Wage dynamics and promotions inside and between firms

António Dias da Silva[*]   Bas van der Klaauw[†]

[very preliminary and incomplete; please do not quote]

29th March 2006

Abstract

This paper studies the process of wage dynamics and promotions inside and betwen firms using large linked employer-employee data set for the Portuguese economy. The main question is if promotions are the result of gained work experience or of learning by the worker and the firm about the ability of the worker. We use the Gibbons and Waldman (1999) framework to distinguish between the case of full information and the case of symmetric learning by the worker and the firm. The theoretical predictions are that under full information after controlling for worker's fixed effect, there is (1) no serial-correlation in wage increases; (2) wage increases do not predict promotions and (3) there is no serial correlation in promotions. Under symmetric learning these correlations are present even after controlling for worker's fixed effect. We emphasize the dynamics of the process taking into account the unobserved heterogeneity and endogeneity problems using appropriate GMM techniques. The serial correlation in wage increases and the serial correlation in promotions is analysed considering state dependence and controlling for individual unobserved heterogeneity. This enable us to assess how important are past wage increases and past promotions, ruling out the hypothesis of the state dependence be caused by worker's time-invariant unobserved characteristics that consistently makes the individual get higher wage increases or higher chances of being promoted. Preliminary evidence support the hypothesis of serial correlation in wage increases, serial correlation in promotion and wage increases predictor of promotion, which supports the existence of learning. **JEL**: M5, J6, L2. **Keywords**: learning, human capital, promotions, unobserved heterogeneity, wages.

[*]Free University Amsterdam and Tinbergen Institute
[†]Free University Amsterdam, Tinbergen Institute, Scholar and CEPR

1 Introduction

Careers inside firms do not match the standard competitive model paradigm in which wages reflect an individual's marginal product. Apparently evident, this is a branch of the literature in labour economics under development and in need of more consistent empirical facts. The first evidence about internal labour markets was provided by Doeringer and Piore (1971). In an internal labour market, employees have a relatively well defined hierarchy they can climb, instead of competing constantly with others in the spot market. Other important characteristic is the fact that wages are tied to the characteristics of the jobs rather than individuals. Thus, wages in an internal labour market are strongly influenced by the rules and administrative procedures that tie wages to jobs. In this context workers promotion assume very important role since it is through them that workers progress in the job ladder and are assigned to higher paid jobs.

Besides these odd facts it took some time to the economic literature devote attention to this issues. The main references in this field appear about 30 years after this evidence (Lazear, 1992 and Baker, Gibbs and Holmstrom, 1994a, b). Lazear focus one the importance of the job as a concept as a complement to human capital theory. Baker, Gibbs and Holmstrom [henceforth BGH] conclude that learning, incentives and human capital are needed to explain the broad pattern of evidence they found concerning wages and career progression in the firm analysed.

This paper will address in detail some of this evidence. The main question is if promotions are the result of gained work experience or of learning by the worker and the firm about the ability of the worker. We use the Gibbons and Waldman (1999) framework to distinguish between the case of full information and the case of symmetric learning by the worker and the firm. The theoretical predictions are that under full information after controlling for worker's fixed effect, there is (1) no serial-correlation in wage increases; (2) wage increases do not predict promotions and (3) there is no serial correlation in promo-

tions. Under symmetric learning these correlations are present even after controlling for worker's fixed effect. We emphasize the dynamics of the process taking into account the unobserved heterogeneity and endogeneity problems using appropriate GMM techniques. The serial correlation in wage increases and the serial correlation in promotions is analysed considering state dependence and controlling for individual unobserved heterogeneity. This enable us to assess how important are past wage increases and past promotions, ruling out the hypothesis of the state dependence be caused by worker's time-invariant unobserved characteristics that consistently makes the individual get higher wage increases or higher chances of being promoted.

Although the growing empirical literature, there is still little evidence derived from matched employer-employee data sets and the dynamics of the process is usually not taken into account. Most of the empirical work use data from one single firm or from questionnaires to individuals - firm-based data and individual-based data. The data from one single firm have the advantage the possibility of a clear promotion concept because they can create a job ladder analysing the worker movements. Although, as case studies they are, the results cannot be generalized beyond the firm under analysis. One the other hand, the individual-based data face the problem of relying in a subjective promotion concept - some workers may tend to label any sort of movements inside firm as promotion, or associate promotions to wage increases[1].

Given the sensitivity of the results to the different promotion concepts, we distinguish between two promotion definitions. The first is based on the skill levels that generically are ranked in a well-defined hierarchy, based on tasks and skills required. The second is based on the answer of the employer about last time worker was promoted. We abstain to relate these concepts to any sort of wage growth which enable us to assess the importance of promotion on worker's wage increase. Contrary to the empirical applications the promotion concept do not arise problems in the empirical literature. Usually the models define an

---

[1]Pergamit and Veum (1998) addresses directly the problem of different promotions concepts in the empirical work and found different outcomes in terms terms of job assignment and wage increases.

hierarchy and a promotion is defined as a progression to an upper level. Small differences may be found in the way the levels are ranked: (1) jobs more demanding in terms of human capital (Prendergast, 1993); or (2) jobs with higher responsibility (Manove, 1997).

Besides some problems faced by the empirical studies, the claims for more empirical evidence (Baker and Holmstrom, 1995 and Gibbons, 1997), and a large set of questions putted by Lazear(1995, 2004) not yet fully answered, there are a set of empirical regularities on promotion and wage dynamics named as stylized facts.

The authors who first summarized this empirical regularities were BGH. More specifically, they emphasised that: (1) real wage decreases are not rare but demotions are; wage increases and promotions are serial-correlated; (3) promotions are associated with large wage increases; (4) wage increases at promotion are small relative to the difference between average wage across levels of the job ladder; (5) workers who receive large wage increases early in their stay at one level of the job ladder are promoted quickly to the next, or putting in other way, wage increase predict promotions. After this pioneering work some other studies have been done on these regularities either focusing on only empirical fact or trying to assess a broader pattern of evidence. Seltzer and Merrett (2000), Kwon(2006) and Dohmen et al (2004) also found the nominal wage cuts are rare. Lima and Pereira (2003) found a small number of demotions (1.66%). The evidence concerning to the serial correlation in wage increases has mix results. Lluis (2005) did not find evidence of serial correlation in wages while Gibbs and Hendriks (2004) and Dohman (2004) have found some evidence of serial correlation in wages. One the main findings in intrafirm mobility concerns the serial correlation in promotions. Seltzer and Merrett (2000) and Treble et al. (2001) have found empirical support for this fact. Promotions are always associated with wage increases but the results may vary in their magnitude. For instance, Pergamit and Veum (1999) found that a promotion increases the wages by about 8% in a study for the US while Booth, Francesconi and Frank, using a similar aproach to UK, estimate a impact of promotion on wage of about 5%. Other studies that conclude for a positive

4

effect of promotion on wage are McCue (1996), Seltzer and Merrett (2000), Treble et al. (2001). Past wage increases forecast promotions (Ariga et al, 1999). Dohmen et al (2004) also conclude the same but the effect of wage growth on promotion probability disappears after include the controls for tenure, age, education and performance evaluation. This is even more evident on the tournament theory literature where, in some cases, looking back to wage increase is possible to predict the position of Chief Executive Officer with great accuracy (Bognanno, 2001).

