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HIGH WAGE WORKERS AND HIGH WAGE FIRMS

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ABSTRACT

We study a longitudinal sample of over one million French workers and over 500,000 employing firms. Real total annual compensation per worker is decomposed into components related to observable characteristics, worker heterogeneity, firm heterogeneity and residual variation. Except for the residual, all components may be correlated in an arbitrary fashion. At the level of the individual, we find that person-effects, especially those not related to observables like education, are the most important source of wage variation in France. Firm-effects, while important, are not as important as person-effects. At the level of firms, we find that enterprises that hire high-wage workers are more productive but not more profitable. They are also more capital and high-skilled employee intensive. Enterprises that pay higher wages, controlling for person-effects, are more productive and more profitable. They are also more capital intensive but are not more high-skilled labor intensive. We also find that person-effects explain 92% of inter-industry wage differentials.

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1 Introduction

For several decades labor economists have lamented the lack of microeconomic data relating characteristics of firms to characteristics of their workers (see, for example, Rosen (1986) and Willis (1986)) because such data would permit researchers to begin to disentangle the effects of firm-level human resource policies from the effects of external choices made by individual workers. Why do high-compensation firms pay more than the apparent going wage? Perhaps such a strategy delivers a gain in productivity or profitability that exceeds the incremental wage cost, as predicted by efficiency wage and agency models.[1] Perhaps high-paying firms select workers with higher external wage rates, thus sorting the workers into firms that have differential observed compensation programs.[2] Although broadly representative linked surveys of firms and workers are not available in the U.S., there have now been numerous studies that attempt to relate firm performance to the design of the compensation system.[3] Furthermore, many have analyzed the inter-industry wage differentials among individuals as they were the manifestation of differences in firm level compensation policies. [4]In this paper we present the first extensive statistical analysis of the individual- and firm-level heterogeneity in compensation determination. We examine variation in personal wage rates holding firm-effects constant and variation in firm wage rates holding personal effects constant. Due to the longitudinal nature of our data, we are able to control for both measured and unmeasured heterogeneity in the workers and their employing firms.

A high-wage worker is a person with total compensation higher than expected on the basis of observable characteristics like labor force experience, education, region, or sex. A high-wage firm is an employer with com-

[1]See Lazear (1979), Shapiro and Stiglitz (1984), Hart and Hölmstrom (1987) and Sappington (1991) for concise statements of the theories generating these predictions. Tests of these models have been performed by Abowd (1990), Abowd and Kramarz (1993), Cahuc and Dormont (1992), Gibbons and Murphy (1990, 1992) and Hutchens (1987) Kahn and Sherer (1990), Leonard (1990).

[2]This view is espoused by Bulow and Summers (1976), Cain (1976), Jovanovic (1979), and Roy (1951). Some tests of these models include Dickens and Lang (1985), Flinn (1986), Gibbons and Katz (1991) and Heckman and Sedlacek (1985).

[3]See Ehrenberg and Milkovich (1987), Ehrenberg (1990), Ichniowski and Shaw (1993)

[4]See Dickens and Katz (1987), Gibbons and Katz (1992), Groshen (1991), Krueger and Summers (1988), Thaler (1989).

pensation higher than expected given these same observable characteristics. Until now all empirical analyses of personal and firm heterogeneity in compensation outcomes have relied upon data that were inadequate to identify separately the individual-effect necessary to classify a worker as high-wage and the firm-effect required to classify a firm as high-wage. Using a unique longitudinal data set on firms and workers that is representative of private French employment, we are able to estimate both components of compensation determination, allowing for unrestricted correlation among them. In the estimated models, we find that individual-effects are statistically more important than firm-effects and that the two are not strongly correlated; however, the economic interpretation of these statements is complicated by the mobility patterns in the data. Although our statistical model allows for the identification of both firm- and individual-effects, we show that for many simple economic models, the structural heterogeneity of the workers and employers is not identical to the statistical heterogeneity measured by our descriptive model.

We use the results of our individual-level data analysis to relate firm-level outcomes and choices to the structure of the firm's compensation policy. Specifically, we ask whether firms that hire high-wage workers are more profitable (no), more productive per worker (yes), more capital intensive (yes), more professional-employment intensive (yes), more skilled labor intensive (no) and more likely to survive (yes). Second, we ask whether high-wage firms are more profitable (yes), more productive per worker (yes), more capital intensive (yes), more professional-employment intensive (no), more skilled labor intensive (no) and more likely to survive (maybe). Finally, we aggregate our results to the industry level, where we find that high-wage workers and high-wage firms are both explanations of the inter-industry wage differential with high-wage workers being much more important empirically.

The paper is organized as follows. Section 2 describes our analysis data set. Section 3 describes our methods for identifying and estimating the large number of statistical effects that characterize worker and firm compensation heterogeneity and provides several potential economic interpretations of the descriptive model's parameters. Section 4 describes our results. Section 5 concludes. A Data Appendix describes our manipulation of the French data in great detail. Finally, a Model Appendix gives details of the theoretical calculations.

2 Data Description and Sampling Plans

Our sample of workers comes from the Déclarations Annuelles de Salaires (DAS), an annual survey of employer-reported earnings subject to French social security taxes. We follow approximately one million individuals over the years from 1976 to 1987. The sample is a 1/25th extract of the French work force, excluding government employees (but including employees of government-owned businesses). Our compensation measure is the real total annual compensation cost for the employee. This includes direct salary and all benefit costs.[5] The data source reports the number of days worked per year. Part time workers were excluded. The total compensation measure for part year workers was annualized on a base of 360 days per year. The data included the individual's age, sex, location of job, occupation, and an identifier for the employer. We supplemented these data with information on the individual's education, available for ten percent of the sample and imputed for the rest (see the Data Appendix). We followed workers and employers across years and assigned a worker to the employer for which he or she had the largest number of paid days in a given year. We refer to the resulting analysis data file as the "individual data."

Our sample of firms comes from the annual survey Bénéfices Industriels et Commerciaux (BIC), which collects a large amount of income statement, balance sheet, employment and flow of funds information in support of the French national accounts. We use a probability sample of 20,000 of these firms, followed from 1978 to 1988, constructed by INSEE to facilitate research on firms (INSEE, 1989, 1990a-1990c). Our measures of firm performance include value added per employee, operating income as a proportion of total assets and sales per employee. As measures of factor inputs we calculated total real assets and total year-end employment. We added detailed measures of the firm's employment structure (professional, skilled and unskilled) from the annual Enquête sur la Structure des Emplois (Survey of employment structure). We refer to the resulting analysis data file as the "firm data."

The worker and firm samples are linked using an identification number (SIREN) for the employer that corresponds to a business unit–one or more establishments engaged in a related economic activity. Thus, our analysis

[5]Some components of employer compensation costs were estimated by the Revenus division at INSEE.

of firm-effects is at the level of an enterprise and not at the level of establishments. We do not use the ownership structure of our firms. When the enterprises change owners but remain in the same business, their SIRENs do not normally change. Thus, we are able to follow the economic activity of our firms through most financial and ownership restructurations. We use the linked individual-firm data to estimate the relation among various compensation policies and firm-level economic variables.

3 A Statistical Model for Individual Compensation

The basic compensation equation for an individual is given by

$$y_{it} = x_{it}\beta + \theta_i + \psi_{\mathrm{J}(i,t)it} + \varepsilon_{it} \tag{1}$$

where y_{it} is the compensation of individual $i = 1, ..., N$, for time $t = F_i, ..., L_i$, F_i is the first year an individual appears in the data, L_i is the last year s/he appears in the sample, and the function $\mathrm{J}(i,t)$ gives the identity j of the employing firm for individual i at date t. The effect $x_{it}\beta$ is the predicted effect of time varying, person-specific characteristics x_{it} with β being a vector of parameters to be estimated. The time-invariant individual-effect θ_i is decomposed as

$$\theta_i = \alpha_i + u_i\eta \tag{2}$$

where u_i is a vector of observable time-invariant person-specific characteristics and η is a vector of parameters to be estimated. The firm-effect $\psi_{\mathrm{J}(i,t)it}$ is decomposed as

$$\psi_{\mathrm{J}(i,t)it} = \phi_{\mathrm{J}(i,t)} + \gamma_{1\,\mathrm{J}(i,t)}s_{\mathrm{J}(i,t)it} + \gamma_{2\,\mathrm{J}(i,t)}\,\mathrm{T}_1(s_{\mathrm{J}(i,t)it} - 10) \tag{3}$$

where $\phi_{\mathrm{J}(i,t)}$, $\gamma_{1\,\mathrm{J}(i,t)}$ and $\gamma_{2\,\mathrm{J}(i,t)}$ are firm-specific parameters to be estimated, $s_{\mathrm{J}(i,t)it}$ is individual i's seniority at date t in firm $\mathrm{J}(i,t)$ and the function $\mathrm{T}_1(z)$ is the linear spline basis function[6]

$$\mathrm{T}_1(z) = \left\{ \begin{array}{c} 0 \text{ for } z < 0 \\ z \text{ for } z \geq 0 \end{array} \right\}. \tag{4}$$

[6]The use of a linear spline at 10 years of seniority is a specification that we found better suited to these data than a quadratic. As will become evident below, three parameters at the firm level is already quite flexible and we did not find much to be gained by adding additio·ı polynomial tems in seniority.

Finally, the error term ε_{it} is stochastically independent of all other effects in equation (1) with $\mathrm{E}[\varepsilon_{it}] = 0$ and $\mathrm{Var}[\varepsilon_{it}] = \sigma_\varepsilon^2$. The stochastic structure of $x_{it}\beta$, θ_i and $\psi_{J(i,t)it}$ is unrestricted so that these effects may be cross-correlated. The identification conditions imposed upon the model are

$$\sum_i \alpha_i = 0$$

and

$$\sum_{i,t} \psi_{J(i,t)it} = 0.$$

3.1 Potential Interpretations of the Descriptive Model

We illustrate the relation between structural heterogeneity in the populations of workers (heterogeneous abilities or tastes) and firms (heterogeneous efficiencies or technologies) and the statistical heterogeneity in equation (1) using three economic models with very simple population structures. In each case we derive the conditional expectation of individual compensation given the identity of the employing firm and the individual. We then relate the parameters of this conditional expectation to our statistical parameterization above.

3.1.1 A matching model with endogenous turnover

Suppose that workers are homogeneous. There are two types of firms, m and n, and two periods. In type m firms a worker's marginal product and wage rate are always w^*, and employment is always available in a type m firm. In type n firms there is a matching process. Worker i's productivity is $w^* + \varepsilon_{in}$ in both periods with ε_{in} drawn from a binomial distribution $B(-H, H, \frac{1}{2})$. The matching outcome, ε_{in}, unknown to both the worker and the firm at the beginning of the first period of employment, is realized at the end of the first period and becomes public information. Workers are offered contracts at the beginning of the first period of the form (w_1, w_2) and workers may leave firm n at the end of the first period. All firms make zero profits. The equilibrium contract for firms of type n is $(w^* - \frac{H}{2}, w^* + \varepsilon_{in})$. All workers in type n firms with a bad matching outcome $(-H)$ quit to type m firms.

To simplify the model, we consider a stationary situation with nine workers who live for two periods each, three born in period 0, three born in period

1, three born in period 2. Two workers in each generation enter type n firms, one worker in each generation enters a type m firm. Of the two workers who entered type n firms, let one draw a positive matching outcome and the other draw a negative matching outcome. The worker with the negative matching outcome leaves the type n firm for a type m firm when the matching parameter is made public.

The structure of the data implied by this theoretical model is shown in appendix Table B1. This corresponds to the following parameter values in our descriptive model:

$$\mu = w^*$$

where μ is the overall mean;

$$\alpha_i = 0, i = 1, ..., 9$$

where α_i is person i person-effect;

$$(\phi_m, \gamma_m) = (0, 0)$$

for the type m firm compensation policy; and

$$(\phi_n, \gamma_n) = (-\frac{H}{2}, \frac{3H}{2})$$

for the type n firm compensation policy.

3.1.2 A rent-splitting model with exogenous turnover

Suppose there are four different individuals, two types of firms, m and n, and two time periods. Each of the two firms earns quasi-rents of q_{jt}, and the quasi-rents are split by negotiation so that the workers receive a share s_j of the quasi-rent in firm j. Suppose that each firm employs two workers. With probability one, exactly one worker is randomly selected to separate from the period one employer and be re-employed at the other firm in the second period. All information about the workers and firms is known to those parties but not to the statistician. All workers are included in the data sample and the typical worker has wages of the form:

$$y_{it} = x_i + s_j q_{jt}$$

where x_j is the measure of wage rate heterogeneity, *i.e.* the worker type, q_{jt} follows a binomial distribution $B(-Q, Q, \frac{1}{2})$, $i = 1..., 4$, $j = m, n$, and $t = 1, 2$.

Table B2 shows the relation among the theoretical parameters, x_i, s_j, and Q, and the statistical parameters of equation (1) for each worker and each period. The model cannot be solved exactly. Thus, we use these relations to solve, by least squares, the moment equations that determine the relations between the statistical parameters and the model parameters. This yields:

$$\mu = \frac{1}{4}\sum_{i=1}^{4} x_i$$

where μ is the overall mean;

$$\alpha_1 = \frac{1}{4}(-3s_m Q - s_n Q - \sum_{i=1}^{4} x_i) + x_1$$

$$\alpha_2 = \frac{1}{4}(-s_m Q - 3s_n Q - \sum_{i=1}^{4} x_i) + x_2$$

$$\alpha_3 = \frac{1}{4}(s_m Q + 3s_n Q - \sum_{i=1}^{4} x_i) + x_3$$

$$\alpha_4 = \frac{1}{4}(3s_m Q + s_n Q - \sum_{i=1}^{4} x_i) + x_4$$

where the α_i are the four person effects;

$$(\phi_m, \gamma_m) = (\frac{(s_n - s_m)Q}{4}, 2s_m Q)$$

and

$$(\phi_n, \gamma_n) = (\frac{(s_n - s_m)Q}{4}, -2s_n Q)$$

are respectively the type m and type n firms' policies.

3.1.3 An incentive model with unobserved individual heterogeneity

Following Kramarz and Rey (1994), consider workers who are heterogeneous with respect to a parameter $q \in [0,1]$, which is known to them but not known to the firms. Suppose, furthermore, that there are two types of firms, m and n, that differ according to their technology, and that there are two time periods. At type m firms, workers are hired for one period and have a level of productivity y^* regardless of their q. At type n firms, workers are hired in period one, produce y regardless of their q, and choose an effort level, either 0 or E, to exert during on-the-job training. At the end of the first period, workers in firm type n take a formal, verifiable test. If worker q exerts effort E, the test is passed with probability q. Otherwise, the test is passed with probability kq, where $(0 < k < 1)$. At the beginning of the second period, the firm decides which workers to keep and the workers may leave on their own. Workers who exert effort E have a level of productivity in the second period of $y + \tau_q$ if they remain in a type n firm.

There are many type m firms and two type n firms, which compete for workers in both periods. Workers in type m firms always receive a wage w^*. Workers in type n firms are offered a wage contract $(w_1(q), w_2(q), b(q))$, where $w_1(q)$ is the first period wage, $w_2(q)$ is the second period wage, and $b(q)$ is the bonus paid to those who pass the test. In equilibrium all firms of both types make zero profits because of the competition to attract workers. Furthermore, if $y + \delta(y + \tau_q)$ is convex in q (δ being the rate of discount of future earnings), the equilibrium contract will be such that $w_1(q) = y - qb^*(q)$, $w_2(q) = y + \tau_q$, and

$$b(q) = \frac{d}{dq}(y + \delta(y + \tau_q))$$

All workers with type q, $q \geq p$, will choose to enter one of the type n firms and will choose to exert effort E when $b(p) \geq \frac{E}{(1-k)p}$.[7]

To simplify the model, we suppose that $\tau_q = \tau\frac{q^2}{2}$ and that parameters are such that $p = \frac{1}{3}$. We also suppose that there are nine workers, three of whom are employed by type m firms and the remaining six work in type n firms.

Appendix Table B3 shows the wage of every individual in each firm and in each period in terms of the theoretical model, as well as in terms of the

[7]Proofs of all these assertions can be found in Kramarz and Rey (1994).

descriptive model. These equations can be solved in order to express each parameter of the descriptive model using parameters of the theoretical model. As in the rent-splitting model, the solution is not exact–we must use least squares to express the function of the theoretical parameters that is closest to the statistical parameter. To see why, consider the workers in type n firms. Individual 7 passed the test and, consequently, received a bonus. This result generates a seniority slope for individual 7. Individual 8 did not pass the test and therefore received no bonus in period 2. Thus individual 8 has a different seniority slope in the same firm. The statistical parameter γ_n measures the average seniority slope in the firm n. Thus, the resulting estimated seniority slope will be the least squares estimate of the average of the two slopes. We illustrate these solutions for all the statistical parameters below.

