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SOURCES OF WAGE DISPERSION: THE CONTRIBUTION OF INTEREMPLOYER DIFFERENTIALS WITHIN INDUSTRY

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Abstract

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Labor economists' current focus on the effect of long-run labor-supply factors on wages leaves unexplained more than half of wage variation. This paper examines whether differences apparently associated with demand may increase our ability to explain earnings.

In BLS Industry Wage Surveys, establishment-based wage differentials (controlling for occupation) paid to blue-collar employees account for 20-70 percent of within-industry wage variation. This corresponds to a standard deviation in wages of 11 percent of the mean, almost as large as wage variation among two-digit industries, and a large portion of the economywide standard deviation of wages of about 50 percent.

Upon investigation, the occupation classifications appear sufficiently narrow to reject the possibility that establishments are simply sorted by education, tenure, or age. Furthermore, since at least half of wage variation among employers is linked to characteristics such as union affiliation, size, product, technology, and method of pay, these differentials are not random. Finally, the evidence is inconsistent with strong versions of compensating differentials models, These findings underscore the need for further research into models of efficiency wages, bargaining over rents, and systematic sorting by unmeasured worker ability.

Introduction

Are employers active participants or passive price takers in the labor market? Currently, most empirical labor economics studies focus on education and experience (that is, long-run labor supply, as introduced in Becker [1964] and Mincer [1974]) to the extent that the variation left unexplained in wage equations (well over half of the total) is ascribed to unobserved human capital or random error.[1]

In the 1940s and 1950s, the administration of wage and price controls led economists to examine employer wage policies (that is, labor demand, see Segal [1981] and Kerr [1983]).[2] Recent research on industry wage effects forcefully documents the existence and correlates of industry wage differentials, and challenges the assumption that wage variation between industries reflects only human capital differences, but remains inconclusive as to the source of the differentials (see summary in Dickens and Katz [1986]).

However, industry is not uniquely defined; sources of variation between industries should affect wages within industry as well. Interindustry studies neglect within-industry sources of wage variation that do not vary much among industries (for example, size of establishment, Brown and Medoff [1987]).

In an analysis of variance of individual production workers' wages within and between establishments, this paper shows that, controlling for detailed occupation, wage variations among employers are almost as large as the variations among industries. In fact, occupation and establishment identity alone can explain 90 percent of wage variation among blue-collar workers.

The paper then performs a variety of tests for the consistency of the findings with simple explanations of establishment differentials. The data include detailed job classification and sex, but no other standard measure of

human capital. Thus, the results are tested for whether the classifications are sufficiently detailed to capture most productive differences due to education, experience, and tenure. The possibility that employer differentials compensate for undesirable conditions of employment is also evaluated. Then, the differentials are tested for evidence of nonrandomness. Finally, some alternative explanations are discussed.

Thus, this paper establishes that employer wage differentials are a large, neglected portion of wage variation that merit continuing research. The wage differentials investigated here accrue, on average, to all employees at an establishment; they are coefficients on establishment dummies, controlling for occupation. The dependent variable is earnings of blue-collar workers in six manufacturing industries, net of fringes and overtime and shift premia. Although certainly well within the topic of employer differentials, differences between the public and private sectors, between manufacturing and nonmanufacturing industries, and between blue-collar and white-collar employees are beyond the scope of this work.[3]

I. Empirical Literature on Employer Wage Effects Within Industry

Previous studies of employer wage effects strongly suggest the existence of within-occupation interemployer differentials, but do not document their existence in the United States. The few U.S. studies have focused on a single aspect of interemployer differences (such as plant size), or on one occupation or city, rather than on estimating the importance of the whole differential across many occupations, as this study does. For a more detailed review of the theoretical and empirical literature, see Groshen (1988a).

Two U.S. case studies find significant differentials between firms, making use of unusually rich information on both worker and firm characteristics. Reynolds (1951) concludes that firms select the general wage level on which they operate until forced to change. Rees and Schultz (1970) estimate individual and establishment effects on wages for four groups of occupations and find systematic differences between firms that are not entirely consistent across all occupations.

Mackay, et al. (1971), Nolan and Brown (1983), and Brown, et al. (1984), are recent case studies of English and Australian labor markets. Although the techniques used are different, their results are similar to those presented in this paper: plant differentials are a large and fundamental component of wage dispersion. And, they are persistent over time and linked to plant performance. Hodson (1983) matches U.S. survey data with employer information and finds employer characteristics to be strongly significant predictors of wages, controlling for standard human capital measures.

Ward (1980) and Van Giezen (1982) suggest that although interoccupational differentials are somewhat compressed within establishments, establishment effects are fairly uniform across occupations. Other support for the probable existence of establishment effects comes from studies of the relationship between wages and particular establishment differences (for example, employer size, Brown and Medoff [1987], and proportion female, Blau [1977]).

II. Microeconomic Sources of Wage Differentials Between Employers

Groshen (1988a) reviews the features of several theories that explain the apparent existence of employer differentials, by taking into account factors costly to the employer-worker relationship.[4] This section introduces the

nature of the puzzle and the three simplest solutions.

Under perfect competition in capital and labor markets, equivalent workers at equivalent jobs earn the same wage. Employers whose wages stray from the market rate (that is, from the horizontal supply curve) will be forced out of business by loss of employees (wages set too low) or capital (wages set too high). Variations in labor demand should affect only quantity hired, never wages, so long as worker utility is unaffected.

The possible existence of employer wage differentials raises two questions: (1) what motivates one employer to pay more than another? and, (2) how do high-wage employers stay in business? If productivity differentials are invoked as answers, they must be due to traits of individuals (not employers), implying the need for more explanation (that is, a reason for sorting). If productivity differentials are not the answer, then costly information or imperfect competition in the product market must be present and operate on all employees of an establishment similarly.

Sorting by Ability. The first model relaxes the assumption of uniform productivity among workers. However, in order to generate establishment differentials rather than just individual differentials, the theories must explain why the marginal product of workers varies by employer. The reason for such segregation by establishment may be 'jobs as dam sites' (Akerlof [1981]), the ability-sensitive technology (Roy [1951]), the sociology of team productivity as a function of team uniformity, or differences in the age of establishments (reflected in average experience of employees). In all versions, all employers (whether high-wage or low), earn zero or equal profits in equilibrium. They maximize profits by sorting; they avoid hiring or retaining workers less productive than their existing work force.

Compensating Differentials Wages will mismeasure the total return to working if they include differentials to compensate workers for extra nonpecuniary costs of their employment (Smith [1776] and Smith [1979]). Employer (rather than individual) differentials arise when quality of working conditions is consistent across all or most of the work force in establishments. Although many standard examples (for example, dirt or physical exertion) do not apply, high risk of layoff, poor ventilation, fringe benefits, personnel treatment, or location could presumably affect all or most workers in an establishment. Then, the costs of improvement of these conditions must vary enough among plants to generate large differentials.[5]

Random Variations. Finally, if search is expensive for job-seekers or firms, the marketplace can sustain a range of wages because the gain from further search becomes uncertain, rather than a known quantity (Stigler [1962] and Rothschild and Stiglitz [1976]). Distributions of wages are sustainable only if the minimum wage paid differs from the mean offer by less than search costs. Lagged adjustment to labor market conditions (Dunlop [1982]) provides a mechanism that generates random wage variations.[6] However, if employer differentials are large, long-lived, or associated systematically with characteristics of employers, they are probably not random variations.

III. An Analysis of Variance of Wages

1. The Application of ANOVA to Wages

The following equation forms the basis of most recent empirical labor economics wage research (following Mincer [1974]):

(1) $$w_k = \mu + Z_k\nu + \varepsilon_k,$$

where w_k = ln(wage) for individual k,
μ = intercept,
Z_k = vector of demographic characteristics (age, schooling, etc.),
ν = vector of coefficients of (returns to having) demographic characteristics, and
ε_k = randomly distributed error term.

If virtually all productive differences in human capital are between, not within, narrowly defined occupations (section IV examines this issue further), occupation dummies capture all significant differences in human capital (and working conditions) among occupations. The index i can be introduced for occupation i, so that k denotes the k^{th} individual in occupation i. Then let X_i be a vector of occupational dummies, with α as the vector of occupation differentials, yielding the following equation:

(2) $$w_{ik} = \mu + X_i\alpha + \varepsilon_{ik}.$$

The test for the importance of differences associated with the demand side is to estimate the contribution of employer variables included in a wage equation with supply-side variables, as follows:

(3) $$w_{ijk} = \mu + X_i\alpha + Y_j\beta + X_iY_j\gamma + \varepsilon_{ijk},$$

where w_{ijk} = ln(wage) of employee k in occupation i at employer j,
Y_j = vector of employer j's characteristics (industry, size, etc.), or a vector of establishment dummy variables,
β = vector of coefficients of (returns to working for) the employer,
X_iY_j = interaction between occupation i and characteristics of employer j, and
γ = vector of returns to occupation i working for employer j.

If wages are at all dependent on employer characteristics, the omission of employer variables diminishes the ability of the model to explain wage

variation, and biases estimates of coefficients on individual characteristics correlated with place of employment. To measure the full impact of employer differentials on wage variation, the first results presented set Y equal to a vector of establishment dummies. Thus, equation (3) can be rewritten and wages may be understood as the sum of a series of differentials:

$$(4) \qquad w_{ijk} = \mu + \alpha_i + \beta_j + \gamma_{ij} + \varepsilon_{ijk},$$

where α_i, β_j, and γ_{ij} are the i^{th}, j^{th}, and ij^{th} elements of the α, β, and γ vectors, respectively, and μ is the overall mean wage. The interaction of occupation and establishment is the group of workers holding the same occupation at the same plant. In this paper, this will be called an employee's "work-group." These differentials can be understood as follows:

1) Occupation differential (α_i) is an occupation's average deviation from mean wages, across all establishments. Presumably, these premia reflect productivity and compensating differences among occupations.