These patterns of evidence do not find explanation in one single building block model on promotion and wage dynamics. This literature is divided into two branches according the role attributed to promotions: assignment or incentive mechanisms[2]. From the side of assignment we have human capital, job assignment, and learning, while in the side of incentives we have the tournament theory and a broad literature that can be include in the large category of contract theory.

Human capital, job assignment and learning, individually considered, cannot explain this broad pattern of facts. Consequently these models have been combined together in order to explain a larger pattern of facts. For example, Bernhardt (1995) develops a model that includes human capital acquisition, assignment and asymmetric learning and Gibbons and Waldman (1999), like Bernhardt, conceive an integrative model that includes human capital acquisition and job assignment, but consider symmetric learning. This is the model that can explain most of the facts concerning the promotions and wage dynamics inside firms described above. The model has been recently improved, becoming able to explain the cohort effects with the introduction of task-specific human capital (Gibbons and Waldman, 2006).

From the incentives side, the tournament theory (Lazear and Rosen, 1981) lends itself to a large number of testable predictions. The workers inside firm are competing for teh higher paid positions that are filled up by the most able workers in the previous rank. Kwon

---

[2]The dual role of promotions is analysed by Fairburn and Malcomson (2001).

(2006) analyse the optimal contracts in the context of incentives in large organizations. Two extensive surveys on promotion and wages literature on assignment and incentives are Gibbons and Waldman (1999b) and Prendergast (1999).

The paper is organised as follows. The next section describes the data set, definition concepts, and gives an overview of the main features of the data. The main issues of the Gibbons and Waldman model and our econometric analysis are described in section 3. In Section 4, we analyse the results of the wage equation with main focus for the serial correlation in wage increases. Section 5 analyse the results of the promotion regression, namely serial correlation in promotion and wage increases forecast promotion. The conclusions summarise the main findings.

2 Data set, sample selection, and definition concepts

This study uses the matched employer-employee data set Quadros de Pessoal. This data are annually collected by the Ministry of Employment, based on an enquiry that every firm with wage earners has to fill in. Public administration, domestic service and independent workers are not covered by this survey. Given the compulsory nature of the survey information for more than 2 millions individuals is record each year. Quadros de Pessoal provides information on individual's characteristics such as gender, age, schooling, detailed occupation, date of admission into the company, several components of monthly earnings, and the duration of work. Firm's characteristics include location, employment, sales, ownership, and legal setting.

The period analysed is 1991-2000, inclusive. The workers in the sample aged between 20 and 70 years old. Additionally, they have to be full time workers, full wage earners, and stay in the panel at least four consecutive periods. These restrictions lead to a sample of workers with a strong attachment to the conventional labour market. Firms and individuals have identification codes that permit track them over time. Consistency checks

6

have been made to guarantee good quality of the information. The employer must post the firm's response (the information on employees) sent to the Ministry of Employment in a public place inside the firm, which considerably reduces the risk of measurement error and increases the confidence in the information contained in the survey. After the restriction imposed and the data cleaning the panel has 7060218 observations and 1142798 workers. The analysis that follows is based on a 5% sample, respectively, 352863 observations and 57140 workers. Sample variable definitions and descriptive statistics are presented in 6.

Quadros de Pessoal is a privileged source of information for the study of promotion and wage dynamics. There are three types of variables that convey information about workers mobility inside firm: professional category, promotion date, and skill level. Unfortunately, due to the existence of more than 60 000 professional categories it is not feasible to use this variable, unless we constraint the analyses to the study of one firm on the survey or, at most, one sector. Hence, the definition of job transition relies on the variables skill level and date of last promotion.

There are eight skill levels (full description in table 14) defined by law (Decreto-Lei n.º 121/78, 2 June):

(1) apprentices, interns, trainees;

(2) non-skilled professionals;

(3) semi-skilled professionals;

(4) skilled professionals;

(5) higher-skilled professionals knowledge;

(6) supervisors, team leaders, foremen;

(7) intermediary executives;

(8) top executives.

Using this criterion promotion means a worker movement from a lower to a higher skill

level.

The second promotion concept is based on the answer of the employer about the last time she promoted the worker. If the date of last promotion is posterior to October of last year (or March for the period 1991-1993), and the worker is still in the same skill level, we consider that the worker was promoted inside the skill level. These two definitions are precise. The first, because based on a clearly defined skill levels, based on skills and tasks. The second, because who promotes says whether promoted or not the worker. Therefore, these promotions definitions do not have the accuracy problems of the individual-based data that rely on worker's subjective judgments their own promotion. The main advantage over the firm based data is that we can generalize the results to the whole economy.

We analyse if these different concepts give different outcomes and also their interaction. More specifically we use first the movement to a higher skill level and promotion based on the date of last promotion, separately. Then we analyse only promotion to a higher skill level that simultaneously are labeled as promotion using the indication of the employer.

Other important concept is the definition of wage used in this study is the regular wage, computed by the following way:

$$wage = bwage + tenure + regearn \tag{1}$$

where bwage stands for base-wage, tenure are tenure-indexed components of pay, and regearn are other regularly paid components. The amounts are presented before taxes and social security contributions and referred to October of each year (or March for the period 1991-1993). Wages were deflated using Consumer Price Index to constant (2000) PTE.

2.1 Frequency of mobility in Portugal

Table 1 presents sample frequencies of job transitions by gender and experience group. We have categorized the transitions into four different groups: no change; separation; promotion to a higher skill level; and promotion in the same skill level. Overall, 76.68% of the observations make no job transition. Promotion in the same level represents the highest number of transitions followed by separation and promotion to a higher skill level, respectively.

One can see that mobility of all types decline with experience, but promotions in the same level fall slowly than separations and promotions to a higher skill level. The fact that mobility decreases with experience is widely documented in the labour economic literature. One natural explanation comes from the matching literature. If we look to the jobs as "experience goods" uncertainty about the quality of the match declines with tenure and poor matches are more likely to end. At the same time as the tenure increases less remain to be learned about worker's ability which reduces the chance of internal promotion.

Comparing our findings with the ones found by McCue (1996) to the United States and Lluis (2005) to the Germany we conclude we have intermediate separation rates but much higher internal mobility. For the first experience group both countries display higher separation rates than in Portugal but these rates fall sharply with experience while in Portugal the decline of separation rates with experience is more smoothly. The much higher rate of internal mobility is certainly related to the different data sets used and the different promotion concepts adopted. Both studies use data from questionnaires to individuals while we use longitudinal employer employee data. Our promotion concept to a higher level is similar to the one adopted by Lluis (2004) but the German Socio-Economic Panel only permits to analyse four ranks while our data permit analyse transitions between eight skill levels. The promotion concept adopted by McCue(1996) is based on the reported position change by respondents themselves. These results are more close to our definition

of movement to a higher hierarchical level but still far from the promotion in the same skill level (reported by the employer).

