

Wage dynamics and promotions inside and between firms

Bas van der Klaauw · António Dias da Silva

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Abstract We focus on the dynamic relation between wage increases, promotions and job changes. In the empirical analyses, we use the Portuguese-matched employer–employee data Quadros de Pessoal. We find substantial wage returns to both promotions and job-to-job transitions. Our results are not consistent with models of full information and symmetric learning in a competitive and frictionless market. This might suggest that there is asymmetric information. An alternative explanation is that workers might search for a good match. Finally, we show that employer-reported promotions differ to a large extent from changes in hierarchical levels.

Keywords Learning · Competition · Matched employer–employee data

JEL Classification M5 · J6 · L2

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B. van der Klaauw (✉)
Department of Economics, VU University Amsterdam, De Boelelaan 1105,
NL–1081 HV Amsterdam, The Netherlands
e-mail: bklaauw@feweb.vu.nl

A. Dias da Silva
European Commission and Portugal's Ministry of Finance and Public Administration,
Av. Infante D. Henrique, no 1C 1o, 1100–278 Lisboa, Portugal

B. van der Klaauw
Tinbergen Institute, Amsterdam, The Netherlands

B. van der Klaauw
CEPR, London, UK

1 Introduction

Career development inside the firm is an important source of wage increases. Topel and Ward (1992) show that for young workers, only one third of the wage increases can be attributed to job changes. Within a firm workers can climb a usually well-defined hierarchy. Promotions to higher levels occur when workers accumulate human capital or when firms learn about workers' productivity. These promotions are often associated with substantial wage increases.

In this paper, we provide empirical evidence on the relation between wage increases, promotions and job-to-job transitions. There exists both an extensive theoretical literature on wage development and promotions (e.g. Gibbons and Waldman 1999), and on job transitions (e.g. Jovanovic 1979; Burdett and Mortensen 1998). But the link on what goes on inside and outside the firm is limited, both theoretically and empirically. Exceptions are recent studies by Ghosh (2007), Kahn (2007), Schönberg (2007) and Pinkston (2009).

We use a dynamic framework to investigate up to what extent promotions and job changes can be predicted by the past career path, and how promotions and job changes affect wage increases. To estimate dynamic models, we need data covering a sufficiently long period. The Portuguese-matched employer–employee data *Quadros de Pessoal* describe a relatively long observation period, and include precise and detailed information on both firms and workers. It is based on an annual enquiry of all firms with wage earners in the private sector. Since firms report wages, hierarchical levels, detailed job descriptions, promotion dates, firm size etc., measurement errors are most likely smaller than in worker survey data. Furthermore, we can continue following workers also when switching employers. Since job turnover is non-random, this is an advantage over the empirical literature on internal labor markets using only data from a single firm.

It should be noted that the Portuguese labor market is characterized by a centralized wage system setting rules for wage increases and career progression. However, empirical studies have concluded that there is a substantial degree of wage flexibility. For example, Cardoso and Portugal (2005) suggest that agreements reached by collective bargaining are adjusted by firms' subsequent arrangements. Our findings are, therefore, not only the consequence of existing institutions, but also reflect labor-market dynamics.

We construct two measures for promotions. The data include the worker's hierarchical level, which is ranked by a well-defined hierarchy. Our first measure for promotions is based on changes in hierarchical level. Also Lluís (2005) uses changes in hierarchical levels as measure for promotions. This definition connects to the theoretical literature where a promotion is considered to be a change in hierarchical level accompanied by a change in the worker's production technology (e.g. Bernhardt 1995; Gibbons and Waldman 1999). An advantage of using changes in hierarchical level as promotion is that it also identifies promotions coinciding with a job-to-job transition. Indeed,

Scoones and Bernhardt (1998) provide a theoretical model in which job-to-job transitions are associated with promotions.

The second measure for promotions uses whether the firm reports that the worker has been promoted in the past year. We show that both promotion concepts differ substantially. Less than 30% of the changes in hierarchical level are also considered promotions by the employer. Furthermore, about 40% of the employer-reported promotions are not associated with a change in detailed job description. The wage returns to an employer-reported promotion are substantially higher than returns to a change in hierarchical level. Also in other aspects the estimation results differ substantially between the two promotion concepts. Our interpretation of these findings is that the eight hierarchical levels distinguished in the data are too broad to capture all changes in job complexity and responsibilities, while firms might also report substantial wage increases as promotions rather than changes in job tasks.

Our empirical results show that after controlling for observed and unobserved heterogeneity there remains serial correlation in changes in hierarchical levels. Within the theoretical framework of Gibbons and Waldman (1999), this is considered evidence in favor of symmetric learning. However, wage increases do not forecast promotions and serial correlation in wage increases is absent. The data also do not show the type of serial correlation in wage increases as predicted by Chiappori et al. (1999) under symmetric learning. There are substantial returns to switching employers, but the pattern of job-to-job transitions is not fully consistent with basic job-search theory (e.g. Burdett and Mortensen 1998). Asymmetric employer learning might be a possible explanation for the substantial returns to both promotions and job turnover. This evidence is only circumstantial, we do not provide direct tests for asymmetric employer learning, and there is no single model which is consistent with all our findings. Another possible explanation might be that workers are searching for a good match, as modeled by Jovanovic (1979). Finally, it should be noted that the estimation results are quite similar for men and women and for different educational groups, but differ between blue and white-collar sectors.

This paper is organized as follows. In Section 2, we discuss recent theoretical literature concerning promotions, wage increases and job transitions. This theoretical literature is used to guide the specification of our empirical models, which are presented in Section 3. Section 4 provides a detailed description of the data. In Section 5 we present our empirical results. Section 6 provides sensitivity analyses. Section 7 concludes.

2 Theoretical considerations

The economic literature on promotions is driven by a number of stylized facts (e.g. Baker et al. 1994a, b). Promotions are associated with large wage increases. Promotions are, therefore, not only used to assign workers to jobs,

but can also act as incentives structures to workers (like what is suggested in rank-order tournaments discussed in Lazear and Rosen 1981). However, wage increases at promotions are small relative to differences between averages wages across hierarchical levels. Both wage increases and promotions are found to be serially correlated. Large wage increases during a stay at one hierarchical level often predict promotions to the next hierarchical level. The final stylized fact is that real wage decreases are not rare, but demotions are.

The model of Gibbons and Waldman (1999) can explain many of stylized facts.¹ They consider two types of workers with different ability. Productivity depends on ability, work experience and shocks.² Gibbons and Waldman (1999) distinguish two cases: symmetric learning where both the worker and firms learn about the worker's ability; and full information where the ability is always known to both the worker and firms. Under full information, past realizations of the worker's productivity are not informative on the worker's ability. Conditional on the worker's ability wages and promotions are only driven by accumulated work experience. Under symmetric learning even after conditioning on the worker's ability, past realizations of the worker's productivity remain important. Conditioning on the true worker's ability and work experience is, therefore, not sufficient to remove serial correlation in wage increases. Workers who experience large wage increases are also more likely to be promoted as firms believe these are high-ability workers. These workers also spend less time in a hierarchical level before being promoted to the next level. This causes wage increases to predict promotions, and that promotions are serially correlated.

Chiappori et al. (1999) add downward wage rigidity to the model with symmetric learning. Downward wage rigidity causes that past performance of a worker with a high recent wage increase which is at least as good as the past performance of a worker with the same wage but with a low recent wage increase. Conditional on the current wage, there is thus positive serial correlation in wage increases. Chiappori et al. (1999) and Gibbons and Waldman (1999) consider frictionless competitive labor markets where firms are homogenous in their productivity. In such models, wages equal expected productivity and workers do not switch employers. However, job turnover is substantial particularly for young workers and contributes to wage progression (Topel and Ward 1992).

Schönberg (2007) models job turnover jointly with wage progression and promotions inside the firm. Like Ghosh (2007), she assumes that workers receive private disutility shocks about the current match. This is in line with Jovanovic (1979) who assumes that while working both the worker and the firm learn about the quality of the match. Both Jovanovic (1979) and Ghosh (2007) predict declining job separation in job tenure. A similar approach is taken

¹Examples of other recent models are Bernhardt (1995), Costrell and Loury (2004), Demougin and Siow (1994), Kwon (2006) and Owan (2004).

²See Gibbons and Waldman (2006) for an extension of their earlier model.

by Kahn (2007), who considers a two-period model with disutility shocks of moving. In the presence of asymmetric learning disutility, shocks generate adverse selection in job turnover. This was already stressed by Greenwald (1986) who argued that the better workers stay with their employers. Gibbons and Katz (1991) first empirically established asymmetric information by comparing laid-off workers and plant closures. Waldman (1984) argued that if outside firms do not observe wages, then promotions are signals. The implication is that wage increases upon promotion should be substantial to keep the worker, but, therefore, also fewer promotions occur. DeVaro and Waldman (2006) assume that education is a signal about ability, and test empirically if low-educated workers are promoted at a lower rate and receive higher wage increases upon promotions than high-educated workers. They find evidence for asymmetric learning. Schönberg (2007) finds that learning is largely symmetric. She argues that in the presence of asymmetric learning, early ability signals such as education have relatively long impacts on wages (this idea is also exploited by Altonji and Pierret 2001). Kahn (2007) who focuses on wage variation, finds strong evidence in favor of asymmetric learning. Finally, Pinkston (2009) assumes that also poaching firms receive a private signal about worker's ability and engage in a bidding war with the current firm. The empirical results show that wage returns to hard-to-observe ability indicators increase with the employment spell length, which Pinkston (2009) interprets as evidence in favor of asymmetric employer learning.

There are alternative explanations for job turnover. Most prominent are job-search models, but these often do not model internal labor markets (e.g. Burdett and Mortensen 1998). An exception is Postel-Vinay and Robin (2002), who incorporate wage bargaining in a search model with worker and firm heterogeneity. Workers who get an outside offer move only to more productive firms. In case the poaching firm is much more productive than the current employer workers might even accept wage cuts, because wage prospects are better at more productive firms. Wage increases are decreasing in job tenure as more tenured workers are less likely to receive good outside offers. Job-search models do not allow for uncertainty about ability. McCall (1990) and Neal (1999) argue that individuals are not only searching for better jobs, but first search for a good occupation. Neal (1999) predicts that occupational changes should not follow simple job changes. And both McCall (1990) and Neal (1999) show that occupational changes are less common among experienced workers.