The overall mean, μ, is given by the following:

$$\mu = \frac{\delta\tau}{18}\sum_{i=4}^{7} q_i(1 - \frac{q_i}{2}) - \frac{\delta\tau}{18}\sum_{i=8}^{9}\frac{q_i^2}{2} + \frac{w^*}{3} + \frac{2y}{3}$$

The individual effects, α_i, $i = 4, 5, 6, 7$ are:

$$\alpha_i = \frac{\delta\tau}{24}[\sum_{j=4, j\neq i}^{7} q_j(\frac{q_j}{2} - 2) + 5q_i(2 - q_i) + \sum_{j=8}^{9} q_j^2], i = 4, 5, 6, 7$$

and those for individual $i = 8, 9$ are:

$$\alpha_i = \frac{\delta\tau}{24}[\sum_{j=4}^{7} q_j(q_j - 2) + q_k^2 - 5q_i^2]$$

where $k = 8, 9$, $i \neq k$. Finally, the individual effects for $i = 1, 2, 3$ and the firm effects for m are not separately identifiable, since there are no movements between firms. We arbitrarily set:

$$\alpha_i = 0, i = 1, 2, 3$$

for these individuals, implying a firm effect of:

$$\phi_m = \frac{\delta\tau}{36}[\sum_{i=4}^{7} q_i(q_i - 2) + \sum_{i=8}^{9} q_i^2] + \frac{2w^*}{3} - \frac{2y}{3}$$

For type n firms we have:

$$\phi_n = \frac{\delta\tau}{36}[\sum_{i=4}^{7} q_i(-5q_i - 2) - 5\sum_{i=8}^{9} q_i^2] - \frac{w^*}{3} + \frac{y}{3}.$$

The seniority slopes are:

$$\gamma_m = 0$$

for firm m and

$$\gamma_n = \frac{\delta\tau}{12}[\sum_{i=4}^{7} q_i(3q_i + 2) + 3\sum_{i=8}^{9} q_i^2]$$

for firm n.

Notice that the α_i of the workers in the type n firm depend upon their hidden characteristics q_i as well as the characteristics of their fellow workers. Note also that the intercept in type m firms is larger than that of type n firms. Finally, as mentioned above, the seniority slope, γ_n, in type n firms is the least squares average of the career paths in the firm, depending on the success or failure of the test.

Although we do not attempt to recover the parameters of any particular theoretical model from the estimates produced below, we will use the simple theoretical frameworks outlined in this subsection to comment upon the results. No single economic model is likely to explain a large, diverse labor market like the one we study. Nevertheless, it is important to keep in mind that it is not always possible to make a direct interpretation of the statistical parameters (for individual or firm) in terms of simple economic parameters. In general, the interpretation of a given statistical parameter depends upon all the elements of the economic model under consideration.

3.2 Computation and Identification in the Statistical Model

In the context of equation (1), our goal is to estimate the invariant parameters β and η consistently in the presence of individual- and firm-effects that may be correlated with the person-specific characteristics. Next, we want to estimate θ_i and $\psi_{J(i,t)it}$ in a manner that allows us to use these estimates, when averaged within a firm j, as potential explanatory variables for differences in firm productivity, profitability, factor utilization and survival. The computational problem we face is that the least squares design matrix implied by equations (2) and (3) is enormous and cannot be simplified using any of the standard techniques in linear models (as, for example, in Scheffe, 1959). There are over one million individuals and 500,000 firms (of which 14,000 have at least 10 individual-year observations) represented in our data. Thus, eliminating the individual-effects from (1) by deviations from person-means leaves a high dimension, non-sparse, non-patterned least squares equation system to solve for the time-invariant and firm-specific parameters. Similarly, eliminating the firm-effects by deviations from firm-means (conditional on seniority) leaves an equally complex least squares equation system to solve. Finally, adopting Chamberlain's (1984) method of projecting the individual- and firm-effects onto a set of person and firm characteristics, while permitting consistent estimation of β and η, complicates our second goal by forcing us to model the firm-level effects of compensation policies directly in (1).

We adopt a variant of Chamberlain's method with a simplification first proposed by Mundlak (1978). In our projection method we project the firm-effect onto a vector of firm and person characteristics constructed so as to allow the desired correlation among the individual-effects, observable individual characteristics and the firm-effects. This permits consistent estimation of β and least squares estimation of θ_i. The resulting estimates are then used to produce consistent estimates of the firm-effects and of the firm-level averages of the individual-effects, which we use in our firm-level analysis.

It is worth discussing why we rejected two potential computational simplifications: sampling individuals and sampling firms, thus reducing the dimensionality of the person- and firm-effects to make the problem tractable. The person effects are typically identified by repeated observations on the same individual and the firm effects are typically identified by multiple employees in the same firm. When both types of effect are present in the same model, firm-effects are identified by the presence in the sample of individuals observed for multiple years and in multiple firms that employ other members of the sample. Without some movement of the individuals among the firms, neither firm- nor person-effects are separately identifiable. However, a relatively small amount of mobility suffices to identify many firm- and person-effects. The identification of the person and firm effects for individuals with at least two observations occurs whenever these individuals work at least once in a firm that has at some point employed a person who changed employers. When sampling individuals, as the size of the sample increases, the representativeness of the estimated firm-effects improves because in small samples of individuals the identified firm-effects are mostly from large firms, whereas in larger samples the additional individuals increase the probability that there will be a mover among the smaller firms. Furthermore, reducing the size of the individual sample would have prevented us from estimating firm-specific seniority returns because there are fewer and fewer firms with adequate sample sizes as the sample of individuals is reduced. On the other hand, when sampling firms we can estimate only selected firm-effects using all the available individual observations, assuming that the firm-effects from the nonsampled firms are zero. To obtain a representative, reasonably large set of firm-effect estimates, this procedure would have to be repeated many times (approximately 1,000 times to reproduce the firm-effects we have estimated by our preferred method). It is not obvious that this procedure offers any computational advantages.

Regardless of the computational approach used, between-employer mobility of the individuals is essential for the identification of our statistical model. Table 1 examines the pattern of inter-employer movements among all sample individuals. The rows of Table 1 correspond to the number of years a person is in the sample. The columns, with the exception of column (1a), correspond to the number of employers the individual had. An individual contributes to only one cell (again, excepting column (1a)). Notice that 59.4% of the individuals in the sample never change employers (column (1)).[8] Approximately one-fifth of the single employer individuals worked in firms with no movers while four-fifths (47.9% of the overall sample, column (1a)) worked in firms that, at one time or another, employed a person who changed employer. Thus, 88.5% of the sample individuals contribute to the estimation of firm-effects. It is also interesting to notice the pattern of employer spells among the movers (columns (2)-(10)). The second line of each cell shows the most frequent configuration of employer spells for individuals in that cell. In almost every case, short spells precede longer spells, indicating that mobility is greater in the early career (as Topel and Ward (1992) found for American men). It seems clear from Table 1 that the data should allow us to separate the individual-effect from the firm-effect.

[8] Notice that the cell (1,1) contains 318,627 individuals who appear in the sample during a single year. Some of these individuals may represent coding errors in the person identifier; however, it is not possible to correct these errors.

3.3 A Projection Method for Estimating Correlated Effects

Our proposed method allows us to estimate the parameters β consistently in the presence of both individual- and firm-effects without adopting a step-wise approach that imposes orthogonality among the different effects. We project the firm-effect onto the firm and individual data according to the equation:

$$\phi_{J(i,t)} + \gamma_{1\,J(i,t)} s_{J(i,t)it} + \gamma_{2\,J(i,t)} \mathrm{T}_1(s_{J(i,t)it} - 10) =$$

$$\left[f_{J(i,t)t} \otimes \left[\begin{array}{ccc} 1 & s_{J(i,t)it} & \mathrm{T}_1(s_{J(i,t)it} - 10) \end{array} \right] \otimes \overline{x}_i \right] \lambda + \nu_{J(i,t)it} \qquad (5)$$

where $f_{J(i,t)t}$ is a vector of time varying firm characteristics (firm size in our application), $\overline{x}_i$ is the vector of person-averages of x_{it}:

$$\overline{x}_i \equiv \frac{1}{T_i} \sum_{t=F_i}^{L_i} x_{it} \qquad (6)$$

$T_i \equiv L_i - F_i + 1$, λ is the parameter vector of the linear projection and $\nu_{J(i,t)it}$ is the stochastic error of the linear projection. Let

$$z_{it} \equiv \left[f_{J(i,t)t} \otimes \left[\begin{array}{ccc} 1 & s_{J(i,t)it} & \mathrm{T}_1(s_{J(i,t)it} - 10) \end{array} \right] \otimes \overline{x}_i \right] \qquad (7)$$

then

$$y_{it} = x_{it}\beta + z_{it}\lambda + \theta_i + \varepsilon_{it} + \nu_{J(i,t)it}. \qquad (8)$$

Restated as deviations from individual-averages, equation (8) becomes

$$\widetilde{y}_{it} = \widetilde{x}_{it}\beta + \widetilde{z}_{it}\lambda + \widetilde{\varepsilon}_{it} + \widetilde{\nu}_{J(i,t)it} \qquad (9)$$

where

$$\widetilde{x}_{it} \equiv x_{it} - \overline{x}_i \qquad (10)$$

and similarly for $\widetilde{z}_{it}, \widetilde{\varepsilon}_{it}$ and $\widetilde{\nu}_{J(i,t)it}$. Least squares estimation of β and λ yields:

$$\left[\begin{array}{c} \widehat{\beta} \\ \widehat{\lambda} \end{array} \right] \rightarrow \mathrm{N} \left(\left[\begin{array}{c} \beta \\ \lambda \end{array} \right] , \sigma_1^2 \left[\begin{array}{cc} \widetilde{X}'\widetilde{X} & \widetilde{X}'\widetilde{Z} \\ \widetilde{Z}'\widetilde{X} & \widetilde{Z}'\widetilde{Z} \end{array} \right]^{-1} \right) \text{as } N \rightarrow \infty \qquad (11)$$

where

$$\widetilde{X} \equiv \begin{bmatrix} \widetilde{x}_{11} \\ \cdots \\ \widetilde{x}_{1T_1} \\ \cdots \\ \widetilde{x}_{N1} \\ \cdots \\ \widetilde{x}_{1T_N} \end{bmatrix}, \widetilde{Z} \equiv \begin{bmatrix} \widetilde{z}_{11} \\ \cdots \\ \widetilde{z}_{1T_1} \\ \cdots \\ \widetilde{z}_{N1} \\ \cdots \\ \widetilde{z}_{1T_N} \end{bmatrix} \text{ and } \sigma_1^2 \equiv \mathrm{Var}\left[\widetilde{\varepsilon}_{it} + \widetilde{\nu}_{\mathrm{J}(i,t)it} \mid \widetilde{X}, \widetilde{Z}\right].$$

Estimates of the individual effects θ_i are recovered in the conventional manner as

$$\widehat{\theta}_i = \overline{y}_{it} - \overline{x}_i\widehat{\beta} - \overline{z}_i\widehat{\lambda} \tag{12}$$

and the limit distribution of $\widehat{\theta}_i$ is

$$\widehat{\theta}_i \rightarrow \mathrm{N}\left(\theta_i, \begin{bmatrix} \overline{x}_i & \overline{z}_i \end{bmatrix} \mathrm{Var}\begin{bmatrix} \widehat{\beta} \\ \widehat{\lambda} \end{bmatrix} \begin{bmatrix} \overline{x}_i' \\ \overline{z}_i' \end{bmatrix} + \frac{\sigma_1^2}{T_i}\right) \text{ as } N \rightarrow \infty \tag{13}$$

We note that although the least squares estimate of the individual effect $\widehat{\theta}_i$ is not consistent as $N \rightarrow \infty$, this is not a problem when we estimate firm-level models because the firm-average of $\widehat{\theta}_i$ can be consistently estimated.

Next consider the estimation of the firm effects $\phi_{\mathrm{J}(i,t)} + \gamma_{1\,\mathrm{J}(i,t)}s_{\mathrm{J}(i,t)it} + \gamma_{2\,\mathrm{J}(i,t)}\,\mathrm{T}_1(s_{\mathrm{J}(i,t)it} - 10)$. Define

$$\{j\} \equiv \{(i,t) \mid \mathrm{J}(i,t) = j\}, \text{ a set with } N_j \text{ elements,} \tag{14}$$

$$\widehat{y}_{\{j\}} \equiv y_{\{j\}} - x_{\{j\}}\widehat{\beta} - \widehat{\theta}_{\{j\}}, \tag{15}$$

$$y_{\{j\}} \equiv \begin{bmatrix} \cdots \\ y_{ns} \\ \cdots \end{bmatrix}, \forall (n,s) \in \{j\}, \tag{16}$$

and similarly for $x_{\{j\}}$ and $\hat{\theta}_{\{j\}}$. Equations (14) and (15) group all of the observations on individuals employed by the same firm into the vector $\widehat{y}_{\{j\}}$, which is expressed as a deviation from the $x\beta$ effects and the individual effects. The firm-level equation is:

$$\widehat{y}_{\{j\}} = F_{\{j\}} \begin{bmatrix} \phi_j \\ \gamma_{1j} \\ \gamma_{2j} \end{bmatrix} + \varsigma_{\{j\}} \tag{17}$$

where

$$F_{\{j\}} \equiv \begin{bmatrix} & \cdots & \\ 1 & s_{ns} & \mathrm{T}_1(s_{ns}-10) \\ & \cdots & \end{bmatrix}, \forall (n,s) \in \{j\} \tag{18}$$

and

$$\varsigma_{\{j\}} \equiv \varepsilon_{\{j\}} + x_{\{j\}}\left(\beta - \widehat{\beta}\right) + \left(\theta_{\{j\}} - \widehat{\theta}_{\{j\}}\right) \tag{19}$$

Least squares estimation of (17) yields the estimator

$$\begin{bmatrix} \widehat{\phi}_j \\ \widehat{\gamma}_{1j} \\ \widehat{\gamma}_{2j} \end{bmatrix} \rightarrow \mathrm{N}\left(\begin{bmatrix} \phi_j \\ \gamma_{1j} \\ \gamma_{2j} \end{bmatrix}, \Omega_j\right) \text{ as } N_j \rightarrow \infty \tag{20}$$

where

$$\Omega_j \equiv \sigma_2^2 \left(F'_{\{j\}} F_{\{j\}}\right)^{-1} + \left(F'_{\{j\}} F_{\{j\}}\right)^{-1} F'_{\{j\}}$$
$$\left(X_{\{j\}} \operatorname{Var}\left[\widehat{\beta}\right] X'_{\{j\}} + \operatorname{Var}\left[\widehat{\theta}_{\{j\}}\right] + 2X_{\{j\}} \operatorname{Cov}\left[\widehat{\beta}, \widehat{\theta}_{\{j\}}\right]\right) F_{\{j\}} \left(F'_{\{j\}} F_{\{j\}}\right)^{-1} \tag{21}$$

and $\sigma_2^2 = \operatorname{Var}[\varsigma]$.

