Interindustry wage differentials: patterns and possible sources

Data from the Occupational Employment Statistics survey are used to investigate wage differences among industries and reveal that occupations that are most closely related to the primary mission of the firm have the greatest differential

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Do workers with similar skills in similar occupations receive similar wages across industries? Differences in interindustry wages have been widely documented over the last two decades, and researchers continue to discuss these differences. In particular, they seek the sources of wage dispersion among individual workers, employers, industries, and geographic areas. Recent attempts to explore the role of particular technologies, including microprocessor technologies, in wage dispersion has heightened interest in this issue.[1]

This article examines interindustry wage differentials, using data from the Occupational Employment Statistics (OES) survey. The OES classifies employment and wages of individuals by detailed occupation and three-digit Standard Industrial Classification (SIC) industry.[2] The OES survey solicits employment and wage data for more than 700 occupations in three-digit SIC industries using a sample of 1.2 million establishments.[3] Estimates of occupational employment and wages are developed for the Nation, individual States, and metropolitan statistical areas, as well as Guam, Puerto Rico, and the Virgin Islands. This article uses data from the 1996, 1997, and 1998 surveys, which when combined account for the total OES sample. (Hereafter referred to as the 1998 OES data.)[4]

The OES is useful for investigating wage differences among industries because its data provide high levels of both occupational and industrial detail. Data by detailed occupation allow researchers to examine wage differences among industries that hold constant a relatively detailed description of individuals' job tasks and duties. Because several of the proposed explanations of interindustry wage differentials have implications for the types of tasks and duties that are expected to be most closely associated with wage differences among industries, OES data have considerable potential to add to our understanding of this issue.

Comparisons with other surveys

Most of the earlier (pre-1985) studies of wage dispersion among industries have used data obtained from households, such as the data from the Current Population Survey or those collected from the decennial census. These data contain information about workers' occupation and industry of employment, in addition to information about workers' demographic characteristics such as age, sex, work experience, and education level.[5] Recently, more studies have used data that are collected at the firm or establishment level. These data contain relatively detailed information about workers' occupation, industry of employment, and demographic characteristics.[6]

Wage data from alternative sources have different strengths. One key measure illustrates wage differences across industries for workers with similar levels of education and other "human capital" characteristics. Data obtained from household surveys that describe the demographic characteristics of workers are used to measure the portion of the difference in the wages of workers in similar occupations that is attributable to average differences in the level of workers' "human capital." Wage differences among industries represent a problem for researchers because differences in the demographic characteristics of workers in similar occupations explain only a portion of the wage differences among industries. The demographic information collected by household surveys is thus a very important strength of these data, relative to surveys that collect data classified by occupation and industry alone.

The OES estimates of wage differences among industries compare the wages of workers employed in the same detailed occupations, without also controlling for demographic characteristics. Controlling for detailed occupation holds the following factors constant: job-specific skills and tasks, differences among occupations in labor market power and conditions, and systematic differences among occupations in the wage setting practices of firms. Recent studies suggest that data by detailed occupation and industry implicitly control well for differences in demographic characteristics such as age, education, and experience. In a 1992 study, David I. Levine found that controls for standard human capital variables explained none of the wage variation among employers after controlling for occupation. Earlier studies by Erica L. Groshen and Jonathan Leonard produced similar findings.[7]

Data that control for detailed occupations are especially appropriate for studying interindustry wage differentials because many of the theories that attempt to explain such differentials suggest that the skills and tasks of certain jobs might play an important role. For example, one explanation suggests that wage premiums are paid in an effort to ameliorate workplace problems, such as shirking, by increasing the cost of job loss to the employee. Jobs for which the configuration of duties and tasks are especially costly to monitor should, for this reason, be paid higher premiums than those that are not as expensive. Another explanation suggests a similar rationale for paying wage premiums in the case of high job turnover. Many jobs plagued by high rates of turnover often have in common a set of particularly undesirable tasks or duties.[8]

Table 1 shows a sample of the OES data containing the mean hourly wages of a range of occupations in selected industries. The size of the wage differences among industries for given occupations is striking. For example, the wages of general managers range from $17.40 in bowling centers to $44.89 in the industrial organic chemicals industry, and the wages of janitors range from $6.69 in bowling centers to $16.36 in motor vehicles and equipment manufacturing. For most occupations, the table reveals a clear pattern of higher wages in industries near the top of the table and lower wages in industries at the bottom. However, this pattern is not apparent for computer programmers, who appear to have similar wages regardless of industry.