3 Empirical models

Gibbons and Waldman (1999) show that under full information in a frictionless competitive labor market (where wages equal expect productivity), wage increases $w_{it} - w_{it-1}$ only depend on the worker's ability θ_i , the level of labor-market experience and the worker's hierarchical level. After controlling for hierarchical level, ability and experience, promotions should not have any effect on the wage level w_{it} . However, our model describes wage increases,

and a promotion implies a switch of production technology. Therefore, even under full information the occurrence of a promotion p_{it} can affect wage growth. Symmetric learning yields serial correlation in wage increases, implying that after controlling for the factors mentioned above and the wage level w_{it-2} , the wage increases $w_{it} - w_{it-1}$ and $w_{it-1} - w_{it-2}$ are correlated. The reason for conditioning on the wage level w_{it-2} is to control for all information already revealed to the market about the worker’s ability. Additionally, we allow wage increases to depend on job separations s_{it} from the current employer and job tenure t_{it} . Our empirical wage equation, therefore, follows

$$w_{it} - w_{it-1} = \beta_{11}(w_{it-1} - w_{it-2}) + \beta_{12}w_{it-2} + \beta_{13}p_{it} + \beta_{14}s_{it} + \beta_{15}t_{it} + \beta_{16}x_{it-1} + \theta_{1i} + \varepsilon_{1it} \tag{1}$$

In the equation, a regressor x_{it-1} is included. This represents all exogenous variables, such as age and age squared (to proxy labor-market experience), firm size, and dummy variables for hierarchical levels, years and industries. These variables should also control for heterogeneity in the firm’s technological function. In Section 5, we present estimation results with different sets of exogenous variables included in the model.

Our data are collected annually. Figure 1 shows at which moment the variables are observed. At the start of year t we know the worker’s monthly wage level w_{it-1} , tenure t_{it} and the exogenous regressors x_{it-1} (from the survey in year $t - 1$). We observe whether or not during year t a worker gets promoted p_{it} or switches employer s_{it} . Finally, at the end of year t we observe again the monthly wage w_{it} , tenure t_{it+1} and the set of regressors x_{it} .

Within the framework of Gibbons and Waldman (1999) a positive value for β_{11} implies symmetric learning rather than full information. The specification has features of Chiappori et al. (1999), who argue that in the presence of downward wage rigidities symmetric learning means that conditional on the wage w_{it-1} the wage increases $w_{it} - w_{it-1}$ and $w_{it-1} - w_{it-2}$ are positively correlated. Because they condition on w_{it-1} instead of w_{it-2} , symmetric learning implies $\beta_{11} > \beta_{12}$. Waldman (1984) argues that in case of asymmetric learning promotions can be signals, and, therefore, wage increases upon promotions should be large. This implies that β_{13} should be large and positive.

In a frictionless competitive labor market both under full information and symmetric learning, wages equal expected productivity. In this case, job separations do not affect wage increases, so $\beta_{14} = 0$. However, this is only the case if there is no match specific component in the worker’s productivity as in Jovanovic (1979). Otherwise, a non-zero value of β_{14} implies either that learning is asymmetric or that the labor market is not competitive and frictionless.

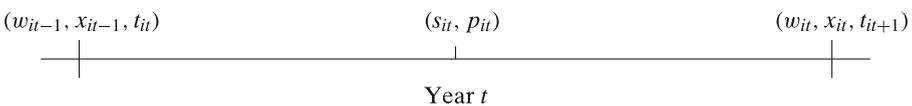


Fig. 1 Annual observations in data

Within the asymmetric employer learning model of Pinkston (2009) workers move when a poaching firm with a different private signal than the current employer wins a bidding war. This implies that job-to-job mobility is always associated to wage increases, i.e. $\beta_{14} > 0$. Also Scoones and Bernhardt (1998) suggests that job separations are associated to wage increases. However, in their model a substantial share of the wage increase is due to workers changing hierarchical level at job separation (i.e. promotion from laborer to manager). In most job-search models workers only change employers if the outside wage offer exceeds their current wage. In such a stylized model, the existence of labor-market frictions β_{14} should exceed 0. Indeed, Postel-Vinay and Robin (2002) show that if firms are heterogeneous workers might be willing to accept a wage cut when they move to a much more productive firm. However, also their results show that the majority of the job-to-job transitions yield positive wage increases. Also Jovanovic (1984) allows for the possibility that workers accept a wage cut at a job transition when moving to an employer with a higher option value.

The model has the specification of a dynamic panel-data model. We follow the approach of Arellano and Bond (1991) to estimate the model. To eliminate worker-specific-fixed effects θ_{it} , we take first differences,

$$\begin{aligned} (w_{it} - w_{it-1}) - (w_{it-1} - w_{it-2}) = & \beta_{11}((w_{it-1} - w_{it-2}) - (w_{it-2} - w_{it-3})) + \\ & \beta_{12}(w_{it-2} - w_{it-3}) + \beta_{13}(p_{it} - p_{it-1}) + \beta_{14}(s_{it} - s_{it-1}) + \\ & \beta_{15}(t_{it} - t_{it-1}) + \beta_{16}(x_{it-1} - x_{it-2}) + \varepsilon_{1it} - \varepsilon_{1it-1} \end{aligned} \quad (2)$$

The equation includes the endogenous regressors $(w_{it-1} - w_{it-2}) - (w_{it-2} - w_{it-3})$, $p_{it} - p_{it-1}$, $s_{it} - s_{it-1}$ and $t_{it} - t_{it-1}$. Usually, one would take $w_{it-2} - w_{it-3}$, p_{it-1} , s_{it-1} and t_{it-1} as instruments. However, $w_{it-2} - w_{it-3}$ is already a regressor. Instead we use w_{it-3} . The validity of our instrumental variables hinges on the lack of autocorrelation in the error terms ε_{it} . We will investigate this further in Section 6 when we add additional lags as instrumental variables and perform Sargan tests. In the baseline specification, we have, however, as many instrumental variables as endogenous regressors. In this just-identified model, estimation simplifies to using 2SLS as proposed in Anderson and Hsiao (1982). The estimation method requires that we observe a worker's wage in four consecutive years (w_{it}, \dots, w_{it-3}). Furthermore, instruments should have a sufficiently large predictive power for the endogenous regressors. In Section 4 after having discussed our data, we investigate the predictive power of our instruments.

For promotions and job separations, we use similar model specifications as for wage increases. Our empirical model for promotions is

$$\begin{aligned} p_{it} = & \beta_{21}(w_{it-1} - w_{it-2}) + \beta_{22}w_{it-2} + \beta_{23}p_{it-1} + \beta_{24}s_{it-1} \\ & + \beta_{15}t_{it} + \beta_{26}x_{it-1} + \theta_{2i} + \varepsilon_{2it} \end{aligned} \quad (3)$$

Gibbons and Waldman (1999) predict that under full information promotions depend only on the worker's ability, the level of labor-market experience and the current hierarchical level. If there is symmetric learning, there remains serial correlation in promotions, and promotions can be predicted by wage increases, which implies $\beta_{21} > 0$ and $\beta_{23} > 0$. Chiappori et al. (1999) argue again that due to downward wage rigidities, symmetric learning implies that conditional on w_{it-1} those workers with higher recent wage increases ($w_{it-1} - w_{it-2}$) are more likely to be promoted, implying $\beta_{21} > \beta_{22}$. In a frictionless competitive labor market, the rate at which promotions occur should not depend whether the worker changed employer, which implies $\beta_{24} = 0$.

Our model for job turnover is

$$s_{it} = \beta_{31}(w_{it-1} - w_{it-2}) + \beta_{32}w_{it-2} + \beta_{33}p_{it-1} + \beta_{34}s_{it-1} + \beta_{35}t_{it} + \beta_{36}x_{it-1} + \theta_{3i} + \varepsilon_{3it} \quad (4)$$

Ghosh (2007) and Schönberg (2007) argue that workers receive private signals about the disutility of the current match. Workers with long tenure are selected towards having a low disutility of their match, i.e. $\beta_{35} < 0$. This also generates state dependence, and, therefore, implies $\beta_{34} > 0$. A similar prediction is made by Jovanovic (1979). In his model, mainly those with a bad job match switch employer. In a competitive market this implies a negative correlation between w_{it-1} and s_{it} , so $\beta_{31} < 0$ and $\beta_{31} = \beta_{32}$. Job-search theory provides the same prediction (e.g. Burdett and Mortensen 1998). If job turnover is mainly due to labor-market frictions, then after controlling for ability θ_{3i} we expect job turnover to be higher for workers with lower wages.

The models for promotions and separations are linear probability models. The main reason for using linear probability models as compared with, for example, logit or probit is that we want to include worker-fixed effects to account for heterogeneity in unobserved innate ability. Since wage changes ($w_{it-1} - w_{it-2}$) and the wage level w_{it-2} are continuous variables, fixed-effects logit including lagged promotion or separation is problematic. We estimate the models for promotions and job separations similar to that for wage increases, so with similar first-stage regressions.

4 Data

In the empirical analyses, we use the Portuguese-matched employer–employee data set *Quadros de Pessoal*. These data are annually collected by the Ministry of Employment, based on a survey that every firm with wage earners has to complete. The data do not cover public administration, domestic services and self-employed workers. The compulsory nature of the survey guarantees that each year information on more than two million workers is recorded. *Quadros de Pessoal* provides information on individual characteristics such as gender, age, schooling, occupation, tenure, earnings, and hours of work.

Firm characteristics include location, employment, sales, ownership, and legal setting. Both firms and workers have identification codes that permit to track them over time. For employers, it is mandatory to post the firm's response to survey questions concerning information on employees in a public place inside the firm. This should reduce measurement errors in the data.

In our empirical analyses, we use data from 1991 to 2000. The data are collected once per year. Until 1993, data were collected in March, and after 1993 in October. In the empirical analyses, we deal with this discrepancy by including year dummies. Furthermore, we perform sensitivity analyses where we only consider the period after 1993. We restrict the sample to full-time workers between 16 and 65 years old. In total, the data contain 4,202,736 workers, who are observed in 16,245,140 worker-years. We use a 10% random sample including 420,274 workers observed in 1,626,415 worker-years. We have done some consistency checks. In particular, we checked the variables gender, birthday, tenure and wage (see the [Appendix](#)). After excluding inconsistencies, which could not be repaired, the data set contains 363,383 individuals and 1,323,298 worker-year observations.

The data contain five components of monthly earnings, a base-wage, tenure-indexed components, other regularly paid components, non-systematic payments and extra-time work payments. As the relevant wages, we take the sum of base-wage, tenure-indexed components and other regularly paid components. We do not include the other two components as these are specific to the month in which the data were collected. It should, however, be noted that the average non-systematic payments are about 7.5% of the average wage, and extra-time work payments 2%.³ The amounts presented are before taxes and social-security contributions, and refer to October of each year (or March for the period 1991–1993). We have deflated wages using the Consumer Price Index to constant (2000) PTE.

The Quadros de Pessoal contains three types of variables that reveal information about workers' mobility inside firms. Most detailed is the professional category, which contains over 60,000 possible job descriptions. Since there is no natural ranking in these job descriptions, using changes in professional category as measure for promotions is not attractive. The second source of information about workers' mobility is hierarchical level, which is based on skills and tasks. The data distinguish eight hierarchical levels (full description in the [Appendix](#)) defined by law (Decreto-Lei n.º 121/78, 2 June):⁴

- (Level 1) apprentices, interns, trainees;
- (Level 2) non-skilled professionals;
- (Level 3) semi-skilled professionals;

³Adding these wage components does not affect the estimation results presented in the next section.

⁴The law does not explicitly offer an explanation how the hierarchical levels were designed. However, it seems that the main purpose lies in using them in collective bargaining processes.

