Productivity, Seniority and Wages

New Evidence from Personnel Data*

Luca Flabbi — NYU
Andrea Ichino — EUI and CEPR

January 8, 2001

Abstract

Wages may be observed to increase with seniority because of firm-specific human capital accumulation or because of self-selection of better workers in longer jobs. In both these cases the upward sloping wage profile in cross sectional regressions would reflect higher productivity of more senior workers. If this were true, the observation of an effect of seniority on wages would depend on the presence of controls for individual productivity. In this paper we replicate, using personnel data from a large Italian firm, the results of the pioneering work of Medoff and Abraham (1980 and 1981) in which supervisors' evaluations were used as productivity indicators. Since the validity of supervisors' evaluations as measures of productivity has been widely criticised, we extend the work of Medoff and Abraham using different direct measures of productivity based on recorded absenteeism and misconduct episodes. Both these indicators and supervisors' evaluation suggest that the observed effect of seniority on wages does not reflect a higher productivity of more senior workers. Only at the lowest levels of the firm's hierarchy, the human capital theory contributes to explain the effect of seniority on wages. At least at all other levels, the explanation of the observed upward sloping profile has to be based on theories in which wages are deferred for incentive or insurance reasons.

Keywords: Wage determination, Returns to Seniority, Productivity.
JEL Classification: J30, J31

*Address correspondence to: Luca Flabbi, New York University, Department of Economics, 269, Mercer Street, 10003, New York, NY, e-mail: lf367@is9.nyu.edu; Andrea Ichino, European University Institute, San Domenico di Fiesole, 50016, Firenze, Italia, e-mail: ichino@iue.it We would like to thank: the firm that kindly provided the data; Pietro Ichino, Robert Waldmann, Rudolf Winter-Ebmer, seminar participants at the 1997 AIEL Conference and in particular an anonymous referee for their comments and suggestions; Elena Belli, Anna Fruttero, Raffaele Tangorra and Federico Targetti for excellent research assistantship. All errors are ours.

1 Introduction

In a well known evaluation of the existing literature on incentives and careers in organizations, Robert Gibbons (1997) invited empirical researchers to "provide evidence on a core set of questions before studying specific issues of their own." Two of these questions ask whether "wage increases and promotions are more likely with higher performance evaluations" and whether "the effect of seniority on wages (is) independent of the presence of controls for performance evaluation." The justification for these questions comes from the fact that most of what we know on the relationship between supervisors' evaluations, seniority, promotions and wages comes from two quite influential but old papers by Medoff and Abraham (1980 and 1981; MA hereafter) whose results, albeit widely quoted and discussed, have almost never been replicated and verified with different datasets.

The wide interest for the pioneering work of MA is motivated by the fact that their evidence is not only relevant for industrial psychologists willing to understand the nature and role of supervisors' evaluations. Perhaps more importantly, their evidence is aimed at offering a test of great interest for labor economists: a test of whether a positive effect of seniority on wages reflects an increase in productivity due to firm-specific human capital investment or not.[1]

In MA's work the basis for this test is the assumption that job performance ratings made by immediate supervisors are valid indicators of the relative current productivity of workers. Under this assumption, if the effect of seniority on wages were due to productivity, it should disappear after controlling for supervisors' evaluations. Furthermore, if more seniority increases the probability of a higher ranking in the distribution of wages it should also increase the probability of a higher ranking in the distribution of job performance indicators. Their finding is instead that the effect of seniority on wages is essentially independent from the presence of controls for supervisors' evaluations and that while higher seniority pushes workers up in the distribution of wages within levels it does not increase the worker's ranking in the distribution of performance ratings. They therefore conclude that the human capital theory cannot explain the effect of seniority on wages and that this effect must have different explanations.

The most prominent of the alternative explanations proposed in the literature is based on the idea that a positive correlation between seniority and wages is required by implicit employment contracts aimed at creating the proper incentives to exert effort, as for example suggested by Lazear (1979 and 1981). A similar positive correlation may also be generated by contracts aimed at protecting risk averse workers from wage changes induced by fluctuations in perceived productivity, as in Harris and Holmstrom (1982) or by sorting mechanisms as in Jovanovic (1979).[2]

[1] See for example Becker (1964), Mincer (1974), Mortensen (1978), Mincer and Jovanovic (1981) Brown (1989) and more recently Mincer (1997).

[2] For recent re-evaluations of this literature, see Carmichael (1989) and Hutchens (1989). See also

Another potentially more disruptive possibility, that received wide attention is that the observed positive correlation in OLS regressions is just an artifact of the data. Abraham and Farber (1987) and Altonji and Shakotko (1987) suggest, for example, that omitted variables representing the worker, the job or the worker-employer match might be positively correlated with lower quit rates and higher productivity. Therefore, the observed positive correlation between seniority and wages would be spurious and driven by these unobserved confounding factors. Both these papers reach the conclusion that earnings in fact do not rise very much with seniority. More recently, Topel (1991) has challenged this conclusion arguing that the two papers who propose it use inappropriate methods and/or data. On the contrary, Altonji and Williams (1997) defend and confirm the conclusion on the basis of a careful re-examination of the entire evidence.

For some scholars, the empirical question of *whether* wages do actually increase with seniority remains still open, as recently stated by Felli and Harris (1996). But, even if one were willing to accept the conservative estimates of Abraham and Farber (1987), Altonji and Shakotko (1987) and Altonjii and Williams (1997), the true effect of seniority on wages would nevertheless be approximately equal to 11% per ten years.[3] Even if this effect is small, it is not insignificant, and one would still like to know if it reflects an increase in productivity or other causes. Furthermore, even if firm-specific human capital investment were irrelevant and self selection of more productive workers in longer jobs were the explanation of the OLS crossectional estimates, controls for individual productivity should still be expected to reduce this effect. For these reasons, we believe that a replication and verification of the MA results using different data is still useful and informative twenty years later.

To be more precise the goal of our paper in not only to check whether MA's results can be replicated, but also to improve and extend their testing procedure using alternative direct indicators of individual productivity. As already mentioned above, the validity of their conclusions is based on an assumption that has been widely criticized in the literature: namely that supervisors' evaluations are a good measure of individual productivity. In their papers, MA anticipate this criticism answering several possible objections and strenuously defending their assumption. But the possibility that supervisors' evaluations have little to do with individual productivity remains a potential weak point of their approach.

We think that nothing can be added to what has been already written and said in defense or against this assumption. What is instead needed is the use of other and direct measures of individual productivity in order to check whether the results obtained by MA with supervisors' evaluations continue to hold.

Our proposed additional measures of current productivity are indicators of absen-

Booth and Frank (1996) and Pencavel (1991) who focus instead on the role of the explicit seniority wage scales often found in unionized sectors.

[3] This is the preferred estimate of Altonjii and Williams (1997) while the Topel (1991) estimate is approximately 24% and the standard OLS estimates are in the order of 35%.

teeism and reported misconduct episodes that can be constructed with the detailed and exhaustive information contained in our dataset. The justification for these measures is intuitive. Workers who are more often and for longer periods absent are less productive for the firm, whether or not their absenteeism is motivated by shirking or true bad health. Furthermore, inasmuch as the accumulation of firm specific human capital has to take place on the job, absenteeism must reduce such accumulation. In the case of misconduct episodes, a higher frequency and gravity of misbehaviour recorded by the personnel office indicates lower productivity precisely from the point of view of what the personnel office considers as harmful for the firm. Neither absenteeism nor misconduct episodes fully measure productivity, but they certainly represent two important components of this multidimensional concept. It seems, therefore, likely that they should be positively correlated to the employee's true current worth for the firm. Note also that being measures of individual productivity or effort they are largely independent from aggregate shocks affecting the firm. We therefore believe that they provide interesting measures of productivity on which to check the robustness of MA's conclusions.

Our results are unambiguous: all our performance indicators do not have any effect on the seniority-wage profile and while tenure increases the worker's ranking in the distribution of wages, it actually reduces his/her ranking in the distribution of these performance indicators. Only at low hierarchical levels (e.g. blue-collar and low level white collars workers) there is some evidence that productivity drives at least partially the relationship between seniority and wages.

Of course, the combination of ours and MA's results could still not disprove the possibility that the effect of seniority on wages reflects higher productivity of more senior workers. Suppose that productivity were the sum of two uncorrelated components: for example, *good conduct* and *knowledge*. If only the second grew with seniority our measures of *good conduct* would still leave the effect of seniority on wages unchanged. This (untestable) assumption notwithstanding, we believe that our results cast strong doubts on the hypothesis that productivity is the factor behind the growth of wages with seniority at least *within* hierarchical levels.