OES data provide an important tool for investigating interindustry wage differentials because they permit such wage range analyses and other types of comparisons of wage characteristics across detailed occupations. The OES data do, however, pose some limitations on the analysis of interindustry wage differentials. For example, the survey provides information for an unusually large number of distinct occupations, but does not incorporate information on the scope and responsibility of these jobs. To illustrate this limitation, we use the occupation, "general manager." It is likely that systematic differences exist in the responsibilities of general managers across industries. For example, among other differences, managers in bowling centers are more likely to be managers of relatively small establishments, while managers in the petroleum refining industries are more likely to be corporate executives. Although the lack of information on the scope and responsibility of certain jobs is not a problem for most occupations across industries, it is a problem for some occupations.[9]

Patterns of wage differentials

Interindustry wage differentials have largely remained a mystery, although research dating back to 1950 has found that industry affiliation accounts for a significant portion of wage differentials after controlling for education, race, sex, and other "human capital" characteristics of workers. The firms in some industries pay both low skilled and high skilled workers wages that are considerably above the average than those in other industries.[10]

Most of what is known about wage differences among industries can be summarized in three basic facts:

- Industry wage differentials are amazingly uniform across occupations. For example, janitors and managers, alike, appear to receive similar wage differentials, depending on the industry in which they work.
- Industry differentials have been remarkably stable over time; wage differentials are largely unchanged from the pattern of the 1950s.
- Industry wage differentials are positively associated with industry characteristics including capital intensity, industry concentration (based on a four-firm concentration ratio[11]), profitability, unionization, and low percentages of women.[12]

Industry wage differentials, calculated using 1998 OES wage and employment data for selected three-digit SIC industries are shown in table 2. The industries selected include manufacturing, trade, and service. Note that these industry wage differentials were constructed from 1998 OES wage and employment data using a method which takes into account the detailed

Table 1. Mean hourly wages of selected occupations in selected industries, 1998

SIC	Industry	General managers	Accountants	Computer programmers	Secretaries	Janitors	Machinery mechanics	Truck drivers
		Occupation						
371	Motor vehicles and equipment manufacturing	$37.78	$23.36	$22.22	$14.24	$16.36	$18.44	$16.49
291	Petroleum refining	44.27	22.65	24.67	15.65	11.09	20.25	16.26
461	Pipelines, except natural gas	40.63	23.06	25.50	14.09	14.44	20.81	15.25
491	Electric services	37.27	22.42	25.42	14.60	11.93	18.26	15.58
372	Aircraft and parts manufacturing	40.88	23.58	24.81	15.18	10.95	19.02	18.34
286	Industrial organic chemicals manufacturing	44.89	24.35	25.28	15.20	11.89	15.72	19.93
363	Household appliances manufacturing	39.39	18.94	26.31	12.47	9.71	14.80	13.25
874	Management and public relations services	38.20	20.54	26.58	13.39	8.27	17.34	14.11
731	Advertising services	39.79	19.80	22.56	13.06	8.67	–	–
513	Apparel, piece goods, and notions wholesale	35.97	22.11	23.51	11.24	8.77	14.72	13.53
394	Toys and sporting goods manufacturing	33.40	20.46	26.31	13.05	8.70	15.00	14.65
317	Handbags and personal leather goods manufacturing	33.62	23.09	27.10	13.39	9.67	–	–
302	Rubber and plastics footwear manufacturing	39.56	18.85	22.49	12.67	8.82	16.40	13.12
422	Public warehousing and storage services	27.89	19.10	22.50	11.00	7.53	14.47	13.56
314	Footwear, except rubber manufacturing	36.20	17.81	20.12	10.95	8.10	13.84	12.95
736	Personnel supply services	33.10	17.38	29.43	10.99	7.14	14.51	12.82
214	Tobacco stemming and redrying	39.61	17.81	13.93	13.29	7.07	12.17	10.30
799	Miscellaneous amusement, recreation services	22.47	16.21	23.41	10.31	7.51	14.22	12.08
723	Beauty shops	18.12	15.46	20.07	9.55	7.03	–	–
581	Eating and drinking places	20.07	17.15	25.37	10.59	6.78	8.09	8.39
793	Bowling centers	17.40	14.13	14.08	8.73	6.69	9.86	12.62
564	Children's and infants' wear stores	19.08	20.15	25.82	12.47	7.61	16.39	12.43
566	Shoe stores	18.83	16.98	23.91	10.90	6.81	15.20	13.55

