

Firm-Wide Versus Establishment-Specific Pay Practices<sup>\*</sup>

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## **Abstract**

Although much has been learned about the role firms play in the labor market, whether establishments within the same firm adopt similar labor-market practices is an open question. This question is particularly relevant for firms with establishments in different locales and industries. For example, a finding that wages within a firm have a common component across unrelated workers and industries would support skill-segregation models like Kremer (1993).

We construct a unique data set that links occupational data from separate establishments to the establishments' ultimate beneficial owners. We use these data to decompose within-establishment wage-level correlations, wage-change correlations, and employment-change correlations into components arising from random establishment effects, random firm within industry effects, and random firm effects.

Looking first at occupational wages, we find significant within-firm wage heterogeneity across establishments and across industries. We also, however, find a statistically significant and economically meaningful wage component common to all establishments and all industries within individual firms. In this sense, we estimate that the internal labor markets of large, multi-establishment, multi-industry firms are partially linked throughout their entire organizations.

Turning next to occupational employment changes, we find that employment changes are correlated across establishments within a three-digit industry, but employment-change correlations within individual establishments are much larger. We find no evidence that employment changes within firms are correlated across three-digit industries.

## 1. Introduction

Some of the most fundamental questions in economics involve the boundaries of the firm. Although some firms are small and easy to categorize, others are diverse organizations with many establishments operating in different industries with different types of employees. Firms exist that simultaneously manufacture computer chips and market business services; that provide consumer credit and produce automotive parts; and that manufacture plastics materials and lease passenger cars. In such cases one presumes sufficient complementarities exist to justify the combination. Since measurement of these complementarities is difficult, it is not always clear what causes them, or even that they exist.

One strand of research [Schmalensee (1985), Rumelt (1991), McGahan and Porter (1999)] examines the extent to which accounting profits are specific to industries as opposed to being specific to firms or to particular business lines within firms. This literature tends to find relatively little common profitability across different business lines within a given diversified firm. Therefore the evidence that diversified firms can take advantage of unspecified complementarities across different business activities, thereby justifying the diversification, appears weak. However, measuring firm profits is difficult, as is allocating total profits across business units.

Another strand of research focuses on the effects of internal capital markets and investment across business lines in multi-industry firms. This literature finds significant evidence that internal capital markets are linked across business lines. Berger and Ofek (1995) find that multi-industry firms invest more in unproductive industries than do single-industry firms. Berger and Ofek also find evidence that unproductive lines of business within a firm drain resources away from more productive lines of business. Along similar lines, Lamont (1997) finds firms

with significant oil-extraction operations responded to an exogenous decrease in oil prices by reducing investment in unrelated lines of business.

In this paper, we study whether the internal labor markets of large and diverse firms appear linked across establishments and business lines. The evidence cited above provides one rationale for this study; if internal capital markets lead to investment expenditures being correlated across business lines, the same could be true for labor expenditures. Diversified firms may also choose business lines with similar contracting environments or with similar skill-level requirements. Studying the degree to which wage levels, wage changes, and employment changes appear correlated across business lines is therefore a natural extension of similar literatures studying profitability or investment.

A separate literature examines the role employers play in labor markets. The existing literature tends to equate employers with either establishments or firms. Groshen (1991) finds evidence of substantial wage variation between establishments after controlling for industry and occupation effects. Lane, Salmon, and Spletzer (1999) find significant wage variation across establishments after controlling for occupation at a more detailed level. Bronars and Famulari (1997) show that differences in hiring practices based on observable characteristics (like education and potential experience) are important determinants of wage differences across establishments. Even after controlling for these observable workforce characteristics, Bronars and Famulari find substantial differences in wages across establishments. Abowd, Kramarz, and Margolis (1999) show that differences across firms in hiring practices based on observable characteristics, differences in hiring practices based on unobserved characteristics, and differences in wage policies are all important determinants of wage differences across firms.