The paper is organized as follows. Section 2 presents the data. Section 3 replicates on our Italian sample the testing procedure proposed by MA in their 1980 article. Section 4 extends the original procedure using our alternative indicators of performance. Section 5 replicates the longitudinal evidence of the 1981 MA article using both their and our measures of productivity. Finally, Section 6 discusses possible alternative interpretations of the evidence and the conclusions that can be drawn upon it.

2 Data and Productivity Measures

The firm studied in this paper is a large bank with branches in every province of the Italian territory. From the personnel department of this bank we received several files containing, for different aspects of the employment relationship, information on all the relevant events characterizing the history of each employee of the bank. The information contained in these original files has been reorganized for the analysis into a panel data set with one observation per year for each worker on payroll between 1974 and 1995. The information on supervisors' evaluations which is crucial for this paper is however available only for the period 1989-95. In order to make our results comparable with the cross-sectional evidence of the 1980 MA article we concentrate on the last of these years.[4] In Section 5 we also replicate the longitudinal analysis of the 1981 MA article using observations for the period 1992-1995. In all sections, to construct some of our alternative productivity measures we also use the retrospective information offered by the panel structure of our data and, again to ensure comparability with MA, we limit the analysis to the male workforce.

A potentially disturbing but unavoidable difference with respect to the MA samples is instead represented by the fact that we received information on supervisors' evaluations only for non-managerial workers, while MA data include also employees in managerial jobs. This difference may make the comparability between ours and MA's results less informative but it does not seem to be in anyway essential for the testing procedure or for the interpretation of our results.

Our final sample contains data on 10809 male employees on payroll during 1995. Descriptive statistics of this sample are given in Table 1. This table reports also, for comparison purposes, the descriptive statistics for the Company A sample described by MA in their 1980 article. Whenever redundant, we omit for brevity the comparison with their Companies B and C. Note that Company A is the MA company with the number of observations and the supervisors' evaluation system more similar to those of our bank. Only in the case of the auxiliary evidence presented in Tables 4 and 5 we compare our bank with MA's Company B because MA do not present that type of evidence for their Company A. For the longitudinal analysis of Section 5 the comparison firm is instead the Company C analysed by MA in their 1981 article.

Both our and MA earnings are measured before taxes but at the annual frequency in the MA firm and at the monthly frequency in our firm. As in the MA's paper, we measure education with the highest school degree attained by the worker.[5] For workers in both firms, pre-company experience was calculated as the difference between potential working experience (computed on the basis of age and educational attainment) and

[4] Results could be replicated for any other year for which all the necessary information is available. The year 1995 has nothing special.

[5] Post-Laurea (post-college) degrees have been introduced very recently in the Italian education system and are irrilevant in the sample considered in this paper.

seniority. Current seniority is based on the precise date in which workers took service in the firms.

Hierarchical levels for our bank were constructed following the methodology described in Baker, Gibbs and Holmstrom (1994). The idea of this procedure is to identify the relevant levels in the firm's hierarchy by looking at the actual paths followed with greatest frequency by workers in their careers. Beginning with the first level, defined as the set of positions in which workers are more frequently hired (the *port of entry*), higher levels are sequentially identified as those positions through which workers more frequently transit in a typical career. The result has been a scale of 8 grade levels for the non-managerial employees on which this paper is focused. The distribution of workers across these levels is given in Table 1. Finally, Table 1 describes also the regional distribution of workers in our sample.

The supervisors' evaluations system at our bank is very similar to the system that characterizes MA's firm A. Supervisors receive detailed instructions on how to rank their subordinates using a four-level scale. These instructions are analogous to those described by MA and involve four possible choices labelled as *low, medium, good and very good*. Table 2 shows for Italy a strong concentration of employees in the higher evaluation ranks: only 2.4% of the Italian workforce is classified in the lowest performance group, while almost half of it is in the highest. Evaluation ratings are, however, more evenly distributed than in MA's company, where 74% of the workforce is concentrated in the third level. These are typical characteristic of subjective evaluation systems and have been used in the literature to argue that they cannot offer reliable measures of relative productivity because the lumping in the top category hides relevant productivity differentials. Evaluations have also been criticized as measures of productivity because supervisors are unlikely to follow uniform criteria and because irrelevant worker's characteristics might instead influence the criteria of supervisors.

If these problems exist they are certainly shared also by the system of supervisors' evaluations in use at our bank, although in this firm the more even distribution of ratings makes them somewhat less worrisome. We have nothing to add to the defense proposed by MA in their papers[6], but we believe that the most important contribution of MA does not live or die with the reliability of supervisors' evaluations as measures of productivity. The crucial value added of their paper consists in the identification of a procedure to test whether the effect of seniority on wages reflects higher productivity of more senior workers. This procedure, originally applied using supervisors' evaluations as measures of productivity, needs now to be applied using different and more direct measures. Therefore, since our data offer this possibility, our goal is not only to show that MA's conclusions can be replicated in our firm but also and more importantly to show that they are robust with respect to other productivity indicators.

We construct these alternative indicators from the detailed information that our

[6]See also Bishop (1987).

data set contains on the episodes of employee's absenteeism and misbehaviour recorded by the Personnel Office of our bank. As far as absenteeism is concerned, the variables that we use are constructed on the basis of the number of absence episodes per year of tenure that were due to illness and that lasted for more than 15 days. We obtain similar results using the average duration of episodes and we do not report them for brevity. Worker's misbehavior is instead measured on the basis of the number of episodes recorded and punished by the personnel office according to the procedure established by collective bargaining and by the *Statuto dei Lavoratori*.[7] These episodes involve unjustified absence and late arrivals, actions taken by the worker outside the relationship with the bank, but potentially relevant for the latter (e.g. fraud, theft etc.), violations of the internal regulations of the bank (e.g. omitted controls on checks, credit to unreliable customers, etc.) and inappropriate behaviour inside the workplace (e.g. sexual harassment, violence, insults, etc.). Possible punishments are chosen from a grid of sanctions established in collective bargaining that go from verbal reproaches to firing. Descriptive statistics concerning our additional performance indicators based on absenteeism and misconduct episodes are contained in Table 2.

Note that it is possible to assess whether our performance indicators correlate closely with supervisors' evaluations. Inasmuch as absenteeism and misconducts measure effectively productivity a close correlation would be evidence that evaluations reflect productivity as well. Table 3 shows that this is the case in our firm. The table reports the average values of the indicators of absenteeism and misconducts for each level of evaluation. Although the standard deviations are high, there is clear evidence that better evaluations are associated with lower absenteeism and more rare misconducts.

MA cannot produce this type of evidence in support of the relevance of supervisors' evaluations as measures of productivity. To anticipate possible critiques on this, they can only show that evaluations are important predictors of the probability that a worker is promoted and of the size of wage increases. In Tables 4 and 5 we show that the same happens in our Italian bank. In both tables, column 1 report the MA's estimates while column 2 reports the analogous estimates for our firm. In both firms, and in particular in the Italian one, controlling for individual characteristics and hierarchical levels, employees receiving better evaluations are more likely to be promoted and receive higher percentage wage increases. The probability of promotion is estimated using a Logit model while an OLS regression is used to predict percentage wage increases.

In columns 3 and 4 of the same tables we show that also our alternative indicators of productivity, based on absenteeism and misbehaviour, are important predictors of promotions (Table 4) and wage increases (Table 5). Controlling for individual characteristics and hierarchical levels, employees who are less frequently involved in absence or misconduct episodes are more likely to be promoted and receive larger percent wage

[7] The *Statuto dei Lavoratori* is the chart of workers' rights that regulates the most crucial aspects of Italian industrial relations.

increases.

Note that as far as supervisors' evaluations are concerned, one could argue that in these regressions causality goes in the opposite way in the sense that better evaluations are granted to justify promotions and wage increases that are previously decided on different grounds. In this case, higher evaluations would just be the bureaucratic consequence of the decision to promote or to give a wage increase. It seems instead difficult to claim that the same reverse link of causation occurs for our alternative indicators of productivity. Therefore, extending MA's procedure on the basis of measures of absenteeism or misbehaviour seems important for this reason as well. But before presenting the results of this extension, we want to show, in the next section, that MA's evidence based on supervisors' evaluations is replicated in our firm.

3 Replication: the effect of supervisors' evaluations

MA's empirical analysis in the 1980 article is based on two distinct steps performed on cross-sectional data. The first one consists of the estimation of earning functions with or without controls for supervisors' evaluations. In these regressions they find that the coefficient of seniority remains the same independently of the presence or absence of these controls. The second step is based on a multinomial logit analysis aimed at establishing if workers who rank higher in the distribution of earnings because of seniority, have also, for the same reason, a higher ranking in the distribution of performance evaluations. In this analysis they find that while higher seniority pushes workers up in the distribution of earnings it tends to lower their position in the distribution of evaluations. In this section we replicate these two steps to check whether MA's results are confirmed in our firm.