- (Level 4) skilled professionals;
- (Level 5) higher-skilled professionals;
- (Level 6) supervisors, team leaders, foremen;
- (Level 7) intermediary executives;
- (Level 8) top executives.

A promotion is defined as a movement from a lower to a higher hierarchical level. To reduce misclassification in hierarchical levels, we have used the information on professional categories. Since the professional category is much more detailed than hierarchical level, we consider changes in hierarchical level that did not imply a change in professional category as misclassifications. The final measure for worker's mobility is the reported date of the most recent promotion. If the date of last promotion is posterior to October of last year (or March for the period 1991–1993), we consider that the worker has been promoted. It should be stressed that the firm reports this promotion date, which most likely reduces the level of subjectiveness in what is considered to be a promotion.

Since we follow firms and workers over years, we are able to identify workers movements between firms. We define a separation as a worker movement from one firm to another in two subsequent years. We use data on tenure to control for misclassifications in separations.

In Table 1, we present some descriptive statistics of the data. Recall that for estimating the model, we require observing the worker's wage in four consecutive years (w_{it}, \dots, w_{it-3}). So in the estimation we use 106,305 workers observed in 659,497 worker-years. We provide descriptive statistics for both samples. Workers who we observe at least in four consecutive waves, are slightly older, have somewhat more tenure and work in larger firms. Since they are somewhat more experienced, they also have a slightly higher wage, but lower annual wage increases. Their promotion rate is slightly higher, and they less often switch employers. Below we mainly focus attention on all workers.

The mean monthly wage is 125,762 PTE, which is about 627 euros. Workers experience, on average, an annual wage increase of 5,329 PTE, which is 3.8% of the mean wage. Annually, approximately 7% of the workers change hierarchical level in two subsequent years. However, firms indicate that each year, on average, 11.2% of the workers get promoted. The majority of the workers that got promoted according to the firm, did not change hierarchical level. Only 2% of all workers are promoted according to the firm and change hierarchical level in the same year. This suggests that both promotion concepts measure different movements within the firm. Furthermore, yearly about 4.4% of the individuals switch firms, and 1.1% of all workers move to a higher hierarchical level at the same time they switch firms.

The average age of workers is 36, and about 41% are female. On average, a worker has eight years of tenure within the current firm. The mean firm size is 30 workers. Almost half of the workers are qualified professionals, which is the fourth hierarchical level out of eight possible levels. Only about 3% of the workers are top executives, which in the highest hierarchical level. Compared

Table 1 Descriptive statistics

Description	Full sample	Restricted sample
Monthly gross wage, constant (2000) PTE	125,762	132,633
Annual wage increase	5,329	4,984
Promotions to higher hierarchical level (annually)	7.01%	7.75%
Employer-reported promotions (annually)	11.18%	14.55%
Job transitions to other firm (annually)	4.40%	3.43%
Female	41.16%	40.16%
Worker's age (in years)	35.9	37.4
Tenure in the current firm (in years)	8.1	10.1
Number of workers in the firm	30	52.4
Level 1 Apprentices, interns, trainees	7.74%	5.29%
Level 2 Non-qualified professionals	10.44%	9.03%
Level 3 Semi-qualified professionals	18.27%	19.11%
Level 4 Qualified professionals	47.42%	49.88%
Level 5 Higher-qualified professionals	5.76%	6.28%
Level 6 Supervisors, team leaders, foremen	4.36%	5.03%
Level 7 Intermediary executives	2.82%	2.69%
Level 8 Top executives	3.19%	2.69%
Highest completed education		
No complete primary school	2.88%	2.51%
Completed primary school (4 years of education)	42.02%	43.65%
6 years of education completed (second ciclo)	22.89%	22.63%
9 years of education completed (third ciclo)	14.10%	14.42%
High school completed (12 years of education)	13.74%	13.05%
University completed (15 to 17 years of education)	4.37%	3.74%
Number of workers	363,383	106,305
Worker-year observations	1,323,298	659,497

Note: The restricted sample contains only workers who appear in four consecutive waves

with other European countries, the level of education in Portugal is very low.⁵ In our sample, about 42% of the workers only completed four years of primary education, while only about 18% of the workers finish high school. Finally, we distinguish 18 industries. The two largest are trade and textile, clothing and leather employing 18% and 17% of the workers, respectively.

Table 2 presents yearly job mobility by gender and age. We have categorized transitions into five different possibilities: no change; separation to the same hierarchical level in another firm; separation to a higher hierarchical level in another firm; promotion inside the firm to a higher hierarchical level; and promotion inside the firm in the same hierarchical level. The latter type of promotions are based on the most recent promotion date reported by the firm. The general picture does not differ much between men and women. About 80% of both men and women do not make a change. Men are slightly more likely to switch employers, while women more often make a transition inside the firm to a higher hierarchical level. Mobility declines as workers get older. For the oldest age group most mobility comes from promotions inside the

⁵OECD (2007) states that in 2005 about 59% of the population between 25 and 64 years had not received any education beyond primary school.

Table 2 Frequency of yearly mobility (in percentage)

Age	No change	Separation			Transition higher level	Promotions same level	Observations
		Same level	Higher level	Lower level			
Men							
16–25	67.01	4.29	3.23	1.96	11.91	11.59	62,763
26–35	78.05	3.45	1.41	1.16	6.17	9.76	138,046
36–45	83.48	2.25	0.57	0.59	4.39	8.73	123,484
46 –	87.22	1.31	0.23	0.31	3.24	7.68	137,269
Total	80.73	2.61	1.08	0.86	5.61	9.12	461,562
Women							
16–25	68.42	3.83	2.33	1.83	12.04	11.55	58,740
26–35	79.57	2.64	1.07	1.09	6.28	9.36	113,723
36–45	84.69	1.54	0.48	0.59	4.71	7.99	87,483
46 –	87.42	0.94	0.21	0.29	3.95	7.19	56,223
Total	80.31	2.25	0.99	0.95	6.50	9.00	316,169
All	80.56	2.45	1.05	0.90	5.97	9.07	777,731

same hierarchical level. A natural explanation that older workers are less often promoted to higher hierarchical levels is that these workers are already in higher hierarchical levels and there are thus fewer possibilities for increases.

McCue (1996) and Lluís (2005) have documented similar statistics for workers' mobility for respectively the USA and Germany. Portugal has lower separation rates than the USA and Germany, which is particularly the case for younger inexperienced workers. Internal job mobility rates are much higher in Portugal. However, this might also be caused by differences in the definition of promotions. Both McCue (1996) and Lluís (2005) use data from questionnaires to individuals and thus rely on self-reported position changes by workers. Furthermore, Lluís (2005) only distinguishes four hierarchical levels, which naturally reduces mobility compared with our eight hierarchical levels. McCue (1996) considers each self-reported position change by the worker as a promotion, but there might still be some discrepancy between worker and firm-reported position changes.

Table 3 presents for each hierarchical level the average wage and some measures for mobility. Except for level 6 (supervisors, team leaders and foremen), the average wage is higher for workers in higher hierarchical levels. Workers in

Table 3 Annual mobility (in percentage) and average wage per hierarchical level

Level	No change	Separation	Transition higher level	Transition lower level	Promotion same level	Average wage
Level 1	51.02	8.66	34.29		17.04	74,364
Level 2	77.52	5.92	12.80	0.89	6.89	86,548
Level 3	81.31	3.81	8.35	1.58	7.54	95,532
Level 4	81.31	4.23	2.55	1.73	9.41	117,795
Level 5	79.81	2.85	4.92	3.15	10.45	194,122
Level 6	84.92	2.42	3.39	2.87	7.37	177,693
Level 7	78.59	3.25	6.77	4.53	8.45	255,188
Level 8	82.35	3.58		3.71	10.70	361,278

level 5 (higher-qualified professionals) are, on average, better educated than workers in level 6, which might explain their higher average wage. Workers in level 8 (top executives) earn, on average, more than five times as much as apprentices and trainees in level 1. Average wages particularly start to increase beyond level 4 (qualified professionals). Recall from Table 1 that less than 16% of the workers are ranked in hierarchical level 5 or higher.

As could be expected, apprentices and trainees are most mobile. They are most likely to be promoted to higher hierarchical levels, within the level or to switch employers. The likelihood of moving to a higher hierarchical level decreases quickly until reaching level 4, and remains roughly the same for higher hierarchical levels. It should also be noted that from level 4 transitions to lower levels occur more frequently particularly compared with transitions to higher levels. Except for workers in the first level, all workers have roughly similar probabilities of being promoted within the hierarchical level, and to separate from the job.

Table 4 shows how workers move through hierarchical levels and the associated wage increases. Average wage increases associated to changes in hierarchical level are always higher than average wage increases of the workers who stay in the same level. This also holds for promotions from level 5. Recall that in hierarchical level 5 workers have, on average, a higher wage than in level 6. However, the average annual wage increase for workers who move from levels 5 to 6 is about 6.8%, while it is 4.4% for workers who stay in level 5. It should be noted that from level 5 more workers move to level 7 than to level 6. In general, average wage increases increase in the number of hierarchical levels a worker is promoted. However, workers are not very likely to skip hierarchical levels beyond the level of qualified professionals (level 4). Workers making a transition to a lower hierarchical level experience a lower

Table 4 Annual job transition matrix within and across firms

		Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
Level 1	a	65.71	3.60	9.60	19.62	0.85	0.27	0.22	0.12
	b	6.32	12.54	11.52	12.92	13.87	20.51	23.95	25.98
Level 2		0.97	86.20	5.76	6.60	0.22	0.26	0.06	0.04
		-0.54	2.68	6.16	9.54	13.64	16.45	15.93	29.25
Level 3		0.69	1.63	89.30	7.53	0.42	0.46	0.09	0.05
		-3.19	0.33	2.79	6.10	8.25	11.13	12.38	19.61
Level 4		0.48	0.52	1.39	95.10	1.31	0.81	0.31	0.17
		-1.83	-1.26	-0.40	3.31	8.19	10.73	13.45	16.48
Level 5		0.19	0.18	0.73	3.76	90.21	1.22	2.65	1.31
		-7.70	-5.97	-2.25	-0.80	4.42	6.77	8.57	12.31
Level 6		0.11	0.24	0.51	2.63	0.90	92.20	2.40	1.15
		-7.40	-6.74	-4.78	-4.16	2.20	3.27	7.37	10.79
Level 7		0.08	0.07	0.32	2.15	2.65	2.11	85.84	7.31
		-6.68	-34.8	-6.45	-0.69	3.56	1.22	5.30	9.65
Level 8		0.06	0.04	0.15	0.84	1.28	0.94	2.57	94.10
		-25.4	-35.0	-14.7	-34.5	2.64	1.42	4.18	5.97

a Fraction of workers (%)

b Wage increase (%)

wage increase than workers staying in their hierarchical level. Furthermore, workers moving down to level 4 or lower, on average, experience a real wage decrease.