Although most of the literature focuses on the roles of either firms or establishments, there is some evidence that wage decisions or hiring decisions are influenced both by firm-wide and establishment-specific factors. Brown and Medoff (1989) show that wages are positively correlated with both establishment size and firm size. These results suggest that wage policies are partially correlated across establishments within firms. We estimate the magnitudes of these within-firm correlations, particularly focusing on how they differ within and between business lines.

In order to study labor-market links within firms but across business lines, we use data from a new establishment survey that has information on firm ownership, wages and employment in jobs within sampled establishments, and the industry affiliation of each establishment. The data set is unique in containing both firm and establishment identifiers in conjunction with wage rates and employment in narrowly defined jobs. The data allow us, at a detailed occupational level, to estimate common establishment and firm components to wage levels, wage changes, and employment changes. For instance, are labor-market outcomes (wage levels, wage changes, or employment changes) more highly correlated within an establishment rather than across establishments but within the same firm? Are labor-market outcomes more highly correlated within the same firm and same industry rather than across industries within the same firm?

Like Brown and Medoff (1989) and others, we find it difficult to distinguish between the various competing hypotheses regarding the cause of the observed firm and establishment effects. In addition to the internal capital markets explanation mentioned earlier, sorting models like that of Kremer (1993) are consistent with the data. Models in which wage correlations are generated by wage policies such as rent sharing [Abowd and Lemieux (1993), Blanchflower,

Oswald, and Sanfey (1996), Hildreth and Oswald (1997)], efficiency wages [Shapiro and Stiglitz (1984)], or group-incentive plans [Kruse (1992), Jones and Kato (1995)], are also consistent with the data. But by studying the extent to which large multi-industry firms appear to be integrated organizations, we demonstrate empirically where in a large firm sorting or other models have power. Should these models apply only at the point of production (the establishment)? Should these models apply only within a line of business (an industry)? Should these models apply throughout an entire multi-industry firm?

The organization of the rest of the paper is as follows. In section 2, we describe our data, particularly focusing on the differences between our data and the data used in previous studies. In section 3, we describe our empirical methodology. In section 4, we present our empirical results on wage-correlations and discuss their implications. In section 5, we present our empirical results on employment-change correlations and discuss their implications. In section 6, we interpret our results and conclude.

## **2. Data: The National Compensation Survey**

The National Compensation Survey (NCS) is an establishment wage survey designed to generate a nationally representative random sample of detailed jobs within establishments. Our wage observations are the average hourly wages for all employees within an establishment who work in a particular detailed occupational category. We typically observe multiple detailed jobs within an establishment.

The survey encompasses large establishments in the non-agricultural, non-Federal economy. Private households and establishments with fewer than 50 employees are out of scope for the survey. Field economists visit sampled establishments at survey initiation and obtain

information on the establishment and on a sample of occupations in the establishment. Since industry coding is done at the establishment level, we often observe multiple industries within a multi-establishment firm. The survey is longitudinal, with annual survey updates conducted via mail and telephone.

There are three stages of sample selection in the NCS. The first stage involves the selection of survey localities, some of which are chosen with certainty. The second stage is the selection of establishments within each sampled area. The sampling frame is based on state unemployment insurance reports. Establishments are chosen within industry strata with a probability proportionate to employment. The final stage is the selection of occupations within sampled establishments, with a probability proportionate to the establishment employment in the detailed occupational group. The number of detailed occupations selected varies with the size of the establishment, and ranges up to a maximum of 20 for the largest establishments.

Establishment information in the NCS includes establishment employment, location, industry, and employer identification number (EIN). These data elements come from the sampling frame and are verified by field economists. Occupation-specific information includes a census occupational classification (roughly 450 categories), earnings data, and work schedule information. Earnings are defined as regular payments from the employer to the employee as compensation for straight-time hourly work, or for any salaried work performed. Earnings include incentive pay and production bonuses such as commissions and piece rates. Earnings exclude premium pay for overtime, holiday, and weekend work; shift differentials; bonuses not directly tied to production; payments by third parties such as tips or referral incentives; and payment in kind such as room and board. Scheduled hours per week are measured exclusive of overtime for hourly workers; for salaried workers actual hours typically worked are measured.