Table 1: Frequency of mobility by experience group

Experience	No change	Separation	Promotion higher level	Promotion same level	N
Men					
0-10	65.19	12.79	11.20	10.81	984448
11-20	74.29	9.48	7.17	9.05	1482592
21-30	79.33	7.28	5.59	7.80	1368914
31 -	83.58	5.25	4.41	6.75	1668469
Total	76.73	8.25	6.66	8.36	5504423
Women					
0-10	67.09	10.87	11.32	10.73	899511
11-20	76.40	7.77	7.17	8.66	1079679
21-30	81.20	5.76	5.90	7.14	854989
31 -	83.99	4.64	5.21	6.16	660024
Total	76.61	7.48	7.56	8.35	3494203
All	76.68	7.95	7.01	8.36	8998626

N - Number of observation in the panel at least two consecutive periods

2.2   Skill levels, promotions, and wages

This section provides summary statistics that describe the relationship between skill level and mobility outcomes. Before, it is necessary to give an idea about the characteristics of workers in each level and to infer about more likely transitions. First, level 1 and level 2 are mainly entry doors (table 7). However, these two levels are substantially different. The workers hired to level 1, are younger, more educated, and with better career perspectives than workers hired to level 2. Second, in the table 14 we can see that level 6 is more important in terms of tasks complexity and skills required than level 5. However, the average wage in level 5 is greater than the average wage in level 6. The explanation relies again on the workers characteristics. In level 6 workers have mostly supervision tasks, the selection for the job is based on experience (table 7) and on a confidence relation with the employer. Most of the workers in this level cannot ascend in the hierarchy. Contrary, in

10

the level 5 we have more educated workers, specialists, it is more likely a transition for level 7 or level 8, where executive tasks are required, than for level 6 (tables 8 and 9).

Table 2 presents the proportion of transition by skill level and associated wage increase. Level 1 is the one with the greatest percentage of promotions and the executive levels the ones who receive the highest percentage of promotees. With the exception of level 3 and level 6 the wage increase increases with the level the worker is promoted to. The proportion of promotions in the same level is more frequent in level 1 and levels 5 and 8. This type of promotions may have different reasons. For instance in level 1 the aim might be the worker motivation although he is not yet prepared to take over higher skill position. In the level 8 the most likely reason is reward for firm's overall performance. Level 5 as mentioned above is composed by specialists that may be very good doing their job but some of them may not have supervision or executive skills. Consequently to avoid the well known phenomenon Peter Principal the firms do better offering these workers lateral promotions keeping the workers motivated and at the same time taking the best benefit from their high skills. There is substantial wage growth within levels and the substantial wage increase at promotion only explain a small part of the average wage difference across levels. The average wage increase in the sample is 3.6% and the table 2 shows considerable heterogeneity in wage increases.

In what concerns mobility across firms one can see that higher separation rates happen in the first two and in the last level. In the first two skill levels firms and workers are learning about the quality of the match and this high separation rates are an expected result. More surprising is the high separation rate for the top executive level. Intuitively we should expect that as higher the compensation level lower should be the separation rate but we should note that this is also the level with high promotion rates and this may signal the ability of these workers to other employers, since we are assuming symmetric learning. We also acknowledge the relative small number of separation for the supervision level which is according to confidence relation character of the job.

Table 2: Proportion of promotion and wage increase per skill level

Level	Number workers	% promotions	% promo into level	Wage var. if prom.	% prom in the level	Wage var prom level
Apprentices, trainees	18596	38.98			16.48	.0816
Non-qualified professionals	32571	14.26	2.35	.0766	6.86	.0358
Semi-qualified professionals	66457	10.48	6.41	.0712	7.52	.0479
Qualified professionals	174670	3.24	7.35	.0791	9.76	.0604
Higher-qualified professionals	22733	5.90	15.81	.0792	10.63	.0847
Supervisors, team leaders, foreman	17892	4.73	13.38	.0959	6.93	.0530
Intermediary executives	10126	9.15	19.46	.0920	7.64	.0987
Top executives	9818		19.53	.1053	10.70	.0788

Level	% separ	Wage var if separ	Aver. wage variation	Median wage	Average wage
Apprentices, trainees	9.90	.0303	.0535	68681.3	76223.7
Non-qualified professionals	7.01	.0306	.0251	81920.0	89777.1
Semi-qualified professionals	5.30	.0552	.0280	86893.6	99051.0
Qualified professionals	6.51	.0552	.0348	105268.6	123330.9
Higher-qualified professionals	6.80	.0919	.0480	179450.0	198063.6
Supervisors, team leaders, foreman	5.69	.0811	.0394	160775.4	183042.6
Intermediary executives	6.41	.1200	.0564	247890.5	272885.7
Top executives	8.68	.1348	.0649	353943.1	386333.6

3 Econometric analysis

Gibbons and Waldman (1999) model incorporate contributions from job assignment, learning, and on-the-job human-capital acquisition theories to explain the wage and promotion

dynamics inside firms. The model emphasizes worker's heterogeneity and learning about workers effective ability. There are three hierarchical levels workers can climb. All workers can reach the top, but some do it much faster than others. The wages are determined in the spot market according to the expected evolution of worker's effective ability. The competition between firms leads to a wage equal to worker's productivity. The wages inside firm rise as the worker accumulates human capital which permits explain wage variation inside levels, but not the overlap of wage between adjacent levels. The promotion occurs when the workers reach some threshold of effective ability. The theoretical predictions are that under full information after controlling for worker's fixed effect, there is (1) no serial-correlation in wage increases; (2) wage increases do not predict promotions and (3) there is no serial correlation in promotions. Under symmetric learning this correlations are present even after controlling for worker's fixed effect.

In this framework successfully control for unobserved heterogeneity is crucial. We must be able to effectively distinguish between true state dependence and the correlation due to unobserved heterogeneity. We analyse these facts using the following specifications:

$$\Delta W_{i,t} = \beta_0 + \beta_1 \Delta W_{i,t-1} + \beta_2 W_{i,t-2} + \beta_3 P_{i,t} + \eta_i + \varepsilon_{it} \tag{2}$$

and

$$P_{i,t} = \alpha_0 + \alpha_1 \Delta W_{i,t-1} + \alpha_2 W_{i,t-2} + \alpha_3 P_{i,t-1} + \theta_i + \varepsilon_{it} \tag{3}$$

where $\Delta W_{i,t} = W_{i,t} - W_{i,t-1}$ and P_{it} is an indicator function if promotion occurred between year t and $t+1$.

The assumption of full information translates into the null hypothesis:

$$H_0 : \beta_1 = 0$$

and

$$H_0 : \alpha_1 = 0 \wedge \alpha_3 = 0$$

In the specifications 2 and 3 the initial conditions problem does not arise. But there is the need to take into account the attrition problem. There can be two sources of attrition in these data. First, workers move to other firms and second, workers move to a state of inactivity. Assuming that transitions to inactivity are caused by exogenous shocks, related to the worker's fixed effects but not to the idiosyncratic error terms, the model is extended to:

$$\Delta W_{i,t} = \beta_0 + \beta_1 \Delta W_{i,t-1} + \beta_2 W_{i,t-2} + \beta_3 P_{i,t} + \beta_4 M_{i,t} + \eta_i + \varepsilon_{it} \tag{4}$$

and

$$P_{i,t} = \alpha_0 + \alpha_1 \Delta W_{i,t-1} + \alpha_2 W_{i,t-2} + \alpha_3 P_{i,t-1} + \alpha_4 M_{i,t-1} + \theta_i + \varepsilon_{it} \tag{5}$$

and

$$M_{i,t} = \gamma_0 + \gamma_1 \Delta W_{i,t-1} + \gamma_2 W_{i,t-2} + \gamma_3 P_{i,t-1} + \gamma_4 M_{i,t-1} + \varsigma_i + \varepsilon_{it} \tag{6}$$

where $M_{i,t}$ indicates a move between firms between year t and $t+1$.