2) Establishment differential (β_j) is the employees' average deviation from occupation mean in an establishment, across all occupations. Thus, these encompass many differentials proposed in earlier research: size of employer, industry, percentage female, union, etc.

3) Work-group (interaction) differential (γ_{ij}) is paid to a particular work group above the occupation and establishment differentials. High variance in this term indicates significantly different internal wage structures among employers.

4) Within work-group (individual) differential (ε_{ijk}) is an individual or residual deviation from the mean for an occupation in an establishment, presumably the result of individual productivity or tenure differences or differing compensation strategies on the part of employers (for example, incentive vs. day rates). The more that wages are tied to individuals rather than to jobs, the larger is this component.

Note that equations (3) and (4) express the same model, in slightly different notation. If the differentials in equation (4) are mutually

independent, analysis of variance (ANOVA) will partition the total variance of wages as follows:

$$(5) \qquad \sigma_w^2 = \sigma_\alpha^2 + \sigma_\beta^2 + \sigma_\gamma^2 + \sigma_\varepsilon^2.$$

The relative size of each variance component estimate indicates its relative economic importance more clearly than would a table of coefficient estimates for each occupation, each establishment and each work-group. Our interest is the economic and statistical significance of the differentials as groups, summarized by the relative sizes of the variance components, as follows:

1) σ_α^2 measures the importance of external occupational labor markets,
2) σ_β^2 measures the impact of employer differences on wage determination,
3) a_γ^2 measures the independence of internal labor markets, and
4) σ_ε^2 measures the importance of worker differences within work-group.

Differing relative sizes of the components suggest very different views of the functioning of the labor market. Table 1 lists eight possible conclusions from ANOVA (all allowing for individual variation) and summarizes their implications for economic wage determination models. The analysis in this paper uses model 8 to test for the other seven models.

The essential complication to the discussion above is that variance component decomposition as shown in equation (5) is not straightforward when data are unbalanced. An unbalanced design produces multicollinearity between the vectors of dummy variables (X_i and Y_j) in equation (3), which prevents a simple separation of the impacts of X and Y. If an establishment employs a relatively large number of workers in a skilled occupation, we cannot distinguish whether a differential paid to those workers is due to their employer or to their occupation.

The ANOVA technique applied is a decomposition of the sum of squares of wages (rather than a variance components estimation), because the correct number of degrees of freedom is unidentified in an unbalanced design.' This technique explicitly estimates the ambiguity arising from design imbalance.

The summary of the technique provided in table 2 shows how a series of own least squares (OLS) regressions is used to partition the sum of squares of wages into components corresponding to those shown in equation (5) by noting the changes in the coefficient of determination (that is, sum of squares explained as a proportion of total). Use of the R^2 standardizes σ_w^2 to a value of one, across industries. First, log wages are regressed on vectors of occupation and establishment dummies, each separately. Then they are both included in an equation (called the full main-effects model). The marginal contribution of each to the full main-effects model (over the equation with the other one alone) measures the portion of wage variation associated unambiguously with that factor. These correspond to minimum estimates of the relative size of the variance contributed by occupation and establishment differentials, or σ_α^2 and σ_β^2. The difference between the R^2 of each set of dummies in the equation alone and its marginal contribution to the full main-effects equation is a measure of the "joint" (collinear, or ambiguous) explanatory power of occupation and establishment. The relative contribution of work-group differentials (σ_γ^2) is measured by the difference between the explanatory power of the regression on work-group dummies and that of the full main-effects model. The individual contribution (σ_ε^2) is measured by the variation unexplained by work-group.

2. The Data

The data used are Bureau of Labor Statistics Industry Occupational Wage Surveys for six manufacturing industries. Table 3 presents means of the basic characteristics of the samples. (Means of all variables used in the analysis appear in the appendix.)

Separate analysis of industries allows occupations to be narrowly defined, while covering a large proportion of each employer's work force. In cross-industry surveys, either occupations must be very broadly defined or the vast majority of the employees of each establishment are excluded from analysis, because only support occupations are employed in common across employers. Since industries as a whole have wage differentials, analysis within industry tends to underestimate the contribution of establishment by the size of the industry effect.

The data consist of the wages, sex, occupation, and establishment identifier of individual production and maintenance workers. Wages reported are straight-time hourly wages (no overtime or shift premia included) for hourly workers, and average hourly earnings for incentive workers. Although confidentiality restrictions prohibit the release of employers' names, the data include unique establishment identifiers and plant characteristics: for example, size, industry sector, major method of pay, union affiliation, major product, and region.

An important feature of these data are the occupation definitions. These industry-specific job classifications are more detailed than 4-digit Dictionary of Occupational Titles or Census codes and cover approximately 60 percent of establishment employment. For example, in the plastics sample, codes distinguished among these three occupations working on a blow-molding machine: 'operate', 'set-up', and 'set-up and operate.' This level of detail

provides strong control for human capital as productively used.

Each extensive survey covers from 11,000 to 168,000 workers and from 57 to 876 establishments. The six manufacturing industries studied are an arbitrary subset of the industries with moderate unionization rates in Freeman (1981). The industries included are fairly diverse, varying widely in proportion unionized, male, and incentive.

3. The Impact of Establishment Effects on Wage Dispersion

Table 4 partitions the total sum of squares of wage for each industry into five categories: occupation, establishment, joint (occupation and establishment), work-group, and individual. In order to control for human capital as fully as possible, sex, region (where available), and an incentive dummy are included with job classification in the analysis below.' For ease of exposition, the entire group of variables is referred to as "occupation" in the tables and discussion that follows, except when stated to the contrary.

In the six industries studied, establishment effects within industry account for a minimum of 12 percent to 58 percent (with a mean of 31 percent) of wage variation. These are differentials paid to all production workers in the establishment, controlling for occupation, sex, incentive, and region. Despite the large number of establishments surveyed relative to occupations, the establishment effects are statistically significant when added as a group to models with occupation already included. Further characteristics of the estimated establishment coefficients are explored below, after a discussion of the other components of wage variation.

As expected, occupation is also a powerful determinant of wage, accounting for 11 percent to 35 percent (with a mean of 20 percent) of wage variation. But, in only one case out of six (cotton textiles), is occupation a more

powerful determinant (alone or with the joint contribution) of wages than is establishment. In the others, establishment clearly dominates.

The contribution of work-group (ranging from 8 percent to 14 percent of variation) indicates that, on average, differing internal labor-market structures cause only 10 percent of wage variance, although they are significant in each of the industries studied. The small size of the work-group term relative to the establishment term (about one third on average), is evidence that the ranking of employers is fairly consistent across occupations. A high-wage employer for one occupation is also a high-wage employer for the other occupations employed there. That is, despite the different ways in which various occupations enter the production process, they tend to have similar establishment differentials.

Finally, individual (within work-group) variation contributes the smallest portion of variance (3 percent to 7 percent) in the industries with few incentive workers (plastics, structural steel, and chemicals) and a larger portion (27 percent to 51 percent) in the industries with many incentive workers (wool and cotton textiles, and shirts and nightwear). Another way to view the small proportion contributed by individual variation in nonincentive workers' wages is to note that the coefficient of determination (R^2) of occupation, establishment, and work-group in a wage equation for these industries averages 96 percent: far higher than that usually achieved in cross-sectional wags equations.

Because the F-statistics for the inclusion of each source of dispersion are all strongly significant, only model 8 in table 1 cannot be rejected. However, the relative size of the components suggests that the best shorthand version of the wage-setting mechanism (in the absence of incentive pay) is actually model 5: wage variation is primarily due to only two factors--occupational differentials and establishment differentials.

4. Characteristics of Estimated Establishment Differentials

Table 5 summarizes information about the estimated establishment differentials. The first column repeats the information from row 3 of table 4: the percent sum of squares (contribution to R^2) from the addition of establishment to a regression with occupation. This percentage does not include differences in total earnings variation between industries. Row 2 presents the results of multiplication of the percentage of the sum of squares due to establishment by the total variance of the industry sample, and then taking the square root to generate a 'suggested standard deviation.' As an upper bound on the contribution of establishment, the third column reports the R^2 from a regression of wages on establishment alone (that is, the establishment, plus 'joint' portions of variation). The fourth column multiplies the previous column by industry wage variation and takes the square root.

These four columns make the following point: establishment differentials account for 12 percent to 58 percent of wage variation, controlling for occupation--and 17 percent to 85 percent, not controlling for occupation. On average, they generate 32 percent or 50 percent of variation, (controlling for, or not controlling for, occupation). And, in terms of standard deviations, establishment contributes a standard deviation of 11 percent to 14 percent of mean wages.

Alternatively, we can evaluate the size of these differentials by examining characteristics of the actual estimated differentials. The last three columns of table 5 present the minimum and maximum estimated differential and the variance of the differentials for each industry, from the model controlling for occupation. The magnitude of the extrema is striking.

Workers in the lowest–wage establishments receive as little as 58 percent below the mean for their occupations, while the highest–wage employers pay as much as 110 percent above occupational averages. The mean spread is from 35 percent below the mean to 66 percent above it; both are three to four times the union wage differential of 12 percent to 15 percent. On average, the most generous employers pay employees in each occupation twice as much as do the lowest–wage employers in the industry.

The final column in table 5 shows the standard deviation of the estimated establishment differentials in each industry. These fall between the estimates in columns 2 and 4 in half of the cases, and above the column 4 estimates in the other three cases. The mean (0.14) is the same as that of column 4, and is well above the figures used in the remainder of this analysis: namely, those in column 2.

For illustrative purposes, figure 1 provides plots of estimated establishment differentials within these six industries, weighted by the number of workers surveyed in each establishment. These patterns reveal differences among wage patterns in the six industries. In the absence of further investigation, the purpose of these plots must be to stimulate discussion and research, and to demonstrate that although some outliers exist, they do not constitute the bulk of variation.