Most theoretical models have labor-market experience as an important individual characteristic (e.g. Gibbons and Waldman 1999). However, the data do not contain information on work experience. Using potential experience defined as the difference between age and years of schooling plus six is not attractive. Recall that the most substantial share of the workers has only four years of primary school. Computing potential experience implicitly assumes that these individuals started working at age ten, which is very unlikely. Therefore, we use the worker's age as proxy variable for work experience, we include both age and age squared.⁶ Finally, for each model specification we estimate the model both without and with firm size, industry dummies and dummies for the different years of observation.

We use instrumental variable methods to estimate our empirical models. It is well known that parameter estimates may be severely biased if instruments are weak (e.g. Staiger and Stock 1997). Therefore, we first investigate the first-stage regressions,

$$\begin{aligned}
 (w_{it-1} - w_{it-2}) - (w_{it-2} - w_{it-3}) &= \gamma_{10} + \gamma_{11}w_{it-3} + \gamma_{12}p_{it-1} + \gamma_{13}s_{it-1} + \\
 &\quad \gamma_{14}l_{it-1} + \gamma_{15}(x_{it-1} - x_{it-2}) + \epsilon_{1it} \\
 (p_{it} - p_{it-1}) &= \gamma_{20} + \gamma_{21}w_{it-3} + \gamma_{22}p_{it-1} + \gamma_{23}s_{it-1} + \\
 &\quad \gamma_{24}l_{it-1} + \gamma_{25}(x_{it-1} - x_{it-2}) + \epsilon_{2it} \\
 (s_{it} - s_{it-1}) &= \gamma_{30} + \gamma_{31}w_{it-3} + \gamma_{32}p_{it-1} + \gamma_{33}s_{it-1} + \\
 &\quad \gamma_{34}l_{it-1} + \gamma_{35}(x_{it-1} - x_{it-2}) + \epsilon_{3it} \\
 (l_{it} - l_{it-1}) &= \gamma_{40} + \gamma_{41}w_{it-3} + \gamma_{42}p_{it-1} + \gamma_{43}s_{it-1} + \\
 &\quad \gamma_{44}l_{it-1} + \gamma_{45}(x_{it-1} - x_{it-2}) + \epsilon_{4it}
 \end{aligned} \tag{5}$$

Table 5 shows the parameter estimates. In all first-stage equations, all instruments have substantial and significant effects on the endogenous regressors. The F test statistics for joint significance of the instruments are much larger than the thresholds for weak instruments mentioned in Staiger and Stock (1997).

⁶Recall that our models contain fixed effects. Years of education is thus absorbed in the fixed effect, which makes it empirically not very important if one includes (potential) work experience or age as regressor.

Table 5 First-stage estimation results for the dynamic panel-data models

	$(w_{it-1} - w_{it-2}) -$ $(w_{it-2} - w_{it-3})$	$(p_{it} - p_{it-1})$	$(s_{it} - s_{it-1})$	$(t_{it} - t_{it-1})$
Model for wage increases				
Lagged wage level (w_{it-3})	0.038*** (0.002)	$1.28e - 08$ *** ($3.04e-09$)	$-3.28e - 08$ *** ($3.20e-09$)	$5.91e - 07$ *** ($4.04e-08$)
Lagged promotion (p_{it-1})	6,671*** (181)	-0.987 *** (0.001)	0.004** (0.002)	0.070*** (0.014)
Lagged separation (s_{it-1})	5,047*** (406)	0.020*** (0.002)	-0.940 *** (0.003)	0.191*** (0.015)
Lagged tenure (t_{it-1})	-28.0 *** (6.5)	-0.0005 *** (0.00003)	-0.001 *** (0.00004)	-0.005 *** (0.0005)
Additional controls	Yes	Yes	Yes	Yes
F test	508	$1.3e+5$	19,054	127
Workers	106,305	106,305	106,305	106,305
Worker-years	659,497	659,497	659,497	659,497
Models for promotions and separations				
Lagged wage level (w_{it-3})	0.038*** (0.002)	$-6.91e - 09$ ** ($2.85e-09$)	$-3.82e - 08$ *** ($2.89e-09$)	$6.36e - 07$ *** ($3.45e-08$)
Lagged promotion (p_{it-2})	907*** (123)	-0.985 *** (0.001)	0.005*** (0.001)	0.052*** (0.011)
Lagged separation (s_{it-2})	581*** (182)	0.013*** (0.002)	-0.944 *** (0.003)	0.092*** (0.009)
Lagged tenure (t_{it-1})	-38.0 *** (6.5)	-0.0004 *** (0.00003)	-0.001 *** (0.00004)	-0.005 *** (0.0004)
Additional controls	Yes	Yes	Yes	Yes
F test	131	$1.6e+5$	25,591	132
Workers	106,305	106,305	106,305	106,305
Worker-years	659,497	659,497	659,497	659,497

Clustered standard errors are in parentheses

*10%, significance level

**5%, significance level

***1%, significance level

5 Results

In this section, we discuss the estimation results for the empirical models introduced in Section 3. Table 6 presents parameter estimates for the model of wage increases. The first two columns use transitions to a higher hierarchical level as promotions, the last two columns use employer-reported promotion dates. From comparing the estimation results in columns (1) and (2) with those in columns (3) and (4), we see that the wage returns to a promotion reported by the employer are 40% to 50% higher than the returns to a job transition to a higher hierarchical level. Because there are only a small number of hierarchical levels, within each hierarchical level there is most likely a large variation in job complexity and responsibility. Recall that our data contain eight hierarchical levels, which is more than the four levels observed by Lluís (2005). An employer-reported promotion may thus reflect an assignment change within a hierarchical level which can have a larger impact on the worker's tasks than a change in hierarchical level. Indeed less than 30% of all changes in hierarchical levels are also considered a promotion by the employer.

Table 6 Estimation results for dynamic panel-data model for wage increases ($w_{it} - w_{it-1}$)

	Δ Hierarchical level		Employer-reported promotion	
	(1)	(2)	(3)	(4)
Lagged wage increase ($w_{it-1} - w_{it-2}$)	-0.006 (0.049)	0.034 (0.049)	-0.016 (0.049)	0.024 (0.049)
Wage at $t - 2$ (w_{it-2})	-0.031 (0.047)	0.010 (0.046)	-0.041 (0.046)	-0.001 (0.046)
Promotion (p_{it})	6,342*** (457)	6,284*** (454)	9,746*** (633)	8,737*** (536)
Separation (s_{it})	5,932*** (673)	6,113*** (687)	7,286*** (722)	7,357*** (725)
Tenure	7,961*** (1,615)	7,325*** (1,501)	8,402*** (1,665)	7,684*** (1,529)
Age	-3,326*** (937)	-3,540*** (964)	-3,594*** (949)	-3,792*** (973)
Age squared	-32.6*** (5.66)	-24.6*** (4.50)	-33.3*** (5.95)	-24.9*** (4.64)
Number of workers in firm		2.28*** (0.38)		2.13*** (0.38)
Hierarchical level	Yes	Yes	Yes	Yes
Industry, Year	No	Yes	No	Yes
Workers	106,305	106,305	106,305	106,305
Worker-years	659,497	659,497	659,497	659,497

Clustered standard errors are in parentheses

*10%, significance level

**5%, significance level

***1%, significance level

On the other hand, 40% of the employer-reported promotions do not yield a change in job description. Recall that the data include over 60,000 different job descriptions. We interpret this as indication that some employers report wage increases as promotions rather than changes in job tasks or responsibilities. However, the raw data show that an employer-reported promotion which does not involve a change in job description only yields a wage increase of 60% of a promotion that coincides with a change in job description. These findings coincide with Pergamit and Veum (1999) who show the sensitivity of empirical results on job assignments and wage increases to different promotion definitions. Using the National Longitudinal Survey of Youth they conclude that for a substantial fraction of individuals a promotion does not mean a change of position. Overall, after a self-reported promotion about 30% of the workers remain to perform the same tasks as before.

Job transitions to higher hierarchical levels raise wages with, on average, about 6,300 PTE. Recall that in case of full information the promotion only reflects a change in production technology, which is not yet captured by indicators for hierarchical levels. Since 6,300 PTE is around 5% of the average wage in our data, the wage returns to promotions seem quite large. Waldman (1984) argues that in the presence of asymmetric learning wage increases upon promotions should be substantial. Our estimate is in line with earlier empirical work. McCue (1996) concludes that promotions account approximately for

9–18% of within-firm wage growth over the life cycle. Booth et al. (2003) find a wage prize for promotions of around 5%. And Lima and Pereira (2003) find, using the same data we use, for firms with more than 500 workers a wage increase of 1.9% for a promotion inside the same level, 4.9% for a job transition to a higher hierarchical level, and 8.3% for a job transition to a higher hierarchical level that coincides with an employer-reported promotion.

We do not find evidence for serial correlation in wage increases (after controlling for worker heterogeneity). The coefficient for $w_{it-1} - w_{it-2}$ is very small and insignificant. This is robust against different measures for promotions, and including firm characteristics. This is an indication for full information as discussed in Gibbons and Waldman (1999). Also the coefficient for w_{it-2} is small and insignificant in all specifications. This implies that we also do not find evidence in favor of learning as discussed by Chiappori et al. (1999). Recall that they exploit the presence of downward wage rigidities. Such wage rigidities are quite strong in the Portuguese labor market, which is considered to be highly regulated and lowering nominal wages is illegal. It should, however, be noted that our observation period was characterized by high wage growth.

Serial correlation in wage increases is one of the stylized facts summarized by Baker et al. (1994b), but has mixed evidence in the empirical literature. Also, Lluís (2005) did not find evidence of serial correlation in wages, while

Table 7 Estimation results for dynamic panel-data model for promotions (p_{it})

	Δ Hierarchical level		Employer-reported promotion	
	(1)	(2)	(3)	(4)
Lagged wage increase ($w_{it-1} - w_{it-2}$)	$-1.49e - 06^{***}$ (2.35e-07)	$-9.60e - 07^{***}$ (1.59e-07)	$1.88e - 06^{***}$ (2.99e-07)	$1.23e - 06^{***}$ (2.14e-07)
Wage at $t - 2$ (w_{it-2})	$-1.44e - 06^{***}$ (2.30e-07)	$-9.18e - 07^{***}$ (1.54e-07)	$1.89e - 06^{***}$ (2.91e-07)	$1.27e - 06^{***}$ (2.08e-07)
Promotion at $t - 1$ (p_{it-1})	0.039*** (0.002)	0.038*** (0.002)	-0.006 (0.004)	0.002 (0.004)
Separation at $t - 1$ (s_{it-1})	-0.010^{***} (0.004)	-0.011^{***} (0.004)	-0.032^{***} (0.005)	-0.032^{***} (0.004)
Tenure	0.082*** (0.013)	0.066*** (0.010)	-0.088^{***} (0.015)	-0.076^{***} (0.012)
Age	0.025*** (0.007)	0.031*** (0.006)	0.026*** (0.008)	0.024*** (0.007)
Age squared	-0.0009^{***} (0.00005)	-0.0008^{***} (0.00003)	0.0004*** (0.00006)	0.0004*** (0.00004)
Number of workers in firm		0.00001*** (1.62e-06)		-0.00002^{***} (2.17e-06)
Hierarchical level	Yes	Yes	Yes	Yes
Industry, Year	No	Yes	No	Yes
Workers	106,305	106,305	106,305	106,305
Worker-years	659,497	659,497	659,497	659,497

Clustered standard errors are in parentheses

*10%, significance level

**5%, significance level

***1%, significance level

Gibbs and Hendricks (2004) and Dohmen (2004) found some evidence for serial correlation in wages. However, Dohmen (2004) controls for performance rating by the employer, which changes the interpretation of this result. Many studies investigating serial correlations in wage increases (e.g. Chiappori et al. 1999) do not control for promotions of workers. As mentioned above a promotion yields a substantial wage increase. If wage increases predict promotions (due to symmetric learning), we underestimate the serial correlation in wage increases. Estimating our model again without controlling for promotions shows that the coefficients are almost unaffected. For specification (1) in Table 6 the coefficient for serial correlation in wage increases becomes 0.004 instead of -0.006 , and for specification (2) it changes from 0.034 to 0.043.