The equation 4 has as dependent variable de variation of the wage and as independent variables, lagged dependent variable, wage in previous period, promotion and separation. We have different specifications of this model in what concerns to the promotion definition.

The lagged dependent variable was introduced as a regressor to address the issue of serial correlation in the wage increases. Once we control for individual specific effect the serial correlation cannot be justified by the presence of unobserved permanent individual heterogeneity, that would increase the probability of the individual receive persistently

higher wage increases.

The variable promotion permit us to analyse the impact of promotion on wage increases and the variable separation can be seen as having a double role: first permits to control for the attrition, assuming that the other exits from the data set to inactivity like employment or retirement are driven by exogenous shocks and secondly permits to study the impact of job transition on the wage growth. Controlling for observed and unobserved variables permit assess if promotion and separations have different roles on worker's wage increase. Additional control variables include observed worker and firm's characteristics: dummies for the hierarchical (skill) level; tenure and polynomial of tenure; age; firm's size (number of workers); time dummies; and dummies for the activity sector.

In the absence of the lagged dependent we could estimate this model (under regular conditions) either by random effects or fixed effects, depending on the assumption about the correlation between individual unobserved heterogeneity and individual observed variables. With lagged dependent variables both of these estimators are biased. Therefore, we take first-differences to deal with unobserved heterogeneity and then use GMM techniques to proceed with the estimation.

With equations 5 and 6 we are interested in the study of serial correlation in promotion and wheteher wage increase predict promotion. The estimation procedure is similar to the one described above for the wage equation.

Additionally, once our promotions definitions enable us to distinguish between promotions is the same level and promotions to upper levels we may want analyse if promotion inside levels are an alternative to the promotions to an upper level or by contrary promotion in levels are a consequence of a more detailed job ladder that workers must go through before they reach the ability threshold that permit them to be assigned to a job in a higher skill level:

$$Pr(promup_{i,t}) = \Lambda(\delta_0 + \delta_1 \Delta W_{i,t-1} + \delta_2 W_{i,t-2} + \delta_3 promsame_{i,t-1} + \delta_4 M_{i,t-1} + \tau_i) \quad (7)$$

and

$$Pr(promsame_{i,t}) = \Lambda(\mu_0 + \mu_1 \Delta W_{i,t-1} + \mu_2 W_{i,t-2} + \mu_3 promup_{i,t-1} + \mu_4 M_{i,t-1} + \lambda_i) \quad (8)$$

Considering that is not likely that the individual fixed term is independent of worker's observable characteristics, we estimate these models by fixed effects. For statistical reasons the binary model that we can estimate consistently is the fixed effects (conditional) logit. The estimation is done by conditional maximum likelihood and the observations that never change their status, either because the individual is never promoted or is promoted in all periods, are discarded because they do not contribute with any information for promotion probability. Put differently, their behaviour would be completely captured by their individual effect τ_i or λ_i. In this model we cannot compute the marginal effect but we have the sign of the coefficient what is sufficient for the analysis. Assuming we have only strictly exogenous variables we can estimate the fixed logit model assuming that time-varying errors are independent of all the other covariates and that they are i.i.d over time with a logistic distribution. Then the model may be estimated by conditional maximum likelihood.

4   Correlation in wage increases

This section presents preliminary evidence on the serial correlation in wage increases, in the sense that a real wage increase today is correlated with a real wage increase tomorrow.

The serial correlation in wage increases is one of the stylized facts summarized by BGH but has mixed evidence on the empirical literature. One reason pointed out is the different sources of data: is expected that survey data are noisier than the individual records of one single firm used by BGH. This may lead to spurious negative correlation in wage increases.

The integrative model by Gibbons and Waldman emphasizes the heterogeneity of workers and learning about ability. In their model the workers differ because they are endowed with different levels of innate ability that permit them accumulate human capital at different rates. More able workers learn faster their job and are more likely to receive higher wage increases. Hence, in the full information case, where firms know the worker's innate ability, wage increases are an increasing function of the worker's innate ability. In the case of symmetric learning, firms only observe a noisy signal every period and update beliefs about worker's innate ability. Controlling for the experience and wage level wage increases will be an increasing function of workers effective ability.

In terms of our econometric model, once we control for the individual innate ability, serial correlation in wage increases is not expected because specific and time invariant ability is captured by the individual fixed effect. When worker's ability is not known the correlation in wage increases, if observed, is due to learning.

Table 3 presents results of our model with six alternative specifications. Model 1, 3 and 5 is the base specification with different promotions concepts respectively, promotion to a higher hierarchical level, promotion based on the indication of the employer and the interaction of the two previous definitions. The model 2, 4 and 6 are respectively the full specification of the model 1, 3 and 5. The full specification includes, besides the variables shown in the table, controls for skill levels, activity sector and year dummies.

We reject the null that the estimate associated to the wage increase in t-1 is statistically equal to zero. According to the exposed above this correlation in wage increases is due to learning. The results are not sensible to the promotion concept used, except to the estimate of the wage increase associated to promotion itself. One can see that the highest

prize is associated to the interaction of both promotion concepts followed by the promotion concept based on the employer indication and the transition for a higher hierarchical level. On average, transition to other firm gives a lower prize than promotion.

Table 3: Wage increase upon promotion and correlation in wage increase - GMM system estimator

Variable	Model					
	1	2	3	4	5	6
Wage increase t-1	.0597***	.0392***	.0524***	.0463***	.0585***	.0482***
	(.0029)	(.0036)	(.0029)	(.0035)	(.0029)	(.0035)
Wage t-2	.0586***	.0331***	.0475***	.0384***	.0565***	.0418***
	(.0038)	(.0043)	(.0037)	(.0042)	(.0038)	(.0042)
Promotion	4741.7***	5546.0***	7083.4***	6956.9***	8236.5***	8640.3***
	(244.6)	(252.4)	(221.4)	(214.4)	(487.1)	(470.0)
Job transition to other firm	2421.2***	1695.7***	2858.9***	2358.3***	2849.8***	2161.8***
	(350.7)	(286.9)	(355.5)	(288.2)	(357.3)	(289.5)
Age		-513.2***		-440.0***		-499.0***
		(112.4)		(112.5)		(113.0)
Age2		5.147***		4.468***		5.006***
		(1.380)		(1.381)		(1.388)
Tenure		82.8*		101.6**		85.5*
		(48.3)		(48.3)		(48.5)
Tenure2		-4.431***		-4.350***		-4.443***
		(1.603)		(1.606)		(1.611)
Numb workers		-.1591***		-.2696***		-.1763***
		(.0446)		(.0441)		(.0453)
Constant	-2875.9***	11689.6***	-1861.4***	11150.5***	-2413.2***	12287.4***
	(486.8)	1968.1	(468.7)	(1961.2)	(491.4)	(1977.5)
Hansen test of overid.	254.22	1005.98	292.33	1160.74	283.09	1103.03
restrictions χ^2 [p-value]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
AR(1) [p-value]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
AR(2) [p-value]	[0.459]	[0.633]	[0.560]	[0.720]	[0.466]	[0.655]
AR(3) [p-value]	[0.254]	[0.324]	[0.255]	[0.339]	[0.252]	[0.329]
AR(4) [p-value]	[0.134]	[0.217]	[0.150]	[0.261]	[0.135]	[0.223]
Number of instruments	59	332	59	333	59	332
N	234497	272082	234497	234497	234497	234497