NOTE: Dashes indicate data not available.

occupation of workers in addition to the detailed industry in which the worker is employed. These categories correspond to a total of 730 detailed occupations and 378 three-digit SIC industries. The industry wage differentials examined in most previous studies use demographic information, such as that available from the Current Population Survey, which takes into account a worker's "human capital" characteristics such as education, job tenure, and sex, in addition to the detailed industry and occupation in which the worker is employed.[13]

The industry wage differential examined here is the employment-weighted average of the occupation-specific wage differentials for each occupation in the industry. The occupation-specific wage differential is the ratio of the average wage of the occupation in a particular industry to the average wage of the occupation in some industry that is used as a base for comparison. The wage differential for each occupation in a given industry is weighted by its share of the industry's total employment. The weighted wage differentials for each occupation in the industry are then summed to produce the average wage differential, or "all-occupation" wage differential, for the industry as a whole.

All calculations in this article utilize data at the five-digit occupation code level, the most detailed level of occupational aggregation that is produced in the OES survey. In the calculation for any given industry, occupations that have no employment in the industry are excluded from the calculation, as are occupations for which there is no employment in the base industry. The miscellaneous plastics manufacturing industry, SIC 308, is used as the base for the calculations in table 2. It was chosen as the base due to the large number of occupations that are in this industry. Otherwise, the choice of base industry is arbitrary. Accuracy and consistency of the calculations was assured by comparing the wage differentials using the miscellaneous plastics manufacturing industry as the base with the differentials using the wholesale trade of motor vehicles (SIC 501) as the base. The wholesale trade of motor vehicles industry contains a large number of occupations that are common to service sector industries. The wage differentials in table 2 reflect an industry ranking that is the same, regardless of which industry is used as a base for calculation.

Table 2 shows that the industry wage differential or "all-occupation" wage differential for motor vehicles manufacturing is 0.32. This means that, on average, the wages paid any given occupation in the motor vehicles manufacturing industry are 32 percent higher than those in the miscellaneous plastics manufacturing industry.

The 1998 OES wage and employment data confirm much that is known about static differences among industries in the level of occupational pay. A striking feature of table 2 is the magnitude of interindustry wage differentials. Among the industries included in the table, the wages paid to given occupations range from 32 percent above those of the miscellaneous plastics manufacturing industry in motor vehicles manufacturing to 72 percent below the wages of miscellaneous plastics manufacturing in shoe stores. The data also accord with existing knowledge about the industrial pattern of industry wage differentials: most high wage industries are manufacturing industries, while lower wage industries tend to be concentrated in the trade and services sectors. Within the manufacturing sector, higher wage industries tend to be those that are large, unionized, highly concentrated, and capital intensive. These industries also tend to employ relatively few women, and have low ratios of labor costs to total cost.

Also visible within the set of industries included in table 2 is a divide between industries that have been more and less affected by technological change and globalization of competition. As discussed by Michael Piore and Charles F. Sabel, Thierry J. Noyelle, and recently by Ray Marshall, global competition and new technology have drastically altered the lines of fragmentation among industries. While, in the decades following World War II, employment and wage-setting policies were clearly related to the degree of market sheltering enjoyed by the industry, these policies were increasingly related to the competitive strategy employed by firms during the 1980s and 1990s. In industries such as bowling centers, shoe stores, and wood products manufacturing, most firms continue to employ a cost-cutting strategy, and tend to have low wages, while in industries including motor vehicles manufacturing, paperboard mills, and business services, firms have largely shifted to a productivity-increasing strategy, and tend to have higher wages.[14]

Causes of wage differentials

The causal connections between industry wage differentials and industry characteristics such as capital intensity and industry concentration are not fully understood. Wage differences between industries do, however, accord closely with some of the well known causes of wage differences, such as skill level.