3.1 Earning functions.

Table 6 reports comparable estimates of ln(pre-tax earning) functions based on our firm and on MA's Company A. The models in columns 1 and 4 are based on the standard human capital specification of these regressions. The first set of regressors are dummies for schooling levels. Until very recently, the Italian education system did not offer master and doctorate degrees and, therefore, dummies for these degrees are not available in the Italian sample. The comparison concerning the other educational coefficients shows that, holding labor market experience constant, returns to education are substantially lower in Italy.[8] With respect to college degree holders (the omitted

[8]This result complements in an important way the comparative evidence offered by Erickson and Ichino (1994) because it shows that their finding of lower educational returns in Italy are not a consequence of the use of after tax earnings. In that paper, in fact only after–tax earnings were available for Italy (compared to pre–tax earnings for the US), while here the comparisons concerns

category in both samples), Italian employees experience an income loss of 18% if they have less than a highschool diploma, while similarly educated US workers lose 25%. Holding just the highschool diploma implies a loss of 5% in Italy and of 13% in the US.

The next set of regressors captures the effect of total labor market experience distinguishing between time potentially spent with previous employers and seniority in the current firm. Both these effects are captured by linear and quadratic terms. Potential previous experience has basically no effect on current wages in the Italian sample. Probably because of high firing costs in Italian large service firms, employees at our bank are usually hired very soon after leaving schools and careers take place within the firm as in the Internal Labor Market paradigm.[9] In this way the firm can minimize the cost of having to keep on payroll workers that after hiring prove undesirable but too costly to fire. As a result, seniority represents more than 80% of total labor market experience for more than 50% of the workforce. We therefore believe that, as far as labor market experience is concerned, the comparison between our's and MA's results is probably interesting and meaningful only for the effect of seniority.

As far as seniority is concerned, 10 years of company service increase wages more in the Italian firm than in the US firm but the effects are similar. At ten years of seniority, ten more years of seniority increase wages by approximately 19% in Italy and by approximately 14% in the U.S.[10] Therefore, in both firms more senior workers are observed to earn substantially higher wages and the question addressed by MA is whether this effect has to be attributed to productivity or to other reasons.

Since supervisors' evaluations can be interpreted as indicators of relative productivity only within hierarchical levels, MA's next step consists in estimating how much of the effects of education and experience remains holding hierarchical levels constant. Their results are presented in column 5 while the comparable Italian results are in column 2. In both countries most of the loss due to holding less than a highschool diploma instead of a college degree comes from assignment to levels with lower mean earnings. For highschool graduates, instead, the loss takes place within grade levels in Italy, but between grade levels in the US.

Coming to seniority, a significant and similar effect of company service remains in both countries also after controlling for hierarchical levels: 44% of the return from one additional year of seniority occurs within grade level in the MA firm while 47% is the analogous figure for our bank.

If this within-level effect of seniority on wages were due to higher productivity of more senior workers, the introduction of productivity indicators should eliminate or at

pre-tax earnings in both countries.

[9]See Doeringer and Piore (1971).

[10]Note that, following MA, these estimates are based on a quadratic specification of the effect of tenure on wages and therefore are not directly comparable with the linear estimates generally found in the literature that we report in footnote 3.

least reduce it. However, columns 3 and 6 show that the introduction of dummies for supervisors' evaluations leave the coefficients on seniority, as well as those on education, basically unchanged. MA interpret this result as evidence that "performance does not appear to be a mediating factor in the within-grade level positive relationship between either education or labor force experience and earnings".

3.2 Multinomial logit analysis

The second step of the MA's analysis is aimed at establishing whether seniority raises the employee's ranking not only in the distribution of wages but also in the distribution of performance evaluations. Following the MA's procedure, given the small fraction of workers who got the lowest rating, we first grouped together the two bottom evaluation levels 1 and 2. In this way we obtained three evaluation categories re-labelled respectively as *low*, *medium* and *high*.

We then created a trivariate categorization of within-level wages (*low, medium, high*) in the following way. Suppose for example that in the first hierarchical level 10% of the workers receive a *low* evaluation, 60% receive a *medium* evaluation and 30% a *high* evaluation. Given these quantiles, we classified in the *low* wage category those workers in level 1 who were in the bottom 10% of their within-level wage distribution; in the *high* wage category those who were in the top 30% and in the *medium* wage category those who were in the intermediate 60% group. We then repeated the same procedure for each of the 8 hierarchical levels. In this way we obtained a trivariate classification for both performance and wages and each worker was assigned to a wage and to a performance category. If workers with higher wages have also higher performance evaluations, the two classifications should match perfectly. Indeed, the match is quite good although not perfect as shown by the fact that the correlation between the two classifications is 0.37. But the crucial question that these two classifications raise is whether the effect of seniority on assignments is the same in both. This question is relevant because if more senior workers were also more productive, higher seniority should increase not only the probability of an assignment to a higher wage category but also the probability of an assignment to a higher evaluation category.

Table 7 reports, for the two firms, multinomial logit estimates of the probability of assignment to the evaluation and wage categories. Looking first at the MA's results in columns 5, 6, 7, and 8, education, previous experience and seniority increase the probability of assignment to the two higher wage categories but reduce or leaves unchanged the probability of assignment to the two higher evaluation categories.

In the Italian firm, disregarding previous experience for the reasons outlined above, education and seniority have again different effects on the employees' position in the two classifications. Higher education increases the probability of assignment to the higher wage categories but reduces or leaves unchanged the probability of higher performance evaluations. As far as company service is concerned, the Italian firm does

not feature opposite effects of seniority on wages and evaluations, but the coefficients remains markedly different in addition to being higher than in the US firm. Seniority increases significantly the probability of a higher ranking in the distribution of wages but much less, in relative terms, the probability of a higher ranking in the distribution of performance evaluations.

The fact that both the earning function and the multinomial logit analysis for our firm confirm MA's results, strengthen the conclusion that, within levels, the effect of seniority on wages does not reflect higher productivity of more senior workers. MA's result are not due to a peculiarity of their firm but can be replicated in a different firm, in different years and in a country characterized by very different labor market institutions.

However, the evidence presented in this section for the Italian firm shares with the MA's evidence the critique concerning the use of supervisors' evaluation. Therefore, in the next section we adapt the testing procedure proposed by MA to alternative direct measures of workers' individual productivity.

4 Extensions: the effect of objective productivity measures

The alternative productivity indicators on which our analysis is based are constructed in the way described in Section 2 from the detailed information that our data set contains on the episodes of absenteeism and misbehaviour recorded by the personnel office of our bank. We examine first the evidence based on earning functions. Then we move to the evidence based on the assignment to productivity and wage categories, that, given the characteristics of our productivity indicators, will take the form of a simple logit analysis.

4.1 Earning Functions

Table 8 reports the results of the estimation of earning functions. For the reader's convenience, the first column reproduces the estimates of the basic human capital specification (augmented with hierarchical levels) presented in column 2 of Table 6. Columns 2, 3 and 4 show how instead these estimates are modified by the introduction of our alternative productivity indicators, separately or together and in combination with supervisor's evaluations. In each specification the productivity measures are highly significant, but they leave the coefficient of the education and experience variables practically unchanged.[11]

[11]Note that given the close relationship diplayed in Table 3 between supervisors' evaluations and our objective indicators of performance it is not surprising that the R^2 of column 4 in Table 8 is very

If anything, absenteeism appears to have a marginally greater negative effect on the seniority coefficient, but the overall picture coming out of this table basically confirms the results of Section 3.1: on average, within hierarchical level, more senior workers do not seem to earn more because they are more productive, at least as far as absenteeism and misconduct episodes are measures of productivity.

One could argue that even if productivity is not the driving force of the wage-seniority profile *within* hierarchical levels, it may still affect this profile *between* levels. Note that MA could not explore this issue because supervisors' evaluations are comparable only within levels and therefore cannot be included as meaningful productivity measures in earnings functions estimated without controlling for the firm's hierarchy. On the contrary, our objective indicators of productivity are comparable across all workers and independent of the employee's level. Hence, using these alternative measures we can replicate the regressions of Table 8 without controlling for levels.[12] This is done in Table 9. The results are again striking and reinforce MA's conclusions. Absenteeism and misconduct episodes have a significant direct effect on between-levels wage growth, but have no influence on the between-levels wage seniority profile.