5 Correlation in promotion and wage increases as predictors of promotion

The reason behind the serial correlation in promotion rates and wage increases predict promotions is similar to the discussion above about serial correlation in wage increases. The workers are promoted after they reach a threshold of ability that enables them to take over a job more demanding in terms of human capital. Naturally, most able workers reach this level of ability faster because they can also learn faster their actual job and perform better. A worker promoted early will have his or her expected effective ability grow more quickly, on average, then the expected effective ability for the worker promoted later, which suggests serial correlation in promotion rates. The same way individuals that receive a higher wage increase indicate that an increase in expected innate ability occurred, which means that on average a worker who experience a large wage increase will need less time to reach the target level of expected effective ability needed for promotion.

Table 4 presents results on the probability of promotion using three different promotion definitions. In the model 1 and 2 the promotion concept is based on the worker transition to a higher skill level, in the model 3 and 4 the promotion concept is based on the employer indication about last time worker was promoted, and model 5 and 6 the promotion concept is based on the interaction of two previous definitions. For each model we estimate a base specification and the full specification where, besides the variables shown in the table, we also control for the skill level, activity sector and year.

We reject the null of no serial correlation in promotion rates. We also reject the null of the estimate associated to the wage increase in period t-1 be equal to zero (except in model 6). Again, with the exception of model 1 we conclude for a positive impact of previous wage growth on promotion probability. Once we control for the individual fixed effect, tenure and age, and wage level we attribute this correlation to the learning about the worker's ability.

Table 4: Correlation in promotions and wage increases as predictor of promotions - GMM system estimator

Variable	Model					
	1	2	3	4	5	6
Promotion t-1	-.0463***	.1375***	.0221***	.0108***	.0015***	.0217***
	(.0027)	(.0029)	(.0038)	(.0037)	(.0028)	(.0026)
Wage increase t-1	-7.76e-08***	1.57e-06***	5.89e-07***	6.66e-07***	1.10e-07***	1.24e-08
	(8.21e-08)	(1.20e-07)	(1.03e-07)	(8.08e-08)	(4.25e-08)	(3.50e-08)
Wage t-2	-2.05e-07	1.53e-06***	4.84e-07***	6.26e-07***	3.08e-08	1.99e-09
	(7.58e-08)	(1.15e-07)	(9.61e-08)	(7.77e-08)	(3.99e-08)	(3.26e-08)
Job transition to other firm	.0029	-.0034	.0137***	-.0128***	-.0006	.0003
	(.0036)	(.0033)	(.0037)	(.0034)	(.0017)	(.0015)
Age		.0005		-.0186***		-.0032***
		(.0019)		(.0018)		(.0007)
Age2		-3.74e-06		.0002***		.00004***
		(.00002)		(.00002)		(8.68e-06)
Tenure		.0040***		-.0035***		-.0004
		(.0007)		(.0007)		(.0003)
Tenure2		-.00004		.00006**		.00002*
		(.00002)		(.00002)		(9.06e-06)
Numb workers		4.16e-06		9.07e-06***		1.73e-06***
		(5.17e-07)		(6.57e-07)		(2.83e-07)
Constant	.1019***	.5118***	.0316**	.5301***	.0121**	.1898***
	(.0102)	(.0347)	(.0128)	(.0331)	(.0053)	(.0143)
Hansen test of overid.	214.09	8426.37	891.09	2265.28	113.01	2607.58
restrictions χ^2 [p-value]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
AR(1) [p-value]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
AR(2) [p-value]	[0.184]	[0.000]	[0.000]	[0.022]	[0.120]	[0.001]
AR(3) [p-value]	[0.088]	[0.734]	[0.000]	[0.000]	[0.266]	[0.234]
Number of instruments	61	334	63	336	61	334
N	234497	234497	234497	234497	234497	234497

Table 5 presents additional evidence on the correlation in promotions. We explore further the differences between the promotion concepts. Since we are able to distinguish promotions in the same level and promotions to a higher skill level may be useful to see whether they are correlated or not. This shed light to the understanding of firm's promotion policies. If the correlation exists, this may indicate that horizontal promotion make clear that there exists a more specific job ladder that workers must go through before take over higher skill level jobs. In the other hand, the lack of correlation may indicate

that firms use promotion inside levels as an alternative to promotion to higher skill levels. This may be efficient if workers perform above average in their job but do not have the skills required by higher level jobs. Using horizontal promotions firms keep the workers motivated at the same time they make the efficient assignment of workers. Doing so firms also avoid the Peter Principle.

Six different models are estimated using conditional logit model. The promotion definition in the models 1, 2 and 5 is the promotion to a higher skill level while the dependent variable in the models 3, 4 and 6 is the promotion in the same level. Model 1 and 3 are the base specification and models 2 and 4 include controls for age, tenure, skill level and sector. Models 5 and 6 are the same as model 2 and 4 but without control for skill levels.

After we control for the skill level there is no evidence of positive serial correlation in wage increases. This may be indicative that firms use promotion in the same level as an alternative to promotions to higher skill levels.

Table 5: Correlation in horizontal and vertical promotions - Conditional Logit estimates

Variable	Model					
	1	2	3	4	5	6
Promotion t-1	.6129***	-.0837*	.2177***	-.2619***	.5842***	.1795***
	(.0332)	(.0475)	(.0331)	(.0380)	(.0336)	(.0334)
Wage increase t-1	-7.67e-06***	7.64e-06***	-6.31e-06***	-6.19e-06***	-4.39e-06***	-4.94e-06***
	(5.31e-07)	(8.69e-07)	(4.84e-07)	(5.56e-07)	(5.42e-07)	(5.39e-07)
Wage t-2	-9.01e-06***	6.58e-06***	-5.40e-06***	-5.07e-06***	-4.92e-06***	-3.75e-06***
	(4.62e-07)	(8.36e-07)	(3.94e-07)	(5.09e-07)	(5.11e-07)	(4.91e-07)
Job transit. to other firm	-.2078***	-.1325**	.1623***	-.0271	-.2117***	-.0264
	(.0356)	(.0582)	(.0359)	(.0397)	(.0390)	(.0391)

6   Conclusions

In this article we have addressed the importance of unobserved heterogeneity explain the worker's wages dynamics and promotions. More specifically, we analysed the theoretical predictions of Gibbons and Waldman model that under full information after controlling

for worker's fixed effect, there is (1) no serial-correlation in wage increases; (2) wage increases do not predict promotions and (3) there is no serial correlation in promotions. We have found preliminary evidence of the existence of these correlations which according to the model is due to learning effect.