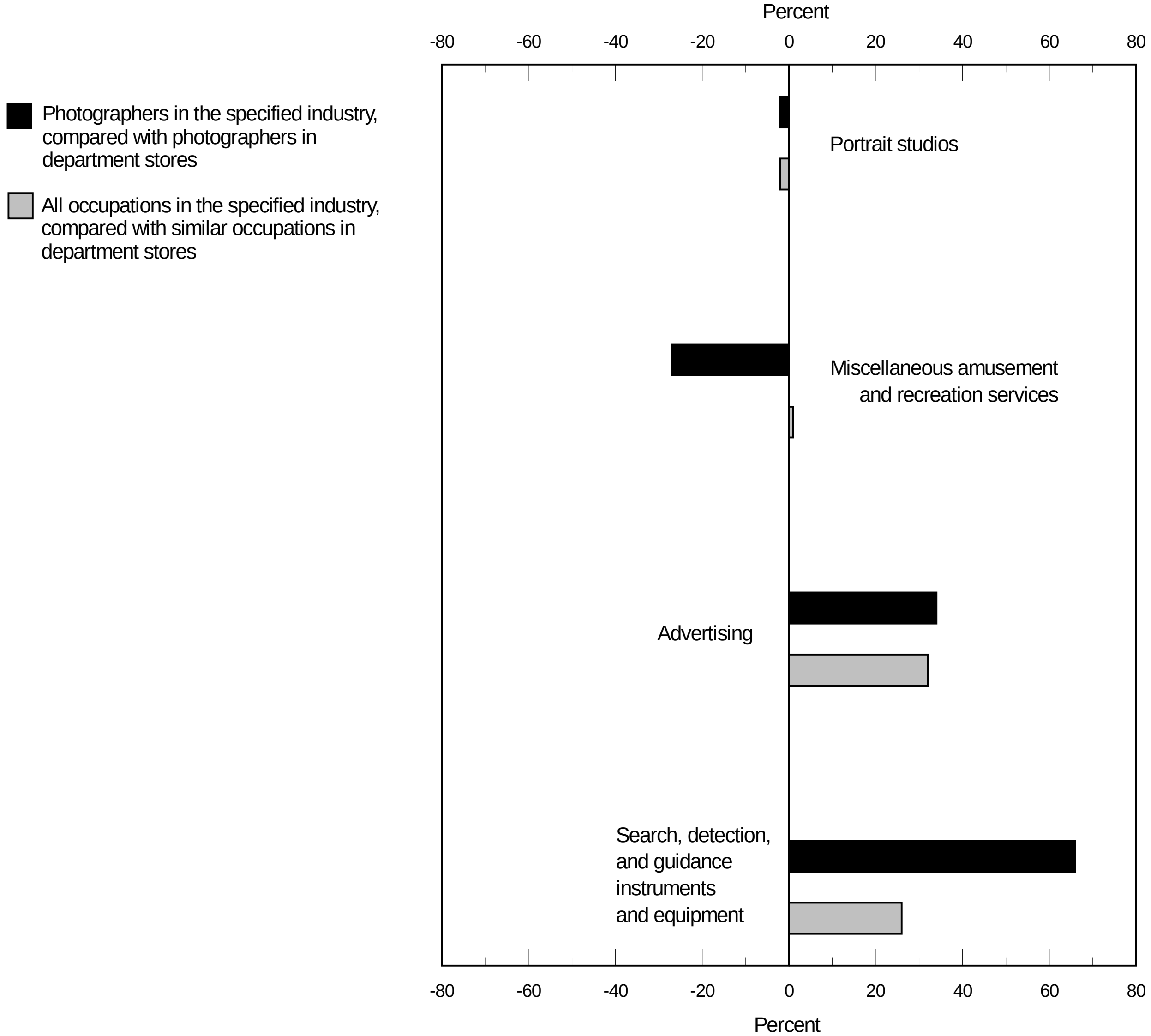
Skills. Some of the wage level differences among industries are explained by differing levels of skill required of workers employed in given occupations. Photographers are an example of an occupation for which skill levels vary greatly among industries. Chart 1 shows the all-occupation wage differentials for selected industries along with the average wage of photographers in selected industries relative to the average wage of photographers in the department store industry.[15] According to the chart, occupations in the miscellaneous amusement and recreation services industry, on average, have a 1-percent higher wage than do similar occupations in the department store industry. The average wage of photographers in this industry is 27 percent lower than the average wage of photographers in the department store industry. By contrast, the wages of photographers working in the search, detection, and guidance instruments and equipment manufacturing industry are higher (39 percent), relative to the average wage of photographers in the department store industry (24 percent) than is true of other occupations in the industry. Much of the higher earnings of photographers working in the search, detection, and guidance instruments and equipment manufacturing industry, as well as in the advertising industry, probably reflects the