To recover the α_i and $u_i\eta$ parts of the individual effect, estimate the equation (2) by generalized least squares to obtain $\widehat{\eta}$, which satisfies:

$$\widehat{\eta} \rightarrow \mathrm{N}\left(\eta, \left(U' \operatorname{Diag}\left(\operatorname{Var}\left[\widehat{\theta}_i\right]\right)^{-1} U\right)^{-1}\right) \text{ as } N \rightarrow \infty \tag{22}$$

where

$$U \equiv \begin{bmatrix} u_1 \\ \cdots \\ u_N \end{bmatrix} \tag{23}$$

and $\operatorname{Diag}\left(\operatorname{Var}\left[\widehat{\theta}_i\right]\right)$is a diagonal matrix containing the variances of $\widehat{\theta}_i$ from equation (13). The estimator of α_i is

$$\widehat{\alpha}_i = \widehat{\theta}_i - u_i\widehat{\eta} \tag{24}$$

and

$$\widehat{\alpha}_i \rightarrow \mathrm{N}\left(\alpha_i, \frac{\sigma_1^2}{T_i}\left[1 - \frac{T_i}{\sigma_1^2} u_i' \left(U' \operatorname{Diag}\left(\operatorname{Var}\left[\widehat{\theta}_i\right]\right)^{-1} U\right)^{-1} u_i\right]\right), \text{ as } N \rightarrow \infty \tag{25}$$

Next we estimate the firm-level average α_i, defined as α_j,

$$\widehat{\alpha}_j \equiv \frac{1}{N_j} \sum_{\forall (i,t) \in \{j\}} \widehat{\alpha}_i \tag{26}$$

with asymptotic distribution:

$$\widehat{\alpha}_j \to \mathrm{N}\left(\alpha_j, \sigma^2_{\alpha_j}\right), \text{ as } N_j \to \infty \tag{27}$$

where

$$\sigma^2_{\alpha_j} \equiv \frac{1}{N_j^2} \sum_{i=1}^{N_j} \frac{\sigma_1^2}{T_i} \left[1 - \frac{T_i}{\sigma_1^2} u_i' \left(U' \operatorname{Diag}\left(\operatorname{Var}\left[\widehat{\theta}_i\right]\right)^{-1} U \right)^{-1} u_i \right].$$

Similarly, the firm-level average education effect is given by

$$\overline{u}_j \widehat{\eta} \equiv \frac{1}{N_j} \sum_{\forall (i,t) \in \{j\}} u_i \widehat{\eta} \tag{28}$$

with asymptotic distribution based upon (22).[9]

3.4 Analysis of Firm-level Outcomes

We consider next the statistical relation between firm-level outcomes and our measures of firm-level compensation policy. Our basic model is

$$p_j = \begin{bmatrix} \alpha_j & \overline{u}_j \eta & \phi_j & \gamma_{1j} & \gamma_{2j} & q_j \end{bmatrix} \begin{bmatrix} \pi \\ \rho \end{bmatrix} + \xi_j \tag{29}$$

where $j = 1, ...J$, the total number of firms in the firm sample, p_j is any firm-level outcome, $\begin{bmatrix} \alpha_j & \overline{u}_j \eta & \phi_j & \gamma_{1j} & \gamma_{2j} \end{bmatrix}$ is a vector of firm-level compensation measures, π is a vector of parameters of interest, q_j is a vector of other firm-level variables, ρ is a vector of associated parameters and ξ_j is a zero-mean homoscedastic statistical error. In the regression analysis, firm-level outcomes and firm-level compensation variables were measured using data from two independently drawn samples. However, the firm-level

[9]In all our asymptotic results we hold constant the distribution of firm sizes. Thus as $N, N_j \to \infty$,we assume that their ratio goes to a non-zero constant.

compensation variables derived from our individual sample are estimated regressors. Consequently, we must allow for the estimation errors in $\widehat{\alpha}_j$, $\overline{u}_j\widehat{\eta}$, $\widehat{\phi}_j$, $\widehat{\gamma}_{1j}$ and $\widehat{\gamma}_{2j}$ in our assessment of the precision of the estimation of firm-level equations.[10] Equation (29) becomes

$$\begin{aligned} p_j = & \left[\begin{array}{cccccc} \widehat{\alpha}_j & \overline{u}_j\widehat{\eta} & \widehat{\phi}_j & \widehat{\gamma}_{1j} & \widehat{\gamma}_{2j} & q_j \end{array} \right] \left[\begin{array}{c} \pi \\ \rho \end{array} \right] + \\ & \left(\left[\begin{array}{ccccc} \alpha_j & \overline{u}_j\eta & \phi_j & \gamma_{1j} & \gamma_{2j} \end{array} \right] - \left[\begin{array}{ccccc} \widehat{\alpha}_j & \overline{u}_j\widehat{\eta} & \widehat{\phi}_j & \widehat{\gamma}_{1j} & \widehat{\gamma}_{2j} \end{array} \right] \right) \pi + \xi_j \end{aligned} \tag{30}$$

where $\left(\left[\begin{array}{ccccc} \alpha_j & \overline{u}_j\eta & \phi_j & \gamma_{1j} & \gamma_{2j} \end{array} \right] - \left[\begin{array}{ccccc} \widehat{\alpha}_j & \overline{u}_j\widehat{\eta} & \widehat{\phi}_j & \widehat{\gamma}_{1j} & \widehat{\gamma}_{2j} \end{array} \right] \right) \pi$ is the error associated with the first-step estimation of the firm-level compensation measures.[11] In order to derive the error covariance matrix for equation (30), let

$$P_j'\left(\widehat{\delta}_j\right) \equiv \left[\begin{array}{cccccc} \widehat{\alpha}_j & \overline{u}_j\widehat{\eta} & \widehat{\phi}_j & \widehat{\gamma}_{1j} & \widehat{\gamma}_{2j} & q_j \end{array} \right]$$

and

$$\widehat{\delta}_j' \equiv \left[\begin{array}{ccccc} \widehat{\alpha}_j & \widehat{\eta} & \widehat{\phi}_j & \widehat{\gamma}_{1j} & \widehat{\gamma}_{2j} \end{array} \right].$$

Now, eouation (30) can be re-expressed in a first order approximation around δ_j as:

$$p_j = P_j'\left(\delta_j\right) \left[\begin{array}{c} \pi \\ \rho \end{array} \right] + \omega_j \tag{31}$$

where

$$\omega_j \equiv (\widehat{\delta}_j - \delta_j)' \frac{\partial P_j\left(\delta_j\right)}{\partial \delta_j} \left[\begin{array}{c} \pi \\ \rho \end{array} \right] + \xi_j$$

[10]The firm-level regressor $\overline{x}_j\widehat{\beta}$ also contains some measurement error, in principle; however, the vector $\widehat{\beta}$ is estimated with such precision that we do not carry along its estimated covariance matrix (including its estimated covariance with $\widehat{\alpha}_j$, $\overline{u}_j\widehat{\eta}$, $\widehat{\phi}_j$, $\widehat{\gamma}_{1j}$ and $\widehat{\gamma}_{2j}$) in these calculations. Hence, we place $\overline{x}_j\widehat{\beta}$ in the list of q_j.

[11]We adopt the model of Pagan (1984) and Murphy and Topel (1985); namely, that the regression of interest relates a function of the individual-level data and several firm-level parameters to the other measured firm-level outcomes. We account for the estimation error $\left(\left[\begin{array}{ccccc} \alpha_j & \overline{u}_j\eta & \phi_j & \gamma_{1j} & \gamma_{2j} \end{array} \right] - \left[\begin{array}{ccccc} \widehat{\alpha}_j & \overline{u}_j\widehat{\eta} & \widehat{\phi}_j & \widehat{\gamma}_{1j} & \widehat{\gamma}_{2j} \end{array} \right] \right)$ explicitly, but we do not add an additional measurement error. Thus, for example, we assert that the outcome p_j depends upon α_j and not upon $\alpha_j + \zeta_j$, where ζ_j is an independent measurement error.

The variance of the regression error term for equation (31) consists of the component due to the estimation error in $\widehat{P}_j$ plus the component due to ξ_j:

$$\mathrm{Var}\left[\omega_j\right] \equiv \begin{bmatrix} \pi' & \rho' \end{bmatrix} \frac{\partial P_j'}{\partial \delta_j'} \mathrm{Var}\left[\widehat{\delta}_j\right] \frac{\partial P_j}{\partial \delta_j} \begin{bmatrix} \pi \\ \rho \end{bmatrix} + \mathrm{Var}\left[\xi_j\right] \tag{32}$$

where the components of $\mathrm{Var}\left[\widehat{\delta}_j\right]$ are defined in the derivations above. We estimate equation (31) using generalized least squares based upon the error variance in equation (32).

4 Estimation Results

Table 2 shows the basic summary statistics, by sex, for the individual-level data. The usable sample consists of 3,434,530 observations on 711,518 men and 1,870,578 usable observations on 454,787 women. The basic individual-level variables consist of labor force experience, region of France, education level and seniority. Note that about 30% of the sample has no known educational attainment. For 74% of the individuals, there are enough observations in the sample to permit estimation of a distinct firm-effect.[12] Recall from Table 1 that some 27% of our individuals appear in only one of the 10 data years while 10.6% are present for all 10 years. More than 59% of the individuals have only a single employer while 2, 3 and 4 employers account for 21.8%, 10.7%, and 4.8% of the individuals, respectively.

The results of our projection method for estimating the basic regression parameters are shown in Table 3, separately for men and women. These estimates are the results of applying the multiple step procedure presented in section 3. The results shown in the columns "Projection Method," thus, come from two separate regression models–the one shown in equation (2), for the education coefficients, and the one shown in equation (9), for the time-varying individual characteristics.[13] For comparison purposes, Table 3 also shows the ordinary least squares results, the within estimates for fixed

[12]The individuals from firms with fewer than 10 observations in the sample were pooled and a single firm-level regression was used to estimate their firm-effects.

[13]The remaining coefficients from equation (9) can be found in the Data Appendix. The seniority coefficients shown for the projection method are the individual averages of $\widehat{\gamma}_{1j}$ and $\widehat{\gamma}_{2j}$ from Table 4.

person-effects and the within estimates for fixed firm-effects. Evidently, the projection method results are much closer to the within-person estimates than to those within firms whereas the least squares results are closer to the within-firm estimates.

Table 4 contains descriptive statistics for the components of real compensation implied by the estimated parameters from equation (1) separately for each sex. For both males and females, the standard deviation of the individual-effect, and its components $\alpha$and $u\eta$, is much larger than that of the firm-effect, and its components ϕ, γ_1 and γ_2. As noted in Table 3, the complete parameterization in explains 80% of the variation in real salaries for men and 75% for women; thus, the idiosyncratic component of variance is still rather important.

Table 5 shows the intercorrelations of the components of compensation. All components of compensation except the residual account for 81% of the variance of real total annual compensation costs (combined result for males and females). Furthermore, the α_i component of the individual-effect (the part not explained by education) is more important than the observable regressors ($x\beta$) in explaining compensation costs. The overall firm effect, ψ_j, on the other hand, is only about one-quarter as important as the overall person-effect. The individual-effect and the firm-effect are correlated 0.10 according to our results. The α and ϕ components are correlated 0.08 according to this method. Notice that although the firm-specific intercept, ϕ, and the α-component of the individual effect are positively correlated, the firm-specific intercept is negatively correlated with the seniority slope (-0.56).

One may get the impression from Table5 that the individual-effects and firm-effects are not highly correlated. Table 6 shows that this is not completely correct. In this table we begin to address the problem of inter-employer mobility in our sample. If the mobility in the economy is exogenous; that is, if the probability of separation from one firm and accession into another does not depend upon the individual's wage path, then the association of the parameter ϕ_j with the pay practices of firm j is correct. Otherwise, the movers and stayers systematically sort according to their values of α, ϕ, and ε. In this second case, measured values of firm-effects are contaminated by the average values of individual-effects of the movers relative to the stayers, as can be seen in the two endogenous mobility models discussed above.

For Table 6, the individuals were divided into three groups according to their α's. High-α workers are much more likely to be observed in a single job (one employer) whereas low-α workers are relatively more likely to have had three or more employers. High-α workers also have more labor-force experience. Although α and ϕ are positively correlated, low-ϕ workers are more likely to have had multiple employers. In particular the low-α low-ϕ low experience workers are the most likely to have had multiple employers. Table 7 examines the mobility of high-α versus low-α workers explicitly. Persons with low estimated individual-effects are much more likely to move between low-ϕ jobs than are persons with high individual-effects (57% versus 40%). Evidently the clean distinction between individual heterogeneity and firm heterogeneity is called into question by this pattern. Do we estimate low α's because the individual has moved through a sequence of low-ϕ jobs or rather because some employers are more likely to choose low-α workers, who are more mobile for a variety of reasons? Our analysis does not provide a clear answer to this question.

Table 8 presents summary statistics for the sample of firms (weighted to be representative of private industrial firms). Table 9 presents regression models for the logarithm of real value added per employee, real sales per employee (measures of productivity) and operating income as a proportion of total assets (a measure of performance). Using the firm-level compensation policy measures generated by our projection method, we note that a larger value of the predicted wage ($x\beta$-component) is associated with higher value-added and sales per worker and higher profitablity. A larger individual-effect (α-component) is associated with a substantially larger value-added per employee and sales per employee but not with higher profitability. The part of the individual-effect related to education ($u\eta$-component) is associated with higher value-added per worker but is not significant in the other two columns. Higher firm-specific wages (ϕ-component) are associated with higher productivity (value-added per worker and sales per worker) and with higher profitability. Neither seniority slope is associated with higher (or lower) productivity or profitability.

Table 10 presents the results for the relations among our compensation measures and a variety of firm-level factor utilization rates. Larger values of the $x\beta$-component of compensation are associated with higher employment, capital, capital-labor ratio, professional employment proportion and skilled employment proportion. The α-component of the individual-effect is positively associated with total employment, total real capital, the capital-labor ratio and the proportion of engineers, technical workers and managers in the work force, and is negatively related to the shares of both skilled and unskilled workers. Larger values of the average education effect are associated with higher total employment, total real capital and professional proportion but lower values of the skilled proportion. The firm-specific intercept (ϕ-component of the firm effect) is strongly positively associated with total employment, total real capital and capital intensity but is not associated with any components of the skill structure of the work force. Employment proportions are not related to this component of the firm effect in compensation. A high firm-specific seniority slope is positively associated with capital intensity and slightly associated with the proportion of professional employees.

Table 11 presents a proportional hazards analysis of the relation between the survival of firms and our estimated compensation components at the firm level. Both components of the individual effect (α and the education part $u\eta$) increase survivorship in a statistically significant manner. The effects related to firm-specific compensation factors are large but very imprecise. The effect associated with the $x\beta$-component goes in the opposite direction.

Finally, Table 12 uses industry-level averages of the individual and firm specific components of compensation to explain the industry-effect found in our raw individual data (regression adjusted for labor force experience, region. year, education and sex) in the spirit of Dickens and Katz (1987) and Krueger and Summers (1988). Since the right-hand side variables in this regression fully account for the industry effects in a statistical sense ($R^2 = 0.97$), the interesting question is the relative importance of individual heterogeneity (α-component of the person effect) and firm heterogeneity (both ϕ and γ-components) as components of the industry effects. The third through sixth columns of Table 12 present separate industry-level regressions using first α alone (column 3 and 4) and then the three parts of the firm-effect by themselves (columns 5 and 6). It is clear from the fact that α alone explains 92% of the inter-industry wage variation, whereas the firm-specific components explain only 25%, that individual effects, as measured statistically are more important than firm-components. One should recall, however, that in our example theoretical models structural firm and individual heterogeneity can influence both of the statistical measures.

5 Conclusions

In all likelihood, our analysis of the separate effects of individual and firm heterogeneity on wage rates and on firm compensation policies has raised more new questions than it has resolved. We find that individual-effects are a significant component of real total annual compensation variation. Firm-effects, while also important, are not as important as individual-effects. Firm-level heterogeneity and individual-level heterogeneity are not highly correlated; however, mobility patterns suggest that the distinction between an individual-effect and a firm-effect is not economically simple. Firms that hire high-wage workers appear to be more productive per worker but not more profitable. High-wage firms–those paying higher wages controlling for the individual heterogeneity of the employees–are more productive per worker and are more profitable. Both sources of wage rate heterogeneity–high-wage workers and high-wage firms–are associated with more capital intensive firms. We also estimated firm-level heterogeneity in the returns to seniority. This component of wage variation is decidedly less important in our sample than the two pure heterogeneity components. We believe that our results provide the statistical basis upon which to begin the process of testing the relevance of agency, efficiency wage, search/matching, and endogeneous mobility models as potential explanations for compensation outcome heterogeneity.

Table 1

Structure of the Individual Data by Years in Sample and Number of Employers

(Number of Individuals, Most Common Configuration of Employers)

Years in Sample	Number of Employers: 1	1a	2	3	4	5	6	7	8	9	10	Total	Percent
1	318,627	247,532										318,627	27.3%
	1	1											
2	75,299	57,411	51,066									126,365	10.8%
	2	2	11										
3	46,385	36,540	32,947	19,583								98,915	8.5%
	3	3	12	111									
4	43,019	34,922	26,631	17,191	8,330							95,171	8.2%
	4	4	13	112	1111								
5	41,130	34,596	26,408	15,291	8,685	3,610						95,124	8.2%
	5	5	14	113	1112	11111							
6	29,755	25,388	20,953	13,734	7,592	4,073	1,653					77,760	6.7%
	6	6	15	114	1113	11112	111111						
7	19,413	16,709	17,384	12,039	7,305	3,864	1,931	735				62,671	5.4%
	7	7	16	115	1114	11113	111112	1111111					
8	23,484	20,378	20,421	13,185	7,673	4,001	2,061	917	327			72,069	6.2%
	8	8	44	116	1115	11114	111113	1111112	11111111				
9	38,505	34,147	26,350	15,791	8,590	4,383	2,104	938	362	114		97,137	8.3%
	9	9	54	117	1116	11115	111114	1111113	11111112	111111111			
10	56,881	51,425	32,616	17,728	8,369	3,839	1,837	739	314	109	34	122,466	10.5%
	10*	10*	64	118	1117	11116	221113	1131112	11111113	111111112	1111111111		
Total	692,498	559,048	254,776	124,542	56,544	23,770	9,586	3,329	1,003	223	34	1,166,305	100.0%
Percent	59.4%	47.9%	21.8%	10.7%	4.8%	2.0%	0.8%	0.3%	0.1%	0.0%	0.0%	100.0%	

Source: DAS individual data.

Notes: Employment configurations are described in terms of the number of consecutive years spent with each of the individual's employers, in order (e.g. configuration 124 means that the individual spent 1 year with his first employer, then 2 years with his second employer, and finally 4 years with his third employer). Column 1a refers to the subset of individuals with only one employer whose employing firm had at least one other individual who had changed firms at least once in his career (required for identification of both firm and individual effects).

* This configuration corresponds to 10 years of data with the first (and only) employer.