Earnings are converted to a dollars per hour basis using the work schedule information. Our wage measure is the log of the average wage rate among workers in the occupation, deflated using the CPI to 1999 dollars.

For the purposes of the NCS, establishments are economic units producing goods or services, auxiliary units providing support services, or central administrative offices. Figure 1 gives a schematic relating establishment and firm definitions in our data. For private sector industries in this survey, establishments are usually at a single physical location. Employer identification numbers (EINs) on the database allow us to link different establishments that have common ownership. Establishments in the same firm, however, can have different EINs, which may indicate some separation of decision-making authority, including pay-setting and hiring decisions.<sup>1</sup> We link EINs that are owned by the same parent firm using data from the Corporate Affiliations Plus (1997).<sup>2</sup> Previous labor-economics researchers have used either data with establishment identifiers (not linking establishments with common ownership) or data with firm identifiers defined using EIN (thereby not linking different EINs with common ownership).

We utilize extracts from the 1997 and 1998 NCS samples. We restrict the data to include private sector establishments only. We keep observations that can be matched across years, losing about 20% of the 1997 sample observations to attrition. We also exclude data from single-establishment firms, since we are particularly interested in characterizing the correlations of wages across establishments within the same firm.<sup>3</sup> This restriction results in an additional 60% decrease in our sample size. Minor exclusions include deleting observations with missing

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<sup>1</sup> Each subsidiary firm, even if it is fully owned by the parent firm, receives a different EIN.

<sup>2</sup> These data are the same data used by the National Register Publishing Company to produce the annual publication titled "Directory of Corporate Affiliations."

<sup>3</sup> Excluded single establishment firms may have additional establishments that were not sampled by the NCS.

occupation codes, missing industry codes, or changing firm identifiers. Since the exclusions in total are substantial, we estimate the parameters of interest using unweighted data.

Table 1 presents summary statistics for our data. After making all of the exclusions mentioned above, we have wage data from 34,792 occupation-establishment cells. These data come from 4,320 establishments and 1,020 firms. Observing wages from multiple establishments within a firm is an important advantage over previous work. Employment in these occupation-establishment cells is about 1.3 million workers.<sup>4</sup>

One attractive feature of our data is that industry is coded at the establishment level, allowing us to study within-firm industry heterogeneity. We observe 457 firms operating in more than one three-digit industry and we observe 196 firms operating in more than one major industry classification.<sup>5</sup> This within-firm industry heterogeneity represents another advantage over the data used in Abowd, Kramarz, and Margolis (1999) who are forced to allocate all employees within a firm to a single industry.

The major weakness of our data compared to data used in Abowd, Kramarz, and Margolis (1999) and others is that we have little information on employees. The data follow jobs—but not individuals—longitudinally. When we observe an establishment that pays high wages we therefore cannot determine whether its employees also received high wages when employed in other firms. We also do not observe worker demographics and productivity-related characteristics such as schooling.

Since our panel is based on significant exclusions from the NCS, Table 1 also presents statistics on how broad occupational and industry distributions compare between our panel and

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<sup>4</sup> Employment in the NCS 1997 cross-section is about 2.6 million workers. The covered population in scope is approximately 52 million private industry workers. Therefore the NCS cross-section samples about 5 percent of the employment in scope.

the full 1997 NCS cross section. Although some differences clearly exist between our panel and the 1997 cross section, we view the industry and occupation distributions to be broadly consistent.

### 3. Empirical Methodology

Our goal is to estimate wage correlations between occupation-establishment cells (sometimes called “job cells”) within a firm. We need an estimation strategy that allows occupational wages within an establishment to be more highly correlated than wages across establishments but within the same firm. A particularly succinct way of summarizing wage correlation patterns in data with a natural hierarchy (establishments within firms, job cells within establishments) is to estimate variance components at each level in the hierarchy. If, for example, one finds a relatively large estimated variance for firms’ effects on wages then it follows that wages within a firm are highly correlated: the different jobs within the firm share a common component that is on average large.