In all specifications a substantial wage premium is associated to switching employers. The wage premium is higher in specifications (3) and (4) than in specifications (1) and (2). The main reason is that if the worker moves to a higher hierarchical level while switching employers, then in specifications (1) and (2) it is recorded as both a promotion and a job separation while in specification (3) and (4) it is only recorded as a job transition. Substantial returns to job-to-job transitions may either imply that learning is asymmetric or that the labor market is not competitive or frictionless. If received signals are different for poaching firms than for the current employer like in the framework of Pinkston (2009), job-to-job transitions are associated to wage

Table 8 Estimation results for dynamic panel-data model for separations (s_{it})

	Δ Hierarchical level		Employer-reported promotion	
	(1)	(2)	(3)	(4)
Lagged wage increase ($w_{it-1} - w_{it-2}$)	$-2.14e - 08$ (1.47e-07)	$-4.89e - 08$ (1.10e-07)	$-2.46e - 08$ (1.50e-07)	$-5.04e - 08$ (1.10e-07)
Wage at $t - 2$ (w_{it-2})	$1.09e - 09$ (1.43e-07)	$-2.18e - 08$ (1.05e-07)	$-8.03e - 10$ (1.45e-07)	$-2.29e - 08$ (1.06e-07)
Promotion at $t - 1$ (p_{it-1})	0.003* (0.002)	0.003 (0.002)	0.004** (0.002)	0.002 (0.002)
Separation at $t - 1$ (s_{it-1})	0.023*** (0.004)	0.022*** (0.004)	0.023*** (0.004)	0.023*** (0.004)
Tenure	0.013* (0.008)	0.006 (0.006)	0.013 (0.008)	0.006 (0.006)
Age	-0.005 (0.004)	-0.001 (0.004)	-0.006 (0.004)	-0.001 (0.004)
Age squared	-0.00005^* (0.00003)	-0.00004^{**} (0.00002)	-0.00005^* (0.00003)	-0.00004^{**} (0.00002)
Number of workers in firm		$7.17e - 07$ (1.08e-06)		$6.74e - 07$ (1.08e-06)
Hierarchical level	Yes	Yes	Yes	Yes
Industry, Year	No	Yes	No	Yes
Workers	106,305	106,305	106,305	106,305
Worker-years	659,497	659,497	659,497	659,497

Clustered standard errors are in parentheses

*10%, significance level

**5%, significance level

***1%, significance level

increases. Also the model of Scoones and Bernhardt (1998) predicts wage increases upon job-to-job transitions. In their model, job-to-job transitions are associated to promotions (from laborer to manager). Therefore, a substantial fraction of the wage increase is due to change in hierarchical level. However, also in columns (1) and (2) where we take account of changes in hierarchical levels at job-to-job transitions, the wage increase is still very substantial. Indeed, also job-search theory predicts that workers move to better paying firms (e.g. Burdett and Mortensen 1998). Raw statistics confirm that larger firms pay, on average, higher wages, which is consistent with job-search theory.

Firm size and industry dummies can also be interpreted as indicators for the firm's production technology. Indeed, as is shown in specifications (2) and (4) wage increases are significantly larger in firms with more workers. However, wage increases following job separations remain unaffected after controlling for firm size and industry dummies. This implies that the wage increase after a job separation cannot be explained only from workers moving to firms with better production technologies. Finally, wage increases increase substantially in job tenure, but decrease in the worker's age. This might imply that job tenure is more relevant to employers than overall labor-market experience. This is consistent with Jovanovic (1979), who stressed the importance of a good match between employer and worker.

Table 9 Estimation results (only years after 1993) for dynamic panel-data model for wage increases ($w_{it} - w_{it-1}$)

	Δ Hierarchical level	Employer-reported promotion
	(1)	(2)
Lagged wage increase ($w_{it-1} - w_{it-2}$)	0.024 (0.073)	0.005 (0.071)
Wage at $t - 2$ (w_{it-2})	-0.001 (0.068)	-0.021 (0.067)
Promotion (p_{it})	5,847*** (631)	9,412*** (756)
Separation (s_{it})	10,129*** (1,350)	11,551*** (1,420)
Tenure	14,860*** (3,732)	15,908*** (3,901)
Age	-7,914*** (2,222)	-8,406*** (2,292)
Age squared	-48.2*** (11.1)	-51.6*** (11.8)
Number of workers in firm	1.30*** (0.27)	1.16*** (0.28)
Hierarchical level	Yes	Yes
Industry, Year	Yes	Yes
Workers	106,305	106,305
Worker-years	529,919	529,919

Clustered standard errors are in parentheses

*10%, significance level

**5%, significance level

***1%, significance level

Table 7 presents parameter estimates for promotion rates. Wage increases have a negative impact on transitions to higher hierarchical levels, i.e. in specifications (1) and (2) the most recent wage increase has a significantly negative coefficient. In specifications (3) and (4) wage variables do have positive effects on the probability that employers report promotions, and these effects are significant. In specifications (1) and (2) there is positive serial correlation in promotions, which is absent when promotions are reported by the employer.

The results thus provide very mixed evidence for learning. Serial correlation in promotion rates present in columns (1) and (2) can be the result of symmetric learning. However, Gibbons and Waldman (1999) also predict that in the presence of symmetric learning the most recent wage increase should predict promotions, which is only the case in columns (3) and (4). According to Chiappori et al. (1999) the coefficient for the recent wage increase $w_{it-1} - w_{it-2}$ should exceed the coefficient of the wage level w_{it-2} in the presence of symmetric learning, which is not true in any specification. More precisely, the coefficient for $w_{it-1} - w_{it-2}$ has about the same size as the coefficient for w_{it-2} . So, only the wage level w_{it-1} is important for explaining promotions. Workers with a higher wage level w_{it-1} are thus less likely to change hierarchical level, but it is more likely that their employer reports a promotion. This provides some evidence that both promotion concept are substantially different.

Table 10 Estimation results (only years after 1993) for dynamic panel-data model for promotions (p_{it})

	Δ Hierarchical level (1)	Employer-reported promotion (2)
Lagged wage increase ($w_{it-1} - w_{it-2}$)	-1.21e - 06*** (3.14e-07)	2.30e - 06*** (3.93e-07)
Wage at $t - 2$ (w_{it-2})	-1.18e - 06*** (3.12e-07)	2.35e - 06*** (3.88e-07)
Promotion at $t - 1$ (p_{it-1})	0.033*** (0.003)	0.005 (0.004)
Separation at $t - 1$ (s_{it-1})	0.002 (0.007)	-0.034*** (0.007)
Tenure	0.130*** (0.031)	-0.115*** (0.034)
Age	-0.016 (0.020)	0.046** (0.020)
Age squared	-0.0009*** (0.00008)	0.0005*** (0.00009)
Number of workers in firm	2.04e-06 (1.80e-06)	-0.00002*** (2.65e-06)
Hierarchical level	Yes	Yes
Industry, Year	Yes	Yes
Workers	106,305	106,305
Worker-years	529,919	529,919

Clustered standard errors are in parentheses

*10%, significance level

**5%, significance level

***1%, significance level

Workers switching employers have significantly lower promotion rates in the next year. The impact of a job separation on the promotion probability is almost three times as large in specification (3) and (4) as in specifications (1) and (2). In a frictionless labor market with symmetric learning (or full information), job separations should not affect promotion rates. Kahn (2007) and Schönberg (2007) argue that in the presence of asymmetric learning there is adverse selection in employer transitions, which might be expressed in the negative impact of job separations on promotion rates. An alternative explanation might be that within the first year at a new firm a worker is unlikely to be promoted. This is particularly true if learning about the quality of a match is important (e.g. Jovanovic 1979). Job tenure has a positive and significant impact on changing hierarchical level, while it has a significantly negative effect on employer-reported promotions. The substantial differences in the estimated coefficients again indicate that changes in hierarchical levels and employer-reported promotions are substantially different measures for inside firm mobility.

Table 8 shows parameter estimates for the model describing job separations. In all four specifications, wages do not significantly affect separations. This is not in agreement with job-search theory, which argues that in the presence of search frictions the wage (w_{it-1}) should have a negative impact on job

Table 11 Estimation results (only years after 1993) for dynamic panel-data model for separations (s_{it})

	Δ Hierarchical level	Employer-reported promotion
	(1)	(2)
Lagged wage increase ($w_{it-1} - w_{it-2}$)	-5.53e-07*** (1.93e-07)	-5.59e-07*** (1.94e-07)
Wage at $t - 2$ (w_{it-2})	-5.36e-07*** (1.88e-07)	-5.40e-07*** (1.90e-07)
Promotion at $t - 1$ (p_{it-1})	0.002 (0.003)	0.004** (0.002)
Separation at $t - 1$ (s_{it-1})	0.025*** (0.006)	0.026*** (0.006)
Tenure	0.055*** (0.018)	0.056*** (0.018)
Age	-0.022** (0.011)	-0.022** (0.011)
Age squared	-0.0002*** (0.00004)	-0.0002*** (0.00004)
Number of workers in firm	-3.15e-06** (1.34e-06)	-3.13e-06** (1.34e-06)
Hierarchical level	Yes	Yes
Industry, Year	Yes	Yes
Workers	106,305	106,305
Worker-years	529,919	529,919

Clustered standard errors are in parentheses

*10%, significance level

**5%, significance level

***1%, significance level

Table 12 Estimation results (by gender) for dynamic panel-data model for wage increases ($w_{it} - w_{it-1}$)

	Δ Hierarchical level		Employer-reported promotion	
	Female	Male	Female	Male
Lagged wage increase ($w_{it-1} - w_{it-2}$)	-0.076* (0.043)	0.058 (0.070)	-0.081* (0.043)	0.044 (0.068)
Wage at $t - 2$ (w_{it-2})	-0.078* (0.043)	0.023 (0.065)	-0.084* (0.043)	0.010 (0.063)
Promotion (p_{it})	4,153*** (408)	7,514*** (711)	6,077*** (375)	10,204*** (864)
Separation (s_{it})	3,560*** (708)	7,596*** (1035)	4,323*** (711)	9,145*** (1107)
Tenure	5,159*** (1,884)	8,321*** (2,043)	5,142*** (1,907)	8,968*** (2,097)
Age	-2556** (1,079)	-3463** (1,341)	-2554** (1,081)	-3,910*** (1362)
Age squared	-14.9** (6.12)	-32.9*** (6.40)	-14.5** (6.27)	-33.6*** (6.65)
Number of workers in firm	1.42*** (0.30)	2.73*** (0.58)	1.25*** (0.30)	2.64*** (0.59)
Hierarchical level	Yes	Yes	Yes	Yes
Industry, Year	Yes	Yes	Yes	Yes
Workers	43,509	62,915	43,509	62,915
Worker-years	264,839	394,658	264,839	394,658

Clustered standard errors are in parentheses

*10%, significance level

**5%, significance level

***1%, significance level

mobility. Also promotions do not have a large effect. In all case the effect is very small, and becomes also insignificant once we control for firm size, industry dummies and year indicators.⁷ Waldman (1984) argues that if there is asymmetric employer learning, promotions are signals to outside firms about the worker's ability. However, upon promotion the current firm should offer a substantial wage increase to avoid the worker from leaving the firm. If firms correctly do so, also in the presence of asymmetric learning promotions do not forecast job-to-job mobility.