Table 2
Descriptive Statistics for Basic Individual Level Variables by Sex for 1976 to 1987

	Men		*Women*	
Variable Definition	Mean	Std Dev	Mean	Std Dev
Log (Real Annual Compensation Cost, 1980 FF)	4.3442	0.5187	4.0984	0.4801
Total Labor Force Experience	17.2531	11.8258	15.4301	12.0089
(Total Labor Force Experience)^2/100	4.3752	4.9197	3.8230	4.9440
(Total Labor Force Experience)^3/1000	13.1530	19.4305	11.6079	19.6863
(Total Labor Force Experience)^4/10000	43.3453	77.9542	39.0589	80.3251
Seniority	7.7067	7.5510	6.5437	6.5268
Lives in Ile-de-France (Paris Metropolitan Region)	0.2561		0.2910	
No Known Degree	0.3064	0.2190	0.2971	0.2124
Completed Elementary School	0.1556	0.1458	0.1893	0.1739
Completed Junior High School	0.0565	0.0792	0.0869	0.1008
Completed High School (Baccalauréat)	0.0528	0.0804	0.0711	0.0881
Basic Vocational-Technical Degree	0.2652	0.1849	0.1926	0.1545
Advanced Vocational-Technical Degree	0.0701	0.0893	0.0532	0.0802
Technical College or University Diploma	0.0469	0.0754	0.0838	0.1247
Graduate School Diploma	0.0465	0.0964	0.0259	0.0551
Year of data	81.3106	3.7250	81.4730	3.7180
Number of Observations for the Firm in Sample	4402.3800	16164.6200	1605.3100	7797.1300
Observations	3,434,530		1,870,578	
Persons	711,518		454,787	
Sufficient Data Available to Estimate Firm Effect	0.7425		0.7448	

Notes: For sources and methods see the Data Appendix.

Table 3

Estimates of the Effects of Labor Force Experience, Region and Year on the Log of Real Total Annual Compensation Costs

Individual Data by Sex for 1976 to 1987

Variable	Projection Method Parameter Estimate	Projection Method Standard Error	Least Squares Parameter Estimate	Least Squares Standard Error	Within Persons Parameter Estimate	Within Persons Standard Error	Within Firms Parameter Estimate	Within Firms Standard Error
Men								
Total labor force experience	0.0729	(0.0004)	0.0522	(0.0003)	0.0675	(0.0004)	0.0434	(0.0003)
(LF experience squared)/100	-0.4509	(0.0027)	-0.2189	(0.0030)	-0.4435	(0.0029)	-0.1518	(0.0027)
(LF experience cubed)/1000	0.1072	(0.0009)	0.0494	(0.0010)	0.1079	(0.0010)	0.0290	(0.0009)
(LF experience quartic)/10000	-0.0095	(0.0001)	-0.0047	(0.0001)	-0.0097	(0.0001)	-0.0025	(0.0001)
Seniority	-3.37e-05	(1.81e-05)	0.0143	(0.0001)	0.0049	(0.0001)	0.0094	(0.0001)
Seniority spline at 10 years	-5.36e-04	(2.92e-05)	-0.0048	(0.0002)	-0.0034	(0.0001)	-0.0030	(0.0001)
Lives in Ile-de-France	0.0800	(0.0010)	0.1400	(0.0005)	0.0820	(0.0011)	0.1116	(0.0007)
Year 1977	0.0203	(0.0007)	0.0379	(0.0010)	0.0275	(0.0008)	0.0202	(0.0009)
Year 1978	0.0531	(0.0008)	0.0692	(0.0010)	0.0640	(0.0009)	0.0489	(0.0009)
Year 1979	0.0782	(0.0009)	0.0895	(0.0010)	0.0922	(0.0010)	0.0629	(0.0009)
Year 1980	0.0914	(0.0010)	0.0957	(0.0010)	0.1076	(0.0011)	0.0678	(0.0009)
Year 1982	0.1289	(0.0014)	0.1200	(0.0011)	0.1497	(0.0015)	0.0846	(0.0009)
Year 1984	0.1723	(0.0018)	0.1505	(0.0011)	0.1973	(0.0018)	0.1045	(0.0009)
Year 1985	0.1966	(0.0020)	0.1727	(0.0011)	0.2235	(0.0020)	0.1182	(0.0009)
Year 1986	0.2304	(0.0021)	0.1906	(0.0011)	0.2592	(0.0022)	0.1349	(0.0009)
Year 1987	0.2517	(0.0023)	0.2020	(0.0011)	0.2825	(0.0024)	0.1433	(0.0009)
Elementary School Education	0.5778	(0.0036)	0.1138	(0.0020)	a		0.0823	(0.0019)
Junior High School Education	0.1494	(0.0058)	0.4515	(0.0031)	a		0.3662	(0.0029)
High School Graduate	0.4249	(0.0063)	0.6665	(0.0033)	a		0.5375	(0.0030)
Basic Vocational-Technical Grad.	-0.0704	(0.0028)	0.2454	(0.0016)	a		0.2123	(0.0015)
Advanced Vocational-Technical Grad.	0.6136	(0.0051)	0.6325	(0.0027)	a		0.5331	(0.0025)
Technical College or Undergrad. Degree	0.1359	(0.0065)	0.6113	(0.0035)	a		0.4716	(0.0031)
Graduate School Degree	1.6032	(0.0051)	1.4392	(0.0028)	a		1.2604	(0.0025)
Intercept	3.6899	(0.0016)	3.4244	(0.0014)	a		0.0518	(0.0022)
Root mean square error	0.2684		0.4227		0.2685		0.3420	b
Error degrees of freedom	2,585,147		3,434,506		2,722,996		5,234,086	b
R-squared	0.7985		0.3358		0.7875		0.5715	b
Sample size	3,434,530		3,434,530		3,434,530		5,305,108	b

(cont.)

Table 3 (continued)

Estimates of the Effects of Labor Force Experience, Region and Year on the Log of Real Total Annual Compensation Costs

Individual Data by Sex for 1976 to 1987

Variable	Projection Method Parameter Estimate	Projection Method Standard Error	Least Squares Parameter Estimate	Least Squares Standard Error	Within Persons Parameter Estimate	Within Persons Standard Error	Within Firms Parameter Estimate	Within Firms Standard Error
Women								
Total labor force experience	0.0334	(0.0005)	0.0299	(0.0004)	0.0268	(0.0006)	0.0210	(0.0004)
(LF experience squared)/100	-0.1796	(0.0037)	-0.0938	(0.0038)	-0.1501	(0.0042)	-0.0230	(0.0035)
(LF experience cubed)/1000	0.0396	(0.0013)	0.0144	(0.0013)	0.0326	(0.0015)	-0.0072	(0.0012)
(LF experience quartic)/10000	-0.0032	(0.0001)	-0.0010	(0.0001)	-0.0026	(0.0002)	0.0012	(0.0001)
Seniority	8.28e-04	(2.38e-05)	0.0172	(0.0001)	0.0055	(0.0001)	0.0116	(0.0001)
Seniority spline at 10 years	-1.64e-03	(4.20e-05)	-0.0069	(0.0002)	-0.0074	(0.0002)	-0.0031	(0.0002)
Lives in Ile-de-France	0.0782	(0.0016)	0.1577	(0.0007)	0.0794	(0.0018)	0.1217	(0.0009)
Year 1977	0.0218	(0.0010)	0.0588	(0.0014)	0.0304	(0.0011)	0.0372	(0.0012)
Year 1978	0.0638	(0.0011)	0.1135	(0.0014)	0.0766	(0.0012)	0.0832	(0.0012)
Year 1979	0.0938	(0.0012)	0.1447	(0.0014)	0.1098	(0.0014)	0.1083	(0.0012)
Year 1980	0.1093	(0.0014)	0.1548	(0.0015)	0.1276	(0.0016)	0.1192	(0.0012)
Year 1982	0.1529	(0.0018)	0.1872	(0.0015)	0.1751	(0.0021)	0.1454	(0.0013)
Year 1984	0.1962	(0.0022)	0.2349	(0.0015)	0.2227	(0.0025)	0.1769	(0.0013)
Year 1985	0.2135	(0.0024)	0.2510	(0.0015)	0.2408	(0.0028)	0.1830	(0.0013)
Year 1986	0.2427	(0.0027)	0.2676	(0.0015)	0.2706	(0.0030)	0.1991	(0.0013)
Year 1987	0.2609	(0.0029)	0.2731	(0.0015)	0.2894	(0.0033)	0.2038	(0.0013)
Elementary School Education	0.2782	(0.0045)	0.0046	(0.0025)	a		-0.0145	(0.0023)
Junior High School Education	0.3480	(0.0065)	0.3472	(0.0032)	a		0.2445	(0.0031)
High School Graduate	0.3348	(0.0078)	0.4813	(0.0040)	a		0.3307	(0.0037)
Basic Vocational-Technical Grad.	0.1279	(0.0045)	0.2578	(0.0024)	a		0.1739	(0.0023)
Advanced Vocational-Technical Grad.	0.4032	(0.0079)	0.4464	(0.0040)	a		0.3208	(0.0039)
Technical College or Undergrad. Degree	0.6014	(0.0057)	0.6078	(0.0029)	a		0.4817	(0.0027)
Graduate School Degree	1.2419	(0.0123)	0.9881	(0.0064)	a		0.7933	(0.0059)
Intercept	3.5422	(0.0023)	3.3364	(0.0019)	a		-0.0518	b
Root mean squared error	0.2855		0.4215		0.2833		0.3420	b
Error degrees of freedom	1,340,697		1,870,554		1,415,775		5,234,086	b
R-squared	0.7466		0.2292		0.7364		0.5715	b
Sample size	1,870,578		1,870,578		1,870,578		5,305,108	b

Notes: The projection method includes the variables for eliminating the firm effect (see Data Appendix for complete list) and is estimated by least squares within person. The estimates from the projection method are the result of a multi-step process described in the text. (a) Not separately calculated. (b) Pooled estimates of firm means, statistics apply to pooled men-women equation.

Table 4
Descriptive Statistics for Components of Log Real Total Compensation by Sex for 1976 to 1987

	Men		Women	
Variable Definition	Mean	Std Dev	Mean	Std Dev
Log (Real annual compensation costs, 1980 FF)	4.3442	0.5187	4.0984	0.4801
$x\beta$ - Predicted value	0.4261	0.1383	0.3234	0.1120
θ - Total individual effect	3.9160	0.4387	3.7776	0.3843
Sampling variance of θ	0.2714	0.2758	0.3444	0.3299
α -Individual effect not related to education	0.0000	0.3947	0.0000	0.3639
Sampling variance of α	0.1357	0.1379	0.1722	0.1649
$u\eta$ -Individual effect related to education	3.9160	0.1915	3.7776	0.1238
Sampling variance of $u\eta$	0.1357	0.1379	0.1722	0.1649
ψ - Total firm effect	0.0028	0.0685	-0.0039	0.0566
Sampling variance of ψ	0.0019	0.0075	0.0020	0.0075
ϕ - Firm-specific intercept	0.0031	0.1044	-0.0072	0.0969
Sampling variance of ϕ	0.0137	1.8867	0.0065	0.1775
γ_1 -Firm-specific seniority slope	-3.37e-05	0.0335	8.28e-04	0.0326
Sampling variance of γ_1	0.0009	0.0490	0.0009	0.0576
γ_2 - Firm-specific slope change at 10 years	-5.36e-04	0.0542	-1.64e-03	0.0574
Sampling variance of γ_2	0.0131	1.5672	0.0122	1.3563
ε - Residual	-0.0006	0.2328	0.0012	0.2417

Notes: For sources and methods see the Data Appendix.

Table 5

Summary Statistics for the Decomposition of Variance Using the Projection Method for Individual Data, both Sexes, 1976-1987

No.	Variable Description	Mean	StD	Simple Correlations with: 1	2	3	4	5	6	7	8	9	10	11
1	y_{it} - log (real total compensation)	4.2575	0.5189	1.0000	0.3271	0.8401	0.7331	0.4143	0.2131	0.1303	0.0053	-0.0293	0.0276	0.4336
2	$x_{it}\beta$ - predicted effect: experience, region, year	0.3899	0.1386	0.3271	1.0000	0.0710	-0.0267	0.2211	0.0325	0.0350	-0.0157	-0.0148	0.0077	-0.0048
3	θ_i -individual effect	3.8672	0.4255	0.8401	0.0710	1.0000	0.9027	0.4303	0.0974	0.0802	-0.0201	-0.0171	0.0203	-0.0243
4	α_i -component of individual effect	0.0000	0.3841	0.7331	-0.0267	0.9027	1.0000	0.0000	0.0853	0.0763	-0.0242	-0.0186	0.0186	-0.0233
5	$u_i\eta$ - component of individual effect	3.8672	0.1831	0.4143	0.2211	0.4303	0.0000	1.0000	0.0473	0.0263	0.0041	-0.0006	0.0081	-0.0076
6	$\psi_{J(i,t)}$ - firm effect	0.0004	0.0647	0.2131	0.0325	0.0974	0.0853	0.0473	1.0000	0.4428	0.2089	-0.0909	0.0717	-0.0001
7	$\phi_{J(i,t)}$ - component of firm effect	-0.0005	0.1019	0.1303	0.0350	0.0802	0.0763	0.0263	0.4428	1.0000	-0.7844	-0.5625	0.2562	-0.0001
8	$\gamma_{1J(i,t)}s_{J(i,t)it} + \gamma_{2J(i,t)}T_1(s_{J(i,t)it}-10)$ - component	0.0009	0.0935	0.0053	-0.0157	-0.0201	-0.0242	0.0041	0.2089	-0.7844	1.0000	0.5507	-0.2298	0.0000
9	$\gamma_{1J(i,t)}$ - slope on seniority	0.0003	0.0332	-0.0293	-0.0148	-0.0171	-0.0186	-0.0006	-0.0909	-0.5625	0.5507	1.0000	-0.2094	0.0000
10	$\gamma_{2J(i,t)}$ - slope on seniority spline at 10 years	-0.0009	0.0553	0.0276	0.0077	0.0203	0.0186	0.0081	0.0717	0.2562	-0.2298	-0.2094	1.0000	0.0000
11	ε_{it} - residual	0.0001	0.2360	0.4336	-0.0048	-0.0243	-0.0233	-0.0076	-0.0001	-0.0001	0.0000	0.0000	0.0000	1.0000

Table 6
Descriptive Statistics for Individual Level Variables by α-Category and Number of Employers for 1976 to 1987

Variable Definition	Low α Mean	Low α Std Dev	Middle α Mean	Middle α Std Dev	High α Mean	High α Std Dev
1 Employer						
Log (Real Annual Compensation Cost, 1980 FF)	3.859	0.476	4.221	0.302	4.673	0.438
Male	0.640		0.606		0.643	
Total Labor Force Experience	15.496	11.861	17.122	12.341	23.826	12.236
xβ - Predicted Value	0.385	0.142	0.378	0.137	0.372	0127
uη -Individual Effect Related to Education	3.872	0.202	3.845	0.165	3.879	0.183
ψ - Total Firm Effect	0.000	0.073	0.009	0.066	0.008	0.058
φ - Firm-specific Intercept	-0.004	0.110	0.011	0.109	0.014	0.114
ε - Residual	0.007	0.213	-0.000	0.159	-0.005	0.179
Number of Observations	710,892		773,743		919,119	
Percent of Observations in α Category	29.57 %		32.19 %		38.24 %	
2 Employers						
Log (Real Annual Compensation Cost, 1980 FF)	3.903	0.458	4.209	0.314	4.611	0.433
Male	0.657		0.603		0.584	
Total Labor Force Experience	12.678	10.242	14.244	11.034	19.694	11.760
xβ - Predicted Value	0.392	0.143	0.386	0.139	0.389	0.125
uη -Individual Effect Related to Education	3.876	0.204	3.839	0.155	3.865	0.178
ψ - Total Firm Effect	-0.009	0.064	-0.001	0.056	0.002	0.057
φ - Firm-specific Intercept	-0.014	0.092	-0.002	0.092	0.001	0.096
ε - Residual	0.005	0.298	-0.002	0.197	-0.007	0.222
Number of Observations	460,275		494,574		458,772	
Percent of Observations in α Category	32.56 %		34.99 %		32.45 %	
3 or More Employers						
Log (Real Annual Compensation Cost, 1980 FF)	3.949	0.467	4.235	0.364	4.644	0.478
Male	0.759		0.679		0.660	
Total Labor Force Experience	11.488	8.751	12.695	9.745	17.518	10.926
xβ - Predicted Value	0.414	0.149	0.405	0.147	0.413	0.132
uη -Individual Effect Related to Education	3.896	0.201	3.851	0.158	3.877	0.183
ψ - Total Firm Effect	-0.013	0.070	-0.005	0.063	0.001	0.068
φ - Firm-specific Intercept	-0.017	0.091	-0.007	0.088	-0.001	0.097
ε - Residual	0.007	0.343	0.000	0.255	-0.007	0.275
Number of Observations	595,220		504,083		388,430	
Percent of Observations in α Category	40.01 %		33.88 %		26.11 %	

Table 7

Decomposition of Job Changes by α, Previous ϕ and New ϕ

α Category:	Low α			Middle α			High α		
ϕ of New Employer:	Low ϕ	High ϕ	Total	Low ϕ	High ϕ	Total	Low ϕ	High ϕ	Total
ϕ of Previous Employer:									
Low ϕ	57.1%	17.2%	74.3%	47.6%	19.5%	67.1%	39.5%	20.8%	60.3%
High ϕ	17.8%	7.8%	25.7%	19.6%	13.3%	32.9%	20.3%	19.4%	39.8%
Total	75.0%	25.0%	100.0%	67.2%	32.8%	100.0%	59.8%	40.2%	100.0%

Notes: Cutoff levels for α were -0.1394 and 0.1196. The cutoff level for ϕ was -0.000497. There were 362,686 transitions of Low α workers, 277,153 transitions of Middle α workers and 205,748 transitions of High α workers.