In an effort to keep the exposition simple, we present a wage model with only two levels of hierarchy: the firm and the establishment within the firm. All of our estimates account for one or two additional levels of hierarchy corresponding to three-digit industry affiliations within firms or major-industry affiliations within firms. Extending the model we present below to one with additional levels of hierarchy is straightforward.

Consider a wage determination model of the form

$$y_{okt} = X_{ok} \beta_t + \psi_{j(k)} + \psi_k + \phi_{j(k)t} + \phi_{kt} + \eta_{ok} + v_{okt}, \quad (1)$$

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<sup>5</sup> We define eight major industry categories: mining; construction; manufacturing; transportation, communications, and utilities; wholesale trade; retail trade; finance, insurance, and real estate; and services.

where  $y_{okt}$  is log wage for occupation  $o$  in establishment  $k$  in year  $t$ ,  $X_{ok}$  are covariates, and  $j(k)$  is the subscript for the firm to which the establishment belongs. The covariates are fixed state, fixed three-digit industry, and fixed occupation effects so  $X_{ok}$  does not vary with time. We are primarily interested in estimating the variances of the error components. Since we are interested in describing wage levels as well as wage changes, we posit time-varying and permanent components of variance. Assume  $\psi_{j(k)}$ ,  $\psi_k$ ,  $\phi_{j(k)t}$ ,  $\phi_{kt}$ ,  $\eta_{ok}$  and  $v_{okt}$  are iid normally distributed mean-zero random variables with variances of  $\sigma_{\psi,j(k)}^2$ ,  $\sigma_{\psi,k}^2$ ,  $\sigma_{\phi,j(k)}^2$ ,  $\sigma_{\phi,k}^2$ ,  $\sigma_{\eta}^2$ , and  $\sigma_v^2$  respectively.

Given estimates for the error variances we can derive wage correlations of interest, net of the fixed controls. Define  $\tilde{y}_{okt} \equiv y_{okt} - X_{ok}\beta_t$ , which is the difference between the log wage for the occupation-establishment cell and the log wage we would expect from the covariates alone. We can then express the wage correlation between any two notional jobs as a function of the estimated variances. According to our model of wage determination, for example, the correlation of  $\tilde{y}_{okt}$  between two jobs within the same establishment in the same time period is

$$\rho[\tilde{y}_{okt}, \tilde{y}_{o'kt}] = \frac{\sigma_{\psi,j(k)}^2 + \sigma_{\psi,k}^2 + \sigma_{\phi,j(k)}^2 + \sigma_{\phi,k}^2}{\sigma_{\psi,j(k)}^2 + \sigma_{\psi,k}^2 + \sigma_{\phi,j(k)}^2 + \sigma_{\phi,k}^2 + \sigma_{\eta}^2 + \sigma_v^2}. \quad (2)$$

Looking at the numerator for the above expression, we see that this correlation has four components. These components reflect random firm effects (permanent and time varying) and random establishment effects (permanent and time varying). The numerator does not, of course,

include the random occupation-establishment components  $\sigma_\eta^2$  and  $\sigma_v^2$  since two different jobs in the same establishment would not share common draws from the distribution of those components.

Another example may be helpful. Suppose we now consider two log wage draws coming from the same firm, but different establishments and different years. In this case, the correlation is

$$\rho[\tilde{y}_{okt}, \tilde{y}_{o'k't'}] = \frac{\sigma_{\psi,j(k)}^2}{\sigma_{\psi,j(k)}^2 + \sigma_{\psi,k}^2 + \sigma_{\phi,j(k)}^2 + \sigma_{\phi,k}^2 + \sigma_\eta^2 + \sigma_v^2},$$

since the two observations only share a permanent random firm effect.

To obtain the correlations in which we are interested, we first estimate the time-varying parameters from the following first-difference model:

$$\Delta y_{ok} = X_{ok}\gamma + (\text{random firm effects})_{j(k)} + (\text{random establishment effects})_k + (\text{random job within establishment effects})_{ok},$$

where  $\Delta y_{ok}$  is the change in the log wage from 1997-1998 for occupation  $o$  in establishment  $k$ .