There is a significant positive serial correlation in job separations, which is in accordance with model predictions of Ghosh (2007) and Schönberg (2007). Tenure does not significantly affect job separations. This does not coincide with the model of Jovanovic (1979) in which workers and employers learn about the quality of the match. However, if all learning takes place in the first year after establishing the match, this effect is absorbed in the serial correlation in job-to-job transitions. So our results might indicate that learning about the quality of the match might be important, but only if such learning is a relatively

⁷The results remain similar if we exclude individual in the first hierarchical level (apprentices, interns and trainees).

short process. Young workers are most mobile, and the likelihood of switching employers decreases during working life. These are well known results, for example, Topel and Ward (1992) showed that the most substantial share of job mobility is in the first ten years of a career.

To summarize the main conclusions from our empirical analyses. Full information about worker’s ability in a competitive and frictionless labor market seems to be rejected. There are substantial wage returns to promotions and job-to-job transitions. There is only very limited evidence in favor of symmetric learning. We do not find serial correlation in wage increases and employer-reported promotions as predicted by Gibbons and Waldman (1999), but there is serial correlation in changes in hierarchical levels and wage increases forecast employer-reported promotions. We also do not find the serial correlation predicted by Chiappori et al. (1999). Symmetric learning alone thus cannot explain our empirical findings. Although our results share features of the model of Jovanovic (1979), in which workers search for a good match. However, we observe large wage returns to both promotions and job-to-job transitions, which may indicate asymmetric learning. But there is no single model of asymmetric learning which is consistent with all our findings. The large return to job-to-job transitions may be explained by job-search models, but wages do not affect job-to-job transitions.

Table 13 Estimation results (by gender) for dynamic panel-data model for promotions (p_{it})

	Δ Hierarchical level		Employer-reported promotion	
	Female	Male	Female	Male
Lagged wage increase ($w_{it-1} - w_{it-2}$)	-1.57e-06*** (3.17e-07)	-8.81e-07*** (1.91e-07)	1.28e-06*** (3.51e-07)	1.36e-06*** (2.89e-07)
Wage at $t - 2$ (w_{it-2})	-1.57e-06*** (3.17e-07)	-8.25e-07*** (1.83e-07)	1.45e-06*** (3.50e-07)	1.33e-06*** (2.79e-07)
Promotion at $t - 1$ (p_{it-1})	0.038*** (0.003)	0.036*** (0.003)	0.035*** (0.006)	-0.019*** (0.005)
Separation at $t - 1$ (s_{it-1})	-0.018*** (0.006)	-0.006 (0.005)	-0.022*** (0.007)	-0.037*** (0.006)
Tenure	0.105*** (0.020)	0.045*** (0.011)	-0.049*** (0.018)	-0.091*** (0.016)
Age	0.003 (0.012)	0.050*** (0.006)	0.007 (0.011)	0.031*** (0.009)
Age squared	-0.0009*** (0.00007)	-0.0008*** (0.00004)	0.0003*** (0.00006)	0.0004*** (0.00006)
Number of workers in firm	8.42e-06*** (1.85e-06)	0.00001*** (2.17e-06)	-0.00001*** (2.53e-06)	-0.00002*** (3.30e-06)
Hierarchical level	Yes	Yes	Yes	Yes
Sector, Year	Yes	Yes	Yes	Yes
Workers	43,509	62,915	43,509	62,915
Worker-years	264,839	394,658	264,839	394,658

Clustered standard errors are in parentheses

*10%, significance level

**5%, significance level

***1%, significance level

6 Sensitivity analyses

In this section, we perform some additional analyses to investigate the robustness of our empirical results. Firstly, the models we have estimated are all just identified, i.e. for each endogenous regressors there is one instrumental variable. Given the length of our observation period, we can easily construct more instrumental variables by using additional lags, which allows to use Sargan tests. When using one additional lag for each instrument, the Sargan test does not reject the model specification for the models for wage increases. However, the Sargan tests reject the models for promotions. The latter is not very surprising as the validity of the Sargan tests depend on homoskedasticity of the error terms. By definition, error terms are heteroskedastic in linear probability models. For the models for job separations, the p values of the Sargan tests are slightly above 0.10.

Next, we stratify the data in a number of different ways, and we estimate the models for wage increases, promotions and separations using the different subsamples. In the tables, we only report estimation results of the most extensive models, i.e. those including firm size and industry and year dummies as covariates.

Recall that until 1993 data were collected in March, while from 1994 onwards the data were collected in October. Between the 1993-wave and the

Table 14 Estimation results (by gender) for dynamic panel-data model for separations (s_{it})

	Δ Hierarchical level		Employer-reported promotion	
	Female	Male	Female	Male
Lagged wage increase ($w_{it-1} - w_{it-2}$)	-1.69e-07 (1.88e-07)	-5.61e-09 (1.46e-07)	-1.69e-07 (1.89e-07)	-6.88e-09 (1.47e-07)
Wage at $t - 2$ (w_{it-2})	-1.36e-07 (1.87e-07)	1.77e-08 (1.38e-07)	-1.35e-07 (1.88e-07)	1.68e-08 (1.39e-07)
Promotion at $t - 1$ (p_{it-1})	0.004 (0.003)	0.002 (0.003)	0.003 (0.002)	0.002 (0.002)
Separation at $t - 1$ (s_{it-1})	0.026*** (0.007)	0.020*** (0.005)	0.027*** (0.007)	0.020*** (0.005)
Tenure	0.011 (0.011)	0.003 (0.008)	0.011 (0.011)	0.003 (0.008)
Age	-0.007 (0.007)	0.004 (0.005)	-0.007 (0.007)	0.003 (0.005)
Age squared	-0.00002 (0.00003)	-0.00006** (0.00003)	-0.00002 (0.00003)	-0.00006** (.00003)
Number of workers in firm	-5.80e-07 (9.91e-07)	8.74e-07 (1.65e-06)	-6.41e-07 (9.95e-07)	8.53e-07 (1.65e-06)
Hierarchical level	Yes	Yes	Yes	Yes
Industry, Year	Yes	Yes	Yes	Yes
Workers	43,509	62,915	43,509	62,915
Worker-years	264,839	394,658	264,839	394,658

Clustered standard errors are in parentheses

*10%, significance level

**5%, significance level

***1%, significance level

1994-wave more promotions and higher wage increases might have occurred due to the extended time period. Even though we included year dummies, this might have biased our parameter estimates. Therefore, as a first sensitivity check we estimate our models only using data collected after 1993. Although the coefficients in the model for wage increases change somewhat, the main results remain the same (see Table 9). Serial correlation in wage increases remains absent, and there are substantial returns to promotions and job separations. However, the wage premium from a job separation increases with about 40% compared with the earlier estimates. Also the effects of tenure increase, which is compensated by a more negative age effect. The estimation results for the promotion probability do not change much (see Tables 10). We find some differences for the model for separation. The workers wage becomes significant. In particular, individuals with a higher wage W_{it-1} are less likely to change employer (see Table 11). This is consistent with standard job-search models. This prediction could also be generated in models where workers search for a good match. But these models predict a negative effect of tenure, while we find a significantly positive effect. However, there remains serial correlation in job-to-job transitions.

We also perform separate analyses for men and women. Men and women might sort into different occupations or jobs, and, therefore, career profiles

Table 15 Estimation results (by years of education) for dynamic panel-data model for wage increases ($w_{it} - w_{it-1}$)

	Δ Hierarchical level			Employer-reported promotion		
	<= 4 years	6 – 9 years	> 9 years	<= 4 years	6 – 9 years	> 9 years
Lagged wage increase ($w_{it-1} - w_{it-2}$)	-0.166 (0.156)	-0.121 (0.092)	0.283* (0.167)	-0.190 (0.152)	-0.143 (0.089)	0.287* (0.168)
Wage at $t - 2$ (w_{it-2})	-0.177 (0.158)	-0.139 (0.090)	0.215 (0.144)	-0.201 (0.154)	-0.161* (0.087)	0.215 (0.144)
Promotion (p_{it})	3,761*** (796)	4,668*** (694)	12,291*** (2,089)	4,824*** (868)	6,561*** (769)	14,795*** (2,284)
Separation (s_{it})	1,598** (649)	2,898*** (784)	23,612*** (4,312)	2,128*** (653)	3,840*** (825)	26,558*** (4,703)
Tenure	4,814*** (1,247)	6,047*** (1588)	557 (5453)	4754*** (1,248)	6,194*** (1,595)	1413 (5,548)
Age	-1,370* (709)	-2381** (987)	-978 (4,015)	-1,319* (699)	-2,499** (980)	-1,875 (4,099)
Age squared	-16.8*** (4.0)	-19.4** (7.7)	-18.7 (19.5)	-16.1*** (4.0)	-18.4** (7.6)	-18.1 (19.8)
Number of workers in firm	2.03*** (0.464)	1.77*** (0.378)	0.872 (0.761)	1.88*** (0.467)	1.61*** (0.375)	0.617 (0.749)
Hierarchical level	Yes	Yes	Yes	Yes	Yes	Yes
Industry, Year	Yes	Yes	Yes	Yes	Yes	Yes
Workers	48,578	39,500	18,317	48,578	39,500	18,317
Worker-years	304,470	244,390	110,637	304,470	244,390	110,637

Clustered standard errors are in parentheses

*10%, significance level

**5%, significance level

***1%, significance level

may differ. Table 12 shows that the estimated coefficients for wage increases, indeed, differ somewhat between men and women. Although the difference is mainly in the size of the coefficients rather than significance or sign. In particular, returns to both promotions and job separations are much larger for men than for women. The results for promotion rates do not differ much between men and women as can be seen in Table 13. The results are also quite similar to the results for the full population. The same holds for the model for separations (Table 14).

Next, we consider the worker’s education. Education is often considered a signal for ability (e.g. Altonji and Pierret 2001; DeVaro and Waldman 2006; Schönberg 2007). Furthermore, workers with different educational levels sort into different job types. We distinguish workers with only completed primary education (low education), workers who completed the second or third ciclo (medium education), and workers who completed high school or more (high education).

