε_{it} represents the unobserved factors that makes observed wages deviates from the average within-firm trajectory. The ε_{it} variable can be defined as to be uncorrelated with w^{0}_{it} and s_{it}. The γ parameter describes the average growth of wage offers as workers become more experienced. The ν_{it} variable represents - for each job offer - the corresponding quality of the job-worker match while η_{it} captures unobserved shocks to the firms'demand for labor.

The timing is assumed the following. At the beginning of the period $[t, t+1]$, the worker discovers the new situation of the firm and the quality of the new job offers, i.e. η_{it} and ν_{it}. The new η_{it} determines F_{it} while the new ν_{it} determines w^{A}_{it} and, as a consequence, determines Q_{it}. Taken together, η_{it} and ν_{it} determine whether the worker changes firm or not at the beginning of $[t, t+1]$.

All in all, after substituting $w^{A}_{it-s_{it}}$ to w^{0}_{it} in the wage equation, we obtain,

$$w_{it} = (\alpha - \gamma)s_{it} + \gamma \exp_{it} + \beta X_{it-s_{it}} + \varepsilon_{it} + \nu_{it-s_{it}}, \tag{1}$$

The parameter $\phi = \alpha - \gamma$ in equation 1 corresponds to the true returns to seniority, namely the extent in which wages rise relative to alternatives as job seniority accumulates. This is the main parameter of interest. The identification problem comes from the fact that s_{it} is generated by the same unobserved shocks as w_{it}.More specifically, the dynamics of seniority is given by,

$$s_{it} = \mathbf{1}(w^{A}_{it} - w_{it-1} \leq 0 \text{ and } \theta Z_{it} + \eta_{it} \leq 0)(s_{it-1} + 1).$$

where $\mathbf{1}(x)$ is dummy indicating whether x holds true. Given that $(w^{A}_{it} - w_{it-1} = \gamma + \beta(X_{it} - X_{it-s_{it-1}}) + (\gamma - \alpha)\, s_{it-1} + (\nu_{it} - \nu_{it-s_{it-1}}) - \varepsilon_{it-1})$, $w^{A}_{it} - w_{it-1}$

depends plausibly on all the present and past values of $X_{it1} - X_{1it-1}, \varepsilon_{it-1}$ and $v_{it} - v_{it-1}$. Hence, the reduced form of s_{it} can be rewritten,

$$s_{it} = S(Z_{it-k}, \eta_{it-k}, X_{it-k+1} - X_{it-k}, \nu_{it-k+1} - \nu_{it-k}, \varepsilon_{it-1-k}; k = 0, ..., \exp_{it}).$$

In other words, s_{it} is a function of (i) all the present and past unobserved and observed determinant of involuntary job loss since the entry in the labor market (i.e., all the Z_{it-k} and η_{it-k} experienced by the worker) (ii) all the observed and unobserved of determinants of voluntary job mobility since the entry in the labor market (i.e.,all the $X_{it-k+1} - X_{1it-k}, \varepsilon_{it-1-k}$ and $\nu_{it-k+1} - \nu_{it-k}$ experienced by the worker).

This model makes clear that an OLS regression of wages on seniority levels may provide us with biased estimates of ϕ because both wages and seniority depend on $\nu_{it-s_{it}}$. Generally speaking, the sign of the bias is difficult to predict. It depends on the sign of the correlation between $\nu_{it} - \nu_{it-s}$ and ν_{it-s}, i.e. on the dynamics of the potential matches. Assume for instance that $\nu_{it} = \nu_{i0} + u_{it}$ where the u_{it} are i.i.d serially uncorrelated random shocks. In such a case, $\nu_{it} - \nu_{it-s}$ and v_{it-s} are negatively correlated. People who move tend to be those holding low-quality jobs, people who stay tend to hold high-quality jobs and OLS are typically downward biased. In contrast, assume that $\nu_{it} = \nu_{it-1} + v_{it}$ where the v_{it} are serially correlated. In such a case, $\nu_{it} - \nu_{it-s}$ and ν_{it-s} are negatively correlated. People who move the most are those holding the highest quality jobs and OLS are typically upward biased.