The fixed effects are nuisance parameters. The random effects capture the first-differenced temporary components. The random job within establishment effects can be viewed as the statistical residual. The variances of random firm effects, random establishment effects, and random occupation within establishment effects correspond to  $2\sigma_{\phi,j(k)}^2$ ,  $2\sigma_{\phi,k}^2$ , and  $2\sigma_v^2$  respectively.

To recover the permanent components we also estimate the model

$$\bar{y}_{ok} = X_{ok}\alpha + (\text{random firm effects})_{j(k)} + (\text{random establishment effects})_k + (\text{random job within establishment effects})_{ok},$$

where  $\bar{y}_{ok}$  is the average log wage for the occupation-establishment cell across the two years in our sample. Here the random effects at any level of aggregation incorporate the permanent effect plus the average of two temporary effect draws. For example, the variance of random firm

effects corresponds to  $\sigma_{\psi,j(k)}^2 + \frac{\sigma_{\phi,j(k)}^2}{2}$ .

Models that include both fixed and random effects are often called mixed models. We follow a suggestion of Groshen (1991) and estimate the above mixed models through restricted maximum likelihood (REML). REML maximizes a vector of linear combinations of the observations that are invariant to the fixed effects of the model. That is, REML obtains estimates of the covariance parameters of the model without obtaining estimates of the fixed effects of the model. REML is also robust to a relaxation of the assumption of normally distributed random effects.<sup>6</sup>

The main specification issues relate to choosing which fixed effects to include and how to represent the random effects. We wish to control for effects that might otherwise confound the estimated common components within firms or establishments. For instance, we include relatively fine industry, occupation, and region controls (fixed effects for three-digit industry, three-digit census occupation category, and state respectively) in order to obtain more

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<sup>6</sup> See Searle, Casella, and McCulloch (1992) for more details. Groshen (1991) estimates anova models with varying sets of fixed effects (first a baseline specification, then one adding establishment effects, and so forth) and compares the R-squared statistics from the models as a variance decomposition technique.

meaningful establishment random effects estimates. Since establishments are not all sampled at the same time, we include the number of months between the two observations in our wage-change models, and the midpoint of the two observations in our average-wage models.

We are especially interested in varying the specifications to include different levels within the hierarchy modeled by the random effects. In particular, effects common to different establishments might be larger when the establishments are in similar industries than when they are in dissimilar ones. For this reason we estimate models that have industry-within-firm random effects in addition to those given in equation 1. Our main constraint, aside from computational issues, is that there is relatively little across-industry variation within firms (recall Table 1).

#### **4. Wage Decompositions Results**

Table 2 gives the results from models that include random effects for the firm, business lines within firm (as captured by interactions between three-digit industry and firm), establishment, and jobs within establishment (the residual). As indicated above, one of our goals is to quantify any wage components common to different establishments within the same firm. The specification in table 2 allows wages within firms but across establishments to be more highly correlated when the establishments are in the same three-digit industry. The table's top panel gives the random effects estimates and their associated standard errors. The second panel transforms the estimates from the two REML models into estimates of the permanent and time-varying random effects, analogous to the decomposition in equation 2. It also gives each component's contribution to the total within establishment correlation of log wages. The third panel shows the implied correlations for different job cell pairs.

Consider first the wage-change model. Note that the variance of random firm and industry-within-firm effects are small and imprecisely estimated. Although the sum of random firm and random firm within industry effects is statistically significant, the magnitude of this sum is quite small. The variance of random establishment effects, however, is statistically significant and considerably larger in magnitude than the other two components combined. The variance of random establishment effects implies a standard deviation of .021, which corresponds to a 2.1 percent wage differential given a random-effect draw that is one standard deviation above the mean.

Table 2 also gives results for the average-wage model, which predictably generates much larger magnitudes than the wage-change model. Random firm effects, random firm within industry effects, and random establishment effects all appear to be of similar magnitude. In particular, each of our three permanent effects explains roughly one third of the correlation of  $\tilde{y}_{okt}$  within the same establishment in the same year. The random effects standard deviations imply wage deviations of 9-10 percent. Therefore a random draw one standard deviation above the mean from any of these distributions represents a substantial wage difference.