The plots offer some intriguing variations. In cotton textiles, the industry with the least between–establishment variation, differentials are highly concentrated close to the 0 percent differential line. Fabricated structural steel, shirts & nightwear, and plastics appear to have fairly even, symmetrical distributions. Wool textiles shows the strongest evidence of bimodality. (Perhaps a dual labor market?) Chemicals is the only industry to show a marked skewness to the left.

5. Summary of Results

Table 4 partitions the sums of squares for each industry, but does not indicate estimated variances for the components of interest. Table 6 presents the "suggested standard deviation" for all components of within-industry wage variation for all six industries. In order to stack the deck against the investigated effect, the joint effects from table 4 are allocated to occupation. The last column presents the simple mean for each factor. By this admittedly crude calculation, employer differentials alone in an industry-wage distribution generate an average standard deviation of 11 percent.

How large are these numbers in practical terms? The experiment that this research tries to simulate is the random transfer of a worker in one establishment to a job in the same occupation at another establishment. What is the expected wage change from such a switch?

This question asks for the expected absolute value of the difference between two identically distributed random variables. Assuming a normal distribution of differentials, the question reduces as follows:

$$(6) \qquad E[\Delta d] = E[|d_1 - d_2|] = \sqrt{2} \cdot (\phi[0]/\Phi[0]) \cdot \sigma_d =$$

$$= \sqrt{2} \cdot (.4/.5) \cdot \sigma_d = 1.13\sigma_d,$$

where d = random differential~$N(0,\sigma_d^2)$, and $\phi[0]$ and $\Phi[0]$ are the normal density and the cumulative normal density functions, evaluated at zero.

Using the results from the last column of table 6, a random switch in establishment within industry (within job classification, sex, region and incentive class) yields an expected change in wages of 12 percent. This

corresponds to a difference of $2,450 per year for the average blue-collar production worker in manufacturing in 1986 (out of $20,400). In contrast, a random switch in occupation (holding establishment fixed) results in an expected difference of 14 percent or $2,860 in yearly income. Switching employers within industry results in a very large expected income change, almost as large as that from a switch in occupation within industry. It will be argued later that the size of these differentials makes it unlikely that they are caused by random variations.

Changes in the internal wage structure (that is, changing the way a particular occupation is rewarded in an establishment) generate a wage change of 7 percent, or $1,430. Finally, switching places with another individual in the same work-group yields an expected difference of from 3 percent to 16 percent, depending on the pay scheme.

6. Are These Results Unrepresentative?

Because union and nonunion wage-setting mechanisms differ and because these industries are more highly unionized than the average, table 7 compares the suggested standard deviations for union and nonunion establishments in the plastics industry. The results for the two sectors are fairly similar, except that (consistent with Freeman [1981]), total variance for the union sample is lower. The decrease in total variance in the union sector shows up consistently in all components of variance except for the establishment contribution. The standard deviation due to establishment appears the same or higher in the union sector. Establishment effects are not primarily a union, nor a nonunion, nor a between-sector phenomenon.

In order to check whether these results are due to unrepresentative data, the following other tests were conducted: (1) establishment characteristics

(size, number, industry sector) were compared to those of establishments in the Census of Manufactures -- no systematic differences were apparent; (2) individual worker characteristics (sex, union coverage, occupational distribution) were compared to those in the CPS--again, no major differences were noted); and, (3) results were recalculated using weights supplied by the Bureau of Labor Statistics (BLS)--the percentage of variation attributed to establishment rose. None of these tests casts doubt on the results reported above.

IV. Understanding Establishment Effects

A first step in the search for explanations for the variation in wages among employers is consultation with personnel officers and personnel texts (for examples, see Groshen [1986], Lester [1948] and Foulkes [1980]).[9] These sources provide suggestions, but do not pinpoint the source(s) of employer wage variation. Most consistent is the emphasis on widespread use of wage surveys by employers in order to maintain awareness of market wages.

1. Sorting by Ability (Education, Age, and Tenure)

Variations in human capital can generate apparent establishment differentials, if establishments are sorted by human capital within occupation. To investigate the likelihood of this, the explanatory power of education and experience in the plastics industry in the CPS is compared to that of establishment in the plastics IWS. Then, the INS data is examined for evidence of differing tenure (or experience) distributions among establishments.

First, the small contribution of variation among individuals within

work-group to total wage variation suggests that differences in ability within occupation within particular establishments are either quite small, or are not reflected in wages. If such differences are small, then either occupation dummies should capture most important differences in ability, or establishments are strongly and consistently sorted by ability. If productive differences in human capital are not reflected in wages, then they presumably affect probability of promotion, which argues again that IWS job classification controls well for ability.

Thus, the crucial question is whether standard measures of ability, if they were available, would reduce the importance of establishment differentials in explaining wage variation. In other words, are the IWS job classifications sufficiently detailed to capture most economically relevant variations in human capital?'' We can test this using the CPS, which provides both occupation and human capital variables for its respondents.

The occupations in the CPS are less detailed: the 42 job classifications in the plastics IWS correspond to about 12 CPS 3-digit occupations. Nevertheless, the explanatory power of education, experience (that is, age-education-61, experience-squared and their interactions with sex are small relative to the explanatory power of establishment in the IWS. Table 8 reports regression results for a CPS sample of 383 plastics industry employees. After occupation, sex, and region, the traditional, measurable human capital variables contribute just 7.5 percent to the R^2 for all plastics workers and 5.5 percent for the 199 workers in IWS occupations, or less than one quarter of the minimum of 29.1 percent of wage variation explained by establishment in the IWS data. Thus, omission of years of education and of experience and any qualities correlated with them, could not be the only source of establishment differentials.

In particular, years of education can be rejected as a source of establishment differentials among plastics workers. The fact that education adds virtually no explanatory power within the relatively coarse CPS occupation categories essentially rules out the possibility that this standard measure of education (or other unmeasured quality differences correlated with it) has an effect on wages within narrow IWS job classifications.

Almost all of the impact of human capital on wages within CPS occupations is due to years of potential experience. To the extent that experience (and other unmeasured quality differences correlated with it) is associated with promotion to different job classifications (within the broad CPS occupations), the fineness of IWS occupational categories will capture this wage variation and not attribute it to establishment. If, on the other hand, increased experience primarily raises wages within job classification, and establishments vary significantly by the average experience of their work force, then some of the establishment-effects reported above could be due to experience differentials. However, the results in table 8 suggest that the maximum possible effect is small relative to the total.

A second guage for the potential effect of sorting by experience, or by length-of-service (tenure) as well, is to examine the robustness of the ANOVA with respect to distribution of wages within work-group. Although differences in mean tenure or experience (for example, because of establishment age) could produce apparent establishment differentials between two establishments with identical wage policies, experience and tenure will vary somewhat among workers within work-groups. The minimum and maximum wage levels in each work-group should be more robust than the mean to the effects of tenure variation. The lower sensitivity of the minima to differences in mean tenure arises from purely random turnover (for example, due to deaths). The lower

sensitivity of maxima arises from productivity ceilings within jobs. That is, wage growth in blue-collar jobs is approximately flat after a small amount of tenure (Abraham and Farber [1987]).

It follows that if differing average tenure or experience is an important source of apparent establishment differentials, work-group minima and maxima should demonstrate less variation by establishment than do work-group means. If, on the other hand, establishment differentials are consistent across all levels of tenure and average tenure does not vary greatly among establishments, then ANOVA of extrema will be similar to ANOVA of means."

The ANOVA in table 4 (based on work-group means) can be performed on work-group minima and maxima. Compared to the results in table 4, establishment effects are not diminished in any of four industries. In fact, employer effects are stronger in all cases. Furthermore, the correlation between the minima and maxima in work-groups is 0.50 in plastics. This suggests that establishments with low starting wages have low average wages and low ceiling wages.

Thus, employer differentials are apparently not due to variations in average education, tenure, experience or unobservable characteristics correlated with these measures of human capital. Other studies that attempt to relate wages to quality uncorrelated with traditional human capital measures find only weak relationships, at best (for tests of ability, see Evans [1960] and Conant [1963]; for IQ and latent measures, see Griliches [1977 and 1979]). These studies throw some doubt on the likelihood of sorting by unmeasured quality differences.

2. Compensating Differentials

In order for compensating differentials to generate establishment

differentials, they must compensate for establishment-wide conditions of employment, and these conditions must vary substantially within the industry. Most studies of compensating differentials attempt to identify differentials between industries, where working conditions presumably vary even more than they do within industry. Nevertheless, such inquiries have been marked by their lack of success (Smith [1979]), except for risk of injury or death, neither of which is a factor across the occupations or industries examined here. For working conditions, see Brown (1980), for layoff risk, see Topel (1984). The IWS data do not include explicit information on working conditions. However, if working conditions vary more among industries than within industry (as most studies assume), the lack of success in between-industry studies makes it unlikely that between-establishment differentials are primarily compensating differentials for working conditions.

It is also unlikely that they compensate for differences in fringe benefits. Freeman (1981), Smith and Ehrenberg (1981), and Atrostic (1983) find that inclusion of fringe benefits exaggerates wage differences, that is, scale effects among employers dominate any detectable substitution effects. This conclusion is supported by Eberts and Stone (1985), who find evidence of compensating differentials (for conditions and fringes) within occupation and industry only after controlling for scale effects associated with employer characteristics.[12] Thus, compensating differentials for fringes and working conditions are apparently second-order, not first-order, effects.

The possibility of less easily identifiable (to researchers, that is) variations in plantwide quality of employment remains. Some of these, (for example, effort level, geographic convenience, personnel treatment, or environmental quality--noise, ventilation, fumes) await further data.

However, two rather mechanical possibilities remain and are explored below: variations in age–earnings profiles (that is, implicit contracts) and staggered annual raise dates.