Table 8
Summary Statistics for Firms
Annual Averages over the Life of the Firm
(weighted by inverse sampling probability, 1978-1988)

Variable Definition	Mean	Std Dev
Average $x\beta$ of employees at the firm	0.3906	0.2420
Average α of employees at the firm	-0.0549	0.6446
Average $u\eta$ of employees at the firm	3.8503	0.2836
ϕ - Firm-specific wage premium	-0.0196	0.2707
γ_1 - Firm-specific seniority slope	0.0027	0.0775
γ_2 - Change in seniority slope at 10 years	-0.0031	0.1728
Number of employees sampled at firm	34.2950	610.4800
Employment at December 31st (thousands)	0.1097	1.6789
Real total assets (millions FF 1980)	59.4769	3,938.9800
Operating Income/Total Assets	0.1254	0.4544
Value-added/Total Assets	1.0051	1.8889
Real total compensation (millions FF 1980)	1.3260	2.3570
Real value added/Employee (thou. FF 1980)	106.7672	936.5212
Real total assets/Employee (thou. FF 1980)	363.0707	21,067.5500
(Engineers, Professionals and Managers)/Employee	0.2362	0.4072
Skilled workers/Employee	0.5414	0.5255
Log(Real total assets)	1.7711	3.3558
Log(Real value added/Employee)	4.5215	1.1050
Log(Real sales/Employee)	5.5673	2.0139
Log(Total employment at December 31)	-3.0262	2.1109
Log(Real capital/Employee)	4.7972	2.2710
Age of firm (N=7,385)	19.5023	23.0331
Number of firms	14,717	

Notes: For sources and definitions, see the Data Appendix.

Table 9

Generalized Least Squares Estimates of the Relation Between Productivity, Profitability and Compensation Policies

Dependent variable:	Log (VAdded/Worker)		Log(Sales/Employee)		Operating Inc./Capital	
Indepenent Variable	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
Average predicted wage ($x\beta$)	0.6057	(0.0310)	0.4833	(0.0494)	0.0569	(0.0161)
Average individual effect (α)	0.2617	(0.0118)	0.1623	(0.0188)	0.0102	(0.0061)
Average education effect ($u\eta$)	0.0725	(0.0275)	-0.0674	(0.0437)	-0.0036	(0.0143)
Firm-specific intercept (ϕ)	0.1240	(0.0343)	0.1128	(0.0546)	0.0415	(0.0179)
Firm-specific seniority slope (γ_1)	0.1492	(0.1195)	0.2852	(0.1902)	0.0571	(0.0623)
Change in slope (γ_2)	-0.0485	(0.0428)	-0.1107	(0.0681)	-0.0264	(0.0223)
(Engineers, Tech., Managers)/Employee	0.6815	(0.0247)	0.8989	(0.0394)	-0.1267	(0.0126)
(Skilled Workers)/Employee	0.2167	(0.0190)	0.4979	(0.0302)	0.0094	(0.0099)
Log(Capital/Employee)	0.1017	(0.0025)	0.2290	(0.0039)		
Intercept	4.3985	(0.1126)	2.9784	(0.1791)	0.1664	(0.0586)

Note: Models were estimated using 14,717 firms with complete data. All regressions included 2-digit industry effects. All sources are discussed in the Data Appendix.

Table 10

Generalized Least Squares Estimates of the Relation Between Factors and Compensation Policies

	Dependent Variable					
Independent Variable	Log(Empl-oyees)	Log(Real Capital)	Log(Capital /Employee)	EPM /Employee	Skilled W /Employee	Unskilled W /Employee
Average predicted effect ($x\beta$)	0.2541	1.0205	0.7665	0.1142	0.0628	-0.1770
	(0.0724)	(0.1036)	(0.0638)	(0.0117)	(0.0150)	(0.0142)
Average α in firm	0.2764	0.7454	0.4690	0.1231	-0.0316	-0.0914
	(0.0273)	(0.0391)	(0.0241)	(0.0043)	(0.0055)	(0.0052)
Average $u\eta$ in firm	0.3478	0.4076	0.0598	0.3307	-0.0964	-0.2343
	(0.0643)	(0.0921)	(0.0567)	(0.0101)	(0.0129)	(0.0122)
Firm-specific ϕ	0.3748	0.7618	0.3869	0.0057	-0.0052	-0.0005
	(0.0802)	(0.1148)	(0.0707)	(0.0131)	(0.0167)	(0.0158)
Firm-specific γ_1	-0.0262	0.5277	0.5539	0.0835	-0.0303	-0.0532
	(0.2798)	(0.4005)	(0.2467)	(0.0456)	(0.0582)	(0.0553)
Firm-specific γ_2	0.0011	0.0497	0.0486	-0.0314	0.0140	0.0174
	(0.1002)	(0.1435)	(0.0884)	(0.0164)	(0.0209)	(0.0198)
(Engi., Tech., Managers)/Employee	-0.1181	2.0038	2.1219			
	(0.0568)	(0.0812)	(0.0500)			
(Skilled Workers)/Employee	-0.2947	0.0707	0.3654			
	(0.0445)	(0.0637)	(0.0392)			
Intercept	-3.4129	3.0371	6.4499	-0.8485	0.8309	1.0176
	(0.2630)	(0.3765)	(0.2319)	(0.0423)	(0.0539)	(0.0512)

Notes: The models were estimated using the 14,717 firms with complete data. All equations include a set of two-industry effects. Sources and methods are discussed in the Data Appendix. Standard errors in parentheses.

Table 11
Proportional Hazards Estimates of the Relation between Firm Survival and Compensation Policies

Independent Variable	Parameter Estimate	Standard Error	Risk Ratio
Average predicted effect ($x\beta$)	2.0751	(0.6241)	7.9650
Average α in firm	-0.5327	(0.2064)	0.5870
Average $u\eta$ in firm	-1.8615	(0.5398)	0.1550
Firm-specific ϕ	-0.5909	(0.5356)	0.5540
Firm-specific γ_1	1.6497	(2.4598)	5.2050
Firm-specific γ_2	0.3592	(0.6677)	1.4320
(Eng., Tech., Managers)/Employee	0.4096	(0.3699)	1.5060
(Skilled Workers)/Employee	0.3372	(0.2926)	1.4010

Notes: Negative coefficients indicate a reduced probability of firm death. This model was estimated using the 7,382 firms with known birth dates. The model includes two-digit industry effects.

Table 12

Generalized Least Squares Estimates of the Relation between Industry Wage Effects and Industry Averages of Firm-specific Compensation Policies

Independent Variable	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
Industry average $x\beta$	-0.5123	(0.0116)				
Industry average α	0.7505	(0.0025)	0.8324	(0.0017)		
Industry average $u\eta$	0.3947	(0.0096)				
Industry average ϕ	0.3350	(0.0153)			-0.6659	(0.0150)
Industry average γ_1	0.8726	(0.1359)			-18.2220	(0.1256)
Industry average γ_2	1.8595	(0.1011)			2.9917	(0.0979)
Intercept	1.7854	(0.0339)	3.1088	(0.0019)	3.0687	(0.0019)
R^2	0.9664		0.9213		0.2486	

Notes: The dependent variable is the 83 industry-effects estimated by least squares controlling for labor force experience (through quartic), region, year, education (eight categories) and sex (fully interacted). The independent variables are the industry averages for the indicated firm-specific compensation policy. The time period is 1976-1987.

A Data Appendix

A.1 Description of the DAS

The Déclarations Annuelles des Salaires are a large collection of matched employer-employee information generated by INSEE (Institut National de la Statistique et des Etudes Economiques). The data cover all individuals employed in French enterprises who were born in October of even-numbered years, with civil servants excluded.[14] Our extract runs from 1976 through 1987, with 1981 and 1983 excluded because the underlying administrative data were not sampled in those years. The initial data set contained 7,416,422 observations. Each observation corresponds to a unique establishment-individual-year combination. The observation includes an identifier that corresponds to the employee (called ID below), an identifier that corresponds to the establishment (SIRET) and an identifier that corresponds to the parent enterprise of the establishment (SIREN). We have information on the number of days the individual worked in the establishment, as well as the full-time/part-time status of the employee. This allows us to aggregate all of the establishments in which an individual worked in a given year, and thus not treat changes of establishment within the same enterprise as if they were changes of employer. Each observation also includes, in addition to the variables listed above, the sex, month, year and place of birth, occupation, total net nominal earnings during the year and annualized gross nominal earnings during the year for the individual, as well as the location and industry of the employing establishment.

A.2 Observation selection, variable creation and missing data imputation

A.2.1 Aggregation of establishments

The creation of the analysis data set involved the selection of desired individuals, the aggregation of establishment-level data to the enterprise level, and the construction of the variables of interest from the variables already

[14] Meron (1988) shows that individuals employed in the civil service move almost exclusively to other positions within the civil service. Thus the exclusion of civil servants should not affect our estimation of a worker's market wage equation.

in the data set. We selected only full-time employees (sample reduced to 5,966,620 observations). We then created a single observation for each ID-year-SIREN combination by aggregating within ID and year over SIRETs in the same SIREN. For each ID-year-SIREN, we summed total net nominal earnings and total days worked over all SIRETs. We used the occupation, location and industry that corresponded to the establishment in which the individual worked the largest number of days during the year. This reduced the number of observations to 5,965,256. We then selected the enterprise at which the individual had worked the largest number of days during that year (sample reduced to 5,497,287 observations). The aggregation of total number of days worked across all establishments occasionally yielded observations for which the total number of days worked was greater than 360 (the maximum permitted). In these cases, we just truncated days worked at 360. We then calculated an annualized net nominal earnings for the ID-year SIREN combination. We eliminated all years of data for individuals who were younger than 15 years old or older than 65 years old at the date of their first appearance in the data set (sample reduced to 5,325,413 observations).

A.2.2 Total compensation costs

The dependent variable in our wage rate analysis is the annualized real total compensation cost of the employee (LFRAISRE). To convert the annualized net nominal earnings to total compensation costs, we used the tax rules and computer programs provided by the Division Revenus at INSEE (J.L. Lhéritier, private communication) to compute both the employee and employer share of all mandatory payroll taxes (cotisations et charges salariales employé et employeur) Total annualized compensation cost is defined as the sum of annualized net nominal earnings, employee payroll taxes and employer payroll taxes. Nominal values were then deflated by a consumer price index to get real annualized net earnings, and real annualized total compensation cost. We eliminated 61 observations with zero values for annualized total compensation cost (remaining sample 5,325,352).

A.2.3 Education and Total Labor Market Experience

Our initial DAS file did not contain education information. We used supplementary information available for 10% of the DAS, (EDP, Echantillon

Démographique Permanent) to impute the level of education of all individuals in the DAS.[15] The EDP includes information on the highest degree obtained. There were 38 possible responses, including "no known degree." These responses were grouped into 8 degree-level categories as shown in table 1. Using these eight categories and data available in the DAS, we ran separate ordered logits for men and women to estimate coefficients used to impute education for the individuals in the DAS who are not part of the EDP. EDP sample statistics for the men are in table 2, and those for the women are in table 3. The estimated logit equations are in table 4 for men and table 5 for women.

[15]Access to the EDP is particularly difficult to obtain due to privacy regulations.

Table 1: Degree Categories

Category	Degree	U.S. Equivalent
1	Sans Aucun Diplôme	No Terminal Degree
2	CEP	Elementary School
	DFEO	
3	BEPC	Junior High School
	BE	
	BEPS	
4	BAC (not F, G or H)	High School
	Brevet superieur	
	CFES	
5	CAP	Vocational-Technical School (Basic)
	BEP	
	EFAA	
	BAA	
	BPA	
	FPA 1er	
6	BP	Vocational-Technical School (Advanced)
	BEA	
	BEC	
	BEH	
	BEI	
	BES	
	BATA	
	BAC F	
	BAC G	
	BAC H	
7	Santé	Technical College and Undergraduate University
	BTS	
	DUT	
	DEST	
	DEUL	
	DEUS	
	DEUG	
8	2ème cycle	Graduate School and Other Post-Secondary Education
	3ème cycle	
	Grande école	
	CAPES	
	CAPET	

Table 2: EDP Sample Statistics - Men (Std. Deviations in Parentheses)

Variable Name	Degree Category								
	Overall	1	2	3	4	5	6	7	8
$DOB_i \leq 1924$	0.188	0.254	0.295	0.160	0.136	0.055	0.098	0.063	0.186
	(0.391)	(0.435)	(0.456)	(0.367)	(0.343)	(0.228)	(0.297)	(0.243)	(0.389)
$1925 \leq DOB_i \leq 1929$	0.056	0.062	0.085	0.042	0.049	0.034	0.048	0.026	0.065
	(0.230)	(0.242)	(0.279)	(0.200)	(0.215)	(0.180)	(0.214)	(0.158)	(0.247)
$1930 \leq DOB_i \leq 1934$	0.097	0.109	0.120	0.067	0.068	0.081	0.095	0.054	0.101
	(0.296)	(0.311)	(0.325)	(0.250)	(0.252)	(0.273)	(0.293)	(0.226)	(0.301)
$1935 \leq DOB_i \leq 1939$	0.061	0.056	0.070	0.048	0.048	0.063	0.079	0.047	0.078
	(0.240)	(0.229)	(0.255)	(0.214)	(0.215)	(0.244)	(0.270)	(0.212)	(0.268)
$1940 \leq DOB_i \leq 1944$	0.094	0.070	0.091	0.075	0.098	0.117	0.133	0.118	0.149
	(0.292)	(0.256)	(0.287)	(0.264)	(0.298)	(0.322)	(0.340)	(0.323)	(0.356)
$1945 \leq DOB_i \leq 1949$	0.102	0.064	0.097	0.099	0.130	0.130	0.152	0.175	0.164
	(0.302)	(0.244)	(0.296)	(0.299)	(0.336)	(0.336)	(0.359)	(0.380)	(0.370)
$1950 \leq DOB_i \leq 1954$	0.159	0.095	0.132	0.166	0.245	0.224	0.217	0.288	0.201
	(0.365)	(0.293)	(0.339)	(0.372)	(0.430)	(0.417)	(0.412)	(0.453)	(0.401)
$1955 \leq DOB_i \leq 1959$	0.101	0.072	0.060	0.182	0.157	0.145	0.110	0.176	0.054
	(0.302)	(0.259)	(0.238)	(0.386)	(0.364)	(0.352)	(0.313)	(0.381)	(0.226)
$1960 \leq DOB_i \leq 1976$	0.141	0.218	0.050	0.160	0.069	0.151	0.068	0.052	0.003
	(0.348)	(0.413)	(0.218)	(0.367)	(0.253)	(0.358)	(0.251)	(0.224)	(0.056)
Works in Ile de France	0.232	0.204	0.226	0.288	0.352	0.187	0.284	0.309	0.457
	(0.422)	(0.403)	(0.418)	(0.453)	(0.478)	(0.390)	(0.451)	(0.462)	(0.498)
CSP62	0.263	0.357	0.282	0.188	0.157	0.199	0.145	0.184	0.105
	(0.440)	(0.479)	(0.450)	(0.391)	(0.364)	(0.399)	(0.352)	(0.387)	(0.307)
CSP61	0.225	0.231	0.255	0.117	0.071	0.299	0.186	0.096	0.058
	(0.418)	(0.422)	(0.436)	(0.321)	(0.266)	(0.458)	(0.390)	(0.295)	(0.233)
CSP50	0.151	0.118	0.166	0.279	0.279	0.108	0.203	0.235	0.203
	(0.358)	(0.322)	(0.372)	(0.448)	(0.448)	(0.310)	(0.402)	(0.424)	(0.402)
CSP40	0.112	0.061	0.110	0.173	0.233	0.080	0.258	0.275	0.225
	(0.315)	(0.240)	(0.314)	(0.379)	(0.423)	(0.272)	(0.438)	(0.447)	(0.418)
CSP30	0.043	0.020	0.025	0.053	0.147	0.015	0.057	0.080	0.359
	(0.203)	(0.142)	(0.157)	(0.224)	(0.354)	(0.121)	(0.232)	(0.271)	(0.480)
Number of Observations	71229	26236	12825	3847	3036	16489	3878	2387	2531

Table 3: EDP Sample Statistics - Women (Std. Deviations in Parentheses)