We now have all of the information we need to estimate the wage correlations for different notional jobs (as in, for example, equation 2). These results are also presented in Table 2. The correlation of log wages between two jobs within the same establishment in the same year, net of the occupation, industry, and location fixed effects, is estimated to be 0.33. The correlation of log wages between two jobs in different establishments within the same 3-digit industry and with common firm ownership is 0.21. The analogous correlation of log wages between two jobs in different establishments and 3-digit industry, but with common firm ownership, is 0.10. We view these as nontrivial numbers given the conceptual experiments.

Our estimates of the wage-change model imply that the correlation of wage changes within an establishment is 0.11. Therefore wage levels for two jobs in the same firm but different industries are about as well correlated, as are wage changes for two jobs in the same establishment. The correlation of wage changes within the same firm but in different establishments is negligible. The contribution of all time-varying shocks to the overall correlation of wages is small, on the order of 2 percent. The contributions of permanent random firm, industry-within-firm, and establishment effects to this overall correlation are 30%, 33%, and 35% respectively.

As we noted in the methodology section, we are especially interested in models that vary the fineness of the random-effects specifications. To this end we estimate another set of specifications in Table 3. These models allow for firm within industry effects at both the three-digit SIC level as well as at the major industry level. The model in Table 2 allows wage correlations across establishments to differ according to the similarity of the establishments' industries; the model in Table 3 allows a finer continuum of dissimilarity. The time-varying effects are unremarkable given the earlier finding that wage growth is only weakly correlated across establishments within the same firm. What is more remarkable is that the permanent firm random effects continue to be substantial. Two jobs in the same firm and industry have correlated wage rates, and the correlation is stronger when industry is defined narrowly. In addition, two jobs in the same firm but in different industries have correlated wages. The permanent firm effect variance of 0.0047 implies a standard deviation of 0.069, or a 6.9 percent wage deviation. For some reason, if a multi-establishment, multi-industry firm finds it profitable to offer higher wages for one job (net of industry, location, and occupation means) it also finds it

profitable to offer higher wages for other jobs, even though the jobs are in apparently unrelated establishments and industries.

The results from Tables 2 and 3 make clear that the labor policies of large, multi-establishment, multi-industry firms are partially linked throughout their entire organizations. The underlying causes of such linkages are less obvious. The intuition from models like Kremer (1993)—employees should sort based on their skill levels—would seem to apply quite well for employees who are working together or performing similar tasks. Consider, however, a firm that chooses a niche as a manufacturer of low-quality items and therefore chooses a low-skilled manufacturing workforce. Is there any reason to believe that this firm would not use the most highly skilled marketers? Alternatively one can interpret the results in terms of pay-differential models. For instance, why would one expect the contracting environments in large firms to be constant across industries? Given all of the tasks performed in large firms, it seems quite intuitive that contracting environments vary considerably throughout the firm. Our results suggest that whatever factors explaining establishment wage premia likely extend beyond establishment boundaries.

## **5. Employment Changes**

The previous section gave estimates of wage-level and wage-change correlations between jobs in a variety of settings. Although we find the application interesting, there is no particular reason to limit the investigation to wages. This section presents results for a different application, also using labor market data: how correlated is employment growth across jobs in different establishments that have common ownership? The job creation and destruction literature has not addressed this question, at least in part because the data have not been available to do so.

Perhaps the main finding in the job destruction and creation literature is the fact that the variance in establishment employment growth is large relative to baseline effects such as business cycle changes and aggregate or industry-specific trends.<sup>7</sup> An employment-change decomposition analogous to the wage-change decomposition stemming from equation 1 would document another baseline effect: that of the firm. Although it is important to exercise caution in comparing results from our data to the economy at large—we have no firm births and deaths, employment growth in our data is at the level of the job, our firms and establishments are large and presumably (for example) less likely to be credit constrained, etc.—we believe the exercise can add to this literature.