Suppose establishments differ in age–earnings profiles, but not in the total of lifetime compensation offered to workers. Some employers offer steep profiles, with low entry–level wages but high wages later on. Others offer a flatter progression. We would see apparent establishment differentials if workers' lifetime employment progressions were primarily within job classification and employers differed both in average tenure and in steepness of profile.'[13] Jobs with low starting wages would have correspondingly high maximum rates. This implies a negative correlation between minimum and maximum wages (controlling for occupation mean). However, the actual correlation for plastics is 0.50, so we can also reject this form of implicit contract explanation.[14]

A final compensating differential possibility is staggered dates of annual salary adjustments: that is, employers pay the same annual wages, but differ in the date of annual adjustment for inflation. Variance attributable to this source is maximized if plants are surveyed on the day before half of the sample receive their annual raise but just after the other half receive theirs. In that case, the maximum variation due to inflation is $(1/4)r^2$, where $r = \ln(1 + i)$, and i = rate of inflation. For instance, in the case of plastics in 1974, the rate of inflation was 8.7 percent, so the maximum possible contribution to variance is .0017, which is 2.8 percent of the total variation and less than a tenth of the estimated establishment effect.[15]

Thus, the observed patterns of wage variation are inconsistent with earlier research on compensating differentials, with age–earnings profiles and with staggered inflation as possible sources.

3. Random Variations

Wage differentials that depend systematically on the characteristics of the establishments are not random. Table 9 provides evidence that the employer differentials estimated above can be associated with measurable employer characteristics. Establishment characteristics provided in IWS data account for about half of the variation due to establishment differentials, even though the number of characteristics variables is about 10 percent of the number of establishments in each industry.[16] As the table indicates, the characteristics included are proportion male, establishment size, and major product, technology, and pay method. These characteristics generally correspond to the factors explored by economists in the 1940s and 1950s and clearly continue to influence wages.[17]

The results reported here are encouraging for the study of employer activity in wage setting because they indicate that wage-relevant differences among employers are observable. Nevertheless, while these factors are important determinants of wages, they do not supply the whole story.

Coefficient estimates for characteristics of establishments in the six industries are reported in Groshen (1986). Because of the large sample sizes, most of the coefficients are statistically significant. Many variables are of economic significance as well (in particular, establishment size, union affiliation, and major pay policy). The following parts describe the relevance of some of the coefficients and other results to wage-determination models.

Both the extent to which the differentials depend on the factors included and the persistence of importance of these factors (since at least the 1940s) make the random variations hypothesis unlikely. For instance, it is

implausible that personnel officers of large firms are all consistently wrong, all mistakenly setting their wages too high, for 40 years. If observed differentials are generated by random errors, information must be costly. The IWS are conducted at no marginal cost to the participants and have been available to the public at no cost for about 40 years. Additional independent, private wage surveys (formal and informal) are prevalent in all sectors of the economy: often provided to employers for the cost of contributing information on their own wage structure.

Futhermore, Groshen (1986 and 1988b) finds that establishment differentials within an area are virtually stationary over six years, and of almost exactly the same magnitude as those estimated here.

One can also compare wage variation to that observed in consumer product prices. For the seven products whose average price was over $90, Pratt, Wise and Zeckhauser (1979) found the average coefficient of variation of prices was 9 percent. This is somewhat smaller than the 11 percent standard deviation among establishments. However, this comparison may not be strongly relevant, because none of these seven expensive items comprised a large portion of consumer expenditures, while wages are a major part of both employee income and employer costs.

In short, the magnitude of establishment differentials, their persistence over time, their correlation with establishment characteristics, and the low cost of wage–survey data provide compelling evidence against the hypothesis that establishment differentials are random noise.

4. Non–Market–Clearing Models: Efficiency Wages and Bargaining

Thus, establishment wage differences cannot be readily explained by simple market models of wage determination. This suggests that attention should be

directed to other models, in particular, to bargaining and efficiency-wage models. However, direct evidence to support or contradict these models is limited.

Efficiency Wages. Efficiency wage arguments posit causality between workers' wages and on-the-job productivity (Yellen [1984], Stiglitz 11984, 19871). Thus, some employers may maximize profits by paying a differential above the market-clearing wage, if resulting increments in productivity exceed costs of the differential. At least five sources of increased productivity have been modeled: reduced monitoring (or shirking) costs (Bulow and Summers [1985] and Shapiro and Stiglitz [1984]), decreased turnover (Salop [1979]), sociological considerations (Akerlof [1982]), market insulation and corporate consistency (Doeringer and Piore 119711). These models can be invoked to explain differentials among firms in two ways. First, the profit-maximizing point is locally (almost) flat, so, firms' indifference among possible combinations (plus costs of adjustment) result in a random distribution of strategies (Bulow and Summers [1985]). Second, differences in technology (for example, vintage effects), or products (for example, differentiated quality niches) may reveal otherwise unobservable variations in the productivity of workers to a few sectors of the market. Efficiency differentials become establishment differentials when workers in all or most occupations in the establishment are affected similarly.

One finding of the ANOVA is relevant for some efficiency-wage explanations: the small contribution of work-group. Its persistently modest size (3 percent to 7 percent of variation) suggests that blue-collar occupations are largely treated similarly by establishments. This suggests that the peculiarities of a job that make it efficient for an employer to offer a wage premium are largely the same for these positions. This mediates

against monitoring versions based on very narrow occupation-specific responsibilities. However, it is not inconsistent with all versions.

A second test for efficiency-wage explanations lies in the contrast between the ANOVA patterns of industries with high and low proportions of incentive workers. If establishment differentials are efficiency-wage premia, then they are unnecessary for workers whose wages are linked to individual performance, producing a negative correlation between prevalence of establishment differentials and incentive workers. Among the industries studied, the correlation between percentage incentive and suggested standard deviations is -0.60.[18] Although this is not significant for a sample of six industries, it is of the correct sign and not small. Thus, it lends some support to the hypothesis.

Bargaining or Insider/Outsider Models. Variation in firms' rents and in employees' bargaining power (or agency costs) are the two necessary conditions for bargaining models to produce wage dispersion. These models differ in the identity of agents and enforcement mechanisms. The bargaining agents are clearest in the case of unionism; otherwise, the workers' bargaining agent is not obvious, although economists have long noted the existence of informal organization by nonunion workers (Dunlop [1957]): including union-threat effect versions, (Dickens [1986]), and managerial capitalismlagency cost versions (Aoki [1984], or Edwards [1980]). For bargaining models to predict establishment differentials, they must include an assumption that binds together workers of different occupations: bargaining power is constant across occupations in establishments, or, workers must form large groups in order to exert bargaining power, or, managerial altruism extends uniformly across occupations.

In bargaining models, a major obstacle is the problem of identification of the bargaining agent for nonunion workers. The strongest direct evidence relevant to the bargaining hypothesis in this study comes from the coefficients and the explanatory power of major union affiliation. To the extent that unions vary by militancy and by the size of rents in the industry sector where they bargain, the rents captured for their members can be expected to vary. Coefficient estimates for the major union affiliation in the six samples suggest differentials of up to 20 percent (in chemicals) between the highest- and lowest-wage unions.[19] Apparently, there are large differences among unions' abilities to raise wages for their members.

The nonunion sector is not monolithic either; table 7 demonstrates that wages vary by establishment in the nonunion sector. These differences are linked to industry sector and principal and secondary product of the establishment, which is also consistent with bargaining models. The more variation in product market conditions, the more variation in available rents. However, bargaining is not the only explanation for the importance of these variables. (For example, different products may demand different worker attention to detail, perhaps affecting the efficient wage for the manufacturer.)

Kleiner and Boullion (1987) support the bargaining hypothesis. In a sample of union and nonunion establishments, they find that average wages are strongly and positively correlated with the extent of provision of firm financial information.

V. Conclusion

1. Summary of Findings

The U.S. manufacturing sector consists of 350,000 establishments, employing 20 million people. Yet, the activities of these enterprises as employers are rarely the focus of labor economics research or theory. Current labor-market research focuses primarily on the wage impact of sex, race, education, and age--even though those factors all together probably account for less wage variation than does identity of employer. The conclusions of the work reported above are as follows:

(1) 20 percent to 70 percent of wage variance among blue-collar workers within industry is due to employer-based differences (estimated standard deviation due to employer differentials within industry is 11 percent). This standard deviation of 11 percent of the mean is comparable to the size of industry effects, which in the Current Population Survey (controlling for occupation and demographic variables) have a standard deviation of approximately 15 percent. Combined, these two sources generate a standard deviation of approximately 19 percent: which is a major portion of the total standard deviation of wages of about 50 percent.

(2) Internal labor market variations (as measured by the work-group, occupation-establishment interaction, term in ANOVA) generate less than 10 percent of wage variance.

(3) Characteristics of establishments (size, union affiliation, principal product, technology, and principal pay method) can account for at least one-half of measured establishment effects.

These observed establishment differentials are almost certainly not random variations. Nor are they consistent with explanations based on observable

human capital or compensating differentials. These findings suggest the need for further investigation of efficiency wages, bargaining or sorting by unmeasured worker quality differences (uncorrelated with standard measures of human capital). However, in these data direct evidence for these later hypotheses is limited.

2. Discussion

This study demonstrates the importance of employer identity in wage determination among blue-collar workers in manufacturing. Groshen (1986, 1988b) extends this analysis to a cross-industry (42 two-digit SICs) sample that includes white-collar occupations, with remarkably consistent results. So although employers differ somewhat in the way they treat different occupations, the average variations between employers overshadows occupation-specific employer (that is, work-group) wage effects. Relative to occupational means, employers tend to compensate janitors as well (or as poorly) as they do millwrights or assemblers.

When job classification and employer are well-identified, they can explain over 90 percent of wage variation. Unless one has an explicit incentive component to one's compensation, working harder at one's job will not significantly increase wages. Only a promotion or a change of employer can raise wages significantly. These effects are roughly comparable in size within industry.