To address this issue, we need a variable which belongs to the set of determinants of involuntary mobility and seniority, but is uncorrelated with the current unobserved determinant of wages (i.e., ε_{it} and $\nu_{it-s_{it}}$). In this paper, we use a measurement of $Z_{it-s_{it}}$ where Z_{it} represents at each period the number of children of worker i relative to the number of children at entry in the firm who proposes the best job offer at t. Given French labor laws, this variable plausibly belongs to the set of determinants of involuntary mobility and, as such, belongs to the set of determinant of seniority. Empirically, one checks that this variable actually belongs to the set of determinants of both involuntary mobility

and seniority. Within this context, the identifying assumption is that -holding education and age constant- there exists no correlation between the quality of the job offered to a worker and his/her number of children at the entry relative to the number of children of the other workers in the firm which makes the best offer. Under this assumption, our measurement for the relative number of children is uncorrelated with the quality that characterizes the current jobs, and affects wage only insofar as it affects seniority.

Table 1 : First stage regressions: the determinants of job tenure and involuntary job loss.

	Job tenure (1)	Involuntary job loss (2)
Intercept	1.42 (0.11)	-1.15 (0.06)
Z=Rank according to nb children at the entry in the firm	.19 (.02)	-.03 (.01)
Experience	.63 (.01)	-.10 (.01)
Experience squared	.0003 (.0002)	.018 (.0001)
[Education < High School]	-.94 (.06)	.29 (.04)
[Education = High School]	Ref.	Ref.
[Education = lower tertiary]	-.41 (.09)	-.15 (.06)
[Education = upper tertiary]	-.37 (.10)	-.38 (.07)
[Nb of children at the beginning of the job = 0]	Ref.	Ref.
[Nb of children at the beginning of the job = 1]	-4.76 (0.07)	.31 (0.04)
[Nb of children at the beginning of the job = 2]	-7.16 (0.08)	.42 (0.04)
[Nb of children at the beginning of the job > 2]	-8.34 (0.10)	.53 (0.05)
Numbers of workers in the firm (4 dummies)	(yes)	(yes)
Year Dummies	(yes)	(yes)
R2	0.59	
Nb Observations	71 712	40 260

Source : Labor Force Surveys t=1991,…,2002.
Field: Male respondants aged less than 50 employed in private sector. Standard deviations are in brackets.
Note: Model 1 is a linear regression where the dependent variable is job tenure at t. Models 2 is a probit regression where the dependent variable is a dummy indicating an involuntary job loss between t and t+1.

Table 2: An estimation of the average returns to tenure using the relative number of children at the entry in the firm as an instrumental variable (men only).

	Dependent variable : (log) hourly wages					
	All workers		High School Dropouts		High School Graduates	
	OLS (3)	IV (4)	OLS (5)	IV (6)	OLS (7)	IV (8)
Intercept	5.03 (.01)	5.00 (.01)	4.89 (.01)	4.87 (.02)	5.15 (.01)	5.10 (.01)
Tenure	.011 (.0002)	.031 (.007)	.011 (.0002)	.024 (.009)	.009 (0.001)	.071 (0.031)
Experience	.033 (0.001)	.020 (.004)	.024 (.001)	.016 (.005)	.048 (0.001)	.016 (0.016)
Experience squared	-.001 (.00001)	-.001 (.00001)	-.001 (.00001)	-.001 (.00002)	-.001 (.00003)	-.002 (.0002)
[Education < High School]	-.22 (.003)	-.20 (.01)				
[Education = High School]	Ref.	Ref.				
[Education = lower tertiary diploma]	.15 (0.004)	.16 (.01)				
[Education > upper tertiary diploma]	.48 (0.01)	.46 (.01)				
[Nb of children at the beginning of the job = 0]	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
[Nb of children at the beginning of the job = 1]	.03 (.003)	.12 (0.03)	.03 (.004)	.10 (.05)	.03 (0.01)	.22 (0.09)
[Nb of children at the beginning of the job = 2]	.05 (0.004)	.18 (0.05)	.04 (.004)	.14 (.07)	.06 (0.01)	.39 (0.17)
[Nb of children at the beginning of the job > 2]	-.004 (0.01)	.16 (0.05)	-.02 (.01)	.09 (.08)	.06 (0.01)	.44 (0.19)
Numbers of workers in the firm (4 dummies)	(yes)	(yes)	(yes)	(yes)	(yes)	(yes)
Year Dummies	(yes)	(yes)	(yes)	(yes)	(yes)	(yes)
R^2	0.43	0.38	0.26	0.22	0.27	0.18
Nb Observations	71 712	71 712	51 072	51 072	20 638	20 638