Variable Name	Degree Category								
	Overall	1	2	3	4	5	6	7	8
$DOB_i \leq 1924$	0.152	0.235	0.206	0.129	0.055	0.034	0.042	0.055	0.056
	(0.359)	(0.424)	(0.405)	(0.336)	(0.229)	(0.181)	(0.202)	(0.228)	(0.230)
$1925 \leq DOB_i \leq 1929$	0.047	0.053	0.078	0.045	0.025	0.024	0.017	0.022	0.023
	(0.212)	(0.224)	(0.268)	(0.206)	(0.156)	(0.153)	(0.130)	(0.146)	(0.148)
$1930 \leq DOB_i \leq 1934$	0.084	0.096	0.118	0.070	0.043	0.061	0.054	0.049	0.052
	(0.278)	(0.294)	(0.322)	(0.255)	(0.203)	(0.239)	(0.226)	(0.216)	(0.222)
$1935 \leq DOB_i \leq 1939$	0.054	0.056	0.069	0.047	0.036	0.050	0.045	0.038	0.047
	(0.226)	(0.229)	(0.254)	(0.211)	(0.185)	(0.218)	(0.208)	(0.190)	(0.212)
$1940 \leq DOB_i \leq 1944$	0.093	0.070	0.113	0.086	0.090	0.103	0.108	0.101	0.127
	(0.290)	(0.255)	(0.317)	(0.281)	(0.287)	(0.304)	(0.311)	(0.301)	(0.334)
$1945 \leq DOB_i \leq 1949$	0.114	0.077	0.125	0.109	0.116	0.135	0.164	0.156	0.209
	(0.317)	(0.267)	(0.331)	(0.311)	(0.321)	(0.341)	(0.371)	(0.363)	(0.407)
$1950 \leq DOB_i \leq 1954$	0.186	0.112	0.180	0.167	0.285	0.247	0.252	0.298	0.354
	(0.389)	(0.315)	(0.384)	(0.373)	(0.451)	(0.431)	(0.434)	(0.457)	(0.478)
$1955 \leq DOB_i \leq 1959$	0.120	0.078	0.067	0.178	0.217	0.166	0.169	0.223	0.125
	(0.325)	(0.267)	(0.251)	(0.383)	(0.412)	(0.372)	(0.375)	(0.416)	(0.331)
$1960 \leq DOB_i \leq 1976$	0.150	0.224	0.043	0.170	0.133	0.180	0.147	0.059	0.008
	(0.357)	(0.417)	(0.202)	(0.375)	(0.339)	(0.384)	(0.355)	(0.236)	(0.088)
Works in Ile de France	0.254	0.237	0.239	0.286	0.333	0.221	0.316	0.283	0.466
	(0.435)	(0.425)	(0.426)	(0.452)	(0.471)	(0.415)	(0.465)	(0.451)	(0.499)
CSP62	0.227	0.343	0.296	0.108	0.079	0.126	0.073	0.061	0.053
	(0.419)	(0.475)	(0.456)	(0.310)	(0.270)	(0.331)	(0.259)	(0.240)	(0.224)
CSP61	0.050	0.061	0.067	0.027	0.023	0.044	0.027	0.029	0.015
	(0.218)	(0.239)	(0.249)	(0.163)	(0.150)	(0.205)	(0.161)	(0.168)	(0.120)
CSP50	0.458	0.365	0.427	0.596	0.570	0.539	0.630	0.420	0.511
	(0.498)	(0.482)	(0.495)	(0.491)	(0.495)	(0.498)	(0.483)	(0.494)	(0.500)
CSP40	0.073	0.040	0.035	0.090	0.165	0.045	0.097	0.350	0.214
	(0.261)	(0.195)	(0.185)	(0.286)	(0.371)	(0.208)	(0.296)	(0.477)	(0.410)
CSP30	0.013	0.008	0.005	0.016	0.048	0.005	0.009	0.032	0.150
	(0.115)	(0.090)	(0.068)	(0.125)	(0.214)	(0.071)	(0.093)	(0.176)	(0.357)
Number of Observations	57677	19822	12768	4760	3112	10388	2633	3173	1021

Table 4: Degree Category Model Coefficients-Men

Degree	Variable	Coefficient	Std. Err.
1	Intercept	6.254	0.122
	$1925 \leq$ Date of Birth ≤ 1929	-0.496	0.105
	$1930 \leq$ Date of Birth ≤ 1934	-0.493	0.090
	$1935 \leq$ Date of Birth ≤ 1939	-1.234	0.100
	$1940 \leq$ Date of Birth ≤ 1944	-2.031	0.085
	$1945 \leq$ Date of Birth ≤ 1949	-2.818	0.085
	$1950 \leq$ Date of Birth ≤ 1954	-3.388	0.086
	$1955 \leq$ Date of Birth ≤ 1959	-2.289	0.113
	$1960 \leq$ Date of Birth ≤ 1976	1.897	0.360
	Unskilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.850	0.116
	Skilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.904	0.132
	Unskilled White-Collar Worker at Date t in Firm $J(i,t)$	-2.758	0.111
	Skilled White-Collar Worker at Date t in Firm $J(i,t)$	-4.028	0.117
	Manager at Date t in Firm $J(i,t)$	-5.892	0.124
	Works in Ile de France	-0.627	0.048
2	Intercept	5.828	0.125
	$1925 \leq$ Date of Birth ≤ 1929	-0.320	0.106
	$1930 \leq$ Date of Birth ≤ 1934	-0.518	0.091
	$1935 \leq$ Date of Birth ≤ 1939	-1.117	0.102
	$1940 \leq$ Date of Birth ≤ 1944	-1.863	0.087
	$1945 \leq$ Date of Birth ≤ 1949	-2.430	0.087
	$1950 \leq$ Date of Birth ≤ 1954	-3.248	0.089
	$1955 \leq$ Date of Birth ≤ 1959	-2.649	0.119
	$1960 \leq$ Date of Birth ≤ 1976	0.246	0.363
	Unskilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-1.311	0.119
	Skilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-1.074	0.135
	Unskilled White-Collar Worker at Date t in Firm $J(i,t)$	-2.635	0.114
	Skilled White-Collar Worker at Date t in Firm $J(i,t)$	-3.740	0.121
	Manager at Date t in Firm $J(i,t)$	-5.996	0.132
	Works in Ile de France	-0.629	0.050

Degree	Variable	Coefficient	Std. Err.
3	Intercept	2.465	0.134
	$1925 \leq$ Date of Birth ≤ 1929	-0.333	0.131
	$1930 \leq$ Date of Birth ≤ 1934	-0.344	0.112
	$1935 \leq$ Date of Birth ≤ 1939	-0.667	0.124
	$1940 \leq$ Date of Birth ≤ 1944	-1.120	0.105
	$1945 \leq$ Date of Birth ≤ 1949	-1.307	0.102
	$1950 \leq$ Date of Birth ≤ 1954	-1.373	0.100
	$1955 \leq$ Date of Birth ≤ 1959	0.074	0.123
	$1960 \leq$ Date of Birth ≤ 1976	2.891	0.364
	Unskilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.681	0.126
	Skilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.557	0.144
	Unskilled White-Collar Worker at Date t in Firm $J(i,t)$	-0.944	0.118
	Skilled White-Collar Worker at Date t in Firm $J(i,t)$	-1.610	0.127
	Manager at Date t in Firm $J(i,t)$	-3.400	0.142
	Works in Ile de France	-0.410	0.057
4	Intercept	0.803	0.142
	$1925 \leq$ Date of Birth ≤ 1929	0.005	0.133
	$1930 \leq$ Date of Birth ≤ 1934	-0.109	0.117
	$1935 \leq$ Date of Birth ≤ 1939	-0.325	0.130
	$1940 \leq$ Date of Birth ≤ 1944	-0.381	0.106
	$1945 \leq$ Date of Birth ≤ 1949	-0.379	0.104
	$1950 \leq$ Date of Birth ≤ 1954	-0.069	0.101
	$1955 \leq$ Date of Birth ≤ 1959	0.830	0.127
	$1960 \leq$ Date of Birth ≤ 1976	2.855	0.369
	Unskilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.193	0.134
	Skilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.294	0.156
	Unskilled White-Collar Worker at Date t in Firm $J(i,t)$	-0.217	0.125
	Skilled White-Collar Worker at Date t in Firm $J(i,t)$	-0.377	0.132
	Manager at Date t in Firm $J(i,t)$	-1.311	0.136
	Works in Ile de France	-0.265	0.057

Degree	Variable	Coefficient	Std. Err.
5	Intercept	3.985	0.125
	$1925 \leq$ Date of Birth ≤ 1929	0.392	0.113
	$1930 \leq$ Date of Birth ≤ 1934	0.734	0.096
	$1935 \leq$ Date of Birth ≤ 1939	0.446	0.105
	$1940 \leq$ Date of Birth ≤ 1944	0.090	0.089
	$1945 \leq$ Date of Birth ≤ 1949	-0.336	0.089
	$1950 \leq$ Date of Birth ≤ 1954	0.700	0.090
	$1955 \leq$ Date of Birth ≤ 1959	0.230	0.116
	$1960 \leq$ Date of Birth ≤ 1976	3.319	0.362
	Unskilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-1.306	0.116
	Skilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.340	0.131
	Unskilled White-Collar Worker at Date t in Firm $J(i,t)$	-2.494	0.110
	Skilled White-Collar Worker at Date t in Firm $J(i,t)$	-3.011	0.117
	Manager at Date t in Firm $J(i,t)$	-5.195	0.131
	Works in Ile de France	-0.766	0.049
6	Intercept	1.714	0.139
	$1925 \leq$ Date of Birth ≤ 1929	0.266	0.132
	$1930 \leq$ Date of Birth ≤ 1934	0.471	0.111
	$1935 \leq$ Date of Birth ≤ 1939	0.318	0.119
	$1940 \leq$ Date of Birth ≤ 1944	0.000	0.102
	$1945 \leq$ Date of Birth ≤ 1949	-0.216	0.102
	$1950 \leq$ Date of Birth ≤ 1954	-0.363	0.103
	$1955 \leq$ Date of Birth ≤ 1959	0.312	0.130
	$1960 \leq$ Date of Birth ≤ 1976	2.742	0.368
	Unskilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.849	0.129
	Skilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.006	0.142
	Unskilled White-Collar Worker at Date t in Firm $J(i,t)$	-1.100	0.121
	Skilled White-Collar Worker at Date t in Firm $J(i,t)$	-1.030	0.126
	Manager at Date t in Firm $J(i,t)$	-3.036	0.141
	Works in Ile de France	-0.510	0.056

Degree	Variable	Coefficient	Std. Err.
7	Intercept	-0.141	0.158
	1925 ≤ Date of Birth ≤ 1929	0.102	0.179
	1930 ≤ Date of Birth ≤ 1934	0.407	0.145
	1935 ≤ Date of Birth ≤ 1939	0.349	0.154
	1940 ≤ Date of Birth ≤ 1944	0.519	0.126
	1945 ≤ Date of Birth ≤ 1949	0.653	0.123
	1950 ≤ Date of Birth ≤ 1954	0.843	0.121
	1955 ≤ Date of Birth ≤ 1959	1.704	0.145
	1960 ≤ Date of Birth ≤ 1976	3.339	0.379
	Unskilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.155	0.136
	Skilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.055	0.157
	Unskilled White-Collar Worker at Date t in Firm $J(i,t)$	-0.437	0.129
	Skilled White-Collar Worker at Date t in Firm $J(i,t)$	-0.100	0.134
	Manager at Date t in Firm $J(i,t)$	-1.648	0.148
	Works in Ile de France	-0.399	0.062

Table 5: Degree Category Model Coefficients-Women

Degree	Variable	Coefficient	Std. Err.
1	Intercept	7.296	0.205
	$1925 \leq$ Date of Birth ≤ 1929	-0.723	0.257
	$1930 \leq$ Date of Birth ≤ 1934	-0.999	0.199
	$1935 \leq$ Date of Birth ≤ 1939	-1.393	0.206
	$1940 \leq$ Date of Birth ≤ 1944	-2.328	0.169
	$1945 \leq$ Date of Birth ≤ 1949	-3.023	0.161
	$1950 \leq$ Date of Birth ≤ 1954	-3.791	0.156
	$1955 \leq$ Date of Birth ≤ 1959	-3.082	0.172
	$1960 \leq$ Date of Birth ≤ 1976	1.070	0.382
	Unskilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.205	0.195
	Skilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.634	0.295
	Unskilled White-Collar Worker at Date t in Firm $J(i,t)$	-2.250	0.144
	Skilled White-Collar Worker at Date t in Firm $J(i,t)$	-3.853	0.161
	Manager at Date t in Firm $J(i,t)$	-5.449	0.191
	Works in Ile de France	-0.925	0.069
2	Intercept	7.148	0.206
	$1925 \leq$ Date of Birth ≤ 1929	-0.224	0.257
	$1930 \leq$ Date of Birth ≤ 1934	-0.683	0.200
	$1935 \leq$ Date of Birth ≤ 1939	-1.073	0.207
	$1940 \leq$ Date of Birth ≤ 1944	-1.743	0.169
	$1945 \leq$ Date of Birth ≤ 1949	-2.429	0.161
	$1950 \leq$ Date of Birth ≤ 1954	-3.433	0.157
	$1955 \leq$ Date of Birth ≤ 1959	-3.323	0.175
	$1960 \leq$ Date of Birth ≤ 1976	-0.673	0.384
	Unskilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.787	0.196
	Skilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.977	0.296
	Unskilled White-Collar Worker at Date t in Firm $J(i,t)$	-2.466	0.146
	Skilled White-Collar Worker at Date t in Firm $J(i,t)$	-4.352	0.165
	Manager at Date t in Firm $J(i,t)$	-6.431	0.216
	Works in Ile de France	-0.983	0.070

Degree	Variable	Coefficient	Std. Err.
3	Intercept	4.645	0.211
	1925 $\leq$ Date of Birth $\leq$ 1929	-0.307	0.265
	1930 $\leq$ Date of Birth $\leq$ 1934	-0.742	0.207
	1935 $\leq$ Date of Birth $\leq$ 1939	-1.021	0.217
	1940 $\leq$ Date of Birth $\leq$ 1944	-1.550	0.177
	1945 $\leq$ Date of Birth $\leq$ 1949	-2.011	0.167
	1950 $\leq$ Date of Birth $\leq$ 1954	-2.537	0.162
	1955 $\leq$ Date of Birth $\leq$ 1959	-1.409	0.176
	1960 $\leq$ Date of Birth $\leq$ 1976	1.506	0.385
	Unskilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.778	0.202
	Skilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.840	0.308
	Unskilled White-Collar Worker at Date t in Firm $J(i,t)$	-1.218	0.149
	Skilled White-Collar Worker at Date t in Firm $J(i,t)$	-2.379	0.166
	Manager at Date t in Firm $J(i,t)$	-3.977	0.209
	Works in Ile de France	-0.738	0.074
4	Intercept	2.263	0.223
	1925 $\leq$ Date of Birth $\leq$ 1929	0.023	0.285
	1930 $\leq$ Date of Birth $\leq$ 1934	-0.314	0.225
	1935 $\leq$ Date of Birth $\leq$ 1939	-0.383	0.233
	1940 $\leq$ Date of Birth $\leq$ 1944	-0.542	0.189
	1945 $\leq$ Date of Birth $\leq$ 1949	-0.894	0.180
	1950 $\leq$ Date of Birth $\leq$ 1954	-0.694	0.172
	1955 $\leq$ Date of Birth $\leq$ 1959	0.075	0.187
	1960 $\leq$ Date of Birth $\leq$ 1976	2.448	0.390
	Unskilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.248	0.210
	Skilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.167	0.320
	Unskilled White-Collar Worker at Date t in Firm $J(i,t)$	-0.502	0.154
	Skilled White-Collar Worker at Date t in Firm $J(i,t)$	-0.880	0.169
	Manager at Date t in Firm $J(i,t)$	-1.725	0.193
	Works in Ile de France	-0.462	0.076

Degree	Variable	Coefficient	Std. Err.
5	Intercept	4.555	0.211
	$1925 \leq$ Date of Birth ≤ 1929	0.391	0.267
	$1930 \leq$ Date of Birth ≤ 1934	0.441	0.208
	$1935 \leq$ Date of Birth ≤ 1939	0.371	0.214
	$1940 \leq$ Date of Birth ≤ 1944	-0.057	0.177
	$1945 \leq$ Date of Birth ≤ 1949	-0.529	0.168
	$1950 \leq$ Date of Birth ≤ 1954	-1.022	0.163
	$1955 \leq$ Date of Birth ≤ 1959	-0.342	0.178
	$1960 \leq$ Date of Birth ≤ 1976	2.753	0.385
	Unskilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.898	0.196
	Skilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.645	0.297
	Unskilled White-Collar Worker at Date t in Firm $J(i,t)$	-1.593	0.144
	Skilled White-Collar Worker at Date t in Firm $J(i,t)$	-3.272	0.162
	Manager at Date t in Firm $J(i,t)$	-5.147	0.218
	Works in Ile de France	-0.967	0.070
6	Intercept	2.693	0.231
	$1925 \leq$ Date of Birth ≤ 1929	-0.148	0.309
	$1930 \leq$ Date of Birth ≤ 1934	0.111	0.233
	$1935 \leq$ Date of Birth ≤ 1939	0.054	0.241
	$1940 \leq$ Date of Birth ≤ 1944	-0.210	0.199
	$1945 \leq$ Date of Birth ≤ 1949	-0.461	0.189
	$1950 \leq$ Date of Birth ≤ 1954	-0.927	0.184
	$1955 \leq$ Date of Birth ≤ 1959	-0.264	0.199
	$1960 \leq$ Date of Birth ≤ 1976	2.531	0.396
	Unskilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.969	0.212
	Skilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.675	0.320
	Unskilled White-Collar Worker at Date t in Firm $J(i,t)$	-1.008	0.153
	Skilled White-Collar Worker at Date t in Firm $J(i,t)$	-2.062	0.174
	Manager at Date t in Firm $J(i,t)$	-4.133	0.272
	Works in Ile de France	-0.541	0.078