Thanks to our larger sample size we can extend MA's work in another interesting direction obtaining results that, in contrast to what we found so far, weakens somewhat their general conclusion. Table 10 shows that if we restrict the analysis to blue-collar workers or low-level white-collar workers, the inclusion of productivity indicators like supervisor's evaluations in the earnings regression affects significantly the wage-seniority profile making it flatter. On the contrary, the wage seniority profile of workers in higher hierarchical levels appears to be totally unaffected by productivity. This hetorogenity of effects by levels is not replicated, however, in Table 11 where productivity is measured by our objective indicators of absenteeism and misconduct Nevertheless, the evidence based on supervisor's evaluations seems strong enough to support the hypothesis that the independence of the wage seniority profile from productivity is not equally strong at all hierarchical levels. Only at the highest levels one can say with confidence that productivity is not the driving force of the wage-seniority profile. In contrast with MA conclusions, at low levels, individual performance appears to contribute significantly to an explanation of the effect of seniority on wages.

4.2 Logit analysis

In order to adapt the MA's multinomial logit analysis to our productivity indicators we proceed as follows. In the case of misconduct episodes, the *high* productivity category is defined by the group of employees who were never reported for misconduct during their company service. Given the proportion of workers in this status for each hierarchical

similar to the R^2 of column 3 in Table 6.

[12] We thank an anonymous referee for suggesting this to us.

level, the same fraction of workers in the highest tail of the distribution of wages of each level was assigned to the *high* wage category. In the case of absenteeism we created a bivariate classification in which the *high* productivity category is defined by the group of employees who were never sick and absent from work for more than 15 days. The corresponding *high* wage category is therefore constituted by those employees who were found in the highest correspondent percentile of the distribution of wages within each level.

As in Section 3.2, if seniority increases the probability of an assignment to the high wage categories it should also increase the probability of an assignment to the high productivity categories defined in terms of absenteeism and misconduct. If this were the evidence the hypothesis that the effect of seniority on wages reflect productivity differences could not be rejected.

However, Table 12 shows that the evidence goes in the opposite direction. While the marginal effect of seniority on the probability of an assignment to the high productivity category is negative, the analogous effect on the probability of an assignment to the high wage category is positive. And this happens with both the indicators based on absenteeism and misbehaviour.

One could argue that this evidence does not exclude that more senior workers are worth more to the firm and therefore are paid more. But shows that this is certainly not happening because more senior workers are less often absent or less often punished for misbehaviour. Quite the opposite, more senior workers appears to be on average more prone to absence and to misconduct episodes.

5 Replication: longitudinal results

In their 1981 article, MA note that even if the human capital explanation of the wage-seniority profile were true, the cross-sectional analysis described so far could be misleading because a correct estimation of the wage-seniority profile requires longitudinal data. Indeed, more senior workers could appear to be more productive not because they invest more in firm specific human capital, but simply because less productive workers (matches) are fired (dissolved) after fewer years of company service.

To address this issue MA use a panel constructed from their Company C data in which they observe workers for four years. They restrict the analysis to workers who do not change levels within a given time period (e.g. one, two or three years) and they compare measures of the relative increase in performance with measures of the relative increase in earnings experienced by these workers. The results are once again quite striking. Overtime, for those persons not changing grade level, relative within-level wage increases substantially while relative within-level performance remains relatively stable or deteriorates.

In Tables 13, 14 and 15 we replicate the evidence on which these conclusions are

based and in particular the estimates contained in Table 3 of the the 1981 article, adjusted appropriately for the performance indicators available in our firm and for the time periods in which we have the necessary data. Each table is based on a different performance indicator: supervisor's evaluations, misconducts and absenteeism. Following the procedure described respectively in the notes to the three tables, we constructed for each indicator a measure of relative performance P_{it} and a corresponding measure of relative wage S_{it}, where i denotes an individual and t is time. Using these measures we estimated the predicted change in relative performance and the predicted change in relative wage using the equations:

$$P_{it+1} - P_{it} = \xi_1 + \xi_2(X^2_{it+1} - X^2_{it}) + \nu_{it+1} - \nu_{it} \quad (1)$$

$$S_{it+1} - S_{it} = \theta_1 + \theta_2(X^2_{it+1} - X^2_{it}) + \omega_{it+1} - \omega_{it}, \quad (2)$$

where X denotes years of tenure.[13] Note that in these first-difference equations all time invariant observable and unobservable determinats of individual performance and wages cancel out. Each table displays the predicted ΔP and ΔS computed for an individual with the mean amount of company tenure and for one-, two-, or three-years changes .

In all cases, there is an evident divergence between the predicted performance and wage increases. When variables are constructed on the basis of supervisor's evaluation (Table 13), both changes are predicted to be positive for all time differences, but wage increases are considerably larger. Hence a big component of the within-level relative wage increase experienced by the representative individual can hardly be attributed to a corresponding increase in relative performance. MA find an even stronger result on the basis of supervisor's evaluations in their firm: i.e. while their predicted ΔP is negative, their predicted ΔS is positive. We do not find a similar pattern of positive and negative signs when we base the analysis on supervisor's evalutaions, but we do find it for both our alternative measures of performance, as shown in Tables 14 (misconducts) and 15 (absenteeism).

Hence, also on the basis of a longitudinal analysis which controls for time invariants determinants of individual wages and performance, we can conclude, in line with MA, that within level growth in relative earnings cannot be explained by improvements in relative performance. Moreover, inasmuch as performance is measured in terms of relative absenteeism and misconducts, while wages increase with tenure, quite surprisingly productivity appears to deteriorate.

6 Discussion and conclusions

The possibility to replicate MA's results twenty years later, in a different firm and in a country characterized by different labor market institutions is a finding that in our

[13] These are the equations 12 and 13 in the 1981 MA article.

opinion reinforces MA's original conclusion that, within hierarchical levels, productivity is not the driving force of the observed upward sloping wage-seniority profiles. Extending MA's original analysis, we find that only at the lowest levels of the firm's hierarchy there is some evidence that workers' performance contributes to explain the effect of seniority on wages.

The simple replication of MA's empirical analysis, based on supervisors' evaluations as indicators of productivity, suffers of the same weakness of their approach: namely, that supervisors' evaluations might not measures in a satisfactory way individual relative productivity. A hopefully interesting contribution of our work is to show that MA's results are robust to the use of alternative objective indicators of relative productivity.

Somewhat surprisingly, in their 1981 article Medoff and Abraham claim that "hard" and "objective" measures of productivity do not dominate "soft" and "subjective" performance ratings or rankings for two main reasons. First, because it is hard to find objective measures that convincingly quantify "the true value of a worker to his or her firm". And second because "there would have to be only one dimension relevant for assessing the employee's true current worth or the researcher would have to know the proper set of weights or shadow prices to attach to each relevant dimension." However, in the same paper, they show that any performance indicator P which captures current productivity, albeit with some errors should reduce the value of the coefficient of seniority in earning equations. "This is true even if the performance variable which is introduced captures current productivity with error, provided only that there is some information about productivity contained in the performance variable and that the error in the performance variable is uncorrelated with experience and ability". Of course the reduction of the coefficient on seniority should be larger the smaller the error with which the performance indicator approximates the true productivity of the worker.

We believe that indicators of absenteeism and reported misconduct episodes satisfy precisely the requirements that a performance indicator needs in order to offer a test of whether the observed effect of seniority on wages reflects productivity differentials. Workers who are more often absent are evidently less productive for the firm, whether or not their absenteeism is motivated by shirking or true bad health. Furthermore, inasmuch as the accumulation of firm specific human capital has to take place "on the job" absenteeism must reduce such accumulation. Similarly, for misconduct episodes, a higher frequency and gravity of misbehaviour recorded by the personnel office clearly indicate lower productivity. These are precisely episodes in which the personnel office considers the behaviour of an employee as harmful for the firm.

In contrast with MA's scarce faith in the usefulness of objective indicators of productivity, we think that our collage of evidence based on both subjective and objective measures, offers more convincing arguments against the idea that the effect of seniority on wages reflects the higher productivity of more senior workers.

Nevertheless, this collage of evidence is certainly not sufficient to *completely* dismiss with confidence the hypothesis of a productivity driven wage-seniority profile.

This because productivity is a multidimensional concept that we do not know how to measure precisely. Suppose for example that productivity were the sum of two uncorrelated components: knowledge and good conduct. Suppose also that knowledge grows with seniority while good conduct is independent of company service. Under these assumptions wages could grow with seniority because of the underlying unobservable increase in knowledge. Yet, proxies for good conduct like indicators of absenteeism and misconduct episodes would have no effect on the wage-seniority profile. The evidence based on our alternative measures would not mean that productivity is irrelevant for the wage-seniority profile. Note that the evidence based on supervisors' evaluations is probably more robust with respect to this problem since evaluations are likely to reflect both knowledge and good conduct. Given the multidimensionality and unobservability of the concept of productivity, each proxy has advantages and disadvantages, and only a collage of different indicators drawn from newer and better data can provide the final answer.