As can be seen from Table 15, for none of the educational groups we find serial correlation in wage increases. The wage increase upon promotion is significant for all groups, but much higher for workers with high education

Table 16 Estimation results (by years of education) for dynamic panel-data model for promotions (p_{it})

	Δ Hierarchical level			Employer-reported promotion		
	<= 4 years	6–9 years	> 9 years	<= 4 years	6–9 years	> 9 years
Lagged wage increase ($w_{it-1} - w_{it-2}$)	-6.88e-06*** (1.18e-06)	-8.82e-07* (4.59e-07)	-1.39e-07 (2.16e-07)	8.27e-07 (1.36e-06)	3.05e-06*** (6.49e-07)	6.44e-07 (4.40e-07)
Wage at $t - 2$ (w_{it-2})	-6.87e-06*** (1.19e-06)	-8.70e-07* (4.52e-07)	-1.19e-07 (2.03e-07)	7.97e-07 (1.37e-06)	3.14e-06*** (6.39e-07)	7.27e-07* (4.24e-07)
Promotion at $t - 1$ (p_{it-1})	0.024*** (0.003)	0.045*** (0.003)	0.034*** (0.005)	0.057*** (0.006)	0.009 (0.005)	-0.076*** (0.010)
Separation at $t - 1$ (s_{it-1})	-0.013** (0.005)	-0.019*** (0.006)	-0.017* (0.010)	-0.015*** (0.006)	-0.021*** (0.007)	-0.078*** (0.015)
Tenure	0.035*** (0.010)	0.018** (0.008)	0.019 (0.043)	-0.042*** (0.009)	-0.049*** (0.011)	-0.202** (0.093)
Age	0.040*** (0.007)	0.073*** (0.006)	0.073** (0.029)	0.015** (0.006)	0.0006 (0.007)	0.102* (0.060)
Age squared	-0.0005*** (0.00004)	-0.0008*** (0.00005)	-0.0009*** (0.0001)	0.0002*** (0.00003)	0.0003*** (0.00006)	0.0008*** (0.0003)
Number of workers in firm	0.00001*** (2.81e-06)	2.63e-06** (1.28e-06)	1.99e-06 (3.09e-06)	-0.00002*** (3.53e-06)	-0.00001** (2.32e-06)	-0.00001* (6.77e-06)
Hierarchical level	Yes	Yes	Yes	Yes	Yes	Yes
Industry, Year	Yes	Yes	Yes	Yes	Yes	Yes
Workers	48,578	39,500	18,317	48,578	39,500	18,317
Worker-years	304,470	244,390	110,637	304,470	244,390	110,637

Clustered standard errors are in parentheses

*10%, significance level

**5%, significance level

***1%, significance level

than for both other groups. This seems to contradict DeVaro and Waldman (2006), who argue that in the presence of asymmetric employer learning wage increases due to promotions should be decreasing in the level of education. The reason is that the signal of promotions is strongest for low-educated workers. Promotions for low-educated workers are, therefore, rare, and should be accompanied by substantial wage increases to avoid outside firms from attracting the worker. However, average wage levels are 106,664 PTE for low-educated, 130,103 PTE for medium-educated, and 209,689 PTE for high-educated workers. As fraction of average wage, wage increases upon promotions are thus only much higher for the high-educated workers. Recall that educational levels are much lower in Portugal than in the USA. DeVaro and Waldman (2006) consider high-school graduates as the lowest educational level, while in our classification these are high educated.

Workers with high education benefit most from switching employers. The premium associated to an employer change is almost twice the wage increase of a promotion. For both other groups, the wage increase upon switching employers is much smaller than the returns of a promotion. These results may imply that the market for low-educated workers has smaller frictions.

Table 17 Estimation results (by years of education) for dynamic panel-data model for separations (s_{it})

	Δ Hierarchical level			Employer-reported promotion		
	≤ 4 years	6–9 years	> 9 years	≤ 4 years	6–9 years	> 9 years
Lagged wage increase ($w_{it-1} - w_{it-2}$)	-8.81e-07 (6.93e-07)	6.19e-08 (3.34e-07)	3.13e-07 (1.90e-07)	-9.09e-07 (6.95e-07)	6.32e-08 (3.33e-07)	3.23e-07* (1.92e-07)
Wage at $t - 2$ (w_{it-2})	-8.56e-07 (6.98e-07)	6.77e-08 (3.24e-07)	3.56e-07** (1.78e-07)	-8.83e-07 (7.00e-07)	6.99e-08 (3.24e-07)	3.60e-07** (1.79e-07)
Promotion at $t - 1$ (p_{it-1})	0.004 (0.003)	-0.003 (0.003)	0.012** (0.005)	0.005** (0.002)	0.0002 (0.002)	-0.001 (0.004)
Separation at $t - 1$ (s_{it-1})	0.020*** (0.006)	0.022*** (0.006)	0.023** (0.010)	0.020*** (0.006)	0.022*** (0.006)	0.025** (0.010)
Age	0.003 (0.004)	0.004 (0.004)	0.005 (0.023)	0.003 (0.004)	0.005 (0.004)	0.004 (0.024)
Age squared	-0.00008*** (0.00002)	-0.00002 (0.00003)	-0.00003 (0.00009)	-0.00008*** (0.00002)	-0.00003 (0.00003)	-7.00e-06 (0.0001)
Tenure	0.010 (0.006)	-0.004 (0.006)	-0.007 (0.035)	0.010 (0.006)	-0.004 (0.006)	-0.009 (0.036)
Number of workers in firm	2.91e-06 (1.82e-06)	-1.58e-06* (9.50e-07)	-3.94e-07 (2.50e-06)	2.82e-06 (1.81e-06)	-1.54e-06 (9.50e-07)	-5.13e-07 (2.53e-06)
Hierarchical level	Yes	Yes	Yes	Yes	Yes	Yes
Industry, Year	Yes	Yes	Yes	Yes	Yes	Yes
Workers	48,578	39,500	18,317	48,578	39,500	18,317
Worker-years	304,470	244,390	110,637	304,470	244,390	110,637

Clustered standard errors are in parentheses

*10%, significance level

**5%, significance level

***1%, significance level

An alternative explanation is that wages for low-educated workers are largely arranged by collective bargaining agreements, and that, therefore, switching employer does not yield large wage increases. High-educated workers may self-select in markets with more job-search frictions, and where asymmetric employer learning is more important. Recall that schooling levels are low in Portugal and, therefore, high-educated workers may be scarce. This might also explain the existence of search frictions for highly educated labor.

For all educational levels, we find serial correlation in promotion rates if promotions are measured as changes in hierarchical levels (see Table 16). Also workers who switched employers, are less likely to get promoted in the following year. For the low-educated workers, there is a significant negative relation between wage increases and changing hierarchical level, which is absent for the medium and high-educated workers. Finally, for all groups we find significant serial correlation in job separation rates (see Table 17). Other covariates, except age, do not seem important in explaining job separations. So although the magnitude of the coefficients differs between groups, the results of the separate groups are consistent with the results for the complete sample.

Table 18 Estimation results (by sector) for dynamic panel-data model for wage increases ($w_{it} - w_{it-1}$)

	Δ Hierarchical level		Employer-reported promotion	
	Construction	Financial	Construction	Financial
Lagged wage increase ($w_{it-1} - w_{it-2}$)	0.775*** (0.216)	0.038 (0.210)	0.788*** (0.218)	0.045 (0.210)
Wage at $t - 2$ (w_{it-2})	0.748*** (0.215)	0.001 (0.201)	0.760*** (0.217)	-0.001 (0.198)
Promotion (p_{it})	12,548*** (2,102)	12,812*** (4,450)	7,533*** (1,976)	14,103*** (2,894)
Separation (s_{it})	5,901 (5,176)	42,382*** (11,050)	7,023 (5,187)	46,719*** (12,008)
Age	-2,944 (11,906)	757 (3,992)	-2,529 (11,908)	133 (4,037)
Age squared	11.1 (20.8)	-11.8 (14.2)	22.4 (20.9)	-12.4 (14.7)
Tenure	1877 (15,501)	-544 (3,380)	36.7 (15,460)	99.9 (3,356)
Number of workers in firm	-1.82 (3.58)	2.08 (1.29)	-1.75 (3.53)	1.89 (1.29)
Hierarchical level	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Workers	8,024	5,180	8,024	5,180
Worker-years	49,950	36,587	49,950	36,587

Clustered standard errors are in parentheses

*10%, significance level

**5%, significance level

***1%, significance level

Table 19 Estimation results (by sector) for dynamic panel-data model for promotions (p_{it})

	Δ Hierarchical level		Employer-reported promotion	
	Construction	Financial	Construction	Financial
Lagged wage increase ($w_{it-1} - w_{it-2}$)	$-8.82e - 07$ ($5.75e - 07$)	$2.23e - 06^*$ ($1.33e - 06$)	$4.13e - 07$ ($7.21e - 07$)	$-2.97e - 06$ ($2.82e - 06$)
Wage at $t - 2$ (w_{it-2})	$-8.33e - 07$ ($5.70e - 07$)	$2.09e - 06^*$ ($1.22e - 06$)	$4.25e - 07$ ($7.15e - 07$)	$-2.48e - 06$ ($2.57e - 06$)
Promotion at $t - 1$ (p_{it-1})	0.031^{***} (0.008)	0.025^{**} (0.010)	0.059^{***} (0.014)	-0.071^{***} (0.011)
Separation at $t - 1$ (s_{it-1})	0.022 (0.018)	0.026 (0.031)	-0.034 (0.022)	-0.224^{***} (0.066)
Age	-0.026 (0.079)	-0.125 (0.116)	0.016 (0.099)	0.256 (0.248)
Age squared	-0.0008^{***} (0.0001)	-0.0008^{***} (0.0001)	0.00008 (0.0001)	0.0004 (0.003)
Tenure	0.135 (0.095)	0.199^* (0.115)	-0.027 (0.119)	-0.273 (0.246)
Number of workers in firm	-0.00001 (0.00002)	-0.00004^* (0.00002)	$-2.28e - 06$ (0.00002)	0.00006 (0.00005)
Hierarchical level	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Workers	8,024	5,180	8,024	5,180
Worker-years	49,950	36,587	49,950	36,587

Clustered standard errors are in parentheses

*10%, significance level

**5%, significance level

***1%, significance level

Next, we consider two specific sectors, construction and banking and insurances. Our idea is that construction is largely dominated by blue-collar workers, while the banking and insurance sector is mainly a white-collar sector.⁸ So by comparing the model estimates for those sectors, we can learn more about what drives dynamics for different types of workers. Table 18 shows that in the financial sector wage increases are not serially correlated, while in the construction sector a wage increase $w_{it} - w_{it-1}$ mainly depends on the current wage w_{it-1} . This might indicate that learning is more important in the construction sector. For both sectors we find substantial returns to promotions. Only in the financial sector there are significant wage increases at job separations. The latter might imply that the labor market in the construction sector is more competitive. Table 19 shows the results for the model for promotions. The main conclusion is that there is some serial correlation in promotions (although negatively for employer-reported promotions in the financial sector). Finally, Table 20 shows the results for the model for separations. For both sectors we do not find any significant effects, which might suggest that the labor markets in both sectors are rather competitive. The results for the construction sector are thus to some extent consistent with symmetric learning in a competitive market. While in the financial sector, it might be the case that learning is more

⁸Our data do not contain any indicator for being a blue or white-collar worker.

asymmetric. One may argue that for a competing firm it is easier to observe the productivity of a construction workers than of a banker or an employee in an insurance company.