Source : Labor Force Surveys t=1991,…,2002.
Field: Male respondent, aged less than 50, private sector. Standard deviations are in brackets.
Instrumental variable in models 4, 6 and 8: the standardized rank of the worker within his/her firm according to the number of dependent children at the entry in the firm.

Table 2 b: An estimation of the average returns to tenure using the relative number of children at the entry in the firm as an instrumental variable (women only).

	Dependent variable : (log) hourly wages					
	All workers		High School Dropouts		High School Graduates	
	OLS (9)	IV (10)	OLS (11)	IV (12)	OLS (13)	IV (14)
Intercept	4.94 (.01)	4.92 (.01)	4.84 (.01)	4.84 (.01)	5.05 (.01)	5.00 (.06)
Tenure	.012 (.0002)	.053 (.0076)	.012 (.0002)	.049 (.008)	.011 (.001)	.22 (.20)
Experience	.026 (.001)	-.01 (.01)	.014 (.001)	-.019 (.007)	.034 (.001)	-.10 (.13)
Experience squared	-.001 (.00001)	-.0003 (.00006)	-.0003 (.00002)	-.00001 (.00007)	-.001 (.00004)	-.001 (.001)
[Education < High School]	-.19 (.003)	.17 (.007)				
[Education = High School]	Ref.	Ref.				
[Education = lower tertiary]	.19 (.004)	.21 (.01)				
[Education = upper tertiary]	.41 (0.01)	.43 (0.01)				
[Nb of children at the beginning of the job = 0]	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
[Nb of children at the beginning of the job = 1]	-.007 (.004)	.25 (.05)	.002 (.004)	.25 (.05)	-.03 (.01)	.91 (.86)
[Nb of children at the beginning of the job = 2]	-.02 (.004)	.31 (.06)	-.013 (.01)	.30 (.07)	-.04 (.02)	1.34 (.27)
[Nb of children at the beginning of the job > 2]	-.055 (.01)	.34 (.07)	-.053 (.01)	.33 (.08)	-.08 (.01)	1.46 (1.42)
Numbers of workers in the firm (4 dummies)	(yes)	(yes)	(yes)	(yes)	(yes)	(yes)
Year Dummies	(yes)	(yes)	(yes)	(yes)	(yes)	(yes)
R^2	0.42	0.28	0.28	0.15	0.24	0.03
Nb Observations	48 532	48 532	31 512	31 512	17 020	17 020

Source : Labor Force Surveys t=1991,…,2002.
Field: Male respondent, aged less than 50, private sector. Standard deviations are in brackets.
Instrumental variable in models 10, 12 and 14: the standardized rank of the worker within his/her firm according to the number of dependent children at the entry in the firm.

Table 3: An estimation of the variation in the average returns to tenure across industries (men).