Table 4 gives estimates for a model that includes random effects for firm, firm-industry cells, establishments, and job cells (the residual). It parallels the wage change model in Table 2. We follow the standard in the job creation and destruction literature by defining the percent change in employment as the increase in employment from 1997-1998 divided by the average of 1997 and 1998 employment. This method treats employment expansions and contractions symmetrically.<sup>8</sup>

One striking feature of Table 4 is that employment changes within a firm appear uncorrelated across business lines. Although employment changes are correlated across establishments within a firm-industry pair, random establishment effects are much more important determinants of employment growth than random industry within firm effects. Note, for instance, that the standard deviation of random firm within industry effects is 0.07, while the corresponding standard deviation for random establishment effects is 0.16. These estimates imply that, even in business lines that are growing substantially, many establishments should be

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<sup>7</sup> See Davis and Haltiwanger (1999) for a review of the literature on job creation and destruction.

reducing employment. In this sense our results parallel and extend the received wisdom of the job creation and destruction literature.

## **6. Conclusions**

We use the labor market to study the extent to which large multi-establishment, multi-industry firms are integrated organizations. One of our main findings—considerable labor-market heterogeneity exists across business lines within firms—closely parallels the findings of similar studies using data on profitability. In particular, we find that the majority of within-establishment wage correlations (levels and changes), and all of the within establishment employment-change correlations, arise from components specific to the establishment or business line. We do, however, find that an economically meaningful component of wage correlations common across all establishments and all business lines within individual firms. In this sense, we find that the internal labor markets of large, multi-industry firms are partially linked throughout their entire organizations.

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<sup>8</sup> The model has the same fixed effects as the wage-change models. On average there are about 37 job incumbents per job cell, but obviously the distribution of that statistic is skewed.

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**Table 1: Sample Statistics**

	Average	Standard Deviation
Average Log Wage for an occupation-establishment cell: 1997 & 1998	2.652	0.579
Change in Log Wage for an occupation-establishment cell: 1997-1998	0.022	0.096
	Number	
Occupation-Establishment Cells	34,792	
Establishments	4,320	
Firms	1,020	
Multi-Industry Firms:		
3 digit SIC	457	
gross industry categories (8)	222	
	Multi-Establishment	
Occupation Distribution	Panel	1997 Cross-Section
Professional	12.5	14.2
Technical	4.9	5.7
Executive	10.3	10.8
Sales	11.9	7.7
Clerical	18.4	19.5
Production, Craft	10.3	9.0
Operators, Assemblers	8.8	8.8
Transport, Material Moving	3.6	3.2
Handlers, Laborers	8.8	7.3
Service	10.7	13.9
Industry Distribution		
Mining	1.3	1.1
Construction	0.6	2.4
Manufacturing	33.2	27.2
Transport, Communications, Utilities	9.8	6.2
Wholesale Trade	3.4	4.0
Retail Trade	22.4	14.2
FIRE	6.1	6.7
Services	23.3	38.3

**Table 2: Wage Models with Random Firm, Random Firm within 3-Digit Industry,  
and Random Establishment Effects**

Dep Var: Change in Log Wage: 1997-1998			Dep Var: Average Log Wage: 1997 & 1998		
random effect	variance	std error	random effect	variance	std error
firm	0.000029	0.000061	firm	0.007974	0.001196
firm*SIC3	0.000099	0.000070	firm*SIC3	0.008797	0.001222
establishment	0.000893	0.000051	establishment	0.009487	0.000492
residual	0.008061	0.000066	residual	0.050995	0.000416

Decomposing the Cross Sectional within Establishment Wage Correlation (Total Correlation = 0.33)

Time-Varying Effects			Permanent Effects		
	variance	contrib to correlation		variance	contrib to correlation
firm	0.000015	0.05%	firm	0.007967	30.05%
firm*SIC3	0.000050	0.19%	firm*SIC3	0.008772	33.08%
establishment	0.000446	1.68%	establishment	0.009264	34.94%
residual	0.004031		residual	0.048979	
total	0.004541	1.93%	total	0.074982	98.07%