Finally, Jovanovic (1979) stresses the importance of the quality of the match between the worker and the firm. In our empirical analyses we have included only worker fixed effects which remain the same also when workers switch jobs. If, indeed, the quality of the job is important, the worker specific effect may change when changing jobs. We perform a sensitivity analysis in which we allow for worker-firm fixed effects. This implies that we can no longer consider job separations. Therefore, we only focus on the models for wage increases and promotions and only use spells of workers staying within the same job to estimate these models.

Table 21 shows the parameter estimates for the model for wage increases. Like in the baseline model there is no serial correlation in wage increases, but the returns to promotions are slightly lower. The coefficients of the age effect differ somewhat. But it should be noted that in the baseline model we can distinguish between age and tenure, which is not possible when considering job match fixed effects. Finally, the coefficient of firm size is much smaller. But in this specification it is identified only from variation in the firm size between years, while in the baseline model also firm size variation of workers changing

Table 20 Estimation results (by sector) for dynamic panel-data model for separations (s_{it})

	Δ Hierarchical level		Employer-reported promotion	
	Construction	Financial	Construction	Financial
Lagged wage increase ($w_{it-1} - w_{it-2}$)	$3.02e - 07$ ($4.82e - 07$)	$1.07e - 07$ ($6.27e - 07$)	$2.98e - 07$ ($4.83e - 07$)	$1.12e - 07$ ($6.20e - 07$)
Wage at $t - 2$ (w_{it-2})	$3.20e - 07$ ($4.78e - 07$)	$1.00e - 07$ ($5.75e - 07$)	$3.17e - 07$ ($4.79e - 07$)	$1.07e - 07$ ($5.66e - 07$)
Promotion at $t - 1$ (p_{it-1})	0.0085 (0.0069)	-0.0007 (0.005)	0.011 (0.009)	0.0006 (0.0023)
Separation at $t - 1$ (s_{it-1})	0.012 (0.015)	-0.013 (0.015)	0.013 (0.015)	-0.013 (0.014)
Age	0.0007 (0.066)	0.034 (0.055)	0.001 (0.066)	0.034 (0.055)
Age squared	-0.00015* (0.00008)	-0.00003 (0.00006)	-0.00014* (0.00008)	-0.00003 (0.00007)
Tenure	0.015 (0.080)	-0.032 (0.054)	0.015 (0.080)	-0.032 (0.054)
Number of workers in firm	0.00002 (0.00002)	0.00001 (0.00001)	0.00002 (0.00002)	0.00001 (0.00001)
Hierarchical level	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Workers	8,024	5,180	8,024	5,180
Worker-years	49,950	36,587	49,950	36,587

Clustered standard errors are in parentheses

*10%, significance level

**5%, significance level

***1%, significance level

Table 21 Estimation results (including worker-firm fixed effects) for dynamic panel data model for wage increases ($w_{it} - w_{it-1}$)

	Δ Hierarchical level	Employer-reported promotion
	(1)	(2)
Lagged wage increase ($w_{it-1} - w_{it-2}$)	0.024 (0.035)	0.018 (0.035)
Wage at $t-2$ (w_{it-2})	0.008 (0.033)	0.002 (0.033)
Promotion (p_{it})	5,504*** (370)	7,937*** (380)
Age	709*** (245)	685*** (245)
Age squared	-3.47* (2.09)	-3.12 (2.09)
Number of workers in firm	0.28*** (0.06)	0.08 (0.06)
Hierarchical level	Yes	Yes
Industry, Year	Yes	Yes

Clustered standard errors are in parentheses

*10%, significance level

**5%, significance level

***1%, significance level

jobs adds to the identification. Table 22 presents the results for the promotion model. Again, we find serial correlation in changes in hierarchical levels and wage increases predict employer-reported promotions. However, the latter effect is somewhat smaller when accounting for match-specific effects.

Table 22 Estimation results (including worker-firm fixed effects) for dynamic panel data model for promotions (p_{it})

	Δ Hierarchical level	Employer-reported promotion
	(1)	(2)
Lagged wage increase ($w_{it-1} - w_{it-2}$)	-1.94e-07** (9.73e-08)	6.82e-07*** (1.45e-07)
Wage at $t-2$ (w_{it-2})	-1.66e-07* (9.27e-07)	7.23e-07*** (1.40e-07)
Promotion at $t-1$ (p_{it-1})	0.029*** (0.002)	0.007* (0.004)
Age	0.065*** (0.002)	-0.024*** (0.002)
Age squared	-0.0006*** (0.00002)	0.0002*** (0.00002)
Number of workers in firm	5.94e-07 (4.80e-07)	-3.66e-06*** (1.49e-06)
Hierarchical level	Yes	Yes
Industry, Year	Yes	Yes

Clustered standard errors are in parentheses

*10%, significance level

**5%, significance level

***1%, significance level

7 Conclusion

In this paper, we analyzed dynamic relations between wage increases, promotions and employer changes. In the empirical analyses, we have used two definitions for promotions available in the Portuguese-matched employer–employee data *Quadros de Pessoal*, which are also often used in the literature. Firstly, promotions defined as changes in hierarchical levels. Secondly, we used employer-reported promotions. Wage returns to both types of promotions are substantial, although an employer-reported promotion yields 30% higher returns. This suggests that hierarchical levels are too broadly defined in terms of job complexity and responsibility. However, 40% of the employer-reported promotions do not yield a change in very precisely defined job descriptions. Even though employer-reported promotions involving a change in job description yield higher wage returns, the wage returns to employer-reported promotions which are not associated to a change in job description are substantial. We interpret this as evidence that employers not only consider changes in job tasks as promotions, but also report substantial wage increases as promotions.

Our empirical results show substantial returns to promotions and job-to-job transitions. This implies that full information in a competitive and frictionless labor market is rejected. Symmetric learning as discussed by Gibbons and Waldman (1999) and Chiappori et al. (1999) also cannot explain our empirical results. In particular, the serial correlation in wage increases predicted by these models is absent in our data. However, this prediction depends on assuming a competitive and frictionless labor market. The substantial returns to job-to-job transitions seem to reject this assumption. However, wages do not affect job-to-job transitions, which is usually predicted by job-search theory. There may be asymmetric employer learning. Indeed, in the presence of asymmetric employer learning Waldman (1984) predicts large returns to promotions, and Pinkston (2009) predicts that job-to-job transitions should be associated to substantial wage increases. An alternative explanation is that workers might be searching for a good match with employers (e.g. Jovanovic 1979). Indeed, there is serial correlation in job-to-job transitions.

We have performed separate analyses for men and women and for different educational levels. Although, the sizes of the coefficients differ between subgroups, the signs and significance are almost always the same as for the full population. Only when considering different sectors, we find different estimation results. The results for blue-collar workers are to some extent consistent with symmetric learning in a competitive market. For white-collar workers the labor market is less competitive or friction might be more important. Observing the productivity of a blue-collar worker might be easier than of a white-collar worker, so there might also be more asymmetric learning about the ability of white-collar workers.

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Appendix: Description of the data

This appendix contains a more detailed description of Quadros de Pessoal, the matched employer–employee data used in the empirical analyses. The data are based on a compulsory survey that all firms with wage earners have to complete. For each year, the data contain information on about two million workers in the private sector. Both firms and workers have identification codes that permit to track them over time. For employers, it is mandatory to post the firm's response to survey questions concerning information on employees in a public place inside the firm.

We use data from 1991 to 2000. The data are collected once per year. Until 1993 data were collected in March, and after 1993 in October. Firstly, from each of the annual surveys we only kept full-time workers between 16 and 65 years old. This restriction excludes about 7.2% of the observations. We also drop about 14.7% of the observations, because they are employers, members of cooperations, and employers' relatives who do not receive any financial compensation. Since our model describes wage earners, the behavior of these individuals does not fit in our model.

Next, we performed a series of consistency checks. Firstly, we considered the identification code, which is a transformation of the social security number. We dropped obvious invalid codes (less than six digits or more than ten digits). Furthermore, since the data should describe only full-time workers, we dropped individuals with two observations in one year (unless the records were exactly the same in gender, birthday, wage, employer etc.). The excluded about 6.5% of the observations.

After also dropping observations in which the hierarchical level is missing, we are left with 16,245,140 yearly observations describing 4,202,736 individuals. This is about 70% of the original yearly observations. From this data, we randomly select 10% of the workers, so 420,274 workers with 1,626,415 yearly observations.

We checked for inconsistencies in gender, birthday, educational level and job tenure at the current employer. If we found an inconsistency in the variables gender, birth date, tenure in the firm or school level, this was repaired if possible or otherwise the worker was dropped from the data. In total, we excluded 40,668 workers (and 183,932 worker-year observations) for which we were not able to recover the correct values of variables.

Finally, we considered wages. Descriptive statistics on wages give some extreme variations. In particular, some individuals experienced strong wage changes with opposite signs in consecutive years. Such observation of the data often suggests that by accident additional digits were added to wages when

recording the data. This implies that the wage change between year $t - 1$ and t and between t and $t - 1$ are almost similar but with opposite signs. To reduce measurement errors in wages we have excluded workers who experienced a wage increase in the top ten percentile in one year and in the lower ten percentile in the next year (or vice versa). This implies a loss of 16,223 workers, which is about 4.3% of the workers. The remaining data set contains 363,383 individuals and 1,323,298 worker-year observations.

This final reduction of the sample caused that average wages decreased about 6.2%. The standard deviation in wages decreased from 112,391 to 98,207 PTE. The wage at the 5th percentile slightly reduced from 60,239 to 59,703 PTE, and at the 95th percentile from 311,155 to 281,899 PTE. Furthermore, wage increases reduced from 7.2% to 5.5%. It should be stressed that the sharp wage changes could not be the result from changes in non-regular wage payments, as these are ignored when constructing wages. The non-regular wage payments consist of non-systematic payments and extra-time payments, which equal, on average, 9,427 and 2,510 PTE. This is thus 7.5% and 2% of the average (regular) wage, respectively.

Structure of the skill levels—Decreto-lei n. 121/78, 2nd June

Level	Tasks	Skills
1 - Apprentices, interns, trainees	Training for a specific task.	Identical, but without practice, to the professional of the qualification level they will be assigned.
2 - Non-skilled professionals	Simple tasks, diverse and usually not specified, totally determined.	Practical knowledge and easily acquired in a short time.
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.
4 - Skilled professionals	Complex or delicate tasks and usually not repetitive and defined by the superiors.	Complete professional qualification implying theoretical and applied knowledge.
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.
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.
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.
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.

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