A related problem in the interpretation of our findings is represented by the fact that there are different ways in which productivity may be the driving force of upward sloping wage-seniority profiles in cross-sectional regressions. First of all, more senior workers may be more productive because they have invested more in firm specific human capital. But, alternatively, they may be more productive simply because less productive workers (matches) are fired (dissolved) after fewer years of company service. To deal with this issue we are able to replicate also the longitudinal analysis of the 1981 MA article, finding additional evidence against the first hypothesis i.e. the one based on genuine human capital accumulation: looking at a panel of workers observed within the same hiearchical levels for three years, we find that while wages increase, all the productivity indicators deteriorate.

The second hypothesis, based on the selection of better workers in longer jobs, may be relevant in general, but probably not in the specific situation of our firm. In principle, employees more prone to absenteeism or misconduct might be expected to be fired or to be induced to quit earlier in their careers. This should induce a selection of workers such that seniority should appear to be associated with a lower number of absence and misconduct episodes per year of tenure. Yet we know from Table 12 that this is not happening in our sample: higher seniority is associated with more absence and misconduct episodes.

We think that this finding is the consequence of the low turnover characterizing this firm (less than 4% per year) and in particular of the insignificant number of firing or induced quits for disciplinary reasons (424 in 21 years and in a firm with employment levels ranging between 15000 and 19000). These numbers suggest that almost no selection of workers has taken place in this firm, and in particular no selection of better workers in longer jobs. This appears to be a firm in which most of the employment is for life because monopolistic rents due to government regulations are large and widely shared with workers, who therefore tend not to quit voluntarily. On the other side

firing costs, particularly those due to the unavoidability of legal conflicts in case of firing[14], are prohibitive and reduce turnover for disciplinary reasons.

Given this situation, even if in less regulated markets it were possible that upward sloping wage-seniority profiles were due to the selection of better workers in longer jobs, this is probably not happening in the case of this Italian firm simply because almost no selection takes place and jobs are for life. Therefore, the fact that our indicators of productivity do not change the wage-seniority profile is more likely to be evidence against explanations in which greater productivity is a genuine driving force of this relationship. As suggested twenty years ago by Medoff and Abraham, alternative theories in which wages are deferred for incentive or insurance reasons are more likely to explain the observed evidence.

[14]See Ichino, Polo and Rettore (2000).

References

Abraham K., and Farber H. (1987), "Job Duration, Seniority, and Earnings", *American Economic Review*, V. 77, No. 3.

Altonji J., and Shakotko R. (1987), "Do Wages Rise with Job Seniority?", *Review of Economic Studies*, V. 54, pp. 437-459.

Altonji J., and Williams N. (1997), "Do Wages Rise with Job Seniority? A Reassessment", *NBER Working Paper*, No. 6010.

Becker G. (1964), *Human capital: a theoretical analysis with special reference to education*, New York: Columbia University Press for NBER.

Baker G., Gibbs M., and Holmstrom B. (1994), "The Internal Economics of the Firm: Evidence from Personnel Data", *Quarterly Journal of Economics*, V. 59, pp. 881-919.

Bishop J. (1987), "The Recognition and Reward of Employee Performance", *Journal of Labor Economics*, V. 5, No. 4, Pt. 2.

Booth, A.L. and J. Frank (1996), "Seniority, Earnings and Unions", *Economica*, V. 63, 673-686.

Brown J. (1989), "Why Do Wages Increase with Tenure? On-the-Job Training and Life-Cycle Wage Growth Observed Within Firms", *American Economic Review*, V. 79, No. 5.

Carmichael H. L. (1989), "Self Enforcing Contracts, Shirking and Life Cycle Incentives", *The Journal of Economic Perspectives*, 3, 65-84.

Doeringer, P.B. and M.J. Piore (1971), *Internal Labor Market and Manpower Analysis*, Lexington, Mass.: D.C. Heath and Co.

Erickson C., and A. Ichino (1994) "Wage Differentials in Italy: Market Forces, Institutions and Inflation", in R. Freeman and L. Katz, *Differences and Changes in the Wage Structure*, NBER, University of Chicago Press, 1995, pp. 265-305.

Felli L., and Harris C. (1996), "Learning, Wage Dynamics, and Firm-Specific Human Capital", *Journal of Political Economy*, V. 104, No. 4.

Gibbons R. (1997), "Incentives and Careers in Organizations", in D. Kreps and K. Wallis (eds.), "Advances in Economic Theory and Econometrics", Cambridge University Press, New York pp. 1-37.

Ichino A., M. Polo And E Rettore (2000), "Are Judges Biased by Labor Market Conditions? The Selection of Firing Litigations for Trial in a Large Italian Firm", EUI mimeo.

Jovanovic B. (1979), "Job Matching and the Theory of Turnover", *Journal of Political Economy*, 87, 973-90.

Harris M., and Holmstrom B. (1982), "A Theory of Wage Dynamics", *Review of Economic Studies*, XLIX, 315-333.

Hutchens R. M. (1989), "Seniority, Wages and Productivity: a Turbulent Decade", *The Journal of Economic Perspectives*, 3, 49-64.

Lazear E. (1979), "Why is there Mandatory Retirement?", *Journal of Political Economy*, 87, 1261-84.

Lazear E (1981), "Agency, Earnings Profiles, Productivity and Hours Restrictions", *American Economic Review*, 71, 606-720.

Medoff J., and Abraham K. (1980), "Experience, Performance, and Earnings", *Quarterly Journal of Economics*, December.

Medoff J., and Abraham K. (1981), "Are Those Paid More Really More Productive? The Case of Experience", *The Journal of Human Resources*, V. 15, No. 2.

Mincer J. (1974), *Schooling, Experience, and Earnings*, New York: NBER.

Mincer J. (1997), "The Production of Human Capital and the Life Cycle of Earnings: Variations on a Theme", *Journal of Labor Economics*, V. 15, No. 1, Pt. 2.

Mincer J., and Jovanovic B. (1981), "Labor Mobility and Wages", in Rosen S. (ed.), "Studies in Labor Market", NBER Universities-National Bureau Conference Series, No. 31, Chicago: University of Chicago Press, 1981, 21-64.

Mortensen D. (1978), "Specific Capital and Labor Turnover", *Bell Journal of Economics*, Autumn 1978, 9, 572-86.

Pencavel J. (1991), *Labor Markets under Trade Unionism*, Cambridge, MA: Basil Blackwell.

Topel R. (1991), "Specific Capital, Mobility, and Wages: Wages Rise with Job Seniority", *Journal of Political Economy*, V. 99, No. 1.

Table 1: Descriptive statistics of the samples used in the analysis

	Means (Standard Deviations)	
	Our Sample (N=10,809)	MA Sample (N=4,788)
Month/Annual wage (Italian lira/dollar)	3,184,906 (472,908)	17,884 (3,240)
Highest level of education:		
Less than high school	0.248	0.05
High school	0.583	0.449
Laurea/Bachelor's degree	0.169	0.444
Master		0.049
Doctorate		0.007
Age (years)	40.7 (8.5)	43.1 (10.5)
Pre-company experience (years)	5 (4.6)	6.8 (6.7)
Seniority (years)	16.4 (8.3)	16.8 (10.4)
Levels:		
Ausiliari (Blue Collar)	0.011	
Commessi (Blue Collar)	0.034	
Low-Entry White Collar	0.053	
High-Entry White Collar	0.202	
White Collar (level 5)	0.127	
White Collar (level 6)	0.238	
White Collar (level 7)	0.179	
Quadro	0.156	
Regional dummies:		
North	0.631	
Centre	0.199	
South	0.170	

Note: The MA Sample is the Company A sample described in MA 1980. The distribution across levels and regions is not reported by MA.

Table 2: Characteristics of the productivity measures used in the analysis

	Mean (standard deviation)	
	Our Sample (N=10,809)	MA Sample (N=4,788)
Supervisors' evaluations:		
1 = Worst	0.024	0.002
2	0.125	0.053
3	0.369	0.743
4 = Best	0.483	0.202
Our performance indicators:		
Number of absences episodes	0.093	
per year of seniority	(0.146)	
Number of misconducts episodes	0.009	
per year of seniority	(0.033)	
= 1 if worker was never absent	0.419	
	(0.493)	
= 1 if worker never misbehaved	0.887	
	(0.316)	

Note: The MA sample is the Company A sample described in MA 1980. Absence episodes are defined as instances in which the employee has been away from work for health related reasons and for more than 15 days. Misconduct episodes are defined as episodes of misbehaviour reporeted to the Personnel Office and punished by the latter according to what is established by collective bargaining and by the *Statuto dei Lavoratori*.