A striking implication of the minimal wage variation within work-group is that all other characteristics of individuals (for example, race, education, marital status) must operate through occupation, employer, or work-group in order for them to have a significant impact on wages. This implies that the research agenda for labor economics should include study of the major

activities of employers: recruitment, promotion, forced separation, and general wage-level policies. For instance, based on this research, barriers to entry (such as discrimination) into highly remunerative occupations or establishments can have a devastating impact on earnings. In particular, many of the most heavily researched wage patterns and inequalities in the labor market are probably manifestations of employer wage differentials.

Endnotes

1. Another reason for the continuing focus on labor-supply variables is the access to household survey data, which typically record no information about employer other than industry.

2. Richard Lester, Lloyd Reynolds, Martin Segal, John Dunlop, Gregg Lewis and others studied interindustry, intra-industry, union, employer size, and regional differentials, focusing on variables controlled by employers (that is, labor demand) and medium-run labor supply.

3. Although the terms wages and earnings are used interchangeably in the text, industrial relations distinguishes between two components of wage determination: the formation of compensation policy (the periodic adjustment of wage and benefit schedules and rules), and the administration of policy (decisions about hiring, piece rates, overtime, discipline, etc.) Because the data used here include both wages and earnings (depending on receipt of incentive payments), the total (net) observed effects investigated here could be the product of differences of policy, administration, or both.

4. Virtually all ideas in the following discussion can be found in the work of earlier economists (notably Adam Smith and the labor economists of the 1940s and 1950s), but were formalized by, and are here referenced to, later authors.

5. Technology is usually assumed to be exogenous, so we need a random distribution of differences in costs of improving conditions. If technology is not exogenous, all firms will choose the one that maximizes profits, so only those combinations of technologies and compensating differentials that yield the maximum profits will coexist.

6. Lagged adjustment, the second type of random variations model, is not inconsistent with the information/search models, but provides a basis for the variations (wage shocks) and an additional reason for their persistence (internal adjustment costs). These models focus on the employer, and are also called "geological models," for example Dunlop (1982).

   Techniques for estimation of variance components of a model of unbalanced design are detailed in Searle (1971) and Henderson (1953). Restricted maximum likelihood (RML) techniques are introduced in Hocking, Hackney and Speed (1978). RML techniques provide single estimates of variance components and their standard errors, but at the expense of imposing a rigid structure on the distribution of the level effects and errors. Because the appropriateness of the structure imposed may vary among industries, and because the purpose of the study is to investigate the nature of establishment differentials, a nonparametric method was preferred for this analysis. Groshen (1986) contains a complete discussion and examples of the application of alternative techniques to these data.

8. The incentive dummy equals one when the worker in question has an incentive component to his or her earnings. These incentives may be in the form of individual or group piece rates, and of individual or group bonuses or commissions.

9. See Pigors and Meyers (1973, p. 363) and Sayles and Strauss (1977, p.355) for lists of the factors to consider in selecting desired establishment pay levels. Both lists include employment conditions: this determines the equilibrium wage. Both include quality of workers, implying the existence of some intentional sorting by human capital but not necessarily consistent across occupations. Finally, 'ability to pay' appears twice. The most direct interpretation of ability to pay is bargaining, but it could be linked to efficiency wages (if employers reversed the causality.) The rest of the second list mentions some compensating differentials and some factors of ambiguous relationship to microeconomic theory (for example, company reputation, pressure from other employers).

   Efficiency wage arguments do not appear explicitly in either list, except perhaps the turnover version. In fact, Pigors and Meyers warn that differentials not tied directly to performance do not guarantee better performance: "When pay is tied to performance ... money is an important motivator; when it is not so tied, it does not motivate...", (p. 362).

10. Note that the purpose of this exercise is <u>not</u> to demonstrate that human capital variables have no influence on wages. Rather, the purpose is to test whether education, experience, experience-squared, and unmeasured ability correlated with them, exert their influence on wages primarily through occupational attainment, as opposed to raising wages within occupation.

11. If tenure mostly leads to movement between occupations or promotion, then occupation will capture differences in tenure, and the employer effect estimates will not be biased.

12. Eberts and Stone (1985) analyze changes in New York public school teacher salaries, controlling for changes in their personal characteristics (education and years experience) and school district characteristics (budget, enrollment and teacher budget share). They find the expected signs and significant coefficients on paid leave days, health benefits, drop-out rate, teacher-student ratio and racial mix of teachers. However, the district characteristics are the strongest predictors in the equation and, when dropped from the regression, coefficients on the conditions of employment switch signs or become insignificant.

13. If the progression is among classifications, steep profile establishments would offer low wages for entry-level positions, but offer high wages for jobs attained after high tenure. Flat profile employers would offer average rates throughout employment. But this would generate high variance due to work-group, not due to establishment alone. So, it would not generate the observed pattern of variation.

14. Abraham and Farber (1987) also reject implicit contract models of this sort in their study of Michigan PSID respondents.

15. This generates the highest possible <u>expected</u> variation due to inflation.

16. Because the characteristics included are dummies based on establishment, they cannot explain more wage variance than do establishment dummies. The dummies span the establishment space, so vectors of establishment characteristics are linear combinations of establishment dummy vectors. Therefore, comparison of the R^2's of regressions with characteristics to those with dummies yield estimates of the extent to which characteristics summarize all the information relevant to wage determination in establishments. That is, if the only important difference among these establishment were union status, then the R^2 of a regression of wages on union status would be the same as that of one on establishment dummies. The dummies would provide no additional information relevant to wage formation.

17. The correspondence is not entirely coincidental, because the IWS program was modified under the influence of these economists, in order to aid in their administration of wage and price controls.

18. The correlation between percent incentive and percent sum of squares due to establishment is -0.56. The correlation between percent incentive and the percent sum of squares due to occupations is -0.25. If the joint part of variation is allocated to establishment, the correlation is -0.52.

19. Independent support for the existence of rent sharing in the union sector comes from John Abowd's (1985) study of the effect of union settlements on value of the enterprise. He finds evidence of zero-sum bargaining over rents. Salinger (1984) gets consistent results using different data and basing results on a union/nonunion comparison.

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Table 1

Variance Components Model Interpretations

MODEL 1. $\sigma_w^2 = \sigma_\varepsilon^2, \quad \sigma_\alpha^2 = \sigma_\beta^2 = \sigma_\Upsilon^2 = 0$
INTERPRETATION: Wages are entirely random or linked to individual characteristics that are independent of occupation and establishment. (Consistent with individual bargaining and/or wages equal to marginal product, which is independent of occupation and establishment.)

MODEL 2. $\sigma_w^2 = \sigma_\alpha^2 + \sigma_\varepsilon^2, \quad \sigma_\beta^2 = \sigma_\Upsilon^2 = 0$
INTERPRETATION: Wages are determined by occupation and individual variation within occupation. Patterns are entirely independent of employer. (Consistent with the dominance of the external labor market in wage determination for each occupation. Employers are price-takers.)

MODEL 3. $\sigma_w^2 = \sigma_\beta^2 + \sigma_\varepsilon^2, \quad \sigma_\alpha^2 = \sigma_\Upsilon^2 = 0$
INTERPRETATION: Wages are set by establishments, and internal wage structures are completely independent of occupation. (Consistent with domination of idiosyncratic internal markets in wage determination, with no worker mobility between employers.)

MODEL 4. $\sigma_w^2 = \sigma_\Upsilon^2 + \sigma_\varepsilon^2, \quad \sigma_\alpha^2 = \sigma_\beta^2 = 0$
INTERPRETATION: Wages are consistent within work group, and, on average, do not differ across occupations or employers. (Consistent with separate bargaining by each occupation in an establishment, with outcome independent of productivity, or productivity independent of occupation and establishment.)

MODEL 5. $\sigma_w^2 = \sigma_\alpha^2 + \sigma_\beta^2 + \sigma_\varepsilon^2, \quad \sigma_\Upsilon^2 = 0$
INTERPRETATION: Wages depend on occupation and employer. Internal wage structures mirror the economywide occupational structure, except for a uniform differential paid to all employees. (Consistent with an external market for each occupation and collective bargaining by employees, or establishment relative wage policies, evenly distributed. Internal labor markets do not vary.)

MODEL 6. $\sigma_w^2 = \sigma_\alpha^2 + \sigma_\Upsilon^2 + \sigma_\varepsilon^2, \quad \sigma_\beta^2 = 0$
INTERPRETATION: Wages are occupational means, plus differences due to varying establishment internal wage structures. On average (across occupations), however, establishments do not deviate from mean wages. (Similar to model 4, with an influential external market for each occupation.)

MODEL 7. $\sigma_w^2 = \sigma_\beta^2 + \sigma_\Upsilon^2 + \sigma_\varepsilon^2, \quad \sigma_\alpha^2 = 0$
INTERPRETATION: Establishments differ in mean wages paid to workers, and although their internal wage structures do depend on occupation, these internal structures have nothing in common from one employer to the next. (Consistent with the dominance of internal labor markets and lack of worker mobility or employee collective bargaining with somewhat unequal distribution.)

MODEL 8. $\sigma_w^2 = \sigma_\alpha^2 + \sigma_\beta^2 + \sigma_\Upsilon^2 + \sigma_\varepsilon^2$
INTERPRETATION: The most general model, wages depend on occupation differentials, establishment differentials and differences in internal structures. (Consistent with a complex labor market: wages dependent on internal and external labor markets and employer relative wage policies.)

Table 2

A Technique for Partitioning the Sum of Squares in Unbalanced Data

Source of Variation	Percent of Total Sum of Squares*
1. Occupation, sex, region, incentive (controlling for establishment)	$R_C^2 - R_B^2$
2. Joint occupation & establishment	$R_A^2 + R_B^2 - R_C^2$
3. Establishment (controlling for occupation, etc.)	$R_C^2 - R_A^2$
4. Work-group (controlling for occupation and establishment)	$R_D^2 - R_C^2$
5. Total between work-groups	R_D^2
6. Individual	$100\% - R_D^2$
7. TOTAL	100%

* The subscripts on the coefficients of determination correspond to the regression models listed below. For ease of exposition, occupation, sex, region, and incentive are listed as occupation.