Degree	Variable	Coefficient	Std. Err.
7	Intercept	2.278	0.223
	$1925 \leq$ Date of Birth ≤ 1929	-0.137	0.289
	$1930 \leq$ Date of Birth ≤ 1934	-0.201	0.224
	$1935 \leq$ Date of Birth ≤ 1939	-0.361	0.233
	$1940 \leq$ Date of Birth ≤ 1944	-0.439	0.189
	$1945 \leq$ Date of Birth ≤ 1949	-0.552	0.178
	$1950 \leq$ Date of Birth ≤ 1954	-0.601	0.173
	$1955 \leq$ Date of Birth ≤ 1959	0.153	0.187
	$1960 \leq$ Date of Birth ≤ 1976	1.638	0.395
	Unskilled Blue-Collar Worker at Date t in Firm $J(i,t)$	-0.511	0.213
	Skilled Blue-Collar Worker at Date t in Firm $J(i,t)$	0.064	0.315
	Unskilled White-Collar Worker at Date t in Firm $J(i,t)$	-0.749	0.155
	Skilled White-Collar Worker at Date t in Firm $J(i,t)$	-0.047	0.166
	Manager at Date t in Firm $J(i,t)$	-2.052	0.201
	Works in Ile de France	-0.738	0.077

With these estimated coefficients, we were able to calculate the probability that a given individual would have a degree in a particular category. We used the data corresponding to the earliest date that an individual appeared in our sample to calculate these probabilities. The probability that a given individual i has a degree in category n was calculated as follows. For all $\tilde{n} \in \{1,2,3,4,5,6,7\}$, let

$$PRE_i^{\tilde{n}} = \exp\left(X_i \beta^{\tilde{n}}\right),$$

where X_i represents the vector of covariates for individual i and $\beta^{\tilde{n}}$ corresponds to the vector of coefficients for degrees of category $\tilde{n}$. Let

$$PRE_i = \sum_{\tilde{n}=1}^{7} PRE_i^{\tilde{n}}.$$

Now, if $n \in \{1,2,3,4,5,6,7\}$,

$$P\left(\text{degree category}_i = n\right) = \frac{PRE_i^n}{1 + PRE_i},$$

and if $n = 8$,

$$P\left(\text{degree category}_i = 8\right) = 1 - \left[\sum_{\tilde{n}=1}^{7} P\left(\text{degree category}_i = \tilde{n}\right)\right].$$

We used this degree category (actual, where possible, otherwise imputed) for all observations on the individual.

To calculate school leaving age we used table 14 in CEREQ-DEP-INSEE (1990), which provides the average age of termination for each French diploma separately for men and women in 1986. Using the probability of each degree category and the average school-leaving age for degrees in that category (the ages were fairly homogeneous within categories), we calculated expected school-leaving age.

A.2.4 Job Seniority and Total Labor Market Experience

Individuals fell into two categories with respect to the calculation of job seniority (employer-specific experience): those for whom the first year of observation was 1976 and those who first appeared after 1976. For those individuals whose first observation was in 1976, we estimated the expected length of the in-progress employment spell by a regression analysis using a supplementary survey, the 1978 Enquête sur la Structure des Salaires (ESS, Salary Structure Survey). In this survey, respondent establishments provided information on seniority (in 1978), occupation, date of birth, industry, and work location for a scientific sample of their employees. Using the ESS information, we estimated separate regressions for men and women to predict seniority in 1976. The coefficients from these regressions were used to calculate expected job seniority in 1976 for DAS individuals whose first observation was in 1976. The dependent variable in the supplementary ESS regressions was current seniority with the employer and the explanatory variables were date of birth (DOB), occupation (CSP, 1-digit), region of employment (metropolitan Paris), and industry (NAP 100, approximately 2-digit).[16] Table 6 provides sample statistics for the ESS data. Results of these regressions

[16]The excluded categories were: $1960 \leq DOB_i$, CSP62 (1 if i is an Unskilled Blue-Collar Worker at Date t in firm $J(i,t)$), and N89 (1 if firm $J(i,t)$ is in industry 89, Financial Organizations). The coefficients on the industry indicators are not shown below.

Table 6: ESS Variables and Means (Std. Deviations in Parentheses)

Variable	**Mean-Men**	**Mean-Women**
$\text{Seniority}_{i,t,J(i,t)}$	10.244 (9.271)	7.910 (7.796)
$\text{DOB}_i \leq 1924$	0.113 (0.317)	0.095 (0.293)
$1925 \leq \text{DOB}_i \leq 1929$	0.112 (0.315)	0.087 (0.281)
$1930 \leq \text{DOB}_i \leq 1934$	0.124 (0.330)	0.097 (0.296)
$1935 \leq \text{DOB}_i \leq 1939$	0.115 (0.319)	0.088 (0.283)
$1940 \leq \text{DOB}_i \leq 1944$	0.111 (0.314)	0.087 (0.282)
$1945 \leq \text{DOB}_i \leq 1949$	0.153 (0.360)	0.145 (0.352)
$1950 \leq \text{DOB}_i \leq 1954$	0.154 (0.361)	0.188 (0.391)
$1955 \leq \text{DOB}_i \leq 1959$	0.094 (0.292)	0.174 (0.379)
Worked in Ile de $\text{France}_{i,t,J(i,t)}$	0.191 (0.393)	0.233 (0.423)
$\text{CSP30}_{i,t,J(i,t)}$	0.106 (0.308)	0.026 (0.161)
$\text{CSP40}_{i,t,J(i,t)}$	0.175 (0.380)	0.072 (0.258)
$\text{CSP50}_{i,t,J(i,t)}$	0.180 (0.384)	0.492 (0.500)
$\text{CSP61}_{i,t,J(i,t)}$	0.283 (0.450)	0.064 (0.245)
$\text{CSP62}_{i,t,J(i,t)}$	0.256 (0.437)	0.346 (0.476)

are shown in equations 33 for men and 34 for women.

$$
\begin{aligned}
\text{seniority}_{i,t,J(i,t)} = & \; 2.513 \\
& (0.081) \\
& +14.151 \; [\text{DOB}_i \leq 1924] && +12.820 \; [1925 \leq \text{DOB}_i \leq 1929] \\
& (0.067) && (0.067) \\
& +10.299 \; [1930 \leq \text{DOB}_i \leq 1934] && +7.445 \; [1935 \leq \text{DOB}_i \leq 1939] \\
& (0.066) && (0.067) \\
& +4.748 \; [1940 \leq \text{DOB}_i \leq 1944] && +2.569 \; [1945 \leq \text{DOB}_i \leq 1949] \\
& (0.067) && (0.065) \\
& +0.612 \; [1950 \leq \text{DOB}_i \leq 1954] && -0.642 \; [1955 \leq \text{DOB}_i \leq 1959] \\
& (0.065) && (0.067) \\
& +4.039 \; \text{CSP30}_{i,t,J(i,t)} && +4.939 \; \text{CSP40}_{i,t,J(i,t)} \\
& (0.038) && (0.031) \\
& +1.885 \; \text{CSP50}_{i,t,J(i,t)} && +2.898 \; \text{CSP61}_{i,t,J(i,t)} \\
& (0.037) && (0.027) \\
& -0.958 \; \text{Ile de France}_{i,t,J(i,t)} \\
& (0.026)
\end{aligned}
$$

$$
\begin{gathered}
N = 547,746 \\
R^2 = 0.461
\end{gathered}
\tag{33}
$$

$$
\begin{aligned}
\text{seniority}_{i,t,J(i,t)} = {} & 2.114 \\
& (0.084) \\
& +12.669\ [\text{DOB}_i \leq 1924] \qquad +11.014\ [1925 \leq \text{DOB}_i \leq 1929] \\
& (0.074) \qquad\qquad\qquad\qquad\quad (0.075) \\
& +8.979\ [1930 \leq \text{DOB}_i \leq 1934] \quad +7.278\ [1935 \leq \text{DOB}_i \leq 1939] \\
& (0.073) \qquad\qquad\qquad\qquad\quad (0.074) \\
& +5.989\ [1940 \leq \text{DOB}_i \leq 1944] \quad +4.604\ [1945 \leq \text{DOB}_i \leq 1949] \\
& (0.075) \qquad\qquad\qquad\qquad\quad (0.070) \\
& +2.822\ [1950 \leq \text{DOB}_i \leq 1954] \quad +0.641\ [1955 \leq \text{DOB}_i \leq 1959] \\
& (0.068) \qquad\qquad\qquad\qquad\quad (0.068) \\
& +5.116\ \text{CSP30}_{i,t,J(i,t)} \qquad\qquad +5.789\ \text{CSP40}_{i,t,J(i,t)} \\
& (0.082) \qquad\qquad\qquad\qquad\quad (0.057) \\
& +1.442\ \text{CSP50}_{i,t,J(i,t)} \qquad\qquad +2.429\ \text{CSP61}_{i,t,J(i,t)} \\
& (0.037) \qquad\qquad\qquad\qquad\quad (0.054) \\
& -0.988\ \text{Ile de France}_{i,t,J(i,t)} \\
& (0.031)
\end{aligned}
$$

$$
\begin{gathered}
N = 260,580 \\
R^2 = 0.373
\end{gathered} \tag{34}
$$

where

$$
\begin{aligned}
\text{DOB}_i &= \text{Date of Birth of Individual } i \\
\text{CSP30}_{i,t,J(i,t)} &= 1 \text{ if } i \text{ is a Engineer, Professional or Manager} \\
\text{CSP40}_{i,t,J(i,t)} &= 1 \text{ if } i \text{ is Technician or Technical White-Collar} \\
\text{CSP50}_{i,t,J(i,t)} &= 1 \text{ if } i \text{ is any other White-Collar} \\
\text{CSP61}_{i,t,J(i,t)} &= 1 \text{ if } i \text{ is a Skilled Blue-Collar} \\
\text{CSP62}_{i,t,J(i,t)} &= 1 \text{ if } i \text{ is an Unskilled Blue-Collar} \\
\text{Ile de France}_{i,t,J(i,t)} &= 1 \text{ if the establishment is in Ile-de-France.}
\end{aligned} \tag{35}
$$

We used these results to impute levels of job seniority in 1976 for the left-censored DAS individuals first observed in 1976. If the individual was left-censored and the imputed job seniority was negative, we set job seniority prior to 1976 to zero. If the individual was first observed after 1976, we assumed that job seniority prior to the date of the first DAS observation for the individual was zero. If the age at the date of any observation (1976 or otherwise) was less than the expected school-leaving age, both total labor force experience and prior job seniority were set to zero. In all other cases (when the age was greater than the expected school-leaving age), we calculated total labor market experience and job seniority as follows. If the observation was the earliest appearance of the individual in our data, we set job seniority equal to job seniority up to the date of the first observation plus the number of days worked for that enterprise in the year of the first observation, divided by 360 and we set total labor market experience to the current age less the school-leaving age. If the observation was not the first for the individual but there was an observation in the previous year for the person[17], we added 1 to total labor market experience. If the individual was employed for the majority of the current year by the same enterprise that employed him or her for the majority of the previous year, i.e. $SIREN_t = SIREN_{t-1}$, we added 1 to the level of seniority at $t-1$. If $SIREN_t \neq SIREN_{t-1}$, we set seniority equal to the number of days worked divided by 360.

If, on the other hand, there was no observation in the previous year, we distinguished between $t = 1982$ or $t = 1984$ and other years. When $t \neq 1982$ or 1984, total labor market experience was increased by 1 (reflecting experience gained in the year of the observation). If the current SIREN and the most recent previous SIREN were the same, we added the number of days worked over 360 to the most previous level of seniority. This is similar to assuming that the worker was temporarily laid off, but retained his or her seniority in the firm when recalled. Otherwise, we set seniority to the number of days worked over 360.

In the case where $t = 1982$ or $t = 1984$, if the preceding observation was 2 years earlier (i.e. the missing data only occurred over a period when no data were available for any individual), we increased total labor market experience by 2. If $SIREN_{t-2} = SIREN_t$,seniority was increased by 2. If $SIREN_{t-2} \neq SIREN_t$, seniority was increased by 0.5 plus the number of days worked over 360[18].

[17]The structure of our database is such that this condition (observations for individual i at both t and $t-1$) could only fail to be satisfied under 3 conditions. The first is that the individual was employed in the civil service in the intervening years. The second is that the individual was unemployed for an entire calendar year. The third is that $t = 1982$ or $t = 1984$, since we were not given access to the data for these years. We largely discount the first possibility, since full-time civil servants rarely move out of the civil service one they have entered (Meron (1988)). The other two possibilities are treated explicitly.

[18]We assumed that the probability the individual was reemployed in the missing year was equal to the probability that the individual was reemployed in the observation year. Thus the expected increment to job seniority is the share of the year worked in the observation

If the preceding observation was more than 2 years earlier, we increased total labor market experience by 1.5[19]. If the current SIREN and the most recent previous SIREN were the same, we added the number of days worked over 360 plus 0.5 to the most previous level of seniority. This is similar to assuming that the worker was recalled from temporary layoff with equal probability in the observation year and in the missing year. If the two SIRENs were different, we set seniority to 0.5 plus the number of days worked over 360.

A.2.5 Elimination of Outliers

After calculating all of the individual level variables, we eliminated observations for which the log of the real annualized total compensation cost (LFRAISRE_{it}) was more than five standard deviations away from its predicted value based on a linear regression model with dependent variable LFRAISRE_{it}, shown in equation (36). This gives us the analysis sample

year plus $(\frac{1}{2} \cdot 0) + (\frac{1}{2} \cdot 1) = 0.5$.

[19]We assumed that the probability the individual was reemployed in the missing year was equal to the probability that the individualwas reemployed in the observation year. Thus the expected increment to total labor market experience is $(\frac{1}{2} \cdot 1) + (\frac{1}{2} \cdot 2) = 1.5$.

of 5,305,108 observations.

$$
\begin{aligned}
LFRAISRE_{it} &= -3.250 \\
&\quad (0.005) \\
&\quad +0.210 \text{ Male}_i \qquad\qquad\qquad +0.123 \text{ Ile de France}_{it} \\
&\quad (0.000) \qquad\qquad\qquad\qquad\quad (0.000) \\
&\quad +0.082 \text{ Year}_t \qquad\qquad\qquad +0.056 \text{ Degree Category } 2_i \\
&\quad (0.000) \qquad\qquad\qquad\qquad\quad (0.002) \\
&\quad +0.415 \text{ Degree Category } 3_i \quad +0.627 \text{ Degree Category } 4_i \\
&\quad (0.002) \qquad\qquad\qquad\qquad\quad (0.003) \\
&\quad +0.266 \text{ Degree Category } 5_i \quad +0.642 \text{ Degree Category } 6_i \\
&\quad (0.001) \qquad\qquad\qquad\qquad\quad (0.003) \\
&\quad +0.648 \text{ Degree Category } 7_i \quad +1.421 \text{ Degree Category } 8_i \\
&\quad (0.002) \qquad\qquad\qquad\qquad\quad (0.003) \\
&\quad +0.055 \text{ Experience}_{it} \qquad\quad -0.222 \text{ Experience}^2_{it} \\
&\quad (0.000) \qquad\qquad\qquad\qquad\quad (0.003) \\
&\quad +0.052 \text{ Experience}^3_{it} \qquad -0.005 \text{ Experience}^4_{it} \\
&\quad (0.001) \qquad\qquad\qquad\qquad\quad (0.000)
\end{aligned}
$$

$$
\begin{gathered}
N = 5,325,352 \\
R^2 = 0.437 \\
\sigma = 0.477
\end{gathered}
\tag{36}
$$

A.3 Supplementary information on projection method variables

The derivation of the individual and firm effects took place in three basic steps: an estimation of the "first-step equation" derived as equation (9), an extraction and decomposition of the individual effect $\left(\hat{\theta}_i\right)$ into observable $(u_i\eta)$ and unobservable (α_i) components, and a decomposition of the correlated component $(\tilde{z}_{it}\lambda)$ into the enterprise-specific constant effect (ϕ_j), the enterprise-specific coefficient on seniority (γ_{1j}) and the enterprise-specific coefficient on the linear spline at seniority of 10 years (γ_{2j}).

A.3.1 The First-Step Regression

Equation (5) represents the projection of the firm-specific variables onto firm and individual data. In order to estimate the first-step equation (9), we require (in addition to the seniority variable derived in section A.2.4 above) some firm specific variable (denoted $f_{J(i,t)t}$ in equation (5)) and a vector of means of some individual specific variables (denoted $\bar{x}_i$ in equation (5)). We calculated firm employment directly from the firms represented in the DAS data. The sampling scheme of the DAS ensures that we have a $\frac{1}{25}$ sample of the private French working population. Since we have 10 years worth of data on the French economy, we calculated $f_{J(i,t)}$as:

$$f_{J(i,t)} = \frac{(2.5 \times \text{Number of DAS Observations for Firm } J(i,t))}{1000} - 8.3.$$

Although this measure does not vary over time for a particular firm, it does vary over time for an individual who changes employers, which is the essence of our identification of firm effects relative to individual effects. The vector x_{it} in equation (5) includes time-varying individual-specific variables. The vector $\bar{x}_i$ in equation (5) contains the individual specific means of the two individual-specific variables onto which the firm effect was projected: individual i's total labor market experience and total labor market experience squared at date t. These individual-specific means were used in the calculation of the matrix z_{it}. Table 7 presents the variables appearing in the matrix z_{it}.