	Dependent variable : (log) hourly wages					
	All workers		High School Dropouts		High School Graduates	
	OLS (15)	IV (16)	OLS (17)	IV (18)	OLS (19)	IV (20)
Intercept	5.00 (.01)	4.90 (.02)	4.89 (.01)	4.77 (0.03)	5.00 (0.01)	4.87 (0.11)
Tenure	.008 (.0003)	.031 (.007)	.006 (.0003)	.026 (.010)	.015 (.001)	.073 (.041)
Tenure * % high-school graduates.	.014 (.001)	-.021 (.001)	.025 (.001)	-.021 (.007)	-.018 (.002)	-.066 (.040)
% high-school graduates.	.097 (.012)	.434 (.059)	-.011 (.017)	.522 (.082)	.538 (.019)	.867 (.282)
Experience	.032 (.0004)	.023 (.004)	.024 (.001)	.017 (.005)	.045 (.001)	.023 (.015)
Experience squared	-.001 (.00001)	-.001 (.00001)	-.001 (.00001)	-.001 (.00002)	-.001 (.00003)	-.001 (.0002)
[Education < High School]	-.20 (.003)	-.19 (.007)				
[Education = High School]	Ref.	Ref.				
[Education = lower tertiary]	.15 (.004)	.15 (.01)				
[Education = upper tertiary]	.43 (.01)	.42 (.01)				
Nb of children at the beginning of the job (4 dummies)	(yes)	(yes)	(yes)	(yes)	(yes)	(yes)
Numbers of workers in the firm (4 dummies)	(yes)	(yes)	(yes)	(yes)	(yes)	(yes)
Year Dummies	(yes)	(yes)	(yes)	(yes)	(yes)	(yes)
R^2	0.44	0.40	0.28	0.23	0.30	0.24
Nb Observations	71 698	71 698	51 060	51 060	20 638	20 638

Source : Labor Force Surveys t=1991,…,2002.
Instrumental variable in models 16, 18 and 20: the standardized rank of the worker within his/her firm according to the number of dependent children at the beginning of the job and the interaction of this rank variable with the rate of high-school graduates in the industry (measured in 1991).

Tables 4 : An estimation of the variation in the average returns of tenure across industries and time.

	Dependent variable: (log) hourly wages					
	All workers		High School Dropouts		High School Graduates	
	OLS (21)	IV (22)	OLS (23)	IV (24)	OLS (25)	IV (26)
Intercept	5.02 (.01)	4.89 (.02)	4.90 (.01)	4.76 (.03)	5.02 (.01)	4.99 (.09)
Tenure	.004 (.0004)	.029 (.007)	.003 (.001)	.024 (.010)	.014 (.001)	.066 (.037)
Tenure * % high-school grad.	.023 (.001)	-.008 (.006)	.034 (.002)	-.005 (.008)	-.019 (.003)	-.079 (.038)
Tenure * t	.001 (.0001)	.0004 (.0003)	.001 (.0001)	.001 (.0003)	.0002 (.0002)	.002 (.002)
Tenure * % high-school grad. *date	-.002 (.0002)	-.003 (.001)	-.002 (.0002)	-.004 (.001)	.0003 (.0004)	.003 (.002)
% high-school grad.	.10 (.01)	.44 (.06)	-.02 (.02)	.53 (.08)	.54 (.02)	.84 (.29)
Experience	.032 (.001)	.023 (.004)	.024 (.001)	.017 (.005)	.045 (.001)	.020 (.017)
Experience squared	-.001 (.00001)	-.001 (.00001)	-.001 (.00001)	-.001 (.00002)	-.001 (.00003)	-.001 (.0002)
[Education < High School]	-.20 (.003)	-.19 (.007)				
[Education = High School]	Ref.	Ref.				
[Education = lower tertiary]	.15 (.004)	.15 (.01)				
[Education = upper tertiary]	.43 (.01)	.42 (.01)				
Nb of children at the beginning of the job (dummies)	(yes)	(yes)	(yes)	(yes)	(yes)	(yes)
Numbers of workers in the firm (dummies)	(yes)	(yes)	(yes)	(yes)	(yes)	(yes)
Year Dummies	(yes)	(yes)	(yes)	(yes)	(yes)	(yes)
R^2	0.44	0.40	0.28	0.23	0.30	0.24
Nb Observations	71 698	71 698	51 060	51 060	20 638	20 638

Source : Labor Force Surveys t=1991,…,2002.
Instrumental variable in models 22, 24 and 26: the standardized rank of the worker within his/her firm according to the number of dependent children at the beginning of the job and the interaction of this rank variable with the rate of high-school graduates in the industry (measured in 1991).