A. $w_{ijk} = \mu + X_i\alpha + \varepsilon_{ijk}$

B. $w_{ijk} = \mu + Y_j\beta + \varepsilon_{ijk}$

C. $w_{ijk} = \mu + X_i\alpha + Y_j\beta + \varepsilon_{ijk}$

D. $w_{ijk} = \mu + X_i\alpha + Y_j\beta + X_iY_j\gamma + \varepsilon_{ijk}$

where w_{ijk} = ln wage of individual k in occupation i at establishment j
X_i = vector of occupation dummy variables for occupation i
Y_j = vector of establishment dummy variables for establishment j
X_iY_j = interaction dummy variables for occupation i in establishment j, that is, for work group ij, and
α, β, γ = vectors of estimated parameters.

Table 3

Summary of Industry Wage Survey Sample Characteristics

	Miscellaneous Plastics	Industrial Chemicals	Wool Textiles	Shirts & Nightwear	Cotton Textiles	Structural Steel
Year	1974	1976	1975	1978	1975	1975
Mean wage	$3.31	$6.45	$3.18	$3.74	$3.11	$4.70
Variance ln (wage)	.063	.028	.032	.042	.026	.031
Percent male	48.1%	96.8%	58.4%	7.5%	53.1%	99.4%
Percent in mostly union plants	52.5%	70.1%	25.1%	33.5%	22.2%	76.9%
Mode establishment size category	100-249	1000-2499	500-999	100-249	500-999	100-249
Percent receive incentive pay of any sort	6.2%	1.3%	21.0%	84.3%	30.1%	11.1%
Percent in mostly individual piece-rate plants	2.9%	0.0%	82.3%	96.2%	81.9%	3.7%
Sample size	70,355	71,921	10,690	40,068	168,014	23,231
Number of occupations	42	27	72	30	46	45
Number of establishments	876	270	57	219	338	331
Avg. number of persons of same sex per job classification	9.4	21.6	10.6	12.6	22.3	5.8

Source: Tabulations from BLS Industry Wage Surveys

Table 4

Analysis of Sources of Wage Variance in Six Industries'

Source of Variation	Miscellaneous Plastics Products		Industrial Chemicals		Wool Textiles	
	Degrees of Freedom	Percent of Total Sum of Squares (F-Statistic)'	Degrees of Freedom	Percent of Total Sum of Squares (F-Statistic)[5]	Degrees of Freedom	Percent of Total Sum of Squares (F-Statistic)[5]
. Occupation, sex, region, and incentive[2]	46	29.1% (2,111)	29	14.3% (1,556)	73	16.9% (65)
. Joint occup., etc. & establishment	-	20.9	-	14.9	-	10.2
. Establishment[3]	875	29.1 (111)	269	58.2 (684)	56	37.8 (188)
. Work group[4]	7,507	13.7 (18)	3,029	8.7 (40)	874	8.4 (4)
. Total between work groups	6,538	92.9	3,327	96.1	1,003	73.3
. Individual	62,847	7.1	68,593	3.9	9,686	26.7
TOTAL	70,354	100.0%	71,920	100.0%	10,689	100.0%
otal Sum of Squares	4,457		2,027		344	

This table is continued on the next page. See table 2 for a guide to this method of partitioning the sum of squares with an unbalanced design.
Controlling for establishment.
Controlling for occupation, sex, region, and incentive.
Including all interactions between occupation, sex, incentive and establishment, controlling for occupation and establishment.
All F-Statistics are significant at well above the 1 percent level.

ource: Tabulations from BLS Industry Wage Surveys.

Table 4, continued

Analysis of Sources of Wage Variance in Six Industries'

Source of Variation	Men's and Boys' Shirts and Nightwear		Cotton and Man-Made Textiles		Fabricated Structural Steel	
	Degrees of Freedom	Percent of Total Sum of Squares (F-Statistic)[5]	Degrees of Freedom	Percent of Total Sum of Squares (F-Statistic)[5]	Degrees of Freedom	Percent of Total Sum of Squares (F-Statistic)[5]
. Occupation, sex, region, and incentive[2]	33	11.0% (217)	47	34.9% (2,583)	49	12.4% (476)
. Joint occup., etc. & establishment	-	7.3	-	4.6	-	43.9
. Establishment[3]	218	20.6 (62)	337	12.4 (128)	331	31.5 (179)
. Work group[4]	2,921	10.5 (3)	7,142	8.6 (5)	3,604	8.4 (12)
. Total between work groups	3,172	49.4	7,526	60.5	3,984	96.2
. Individual	36,895	50.6	160,487	39.5	19,246	3.8
TOTAL	40,067	100.0%	168,013	100.0%	23,230	100.0%
Total Sum of Squares	1,637		4,379		1,190	

'See table 2 for a guide to this method of partitioning the sum of squares with an unbalanced design.
'Controlling for establishment.
'Controlling for occupation, sex, region and incentive.
'Including all interactions between occupation, sex, incentive and establishment, controlling for occupation and establishment.
'All F-statistics are significant at well above the 1 percent level.

Source: Tabulations from BLS Industry Wage Surveys.

Table 5

Characteristics of Estimated Establishment Differentials

	Without Joint Contribution		With Joint Contribution		Range of Estimated Differentials		Standard Deviation of Estimated Differentials
	%SS	Suggested Std. Deviation*	%SS	Suggested Std. Deviation*	Low	High	
Plastics	29.1	.14	40.0	.16	-38%	+110%	.15
Industrial Chemicals	58.2	.13	73.1	.14	-58%	+27%	.15
Wool Textiles	37.8	.11	58.0	.14	-27%	+55%	.15
Shirts & Nightwear	20.6	.09	27.9	.10	-30%	+48%	.13
Cotton Textiles	12.4	.06	17.0	.06	-25%	+62%	.09
Structural Steel	31.5	.13	85.4	.21	-34%	+93%	.18
RANGE							
Minimum	12.4	.06	17.0	.06	-25%	+27%	.09
Maximum	58.2	.14	85.4	.21	-58%	+110%	.18
MEAN	31.6	.11	50.2	.14	-35%	+66%	.14

* Suggested standard deviation =([category proportion of CSS] x [industry variance]) $^{1/2}$.
Source: Tabulations from BLS Industry Wage Surveys.

Table 6

Suggested Standard Deviations for Industry Wage Surveys*

Source	Plastics	Industrial Chemicals	Wool Textiles	Shirts and Nightwear	Cotton Textiles	Structural Steel	SIMPLE MEAN
Occupation, sex, Region & incentive	.18	.09	.09	.09	.10	.17	.12
Establishment	.14	.13	.11	.09	.06	.13	.11
Work-Group	.09	.05	.05	.07	.05	.07	.06
Individual	.07	.03	.09	.14	.10	.04	.08
TOTAL	.25	.17	.18	.20	.16	.18	.19

*Suggested Standard Deviation=([category proportion of CSS]x[industry variance])$^{1/2}$
Joint contribution is allocated to occupation.

Source: Table 4

Table 7

Analysis of Variance of Plastics Industry Wage Survey
Union vs. Nonunion Samples

Source of Variation	UNION ESTABLISHMENTS		NONUNION ESTABLISHMENTS		SUGGESTED STANDARD DEVIATIONS*	
	Degrees of Freedom	% Total Sum of Squares	Degrees of Freedom	% Total Sum of Squares	Union	Nonunion
Occupation and sex	42	22.8%	42	33.5%	.16	.18
Joint sex, occupation, and establishment	-	20.7%	-	17.2%	-	-
Establishment	397	39.9%	498	30.3%	.15	.14
Work-group	3,277	10.4%	3,225	10.4%	.08	.10
Individual	33,032	6.4%	29,940	8.6%	.06	.07
TOTAL	36,748	100.0%	33,605	100.0%	.24	.25

*Suggested standard deviation=([category proportion of CSS]x[industry variance])$^{1/2}$.
Joint contribution is allocated to occupation.

Source: Tabulations from BLS Miscellaneous Plastics Products Industry Wage Survey.

Table 8

Additional Contribution of
Human Capital Variables When Added to Current Population Survey
Ln(Earnings) Regressions With Occupation, Sex, and Region Dummies

	All Plastics Employees			Plastics Workers in IWS Surveyed Occupations		
Independent Variables	d.f. or Coeff.	Total R^2	ΔR^2	d.f. or Coeff.	Total R^2	ΔR^2
Occupation, male, and region	55	37.8		13	29.0	
Education	0.019 (0.011)	38.0	0.2	0.014 (0.015)	29.1	0.1
Experience (i.e., age-ed.-6)	0.013 (0.004)	42.8	4.8	0.010 (0.007)	32.4	3.3
Exper.^{2}/100	-0.024 (0.010)	44.8	2.0	-0.017 (0.016)	34.2	1.8
Male*education	0.005 (0.708)	44.8	0.0	0.003 (0.019)	34.2	0.0
Male*experience	0.004 (0.482)	45.3	0.5	0.006 (0.009)	34.4	0.2
Male*exp.^{2}/100	0.001 (0.942)	45.3	0.0	-0.011 (0.022)	34.5	0.1
TOTAL	58	45.3		12	34.5	
Contribution of education, experience, experience squared and interactions with male		7.5%			5.5%	
Number of Observations		383			199	
Mean ln(Earnings)		1.20			1.22	
Variance		.084			.086	
Standard Deviation		.29			.29	

Dummies for years were included; all reported figures are net of annual effects. Three-digit occupation classifications were used.

Source: Merged May CPS tapes, 1973, 1975, 1977.