Table 3: Abseenteeism and misbehavior at each level of supervisors' evaluations

Supervisors' evaluation	Number of absence episodes per year of seniority	Number of misconduct episodes per year of seniority	Sample size
1 = Worst	0.212	0.036	255
	(0.309)	(0.088)	
2	0.113	0.013	1349
	(0.213)	(0.048)	
3	0.094	0.009	3985
	(0.145)	(0.032)	
4 = Best	0.081	0.006	5220
	(0.103)	(0.021)	

Note: The table reports the average values of our performance measures for each of the four levels of supervisors' evaluation. Standard deviations are reported in parenthesis.

Table 4: Determinants of the Probability of Promotion; Logit estimates

	MA Sample (N=2,728)	Our Sample (N=10,809)		
< High School	0.09	-0.60	-0.51	-0.51
	(0.66)	(0.17)	(0.17)	(0.17)
High School	-0.39	-0.21	-0.21	-0.21
	(0.23)	(0.09)	(0.09)	(0.09)
Master	0.25			
	(0.28)			
Doctorate	-0.002			
	(0.49)			
Previous exper./10	-0.71	-0.41	-0.50	-0.49
	(0.32)	(0.22)	(0.22)	(0.22)
(Previous exper.)^2/100	0.08	0.02	0.08	0.08
	(0.11)	(0.09)	(0.09)	(0.09)
Seniority/10	-1.28	0.51	1.18	1.14
	(0.30)	(0.22)	(0.21)	(0.21)
(Seniority)^2/100	0.23	-0.47	-0.65	-0.65
	(0.08)	(0.07)	(0.07)	(0.07)
Evaluation = 1 or 2 (MA sample)	-0.99	-1.13		
Evaluation = 1 (our sample)	(0.21)	(0.43)		
Evaluation = 3		0.93		
		(0.12)		
Evaluation = 4	-0.14	1.31		
	(0.38)	(0.13)		
N. of absences episodes			-0.74	
per years of seniority			(0.25)	
N. of misconducts episodes				-3.01
per years of seniority				(1.13)
Regional dummies	Yes	Yes	Yes	Yes
Level dummies	Yes	Yes	Yes	Yes
Constant	Yes	-3.01	-2.31	-2.30
	—	(0.21)	(0.19)	(0.19)
PseudoR^2	—	0.115	0.095	0.095

Note: The table presents the logit coefficients, as in MA 1980, with standard errors in parenthesis. MA sample (Company B of MA 1980): dependent variable = 1 if promotion takes place between July 1, 1976 and July 1, 1977; omitted dummies: College degree and evaluations = 3 and 4. Our Sample: dependent variable = 1 if promotion takes place between November 1, 1994 and December 31, 1995; omitted dummies: Laurea and evaluation = 2.

Table 5: Determinants of the percentage wage increases; OLS estimates

	MA Sample (N=2,763)	Our Sample (N=10,615)		
$<$ High School	0.12	0.73	1.04	1.06
	(0.50)	(0.49)	(0.49)	(0.49)
High School	-0.06	-0.89	-0.77	-0.76
	(0.19)	(0.30)	(0.30)	(0.30)
Master	-0.49			
	(0.29)			
Doctorate	-0.35			
	(0.50)			
Previous exper./10	-0.71	-0.91	-1.06	-1.01
	(0.29)	(0.63)	(0.63)	(0.63)
(Previous exper. $)^2/100$	0.04	-0.32	-0.22	-0.25
	(0.10)	(0.26)	(0.26)	(0.26)
Seniority/10	-1.52	-0.24	0.34	0.22
	(0.28)	(0.53)	(0.53)	(0.53)
$(\text{Seniority})^2/100$	0.26	0.08	-0.05	-0.03
	(0.08)	(0.13)	(0.13)	(0.13)
ln(annual wage) at $t-1$	-8.30	-25.32	-23.98	-24.03
	(0.80)	(1.11)	(1.10)	(1.10)
Evaluation = 1	-2.88	-2.99		
	(0.68)	(0.75)		
Evaluation = 2	-1.74			
	(0.16)			
Evaluation = 3		1.52		
		(0.33)		
Evaluation = 4	0.99	2.09		
	(0.38)	(0.35)		
N. of absences episodes			-2.38	
per year of seniority			(0.68)	
N. of misconducts episodes				-15.33
per year of seniority				(2.93)
Regional dummies	Yes	Yes	Yes	Yes
Level dummies	Yes	Yes	Yes	Yes
Constant	Yes	467.88	445.41	446.37
	—	(19.77)	(19.60)	(19.57)
R^2	0.147	0.068	0.062	0.064

Note: MA sample (Company B of MA 1980): Dependent variable = Percentage wage change beteewn 1977 and 1976; omitted dummies: College degree and evaluation = 3. Our Sample: Percentage wage change between 1995 and 1994. Omitted dummies: Laurea and evaluation = 2. Standard errors in parentheses.

Table 6: Earning functions; OLS estimates

	Our Sample			MA Sample		
Model:	1	2	3	4	5	6
N. obs:	10809	10809	10809	4788	4788	4788
< High School	-0.18	-0.04	-0.04	-0.25	-0.08	-0.08
	(0.004)	(0.003)	(0.003)	(0.01)	(0.007)	(0.007)
High School	-0.05	-0.04	-0.04	-0.13	-0.01	-0.02
	(0.003)	(0.002)	(0.002)	(0.005)	(0.003)	(0.003)
Master				0.10	0.02	0.02
				(0.01)	(0.006)	(0.006)
Doctorate				0.21	0.05	0.05
				(0.025)	(0.016)	(0.016)
Previous exper./10	-0.003	-0.005	-0.003	0.04	0.02	0.03
	(0.006)	(0.004)	(0.004)	(0.008)	(0.005)	(0.005)
(Previous exper.)^2/100	-0.006	0.003	0.001	-0.00	-0.00	-0.00
	(0.002)	(0.001)	(0.001)	(0.003)	(0.002)	(0.002)
Seniority/10	0.25	0.13	0.12	0.20	0.09	0.09
	(0.004)	(0.003)	(0.003)	(0.008)	(0.006)	(0.006)
(Seniority)^2/100	-0.03	-0.01	-0.01	-0.03	-0.01	-0.01
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
Evaluation = 1			-0.16			-0.05
			(0.004)			(0.027)
Evaluation = 2						-0.04
						(0.006)
Evaluation = 3			0.022			
			(0.002)			
Evaluation = 4			0.029			0.03
			(0.002)			(0.003)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Level dummies		Yes	Yes		Yes	Yes
Constant	14.75	15.00	14.98	Yes	Yes	Yes
	(0.003)	(0.003)	(0.003)	—	—	—
R^2	0.648	0.856	0.860	0.356	0.741	0.747

Note: The dependent variable is the log of pre-tax month (our sample) or annual (MA sample) earnings for both firms; the omitted dummies in our sample are: Laurea and Evaluation = 2; the omitted dummies in MA's sample are: College degree and Evaluation = 3; the MA sample is Company A sample in MA 1980; standard errors are in parentheses.

Table 7: Assignment to performance and wage categories; multinomial logit estimates

Model:	Our Sample				MA sample			
N. obs:	10809		10809		4784		4784	
Depvar:	Performance		Wage		Performance		Wage	
	Medium	High	Medium	High	Medium	High	Medium	High
$<$ High School	0.31	1.33	-1.52	-3.54	0.21	0.50	-2.54	-3.04
	(0.17)	(0.17)	(0.26)	(0.29)	(0.31)	(0.37)	(0.29)	(0.34)
High School	-0.08	0.29	-1.90	-3.29	0.23	0.47	-0.58	-0.57
	(0.09)	(0.10)	(0.13)	(0.15)	(0.17)	(0.18)	(0.19)	(0.20)
Master or Phd					0.11	0.24	1.16	1.65
					(0.35)	(0.36)	(0.47)	(0.49)
Previous exper.	-0.52	-0.79	-0.33	-0.55	-0.81	-1.32	0.44	0.83
/10	(0.23)	(0.23)	(0.28)	(0.31)	(0.27)	(0.29)	(0.27)	(0.29)
(Previous exper.)^2	0.26	0.51	0.17	0.25	0.20	0.27	-0.07	-0.08
/100	(0.10)	(0.10)	(0.12)	(0.13)	(0.10)	(0.11)	(0.09)	(0.11)
Seniority/10	1.78	2.61	10.74	7.99	0.43	-0.12	1.12	2.90
	(0.16)	(0.17)	(0.41)	(0.45)	(0.26)	(0.29)	(0.28)	(0.32)
(Seniority)^2/100	-0.49	-0.57	-2.67	-0.50	-0.13	-0.06	-0.13	-0.41
	(0.04)	(0.04)	(0.14)	(0.15)	(0.06)	(0.07)	(0.07)	(0.08)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Level dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	1.42	1.35	-3.10	-2.42	Yes	Yes	Yes	Yes
	(0.26)	(0.27)	(0.34)	(0.37)	–	–	–	–
PseudoR^2	0.161		0.469		–		–	

Note: The dependent variables are the trivariate performance and wage classifications. The omitted category for both classifications is the lowest one. The college degree is the omitted education dummy. The MA's sample is the Company A sample in MA 1980; standard errors in parentheses.