Data Appendix

Table A1: Workers and Co-workers in a typical French LFS.

Nb of workers with	
0 coworker	20 527
Only 1 coworker	5 092
2 coworkers	2 214
3 coworkers	1 552
more than 3 coworkers	7 215
Total	36,600
Numbers of firms with at least two co workers	4 354

Source : Labor Force Surveys t=2000.
Field: Workers employed in private sector in 2000.

Table A2: Descriptive statistics.

	Mean	SD
(log) hourly wages	5,37	0,36
Tenure	9,88	8,38
Experience	17,70	9,24
[Education < High School]	0,71	0,45
[Education = High School]	0,54	0,77
[Education = lower tertiary]	0,10	0,25
[Education = upper tertiary]	0,07	0,25
Nb of children at the beginning of the job	0,47	0,95
Standardized Rank (Z)	1,00	1,06
Involuntary Job change	0,044	0,205

Source : Labor Force Surveys t=1991,…,2002.
Field: Men aged less than 50, private sector.

Table A3: The average returns of tenure : a reestimation using coworkers' mean age as a supplementary control variable.

	Dependent variable : (log) hourly wages					
	All workers		High School Dropouts		High School Graduates	
	OLS (27)	IV (28)	OLS (29)	IV (30)	OLS (31)	IV (32)
Intercept	4.98 (0.01)	5.02 (0.02)	4.85 (0.01)	4.88 (0.02)	5.05 (0.02)	5.15 (0.06)
Tenure	0.011 (0.0002)	0.031 (0.007)	0.011 (0.0002)	0.024 (0.010)	0.009 (0.001)	0.072 (0.033)
Experience	0.033 (0.001)	0.020 (0.004)	0.024 (0.001)	0.016 (0.005)	0.047 (0.001)	0.016 (0.016)
Experience squared	-0.001 (0.00001)	-0.001 (0.00001)	-0.001 (0.00001)	-0.001 (0.00002)	-0.001 (0.00003)	-0.002 (0.0002)
[Education < High School]	-0.22 (0.003)	-0.20 (0.007)				
[Education = High School]	Ref.	Ref.				
[Education = lower tertiary]	0.15 (0.004)	0.16 (0.005)				
[Education = upper tertiary]	0.45 (0.005)	0.46 (0.006)				
[Nb of children at the beginning of the job = 0]	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
[Nb of children at the beginning of the job = 1]	0.03 (0.003)	0.12 (0.03)	0.03 (0.003)	0.10 (0.05)	0.03 (0.008)	0.22 (0.10)
[Nb of children at the beginning of the job = 2]	0.04 (0.004)	0.18 (0.05)	0.04 (0.004)	0.14 (0.07)	0.05 (0.009)	0.40 (0.17)
[Nb of children at the beginning of the job > 2]	-0.007 (0.005)	0.16 (0.06)	-0.02 (0.005)	0.09 (0.08)	0.05 (0.003)	0.45 (0.18)
Numbers of workers in the firm (4 dummies)	(yes)	(yes)	(yes)	(yes)	(yes)	(yes)
Year Dummies	(yes)	(yes)	(yes)	(yes)	(yes)	(yes)
Mean age of coworkers	0.001 (0.0001)	-0.001 (0.001)	0.001 (0.0001)	-0.0001 (0.001)	0.003 (0.0003)	-0.001 (0.002)
R^2	0.43	0.38	0.26	0.22	0.27	0.18
Nb Observations	71 712	71 712	51 072	51 072	20 638	20 638

Source : Labor Force Surveys t=1991,…,2002.
Field: Male respondent, aged less than 50, private sector. Standard deviations are in brackets.
Instrumental variable in models 28, 30 and 32: the standardized rank of the worker within his/her firm according to the number of dependent children at the entry in the firm.