Table 9

Comparison of Regressions on Establishment Dummies With Regressions on Establishment Characteristics in Industry Wage Surveys

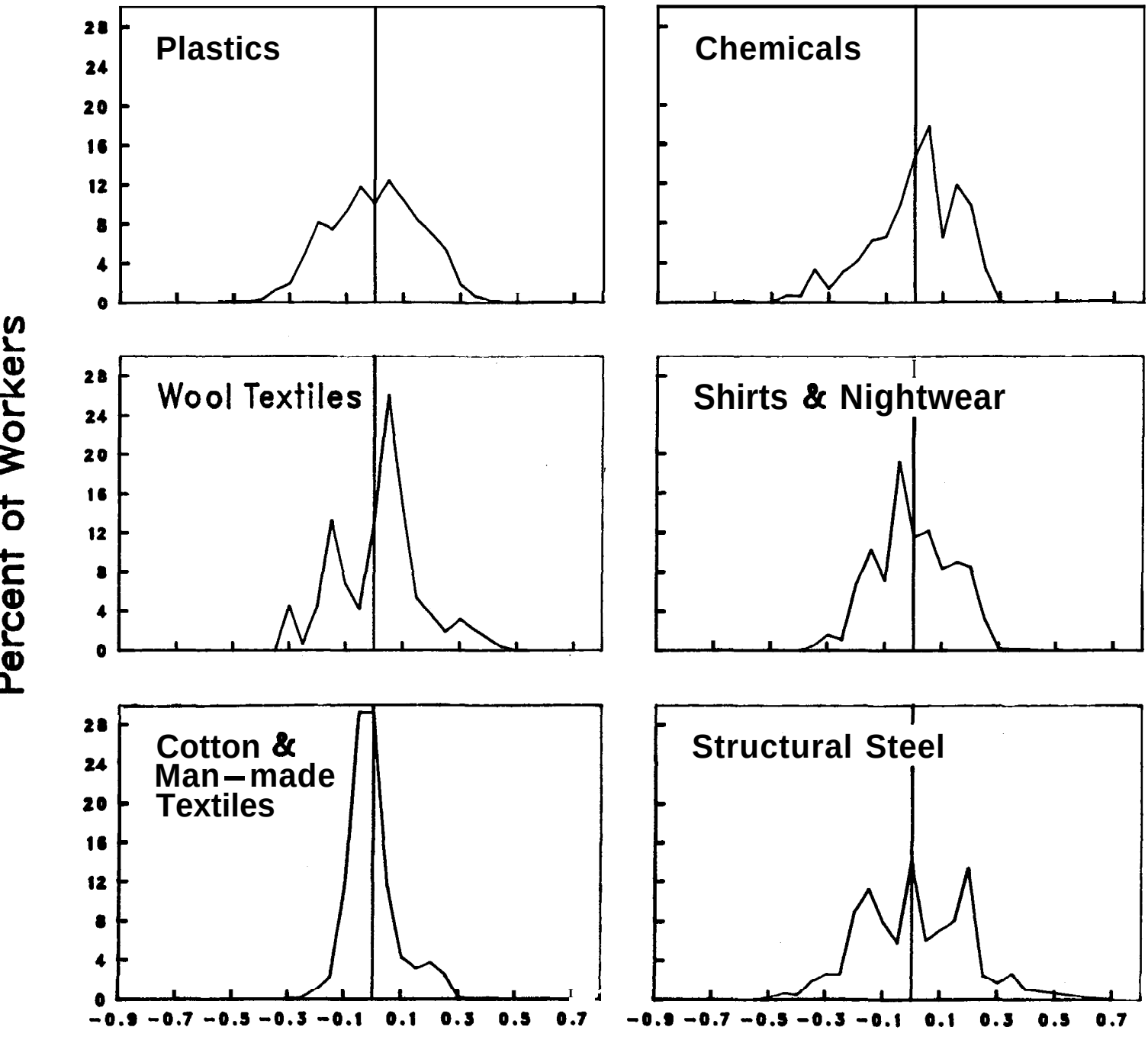
Eq.	Independent Variables	Plastics		Industrial Chemicals		Wool Textiles		Shirts and Niahtwear		Cotton Textiles		Structural Steel	
		R^2	Change from Eq.1	R^2	Change from Eq.1	R^2	Change from Eq.1	R^2	Change from Eq.1	R^2	Change from Eq.1	R^2	Change from Eq.1
1.	Occupation, sex, region & incentive	50.0	-	29.2	-	27.1	-	18.3	-	39.5	-	56.3	-
2.	Occup., etc. and establishment dummies	79.1	+29.1	87.4	+58.2	65.9	+37.8	38.9	+20.6	51.9	+12.4	87.8	+31.5
3.	Occup., etc. and establishment characteristics'	61.3	+11.3	53.8	+28.7	53.8	+26.6	29.0	+10.7	44.2	+4.7	66.9	+10.6
Ratio of explanatory power of characteristics to establishment dummies		.388		.492		.703		.519		.379		.337	

[1] See table 4 for means of selected characteristics, and the appendix for coefficient estimates and means of all characteristics. In general, the establishment characteristics included as follows: in SMSA, percent male in establishment, principal and secondary product, principal and secondary pay methods, establishment size range, major union affiliations, and technology.

Source: Tabulations from BLS Industry Wage Surveys.

Figure 1

Distribution of Establishment Wage Differentials



Source: Tabulations from BLS Industry Wage Surveys.

Table A-1

The Effect of Establishment Characteristics on Log Earnings
Plastics Products

Characteristic	Levels	Mean (in percent)	Coefficient or No. of Dummies
Occupation		--	41
Region		--	3
In SMSA		75.2	0.051 (0.001)
Proportion male		--	0.127 (0.003)
Male		48.1	0.060 (0.002)
Receive incentive pay		6.2	0.117 (0.004)
Establishment size	1-19	0.2	-0.050 (0.011)
	20-49	4.0	-0.051 (0.003)
	50-99	11.5	-0.040 (0.002)
	100-249	36.8	--
	250-499	30.4	0.054 (0.001)
	500-999	13.1	0.041 (0.002)
	1000-2499	3.9	0.160 (0.004)
Major union affiliation	None, minority	47.8	--
	Gl & bottle wkrs	2.5	0.037 (0.004)
	Machine & aero	3.6	0.053 (0.003)
	Chemical wkrs	0.9	0.004 (0.006)
	IGLWU	0.7	-0.098 (0.007)
	UAW	9.5	0.084 (0.003)
	Rubber wkrs	3.7	0.017 (0.002)
	Independent	0.7	-0.027 (0.007)
	Other unions	30.6	-0.005 (0.001)
Major pay policy	Indiv. determin.	6.0	--
	Range-merit	11.6	-0.015 (0.003)
	Range-auto.	29.6	0.050 (0.003)
	Range-merit & auto.	27.6	0.018 (0.003)
	Single rate	19.4	0.070 (0.003)
	Indiv. piece	2.9	-0.021 (0.005)
	Indiv. bonus	0.6	0.102 (0.009)
	Group piece	2.1	0.008 (0.006)
	Group bonus	0.2	-0.012 (0.014)
Principal product	Apparel	2.4	-0.052 (0.004)
	Bldg. materials	5.9	0.003 (0.004)
	Containers	18.0	--
	Dishes & housewr.	13.3	-0.063 (0.002)
	Pipes	4.7	-0.033 (0.003)
	Other	55.7	-0.025 (0.002)

Table A-1, continued

The Effect of Establishment Characteristics on Log Earnings
Plastics Products

Characteristic	Levels	Mean (in percent)	Coefficient or No. of Dummies
Molding activity	None	3.0	--
	Blow molding	5.3	0.069 (0.005)
	Compression	14.3	0.102 (0.005)
	Extrusion	14.4	0.096 (0.004)
	Injection	52.7	0.028 (0.004)
	Lamination	4.7	0.087 (0.005)
	Vacuum	3.9	0.005 (0.005)
	Other	1.7	0.067 (0.006)
Secondary pay policy			9
Secondary molding activity			7
R^2		66.0	

Source: Tabulations from BLS Industry Wage Surveys.

Table A-2

The Effect of Establishment Characteristics on Log Earnings
Industrial Chemicals

Characteristic	Levels	Mean (in percent)	Coefficient or No. of Dummies
Occupation		--	26
Region		--	1
In SMSA		73.1	0.059 (0.001
Proportion male		--	0.028 (0.005)
Male		96.8	0.087 (0.003)
Receive incentive pay		1.3	0.039 (0.006)
Establishment size	20-49	0.2	-0.123 (0.101)
	50-99	2.5	-0.009 (0.003)
	100-249	7.1	--
	250-499	17.0	0.042 (0.002)
	500-999	29.0	0.054 (0.002)
	1000-2499	31.3	0.095 (0.002)
	2500+	12.9	0.110 (0.002)
Major union affiliation	None or minority	29.9	--
	Intl chem wkrs	11.5	-0.083 (0.002)
	Oil, chemical & atomic	14.9	-0.074 (0.002)
	Steelworkers	20.2	-0.025 (0.002)
	Independent	8.8	0.057 (0.002)
	Other unions	14.7	0.119 (0.007)
Major pay policy	Indiv. determin.	0.4	--
	Range-merit	2.4	0.313 (0.007)
	Range-auto	21.4	0.420 (0.007)
	Range-merit & auto.	11.4	0.331 (0.007)
	Single rate	62.8	0.408 (0.007)
	Indiv. piece rate	0.0	0.368 (0.019)
	Group bonus	1.6	0.249 (0.010)
	Commission	0.1	0.474 (0.020)
Principal products	Org. 1 prod.	21.7	-0.050 (0.009)
	Org. only	6.8	0.008 (0.010)
	Org. & inorg.	9.1	0.008 (0.010)
	Org. & plastics	16.8	0.052 (0.010)
	Org. & ot. chem.	1.8	-0.113 (0.026)
	Inorg. 1 prod.	24.9	-0.080 (0.009)
	Inorg. only	10.0	-0.025 (0.010)
	Inorg. & org.	2.7	-0.038 (0.010)
	Inorg. & plastics	3.7	0.005 (0.010)
	Inorg. & gases	1.8	-0.080 (0.010)
	Inorg. & ot. chem.	0.4	-0.014 (0.022)
	Inorg. & non-chem.	0.3	--
Secondary product			7
Secondary pay policy			7
R^2		56.0	

Source: Tabulations from BLS Industry Wage Surveys.