Table 8: Earning functions with objective productivity measures; OLS estimates

Model :	1	2	3	4
N. obs:	10809	10809	10809	10809
< High School	-0.04	-0.04	-0.04	-0.04
	(0.003)	(0.003)	(0.003)	(0.003)
High School	-0.04	-0.04	-0.04	-0.04
	(0.002)	(0.002)	(0.002)	(0.002)
Previous exper./10	-0.01	-0.005	-0.005	-0.003
	(0.004)	(0.004)	(0.004)	(0.004)
(Previous exper.)^2/100	0.003	0.003	0.002	0.001
	(0.002)	(0.002)	(0.002)	(0.002)
Seniority/10	0.13	0.13	0.13	0.12
	(0.003)	(0.003)	(0.003)	(0.003)
(Seniority)^2/100	-0.02	-0.02	-0.02	-0.01
	(0.001)	(0.001)	(0.001)	(0.001)
N. of absences per year of seniority		-0.02		-0.01
		(0.007)		(0.007)
(N. of absences per year of seniority)^2		-0.004		0.003
		(0.007)		(0.007)
N. of misconducts per year of seniority			-0.08	-0.03
			(0.03)	(0.03)
(N. of misconducts per year of seniority)^2			-0.19	-0.22
			(0.08)	(0.08)
Evaluation = 1				-0.01
				(0.004)
Evaluation = 3				0.02
				(0.002)
Evaluation = 4				0.03
				(0.002)
Regional dummies	Yes	Yes	Yes	Yes
Level dummies	Yes	Yes	Yes	Yes
Constant	15.00	15.00	15.00	14.98
	(0.003)	(0.003)	(0.003)	(0.004)
R^2	0.856	0.857	0.857	0.861

Note: The dependent variable is the log of pre-tax monthly earnings. Omitted dummies: Laurea and Evaluation = 2. Absence episodes are defined as instances in which the employee has been away from work for health related reasons and for more than 15 days. Misconduct episodes are defined as episodes of misbehaviour reporeted to the Personnel Office and punished by the latter according to what is established by collective bargaining and by the *Statuto dei Lavoratori*. Standard errors in parentheses.

Table 9: Earning functions with objective productivity measures without controlling for hierarchical levels; OLS estimates

Model :	1	2	3	4
N. obs:	10809	10809	10809	10809
< High School	-0.18	-0.18	-0.18	-0.18
	(0.004)	(0.004)	(0.004)	(0.004)
High School	-0.05	-0.05	-0.05	-0.04
	(0.003)	(0.003)	(0.003)	(0.003)
Previous exper./10	-0.003	-0.002	-0.002	-0.001
	(0.006)	(0.006)	(0.006)	(0.006)
(Previous exper.)^2/100	-0.01	-0.01	-0.01	-0.01
	(0.002)	(0.002)	(0.002)	(0.002)
Seniority/10	0.25	0.26	0.25	0.26
	(0.004)	(0.004)	(0.004)	(0.004)
(Seniority)^2/100	-0.03	-0.04	-0.03	-0.04
	(0.001)	(0.001)	(0.001)	(0.001)
N. of absences per year of seniority		-0.14		-0.13
		(0.010)		(0.010)
(N. of absences per year of seniority)^2		0.04		0.04
		(0.011)		(0.011)
N. of misconducts per year of seniority			-0.32	-0.25
			(0.042)	(0.042)
(N. of misconducts per year of seniority)^2			0.05	-0.05
			(0.121)	(0.120)
Regional dummies	Yes	Yes	Yes	Yes
Constant	14.75	14.75	14.75	14.75
	(0.003)	(0.003)	(0.003)	(0.003)
R^2	0.649	0.659	0.653	0.662

Note: The dependent variable is the log of pre-tax monthly earnings. Omitted dummy: Laurea. Absence episodes are defined as instances in which the employee has been away from work for health related reasons and for more than 15 days. Misconduct episodes are defined as episodes of misbehaviour reporeted to the Personnel Office and punished by the latter according to what is established by collective bargaining and by the *Statuto dei Lavoratori*. Standard errors in parentheses.

Table 10: Earning functions within levels; OLS estimates

	Blue Collar		White Collar		White Collar H.		Quadro	
Model :	1	2	3	4	5	6	7	8
N. obs:	479	479	2756	2756	5883	5883	1691	1691
< High School	0.001	0.003	-0.13	-0.12	-0.07	-0.08	-0.01	-0.01
	(0.020)	(0.020)	(0.006)	(0.006)	(0.005)	(0.005)	(0.007)	(0.007)
High School	Drop'd	Drop'd	-0.07	-0.07	-0.04	-0.05	-0.01	-0.01
			(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
Previous exper.	-0.01	-0.01	-0.01	-0.01	0.01	0.01	-0.02	-0.02
/10	(0.018)	(0.018)	(0.008)	(0.008)	(0.007)	(0.007)	(0.010)	(0.010)
(Previous exper.)^2	0.004	0.003	0.004	0.002	-0.01	-0.01	0.02	0.02
/100	(0.006)	(0.006)	(0.003)	(0.003)	(0.004)	(0.004)	(0.009)	(0.009)
Seniority/10	0.14	0.10	0.18	0.15	0.12	0.12	0.13	0.13
	(0.015)	(0.016)	(0.008)	(0.008)	(0.006)	(0.005)	(0.006)	(0.006)
(Seniority)^2/100	-0.01	-0.005	-0.02	-0.02	-0.01	-0.01	-0.02	-0.02
	(0.006)	(0.005)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Evaluation = 1		-0.04		-0.001		-0.02		0.01
		(0.012)		(0.007)		(0.007)		(0.040)
Evaluation = 3		0.01		0.02		0.03		0.01
		(0.009)		(0.003)		(0.003)		(0.008)
Evaluation = 4		0.04		0.03		0.05		0.02
		(0.010)		(0.004)		(0.003)		(0.008)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	14.55	14.56	14.75	14.75	14.86	14.83	14.98	14.97
	(0.021)	(0.020)	(0.004)	(0.004)	(0.005)	(0.006)	(0.007)	(0.01)
R^2	0.491	0.536	0.463	0.478	0.376	0.416	0.532	0.536

Note: The dependent variable is the log of pre-tax earnings. Omitted dummy: Laurea and Evaluation = 2. With reference to the categories described in the note of Table 1, Blue Collars = Ausiliari and Commessi; White Collar = Low-Entry and High-Entry White Collar; White Collar H. = White Collar of Level 5-7. Standard errors are in parentheses.