The first step equation (9) requires that the variables all be restated in terms of deviations from individual-specific means shown below for men with

Table 7: z_{it} Variables and Means (Std. Deviations in Parentheses)

Variable	Name	Mean
Firm Employment*Mean Experience$_i$	ZX_{it}	15.710 (746.422)
Firm Employment*Mean Experience$_i^2$	$ZX2_{it}$	4.032 (222.783)
Firm Employment*Mean Experience$_i$*Seniority$_{it}$	SX_{it}	726.375 (8,747.38)
Firm Employment*Mean Experience$_i^2$*Seniority$_{it}$	$SX2_{it}$	178.764 (2,752.69)
Firm Employment*Mean Experience$_i$*Seniority$_{it}^2$	$S2X_{it}$	7,766.07 (135,011.21)
Firm Employment*Mean Experience$_i^2$*Seniority$_{it}^2$	$S2X2_{it}$	2,175.18 (43,035.26)

more than one observation (37)

$$
\begin{aligned}
LFRAISRE_{it} = {} & 0.073\, EXPER_{it} \underset{(0.000)}{} - 0.451\, EXPER_{it}^2 \underset{(0.003)}{} + 0.107\, EXPER_{it}^3 \underset{(0.001)}{} \\
& - 0.009\, EXPER_{it}^4 \underset{(0.000)}{} + 0.080\, ILEDF_{it} \underset{(0.001)}{} + 0.084\, AN77_{it} \underset{(0.001)}{} \\
& + 0.169\, AN78_{it} \underset{(0.001)}{} + 0.266\, AN79_{it} \underset{(0.001)}{} + 0.394\, AN80_{it} \underset{(0.001)}{} \\
& + 0.615\, AN82_{it} \underset{(0.001)}{} + 0.803\, AN84_{it} \underset{(0.002)}{} + 0.860\, AN85_{it} \underset{(0.002)}{} \\
& + 0.880\, AN86_{it} \underset{(0.002)}{} + 0.906\, AN87_{it} \underset{(0.002)}{} + 5.237\text{e-}5\, ZX_{it} \underset{(2.96\text{e-}6)}{} \\
& - 1.477\text{e-}6\, ZX2_{it} \underset{(1.002\text{e-}5)}{} - 8.001\text{e-}6\, SX_{it} \underset{(2.8\text{e-}7)}{} + 1.977\text{e-}5\, SX2_{it} \underset{(1.00\text{e-}6)}{} \\
& + 6.99\text{e-}7\, S2X_{it} \underset{(2\text{e-}8)}{} - 1.883\text{e-}6\, S2X2_{it} \underset{(6\text{e-}8)}{}
\end{aligned}
$$

$$N = 3,248,901$$
$$R^2 = 0.604$$
$$\sigma = 0.245 \qquad (37)$$

and for women with more than one observation (38).

$$
\begin{array}{llll}
LFRAISRE_{it} & = 0.033\ EXPER_{it} & -0.180\ EXPER2_{it} & +0.040\ EXPER3_{it} \\
 & (0.000) & (0.004) & (0.001) \\
 & -0.003\ EXPER4_{it}^{4} & +0.078\ ILEDF_{it} & +0.086\ AN77_{it} \\
 & (0.000) & (0.002) & (0.001) \\
 & +0.180\ AN78_{it} & +0.281\ AN79_{it} & +0.412\ AN80_{it} \\
 & (0.001) & (0.001) & (0.001) \\
 & +0.639\ AN82_{it} & +0.827\ AN84_{it} & +0.877\ AN85_{it} \\
 & (0.002) & (0.002) & (0.002) \\
 & +0.893\ AN86_{it} & +0.915\ AN87_{it} & +5.573\text{e-}5\ ZX_{it} \\
 & (0.003) & (0.003) & (6.67\text{e-}6) \\
 & -1.29\text{e-}4\ ZX2_{it} & -1.198\text{e-}5\ SX_{it} & +2.847\text{e-}5\ SX2_{it} \\
 & (2.263\text{e-}5) & (6.0\text{e-}7) & (1.94\text{e-}6) \\
 & +6.46\text{e-}7\ S2X_{it} & -1.713\text{e-}6\ S2X2_{it} & \\
 & (6\text{e-}8) & (1.9\text{e-}7) &
\end{array}
$$

$$
\begin{array}{c}
N = 1,739,996 \\
R^2 = 0.564 \\
\sigma = 0.256
\end{array}
\tag{38}
$$

A.3.2 Imputed firm effects

For individual in firms with insufficient data to calculate a firm effect (less than 10 observations in the firm), we ran a single regression of equation (17), pooling all of the data and assigning the estimated coefficients to all firms in the group. This group included 1,353,794 observations (26% of the total), although it represented 86% of the firms. The results of the regression on this group are presented in equation (39).

$$
\begin{array}{llll}
DLFRAISR_{it} = & -0.028 & +0.003\ s_{it} & -0.005\ s_{it}^{*} \\
 & (3.375\text{e-}4) & (8.476\text{e-}5) & (1.772\text{e-}4) \\
 & & & \\
 & N = 1,353,794 & & \\
 & R^2 = 0.0013 & &
\end{array}
\tag{39}
$$

A.4 Construction of the Firm-Level Data

A.4.1 Calculation of the Firm-Level Averages

We need to calculate α_j, $u_j\eta$ and their respective variances based on the $\alpha_i$and $u_i\eta$ estimated according to the procedure laid out in section ?? above. α_j, $u_j\eta$ are simply the means of $\alpha_i$and $u_i\eta$, weighted by individual-years. In other words,

$$\alpha_j = \frac{\sum_i [\alpha_i T_{ij}]}{\sum_i T_{ij}}, \qquad u_j\eta = \frac{\sum_i [(u_i\eta)\, T_{ij}]}{\sum_i T_{ij}},$$

where T_{ij} represents the number of observation for individual i for which he or she is employed in firm j. The variances of α_j, $u_j\eta$ are calculated as

$$\mathrm{Var}(\alpha_j) = \frac{\sum_i [\mathrm{Var}(\alpha_i)\, T_{ij}]}{\left(\sum_i T_{ij}\right)^2}, \qquad \mathrm{Var}(u_j\eta) = \frac{\sum_i [\mathrm{Var}(u_i\eta)\, T_{ij}]}{\left(\sum_i T_{ij}\right)^2},$$

since each $\alpha_i$and $u_i\eta$ is a random variable with known variance. The variables ϕ_j, γ_{1j} and γ_{2j} already have unique values for a given SIREN (enterprise). Unfortunately, even having restricted estimation of firm-specific ϕ_j, γ_{1j} and γ_{2j} to those SIRENs for which we had 10 or more observations, we still ended up with some outliers. Thus, in cases where either $-3 \leq \phi_j \leq 3$ or $-2 \leq \gamma_{1j} \leq 2$ or $-2 \leq \gamma_{1j} + \gamma_{2j} \leq 2$, we set ϕ_j, γ_{1j} and γ_{2j} equal to the values estimated in the pooled regression. Weighting by individual-years, this affected only 0.15 percent of the observations in our sample.

A.4.2 Firm-level Employment and Capital Stock

The variable EFFEC (effectif, in thousands of workers) measures the total full-time employment in an enterprise as of December 31 (prior to 1984) and the annual average full-time employment (1984 and later) as found in the BIC. We then took its mean over all years that the firm appeared in the sample to get MEFFEC, the mean number of employees. Total capital in the enterprise is defined as the sum of Dettes (Debt) and Fonds propres d'entreprise (Owners' Equity). Our capital measure is equal to Actif total (Total assets) in French accounting systems. This information was taken directly from the BIC for every firm-year. We used a sector-by-sector, time varying index of the cost of capital (KAPP, 1980=100), available from the Banque de Donées Macroéconomiques (BDM). CAPITR is defined as total capital divided by cost of capital (in millions of 1980 FF). MCAPITR is the annual average of CAPITR over all available years for the firm. The capital labor ratio is defined as CAPITR/EFFEC and its annual average is MCAPITRF (thousands of 1980 FF)

A.4.3 Real Operating Income per Unit of Capital

We used the BIC to obtain the Excédent brut d'exploitation (Operating Income), or EBE, for each firm in each year that it appeared in the firm sample. The formula used to calculate the EBE is shown in equation 40.

$$
\begin{aligned}
\text{EBE} \;=\;& \text{ventes de marchandises (merchandise sold)} \\
-\;& \text{achat de marchandises (merchandise purchased)} \\
-\;& \text{variation de stock de marchandises} \\
& \;\text{(variation in merchandise inventory)} \\
+\;& \text{ventes de biens (goods sold)} \\
+\;& \text{ventes de services (services sold)} \\
+\;& \text{production stockée (inventoried production)} \\
+\;& \text{production immobilisée (unfinished production)} \\
-\;& \text{achats de matières premières (primary materials purchased)} \\
-\;& \text{variation de stocks sur matières premières} \\
& \;\text{(variation of primary materials inventories)} \\
-\;& \text{autres achats et charges externes} \\
& \;\text{(other purchases and outside charges)} \\
+\;& \text{subventions d'exploitation (incentives for production)} \\
-\;& \text{impôts, taxes et versements assimilés} \\
& \;\text{(value added tax and other accrued taxes on} \\
& \;\text{or credits for production)} \\
-\;& \text{salaires et traitements (salaries and benefits)} \\
-\;& \text{charges sociales (payroll taxes)}
\end{aligned}
\tag{40}
$$

The EBE was deflated by the prix de valeur ajoutée (value added price index), also found in the BDM, to yield EBER (thousands of 1980 FF). EBER was divided by CAPITR (times 1,000) to yield EBERC, real operating income per unit of capital (1980 FF). Lastly, we took the mean of EBERC over all of the firm-years to get MEBERC, mean real operating income per unit of capital (1980 FF).

A.4.4 Real Value Added Inclusive of Labor Costs

To calculate the valeur ajoutée réelle brute au coût des facteurs-(real value added inclusive of labor costs), VABCFR, we divided the frais de personnel (employer's compensation cost) from the BIC (thousands of FF) by the indice des prix à la consommation (consumer price index) from the BDM to yield the employer's real compensation cost (thousands of 1980 FF). The results was added to EBER, as defined above in section A.4.3, to yield the VABCFR, real value added inclusive of labor costs (thousands of 1980 FF). VABCFR was divided by EFFEC to yield VABCFRF, real value added inclusive of factor costs per worker (1980 FF). We took the mean of VABCFRF over all of the years that the firm appeared in the sample to get MVABCFRF, mean real value added inclusive of labor costs per worker (1980 FF).

A.4.5 Employment structure

The variable MING, proportion of engineers, technicians and managers in the work force (EFFEC), was calculated from the ESE using the PCS occupation classification (35) for individuals in categories 30 and 40. MOQA, the proportion of skilled workers in the work force, was calculated from the ESE using the PCS occupation classification (35) for individuals in categories 50 and 61. Both variables were expressed as a ratio to EFFEC and averaged over all the available firm-years.

B Model Appendix

Tables B1 to B3 show the first- and second-period wage equations for each of the representative individuals as a function of the statistical parameters of equation (1) and the parameters specified in each of the theoretical models in section 3.1.

Table B1

Matching Model with Homogeneous Workers

Individual	Wage Period 1	Wage Period 2
1	$y_{11} = \mu + \alpha_1 + \phi_m = w^*$	$y_{12} = \mu + \alpha_1 + \phi_m + \gamma_m = w^*$
2	$y_{21} = \mu + \alpha_2 + \phi_m = w^*$	
3	$y_{31} = \mu + \alpha_3 + \phi_m + \gamma_m = w^*$	
4		$y_{42} = \mu + \alpha_3 + \phi_m = w^*$
5	$y_{51} = \mu + \alpha_5 + \phi_n = w^* - \frac{H}{2}$	$y_{52} = \mu + \alpha_5 + \phi_n + \gamma_n = w^* + H$
6	$y_{61} = \mu + \alpha_6 + \phi_n + \gamma_n = w^* + H$	
7	$y_{71} = \mu + \alpha_7 + \phi_n = w^* - \frac{H}{2}$	$y_{72} = \mu + \alpha_7 + \phi_m = w^*$
8		$y_{82} = \mu + \alpha_8 + \phi_n = w^* - \frac{H}{2}$
9		$y_{92} = \mu + \alpha_9 + \phi_n = w^* - \frac{H}{2}$

Notes: Individual 1 enters type m firm in period 1; individual 2 entered type m firm in period 0 (before period 1); individual 3 entered type n firm in period 0 (before period 1), had a negative matching outcome and left for a type m firm; individual 4 enters type m firm in period 2; individual 5 enters type n firm in period 1, has a positive matching outcome; individual 6 entered type n firm in period 0 (before period 1), had a positive matching outcome and remained in type n firm for period 1; individual 7 enters type n firm, has a negative matching outcome and leaves for a type m firm in period 2; individuals 8 and 9 enter type n firm in period 2.

Table B2

Rent-Splitting Model

Individual	Wage Period 1	Wage Period 2
1	$y_{11} = \mu + \alpha_1 + \phi_m = x_1 - s_m Q$	$y_{12} = \mu + \alpha_1 + \phi_m + \gamma_m = x_1 + s_m Q$
2	$y_{21} = \mu + \alpha_2 + \phi_m = x_2 - s_m Q$	$y_{22} = \mu + \alpha_2 + \phi_n = x_2 - s_n Q$
3	$y_{31} = \mu + \alpha_3 + \phi_n = x_3 + s_n Q$	$y_{32} = \mu + \alpha_3 + \phi_n + \gamma_n = x_3 - s_n Q$
4	$y_{41} = \mu + \alpha_4 + \phi_n = x_4 + s_n Q$	$y_{42} = \mu + \alpha_4 + \phi_m = x_2 + s_n Q$

Notes: The quasi-rent is $-Q$ in type m firm in period 1 and Q in period 2. The quasi-rent is Q in type n firm in period 1 and $-Q$ in period 2. Individual 1 works in type m firm in both periods. Individual 2 works in type m firm in period 1 and in type n firm in period 2. Individual 3 works in type n firm in both periods. Individual 4 works in type n firm in period 1 and in type m firm in period 2.

Table B3

Incentive Model with Heterogeneous Workers

Individual	Wage Period 1	Wage Period 2
1	$y_{11} = \mu + \alpha_1 + \phi_m = w^*$	$y_{12} = \mu + \alpha_1 + \phi_m + \gamma_m = w^*$
2	$y_{21} = \mu + \alpha_2 + \phi_m = w^*$	$y_{22} = \mu + \alpha_2 + \phi_m + \gamma_m = w^*$
3	$y_{31} = \mu + \alpha_3 + \phi_m = w^*$	$y_{32} = \mu + \alpha_3 + \phi_m + \gamma_m = w^*$
4	$y_{41} = \mu + \alpha_4 + \phi_n = y - \delta\tau q_4^2$	$y_{42} = \mu + \alpha_4 + \phi_n + \gamma_n = y + \frac{\delta\tau}{2} q_4^2 + \delta\tau q_4$
5	$y_{51} = \mu + \alpha_5 + \phi_n = y - \delta\tau q_5^2$	$y_{52} = \mu + \alpha_5 + \phi_n + \gamma_n = y + \frac{\delta\tau}{2} q_5^2 + \delta\tau q_5$
6	$y_{61} = \mu + \alpha_6 + \phi_n = y - \delta\tau q_6^2$	$y_{62} = \mu + \alpha_6 + \phi_n + \gamma_n = y + \frac{\delta\tau}{2} q_6^2 + \delta\tau q_6$
7	$y_{71} = \mu + \alpha_7 + \phi_n = y - \delta\tau q_7^2$	$y_{72} = \mu + \alpha_7 + \phi_n + \gamma_n = y + \frac{\delta\tau}{2} q_7^2 + \delta\tau q_7$
8	$y_{81} = \mu + \alpha_8 + \phi_n = y - \delta\tau q_8^2$	$y_{82} = \mu + \alpha_8 + \phi_n + \gamma_n = y + \frac{\delta\tau}{2} q_8^2$
9	$y_{91} = \mu + \alpha_9 + \phi_n = y - \delta\tau q_9^2$	$y_{92} = \mu + \alpha_9 + \phi_n + \gamma_n = y + \frac{\delta\tau}{2} q_9^2$

Notes: Individuals 1, 2, 3 belong to type m firm with q_i, $i = 1, 2, 3$ between 0 and 1/3, individuals 4 to 9 belong to type n firm with q_i, $i = 4$ to 9 above 1/3. Individuals 4, 5, 6, 7 pass the test and receive the bonus; individuals 8 and 9 fail.

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