Different patterns of mobility have been found by the empirical literature in cross country comparisons. We compare the mobility patterns for Portugal with mobility patterns for Germany and United States. We found a much higher rate of internal mobility in Portugal than in these two countries while the mobility across firms lies in an intermediate position. One possible explanation for our findings in what concerns internal mobility relies on the differences in data sets used that allows for different promotions definitions.

7 References

Ariga, Kenn; Yasushi Ohkusa and Giorgio Brunello (1999). "Fast track: is it in genes? The promotion policy of a large Japanese firm." Journal of Economic Behavior & Organization, 38, 385-402.

Baker, George; Michael Gibbs and Bengh Homstrom (1994a). "The internal economics of the firm evidence from personnel data." Quarterly Journal of Economics, 109 (4), 881-919.

Baker, George; Michael Gibbs and Bengh Homstrom (1994b). "The wage policy of a firm." Quarterly Journal of Economics, 109 (4), 921-955.

Bernhardt, Dan (1995). "Strategic promotion and compensation." Review of Economic Studies, 62, 315-339.

Bernhardt, Dan and David Scoones (1993). "Promotion, turnover, and preemptive wage offers." American Economic Review, 83 (4), 771-791.

Bognanno, Michael L. (2001). "Corporate tournament." Journal of Labor Economics,

19 (2), 290-315.

Booth, Alison; Marco Francesconi and Jeff Frank (2003). "A sticky floors model of promotion, pay, and gender." European Economic Review, 47, 295-322.

Bognanno, Michael L. (2001). "Corporate tournament." Journal of Labor Economics, 19 (2), 290-315.

Doeringer, Peter and Michael Piore (1971). Internal Labor Markets and Manpower Analysis, Lexington, MA: D. C. Health and Company.

Dohmen, Thomas J. (2004). "Performance, seniority and wages: formal salary systems and individual earnings profile." Labour Economics, 11, 741-763.

Dohmen, Thomas J.; Ben Kriechel and Gerard A. Pfann (2004). "Monkey bars and ladders: the importance of lateral and vertical job mobility in internal labour market careers." Journal of Population Economics, 17, 193-228.

Gibbons, Robert (1997). Incentives and careers in organizations, in Advances in Economic Theory and Econometrics, Vol. 2, D. Kreps and K. Wallis, eds. NY: Cambridge University Press, 1-37.

Gibbons, Robert and Michael Waldman (2006). "Enriching a theory of wage and promotion dynamics inside firms." Journal of Labor Economics, 24(1) 59-107.

Gibbons, Robert and Michael Waldman (1999). "A theory of wage and promotion dynamics inside firms." Quarterly Journal of Economics, 114, 1321-1358.

Gibbons, Robert and Michael Waldman (1999b). "Careers in organizations: theory and evidence." in Handbook of Labor Economics, O. Ashenfelter and D. Card eds. North-Holland, 2373-2437.

Gibbs, Michael and Wallace Hendricks (2004). "Do formal salary systems really matter?" Industrial and Labor Relations Review, 58 (1), 71-93.

Kwon, Illoong (2006). "Incentives, wages, and promotions: theory and evidence."

Rand Journal of Economics, *Forthcoming.*

Lazear, Edward (1992). "The job as a concept." in Performance Measurement, Evaluations, and Incentives, ed. W. Bruns. Boston, MA: Harvard University Press.

Lazear, Edward P. (1995). "A job-based analysis of labour markets." American Economic Review, 85 (2), 260-265.

Lazear, Edward P. (1999). "Personnel economics: past lessons and future directions."Journal of Labor Economics, 17 (2), 199-236.

Lazear, Edward and Paul Oyer (2004). "Internal and external labour markets: a personnel economics approach." Labour Economics, 11(5), 527-54.

Lima, Francisco and Pedro T. Pereira (2003). "Careers and wage growth within large firms," International Journal of Manpower, 24(7), 812-35.

Lluis, Stéphanie (2005). "The role of comparative advantage and learning in wage dynamics and intra-firm mobility: evidence from Germany." Journal of Labor Economics, 23(4), 725-68.

Fairburn and Malcomson (2001). "Performance, promotion, and the Peter principal." Review of Economic Studies, 68, 45-66.

Manove, Michael (1997). "Job responsibility, pay and promotion." Economic journal, 107, 85-103.

McCue, Kristin (1996). "Promotions and wage growth." Journal of Labour Economics, 14, 175-209.

Pergamit Michael R. and Jonathan R. Veum (1999) "What is a promotion." Industrial and Labor Relations Review, 52(4), 581-601.

Prendergast, Canice (1993). "The role of promotion in inducing specific human capital acquisition." Quarterly Journal of Economics, 108,.523-534.

Prendergast, Canice (1999). "The provision of incentives in firms." Journal of Eco-

nomic Literature, 37, 7-63.

Roodman, D. (2005). "xtabond2: Stata module to extend xtabond dynamic panel data estimator. Center for Global Development, Washington.

Seltzer and Merrett (2000). "Personnel policies at the Union bank of Australia: evidence from the 1888-1900 entry cohorts." Journal of Labor Economics, 18(4), 573-613.

Topel, Robert H. and Michael P. Ward (1992). "Job mobility and the careers of young men." Quarterly Journal of Economics, 107, 255-267.

Treble, John; Edwin van Gameren; Sarah Bridges and Tim Barmby (2001). "The internal economics of a firm: further evidence from personnel data." Labour Economics, 8, 531-552.
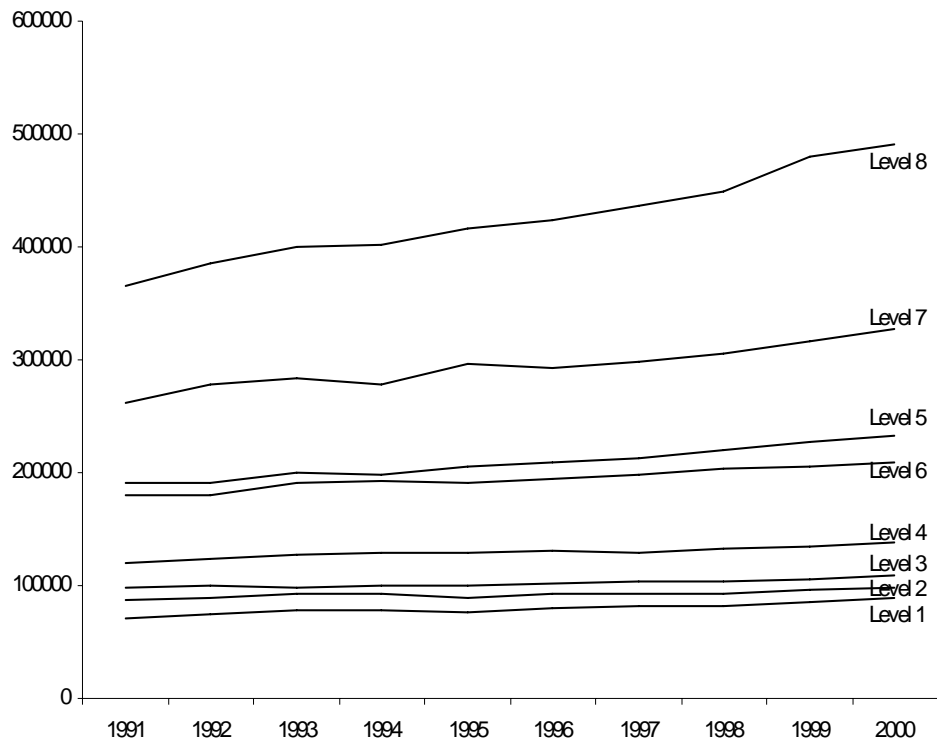
A   Statistical data