Table 11: Earning functions within levels with objective productivity measures; OLS estimates

	Blue Collar		White Collar		White Collar H.		Quadro	
Model :	1	2	3	4	5	6	7	8
N. obs:	479	479	2756	2756	5883	5883	1691	1691
< High School	0.001	0.004	-0.13	-0.13	-0.07	-0.07	-0.01	-0.01
	(0.020)	(0.019)	(0.006)	(0.006)	(0.005)	(0.005)	(0.007)	(0.007)
High School	Drop'd	Drop'd	-0.07	-0.07	-0.04	-0.04	-0.01	-0.01
			(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
Previous exper.	-0.01	-0.01	-0.01	-0.01	0.01	0.01	-0.02	-0.01
/10	(0.018)	(0.018)	(0.008)	(0.008)	(0.007)	(0.007)	(0.010)	(0.010)
(Previous exper.)^2	0.004	0.003	0.004	0.004	-0.01	-0.01	0.02	0.02
/100	(0.006)	(0.006)	(0.003)	(0.003)	(0.004)	(0.004)	(0.009)	(0.009)
Seniority/10	0.14	0.15	0.18	0.18	0.12	0.12	0.13	0.13
	(0.015)	(0.015)	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)	(0.006)
(Seniority)^2/100	-0.01	-0.01	-0.02	-0.02	-0.01	-0.01	-0.02	-0.02
	(0.006)	(0.005)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
N. of misconducts		-0.20		-0.07		-0.20		0.32
per year of seniority		(0.101)		(0.08)		(0.058)		(0.18)
(N. of misconducts		-0.19		0.11		0.14		-6.97
per year of seniority)^2		(0.165)		(0.294)		(0.29)		(2.538)
N. of absences		-0.03		-0.01		-0.08		-0.01
per year of seniority		(0.029)		(0.017)		(0.011)		(0.023)
(N. of absences		-0.02		-0.03		0.03		-0.04
per year of seniority)^2		(0.023)		(0.024)		(0.011)		(0.062)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	14.55	14.55	14.75	14.75	14.86	14.86	14.98	14.98
	(0.021)	(0.020)	(0.004)	(0.004)	(0.005)	(0.005)	(0.007)	(0.007)
R^2	0.491	0.551	0.463	0.466	0.376	0.39	0.532	0.536

Note: The dependent variable is the log of pre-tax earnings. Omitted dummy: Laurea. With reference to the categories described in the note of Table 1, Blue Collars = Ausiliari and Commessi; White Collar = Low-Entry and High-Entry White Collar; White Collar H. = White Collar of Level 5-7. Standard errors are in parentheses.

Table 12: Assignment to performance and wage categories with objective productivity measures; Logit estimates

Model:	1		2	
N. obs:	10809		10809	
	Misconduct		Absence	
Dependent variable:	performance	wage	performance	wage
< High School	0.003	-0.04	-0.02	-0.32
	(0.013)	(0.01)	(0.03)	(0.03)
High School	-0.03	-0.04	-0.05	-0.26
	(0.01)	(0.004)	(0.02)	(0.02)
Previous exper./10	-0.05	0.001	-0.06	-0.09
	(0.02)	(0.006)	(0.04)	(0.04)
(Previous exper.)^2/100	0.03	0.0005	0.03	0.04
	(0.01)	(0.003)	(0.01)	(0.02)
Seniority/10	-0.14	0.12	-0.74	1.31
	(0.01)	(0.01)	(0.03)	(0.05)
(Seniority)^2/100	0.02	-0.01	0.13	-0.14
	(0.003)	(0.003)	(0.01)	(0.01)
Regional dummies	Yes	Yes	Yes	Yes
Level dummies	Yes	Yes	Yes	Yes
Constant	0.44	-0.07	0.90	-1.97
	(0.02)	(0.01)	(0.04)	(0.06)
PseudoR^2	0.090	0.369	0.174	0.403

Note: The table reports marginal effects with standard errors in parentheses. For misconduct episodes: performance dependent variable = 1 if worker never misbehaved (mean = 0.89); wage dependent variable = 1 if wage is in the high categogry (see Section 4.2; mean = 0.88). For absence episodes: performance dependent variable = 1 if worker never absent for more than 15 days (mean = 0.42); wage dependent variable = 1 if wage is in the high category (see Section 4.2; mean = 0.41). Absence episodes are defined as instances in which the employee has been away from work for health related reasons and for more than 15 days. Misconduct episodes are defined as episodes of misbehaviour reporeted to the Personnel Office and punished by the latter according to what is established by collective bargaining and by the *Statuto dei Lavoratori*.

Table 13: Predicted changes in relative performance and relative wage for individuals staying in the same level, using supervisor's evaluations as measures of performance

	Period		
	1995-94	1995-93	1995-92
Fraction not changing level (by period)	0.898	0.785	0.696
Predicted change in relative performance	0.024	0.018	0.032
	(0.014)	(0.020)	(0.034)
Predicted change in relative wage	0.051	0.062	0.087
	(0.025)	(0.034)	(0.042)
Fraction not changing level (all periods)	0.696	0.696	0.696
Predicted change in relative performance	0.021	0.018	0.032
	(0.012)	(0.019)	(0.034)
Predicted change in relative wage	0.049	0.061	0.087
	(0.030)	(0.036)	(0.042)

Note: The predicted change in relative performance and in relative wage are computed on the basis of estimates of the equations 1 and 2 in the text, where P_{it} and S_{it} are defined as follows. The relative performance indicator is calculated as:

$$P_{it} = F_{it}(j-1) + [F_{it}(j) - F_{it}(j-1)]/2$$

where $F_{it}(j)$ is the fraction of individuals in a given level at time t that receive a supervisor's evaluation of j or lower. j could assume values: 1=Low, 2=Medium or 3=High. S_{it} is constructed in the same way but using the corresponding salary distribution. In other words, given the fractions F's from the evaluations distribution, we assign to those in the bottom $F_{it}(1)$ of the within-grade-level salary distribution a salary percentile value of $F_{it}(1)/2$, to those between $F_{it}(1)$ and $F_{it}(2)$ a salary percentile value of $F_{it}(1) + [F_{it}(2) - F_{it}(1)]/2$, and so on. Standard errors are in parentheses. The number of observations in the 1995-1992 sample is 6651.

Table 14: Predicted changes in relative performance and relative wage for individuals staying in the same level, using misconducts as measures of performance

	Period		
	1995-94	1995-93	1995-92
Fraction not changing level (by period)	0.898	0.785	0.696
Predicted change in relative performance	-0.006	-0.005	-0.007
	(0.0004)	(0.001)	(0.002)
Predict change in relative wage	0.025	0.020	0.025
	(0.020)	(0.011)	(0.015)
Fraction not changing level (all periods)	0.696	0.696	0.696
Predicted change in relative performance	-0.007	-0.006	-0.007
	(0.001)	(0.001)	(0.002)
Predicted change in relative wage	0.018	0.018	0.025
	(0.016)	(0.010)	(0.015)

Note: The predicted change in relative performance and in relative wage are computed on the basis of estimates of the equations 1 and 2 in the text, where P_{it} and S_{it} are defined as follows. The relative performance indicator is calculated as:

$$P_{it} = F_{it}(j-1) + [F_{it}(j) - F_{it}(j-1)]/2$$

where $F_{it}(j)$ is the fraction of individuals in a given level at time t with a value of the indicator equal to j or lower. The indicator assume value j=1 if the individual misbehave and value j=2 if never misbehave. See Table 2 for the definition of misconduct episodes. S_{it} is constructed in the same way but using the corresponding salary distribution. In other words, given the fractions F's from the misconduct indicator distribution, we assign to those in the bottom $F_{it}(1)$ of the within-grade-level salary distribution a salary percentile value of $F_{it}(1)/2$ and to those above $F_{it}(1)$ a salary percentile value of $F_{it}(1) + [F_{it}(2) - F_{it}(1)]/2$. Standard errors are in parentheses. The number of observations in the 1995-1992 sample is 6651.

Table 15: Predicted changes in relative performance and relative wage for individuals staying in the same level, using absenteeism as measure of performance

	Period		
	1995-94	1995-93	1995-92
Fraction not changing level (by period)	0.898	0.785	0.696
Predicted change in relative performance	-0.078	-0.010	-0.018
	(0.006)	(0.006)	(0.011)
Predicted change in relative wage	0.054	0.053	0.078
	(0.027)	(0.008)	(0.007)
Fraction not changing level (all periods)	0.696	0.696	0.696
Predicted change in relative performance	-0.078	-0.011	-0.018
	(0.007)	(0.006)	(0.011)
Predicted change in relative wage	0.065	0.055	0.078
	(0.021)	(0.009)	(0.007)

Note: The predicted change in relative performance and in relative wage are computed on the basis of estimates of the equations 1 and 2 in the text, where P_{it} and S_{it} are defined as follows. The relative performance indicator is calculated as:

$$P_{it} = F_{it}(j-1) + [F_{it}(j) - F_{it}(j-1)]/2$$

where $F_{it}(j)$ is the fraction of individuals in a given level at time t with a value of the indicator equal to j or lower. The indicator assume value j=1 if the individual was absent and value j=2 if never absent. See Table 2 for definition of absence episodes. S_{it} is constructed in the same way but using the corresponding salary distribution. In other words, given the fractions F's from the absence indicator distribution, we assign to those in the bottom $F_{it}(1)$ of the within-grade-level salary distribution a salary percentile value of $F_{it}(1)/2$ and to those above $F_{it}(1)$ a salary percentile value of $F_{it}(1) + [F_{it}(2) - F_{it}(1)]/2$. Standard errors are in parentheses. The number of observations in the 1995-1992 sample is 6651.