Wage Correlations across Occupation-Establishment Cells

	wage levels	wage changes
same establishment & same year	0.33	0.11
same establishment; different years	0.33	
same firm, SIC3 & year; different estabs	0.21	0.01
same firm & SIC3; different estabs & years	0.21	
same firm & year; different estabs & SIC3	0.10	0.00
same firm; different estabs, SIC3, & years	0.10	

Notes: Both models are estimated using restricted maximum likelihood (REML). Both models include fixed state effects, fixed 3-digit industry effects, and fixed 3-digit Census occupation effects. Wage-change model includes number of months between observations as a control. Average log-wage model includes linear time trend for the midpoint of the two observations. All correlations are of the components of log wages (or changes in log wages) that are not explained by the fixed effects. In the wage-change model, the sum of random firm and random firm\*SIC3 effects has a z-statistic of 4.02.

**Table 3: Wage Models with Random Firm, Random Firm within Major Industry, Random Firm within 3-Digit Industry, and Random Establishment Effects**

Dep Var: Change in Log Wage: 1997-1998			Dep Var: Average Log Wage: 1997 & 1998		
random effect	variance	std error	random effect	variance	std error
firm	0.000023	0.000064	firm	0.004705	0.001570
firm*majind	0.000063	0.000171	firm*majind	0.006581	0.002082
firm*SIC3	0.000041	0.000171	firm*SIC3	0.005520	0.001383
establishment	0.000895	0.000052	establishment	0.009534	0.000494
residual	0.008061	0.000066	residual	0.050990	0.000416

Decomposing the Cross Sectional within Establishment Wage Correlation (Total Correlation = 0.33)

Time-Varying Effects			Permanent Effects		
	variance	contrib to correlation		variance	contrib to correlation
firm	0.000011	0.04%	firm	0.004699	17.67%
firm*majind	0.000031	0.12%	firm*majind	0.006566	24.69%
firm*SIC3	0.000021	0.08%	firm*SIC3	0.005509	20.72%
establishment	0.000448	1.68%	establishment	0.009311	35.01%
residual	0.004031		residual	0.048975	
total	0.004542	1.92%	total	0.075059	98.08%

Wage Correlations across Occupation-Establishment Cells

	wage levels	wage changes
same establishment & same year	0.33	0.11
same establishment; different years	0.33	
same firm, SIC3 & year; diff estabs	0.21	0.01
same firm & SIC3; diff estabs & year	0.21	
same firm, maj ind, & year; diff estabs & SIC3	0.14	0.01
same firm & maj ind; diff estabs, SIC3, & years	0.14	
same firm & year; different estabs & maj inds	0.06	0.00
same firm; different estabs, major inds, & years	0.06	

Notes: Both models are estimated using restricted maximum likelihood (REML). Both models include fixed state effects, fixed 3-digit industry effects, and fixed 3-digit Census occupation effects. Wage-change model includes number of months between observations as a control. Average log-wage model includes linear time trend for the midpoint of the two observations. All correlations are of the components of log wages (or changes in log wages) that are not explained by the fixed effects.

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**Table 4: Employment-Change Model with Random Firm, Random Firm within 3-Digit Industry, and Random Establishment Effects**

Dependent Variable: % Change in Employment for Occupation-Establishment Cell

	variance	std error	contrib to correlation
firm	0.000941	0.001203	3.14%
firm*SIC3	0.004902	0.001587	16.36%
establishment	0.024126	0.001344	80.51%
residual	0.186692	0.001520	

Employment-Change Correlations across Occupation-Establishment Cells

same establishment	0.14
same firm & SIC3; different estabs	0.03
same firm; different estabs & SIC3	0.00

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Notes: Model is estimated using restricted maximum likelihood (REML). Model includes fixed state effects, fixed 3-digit industry effects, fixed 3-digit Census occupation effects, and number of months between observations. All correlations are of the components of employment changes that are not explained by the fixed effects.

Figure 1: Stylized Structure of a Large Multi-Industry Firm