Table A-3

The Effect of Establishment Characteristics on Log Earnings
Wool Textiles

Characteristic	Levels	Mean (in percent)	Coefficient or No. of Dummies
Occupation		--	71
In SMSA		33.1	0.074 (0.003)
Proportion male		--	0.211 (0.010)
Male		58.4	0.065 (0.002)
Receive incentive pay		21.0	0.070 (0.003)
Establishment size	20-49	1.9	0.022 (0.008)
	50-99	5.7	-0.113 (0.005)
	100-249	29.0	--
	250-499	31.1	-0.059 (0.003)
	500-999	32.2	0.144 (0.005)
Major union affiliation	None or minority	74.9	--
	Textile wkrs union	17.7	-0.095 (0.006)
	U. textile wkrs	1.8	0.066 (0.007)
	Other unions	5.5	-0.033 (0.009)
Major pay policy	Indiv. determin.	3.8	--
	Range-merit	1.2	0.331 (0.010)
	Range-auto.	1.3	0.043 (0.013)
	Range merit & auto.	0.0	0.052 (0.007)
	Single rate	6.3	0.057 (0.006)
	Indiv. piece	82.3	-0.144 (0.024)
	Group piece	2.6	0.153 (0.023)
Principal product	Apparel	63.5	--
	Blanketing	1.4	0.075 (0.008)
	Woven nonapparel	22.0	0.017 (0.003)
	Yarn ex. rug	8.4	0.218 (0.017)
	Rug yarn	4.7	.261 (0.016)
Scope of operations	All wool	11.8	--
	Mostly wool	25.1	0.001 (0.004)
	All blends	24.3	0.017 (0.004)
	Mostly blends	37.6	-0.096 (0.005)
	Other	1.1	0.111 (0.009)
Mill type	Spinning mill	13.1	--
	Weaving mill	4.2	0.133 (0.007)
	Integrated mill	82.7	--
Secondary pay policy			5
R^2		73.6	

Source: Tabulations from BLS Industry Wage Surveys.

Table A-4

The Effect of Establishment Characteristics on Log Earnings
Mens' and Boys' Shirts and Nightwear

Characteristic	Levels	Mean (in percent)	Coefficient or No. of Dummies
Occupation		--	29
Region		--	2
In SMSA		29.6	0.007 (0.001)
Proportion male		--	-0.081 (0.010)
Male		7.5	0.039 (0.003)
Receive incentive pay		84.3	0.094 (0.002)
Establishment size	1-19	0.0	0.179 (0.047)
	20-49	1.4	-0.025 (0.005)
	50-99	5.2	-0.014 (0.002)
	100-249	28.0	--
	250-499	41.9	0.012 (0.001)
	500-999	21.4	0.019 (0.002)
	1000-2499	2.1	0.088 (0.004)
Major union affiliation	None or minority	66.5	--
	Clothing & text.	29.3	0.103 (0.002)
	U. garment wkrs.	0.9	-0.050 (0.005)
	Other unions	3.3	0.098 (0.003)
Major pay method	Indiv. determin.	2.3	--
	Indiv. piece rate	96.2	-0.104 (0.020)
	Group piece rate	1.5	-0.169 (0.021)
Principal product	Dress shirts	39.6	0.004 (0.001)
	Sports shirts	53.1	--
	Nightwear	4.7	0.036 (0.004)
	Other	2.6	0.044 (0.005)
Secondary product	None	53.9	--
	Dress shirts	6.8	-0.020 (0.002)
	Sports shirts	13.6	0.004 (0.002)
	Nightwear	1.2	0.160 (0.005)
	Other	24.6	-0.004 (0.001)
Production method	Line system	1.7	0.034 (0.004)
	Bundle system	42.7	-0.017 (0.001)
	Prog. bundle	54.8	--
	Other	0.8	0.036 (0.006)
Secondary pay policy			7
R^2		58.7	

Source: Tabulations from BLS Industry Wage Surveys.

Table A-5

The Effect of Establishment Characteristics on Log Earnings
Cotton and Man-made Textiles

Characteristic	Levels	Mean (in percent)	Coefficient or No. of Dummies
Occupation		--	45
In SMSA		33.7	0.014 (0.000)
Proportion male		--	0.102 (0.002)
Male		53.1	0.062 (0.000)
Receive incentive pay		30.1	0.069 (0.001)
Establishment size	20-49	0.0	0.077 (0.008)
	50-99	1.2	-0.029 (0.002)
	100-249	7.3	--
	250-499	17.8	0.024 (0.001)
	500-999	35.3	0.015 (0.001)
	1000-2499	23.3	0.041 (0.001)
	2500+	15.0	0.036 (0.001)
Major union affiliation	None or minority	77.8	--
	Textile wkrs union	14.7	0.027 (0.001)
	U. textile wkrs.	7.4	0.040 (0.001)
	Other unions	0.1	0.029 (0.005)
Major pay policy	Indiv. determin.	3.4	--
	Range-merit	0.6	0.049 (0.002)
	Range-auto.	1.5	0.018 (0.002)
	Range-mer & auto.	1.1	-0.005 (0.002)
	Single rate	81.9	-0.013 (0.001)
	Indiv. piece	10.8	-0.038 (0.002)
	Indiv. bonus	0.2	-0.014 (0.004)
	Group piece	0.1	-0.024 (0.007)
	Group bonus	0.5	0.059 (0.004)
SIC	Fabric >12" cotton	47.5	--
	Fabric >12" silk	28.1	-0.010 (0.003)
	Spinning cotton	16.2	-0.057 (0.004)
	Spinning silk	5.9	-0.017 (0.005)
	Threadmaking	2.3	0.010 (0.005)
Scope	All 100 percent cotton	12.0	--
	M. 100 percent cotton	30.1	0.028 (0.001)
	All blend w/cot.	4.1	0.020 (0.001)
	M. blend w/cot.	19.4	0.020 (0.001)
	A. silk or synth.	23.3	0.030 (0.001)
	M. silk or synth.	10.3	-0.003 (0.001)
	Wool blends	0.7	0.000 (0.003)
	Other	0.2	0.176 (0.004)

Table A-5, continued

The Effect of Establishment Characteristics on Log Earnings
Cotton and Man-made Textiles

Characteristic	Levels	Mean (in percent)	Coefficient or No. of Dummies
Principal product	Carded cotton	45.5	--
	Combed cotton	8.8	0.013 (0.001)
	Silk or man-made fil.	16.8	0.014 (0.002)
	Silk or man-made spun	28.9	0.038 (0.001)
Fabric type	Duck	1.3	0.027 (0.002)
	Sheeting<42"	1.9	-0.025 (0.001)
	Sheeting>42"	13.3	-0.010 (0.001)
	Print. cloth yarn	5.7	0.015 (0.001)
	Colored yarn	10.0	0.016 (0.001)
	Towels	8.0	0.019 (0.001)
	Napped & blankets	1.0	-0.012 (0.002)
	Fine cotton	2.0	0.069 (0.002)
	Other woven cottons	4.3	--
	Filament glats	2.7	0.035 (0.003)
	Filament twisted	4.7	0.022 (0.003)
	Spun man-made	17.0	-0.014 (0.003)
	Man-made wool mixtures	0.1	0.025 (0.008)
	Silk & mixtures	0.1	0.183 (0.008)
	Pile & upholstery	3.8	0.066 (0.003)
	Other	0.9	0.125 (0.004)
Mill type	Spinning	23.8	--
	Weaving	9.3	-0.024 (0.004)
	Integrated	66.9	-0.018 (0.004)
Secondary pay policy			5
R^2		56.0	

Source: Tabulations from BLS Industry Wage Surveys.

Table A-6

The Effect of Establishment Characteristics on Log Earnings
Fabricated Structural Steel

Characteristic	Levels	Mean (in percent)	Coefficient or No. of Dummies
Occupation		--	44
Region		--	3
In SMSA		86.6	0.075 (0.003)
Proportion male		--	0.549 (0.053)
Male		99.4	0.057 (0.011)
Receive incentive pay		11.1	0.053 (0.005)
Establishment size	1-19	0.4	0.113 (0.013)
	20-49	5.3	0.018 (0.004)
	50-99	11.9	0.002 (0.003)
	100-249	29.5	--
	250-499	27.7	0.017 (0.002)
	500-999	16.8	0.088 (0.003)
	1000-2499	8.4	0.197 (0.005)
Major union affiliation	None or minority	23.1	--
	Steelworkers	23.8	0.073 (0.003)
	Bridge, str & iron	39.0	-0.027 (0.004)
	Boilermakers	7.3	0.021 (0.007)
	Machinists	1.8	0.077 (0.005)
	Other unions	5.0	0.022 (0.004)
Major pay policy	Indiv. determin.	8.7	--
	Range-merit	11.0	0.001 (0.004)
	Range-auto.	7.5	0.063 (0.005)
	Range-merit & auto.	14.4	0.066 (0.004
	Single rate	45.1	0.105 (0.004)
	Indiv. piece rate	3.7	0.184 (0.008)
	Indiv. bonus	5.6	0.148 (0.010)
	Group piece rate	1.4	0.045 (0.010)
	Group bonus	2.6	0.181 (0.008)
	Commission	0.0	0.474 (0.020)
Process	No joining	0.4	0.054 (0.014)
	Welding only	26.0	0.006 (0.002)
	Bolting only	68.6	0.095 (0.063)
	Mostly bolting	0.0	0.048 (0.004)
	Other	4.3	0.217 (0.010)
	Mostly welding	0.7	--
Secondary pay policy			5
R^2		56.0	

Source: Tabulations from BLS Industry Wage Surveys.