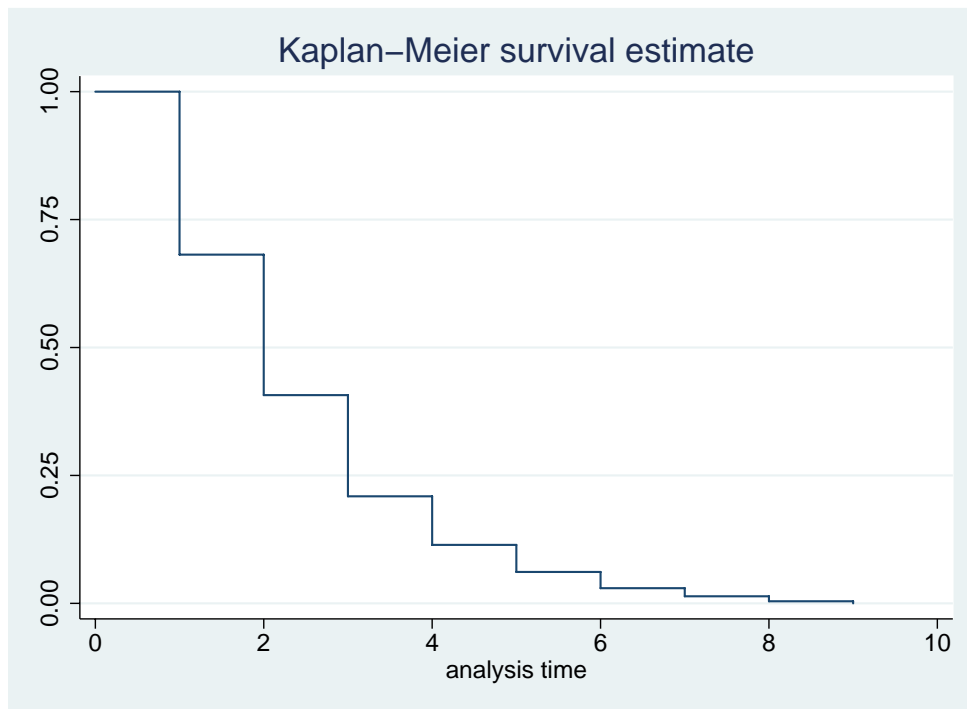Figure 1: Average wage per skill level

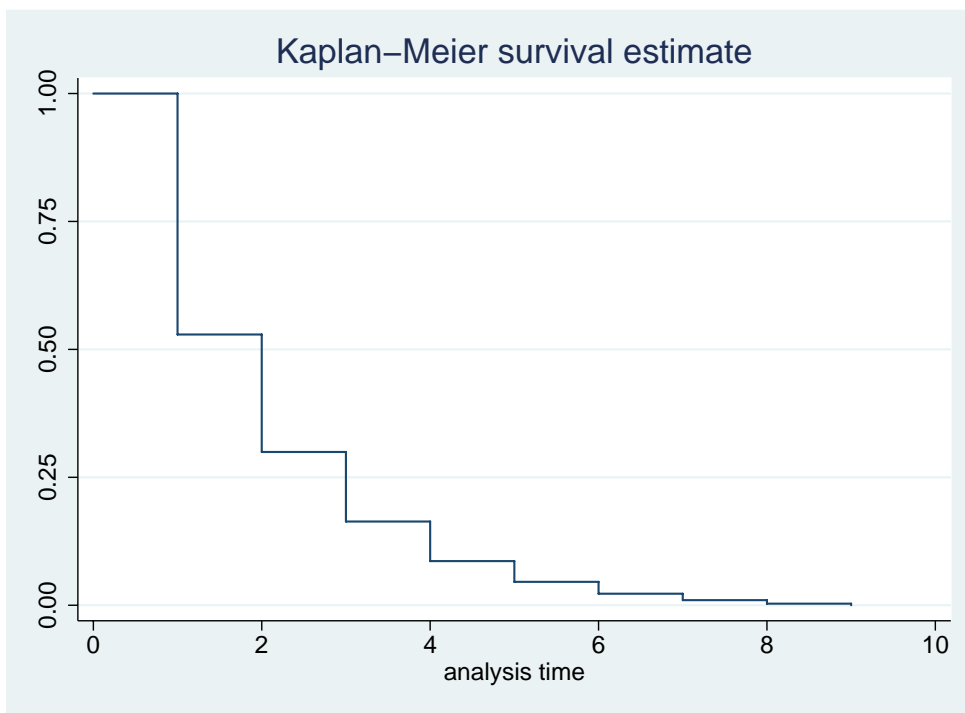Figure 2: Time to promotion to a higher skill level

Figure 3: Time to promotion (promotion concept based on employer indication)

Table 6: Definition of the variables and descriptive statistics for the sample

Variables	Description	Mean
Female	Dummy variable, 1 if female, 0 otherwise	40.03
Tenure	Time in the firm in years	10.02
Experience	Work experience in years	24.77
Age	Worker's age in years	37.48
Promdate	Dummy variable, 1 if date last prom > Oct t-1, 0 otherwise	11.62
Promup	Dummy variable, 1 if the individual moved to a higher skill level, 0 otherwise	8.00
Prom*level	Dummy variable, 1 if the indiv. prom.using both previous concepts, 0 otherwise	1.99
Promsame	Dummy variable, 1 if the indiv. prom. in the same level, 0 otherwise	9.24
Wage	Worker's wage, constant (2000) PTE	132630.1
Separ	Job transition to other firm	6.55
WageVar1	Wage differences in levels	5093.4
WageVar2	Log wage differences	0.036
Nworkers	Number of workers per firm	54
Skill level	Set of dummy variables indicating the worker skill level	
Level1	1 if Apprentices, Trainees	5.27
Level2	1 if Non-qualified professionals	9.23
Level3	1 if Semi-qualified professionals	18.83
Level4	1 if Qualified professionals	49.50
Level5	1 if Higher-qualified professionals	6.44
Level6	1 if Supervisors, team leader, foreman	5.07
Level7	1 if Intermediary executives	2.87
Level8	1 if Top executive	2.78
School	Set of dummy variables indicating the years of education each worker	
School0	1 if zero years of education	2.93
School4	1 if four years of education	41.99
School6	1 if six years of education	22.25
School9	1 if nine years of education	14.68
HSchool	1 if High school Degree	14.42
USchool	1 if University Degree	3.74
Sector(18)	18 dummy variables for the activity sector	

Table 7: Careers and level characteristics

	Level1	Level2	Level3	Level4	Level5	Level6	Level7	Level8
Number outside entrants into level	3851	3228	3712	10926	1007	679	523	550
in % workers each level	20.71	9.91	5.59	6.26	4.43	3.80	5.16	5.60
in % new hires	15.73	13.19	15.17	44.64	4.11	2.77	2.14	2.25
Average age new hires	24.3	32.5	31	31.9	32.1	37.4	32.2	33.7
Average years school new hires	6.9	5.6	6.1	6.9	10.2	7.5	12.1	14.6
Average work experience new hires	11.3	20.9	19	19	16.1	23.8	14.2	13.2
Average age of those promoted into level		27.7	31.5	32.1	37	38.6	38.6	39.3
Average years school of those promoted into level		5.8	5.6	6.3	8.5	7.1	10.3	12.6
Average work exper. of those promoted into level		15.9	19.8	19.8	22.5	25.5	22.3	20.7

Table 8: Job transition matrix within and across firms

		Level2	Level3	Level4	Level5	Level6	Level7	Level8	N
Level1	Wage incre(%)	7.66	9.29	11.56	14.68	10.48	27.99	26.24	
	Num worke(%)	9.44	26.72	59.11	3.00	0.92	0.52	0.29	6556
Level2			5.00	8.35	11.27	11.27	11.36	18.91	
			45.90	48.51	2.36	2.31	0.62	0.31	3902
Level3				4.98	9.67	10.15	11.68	17.29	
				87.62	4.98	5.31	1.50	0.59	5802
Level4					7.07	9.87	12.08	15.28	
					53.87	28.90	10.84	6.38	4685
Level5						6.62	7.27	10.05	
						22.83	51.69	25.48	1095
Level6							6.42	7.90	
							66.09	33.91	693
Level7								8.82	
								100	757

Table 9: Job transition matrix within firms

		Level2	Level3	Level4	Level5	Level6	Level7	Level8	N
Level1	Wage incre(%)	6.89	8.64	10.50	10.71	7.59	18.61	14.13	
	Num worke(%)	8.05	27.44	60.06	2.88	0.86	0.49	0.22	5478
Level2			4.16	6.66	6.04	9.45	11.26	9.85	
			48.15	46.40	2.03	2.49	0.65	0.28	3248
Level3				4.43	6.95	8.87	9.59	11.14	
				87.47	5.00	5.51	1.40	0.63	4939
Level4					6.22	8.70	9.86	10.21	
					55.16	28.77	10.24	5.84	3976
Level5						6.75	6.84	8.61	
						22.14	52.76	25.10	980
Level6							5.19	6.71	
							67.50	32.50	603
Level7								7.23	
								100	682

Table 10: Wage increases and promotions

Wage increase period t-2	Wage increase period t-1	Wage increase period t	Wage increase period t+1	Promotion higher skill level
.0446379	.0496773	.0820998	.0397071	yes
.0359394	.0347953	.032055	.0348378	no
				Prom same level
.0451956	.0426394	.0615581	.0385742	yes
.0356729	.0352125	.0334621	.0348879	no
				Promot*dlevel
.051549	.0638847	.108948	.0395921	yes
.034976	.0339614	.0287616	.0344043	no

Table 11: Number of promotions per worker

Number of promotions	Promotions to higher skill level	Promotions in the same skill level
0	41228	43518
1	13623	8861
2	2055	2891
3	219	1110
> 4	15	660
Total	57140	57140

Table 12: Promotion and associated wage increase by tenure group

tenure in the firm (in years)	0-1	2-3	3-5	5-10	10-20	>20
% of workers	12.54	15.43	13.72	22.27	20.40	15.65
Average wage	106967	110246	116393	126093	151685	173964
% workers promoted to higher skill level	16.65	11.49	9.39	6.63	5.28	4.47
Δ% wage if worker promoted to higher skill level	13.23	9.40	8.26	6.38	5.33	3.73
Δ% wage if worker not promoted to higher skill level	4.43	4.04	3.49	3.07	2.82	2.37
Δ% wage due to promotions to higher skill level	8.80	5.36	4.77	3.31	2.51	1.36
% workers promoted same skill level	6.89	11.12	10.49	9.02	8.72	8.63
Δ% wage if worker promoted same skill level	7.52	7.29	6.23	5.65	5.76	5.41
Δ% wage if worker not promoted same skill level	5.78	4.33	3.67	3.06	2.69	2.15
Δ% wage due to promotions same skill level	1.74	2.96	2.56	2.59	3.07	3.26

Table 13: Activity sector and wage increase

Sector	Num Workers	Wage increase
Agric, fishery	4989	.0265
Extract	1658	.0406
Food, beverages, tobbaco	14084	.0294
Textiles, clothing, leather	58298	.0241
Wood, cork	13285	.0345
Paper	7633	.0365
Chemicals	9409	.0356
Non-metalic mineral prod	10770	.0309
Base metals	2571	.0440
Metal products	31885	.0393
Elect., gas, water	5634	.0437
Building	26674	.0327
Trade	65395	.0391
Restaurants, hotels	16979	.0295
Transp, communications	27016	.0424
Banking, insurance	19252	.0554
Serv. to companies	3741	.0382
Other activities	33590	.0410

Table 14: Structure of the skill levels - Decreto-lei n. 121/78, 2nd june

Level	Tasks	Skills
8 - Top executives	Definition of the firm general policy or consulting on the organization of the firm. Strategic planning. Creation or adaptation of technical, scientific and administrative methods or processes.	Knowledge of management and coordination of firm's fundamental activities. Knowledge of management and coordination of the fundamental activities in the field to which the individual is assigned and that requires the study and research of high responsibility and technical level problems.
7 - Intermediate executives	Organization and adaptation of the guidelines established by the superiors and directly linked with the executive work.	Technical and professional qualifications directed to executive, research, and management work.
6 - Supervisors, team leaders, foremen	Orientation of teams, as directed by the superiors, but requiring the knowledge of action process.	Complete professional qualification with a specialization.
5 - Higher-skilled professionals	Tasks requiring a high technical value and defined in general terms by the superiors.	Complete professional qualification with a specialization adding to theoretical and applied knowledge.
4 - Skilled professionals	Complex or delicate tasks and usually not repetitive and defined by the superiors.	Complete professional qualification implying theoretical and applied knowledge.
3 - Semi-skilled professionals	Well defined tasks, mainly manual or mechanical (no intellectual work) with low complexity, usually routine and sometimes repetitive.	Professional qualification in a limited field or practical and elementary professional knowledge.
2 - Non-skilled professionals	Simple tasks, diverse and usually not specified, totally determined.	Practical knowledge and easily acquired in a short time.
1 - Apprentices, interns, trainees	Training for a specific task.	Identical, but without practice, to the professional of the qualification level they will be assigned.