Table 2. Industry wage differentials for selected manufacturing and service industries, 1998

SIC	Industry	All-occupation industry wage differential (base = SIC 308)[1]
371	Motor vehicles and equipment manufacturing	.32
291	Petroleum refining	.29
461	Pipelines, except natural gas	.27
491	Electric services	.25
372	Aircraft and parts manufacturing	.23
286	Industrial organic chemical manufacturing	.21
263	Paperboard mills	.21
363	Household appliances manufacturing	.15
731	Advertising services	.05
874	Management and public relations services	.05
513	Apparel, piece goods, and notions wholesale	–.03
394	Toys and sporting goods manufacturing	–.03
302	Rubber and plastics footwear manufacturing	–.05
317	Handbags and personal leather goods manufacturing	–.05
422	Public warehousing and storage services	–.07
249	Miscellaneous wood products manufacturing	–.08
314	Footwear, except rubber manufacturing	–.15
736	Personnel supply services	–.17
214	Tobacco stemming and redrying	–.20
799	Miscellaneous amusement, recreation services	–.28
723	Beauty shops	–.35
581	Eating and drinking places	–.36
793	Bowling centers	–.45
564	Children's and infants' wear stores	–.68
566	Shoe stores	–.72

[1] Service sector industries include SICs 400–899, and regulated, trade, and service industries. Occupations not surveyed in the base industry are excluded from the calculation.

Chart 1. Industry wage differentials for photographers and for all occupations within selected industries, compared with the department store industry,1998



NOTE: This chart shows, for example, that the average wage of photographers in advertising is 34 percent higher than the average wage of photographers in the department store industry, and the wages of occupations in advertising are on average 32 percent higher than the wages of similar occupations in the department store industry.

higher skill requirements for jobs in these industries.[16]

Industry wage differentials remain a problem for researchers because only a portion of the differences in wage levels among industries are explained by workers' skill levels. A sizable portion of the differences appears to be somehow related to industry characteristics including capital intensity, profitability, unionization, and the percentage of female employment. A full discussion of theories attempting to explain industry wage differentials is beyond the scope of this article. However, a brief review of the main explanations is offered here to illustrate the potential usefulness of OES data for the study of this issue.[17]

At least partially accounting for the unexplained portion of wage differences between industries, according to most researchers, are workers' skills that are not captured by the standard "human capital" measures of worker characteristics such as age, sex, years of education, and work experience. Workers certainly vary greatly by skill level in the way they negotiate, persuade, or handle uncertainty, for example. However, few of these skills are measured in the data currently available to researchers. Theories emphasizing the importance of unmeasured skills suggest a variety of mechanisms by which industry characteristics, such as capital intensity, affect both the measured and unmeasured skills that are required of workers. Because measured and unmeasured abilities are not perfectly correlated, such theories would explain why measured skills account for only a portion of industry wage differentials. The portion of the wage differential that actually makes up payment to unmeasured worker characteristics appears to the observer as an unexplained portion of the wage differential, or one that is somehow due to industry affiliation alone.[18]

Job conditions. For many occupations within the manufacturing sector, another important source of wage variation is the degree of workers' exposure to unpleasant, risky, or hazardous conditions on the job. Dangerous or risky working conditions necessitate the payment of a *compensating differential* that brings the net benefits from work into line with those enjoyed by individuals working under less hazardous conditions.[19] Welders, for example, receive a compensating differential. Chart 2 shows the all-occupation wage differential for selected industries, along with the average wage of welders in each industry, relative to the average wage of welders in the miscellaneous plastics industry.[20] The chart shows that the wages of welders working in electric and petroleum-related industries are much higher, relative to the average wage of welders in the miscellaneous plastics industry. This holds true in comparisons with other occupations in these industries. Some of the higher earnings for welders can likely be attributed to the danger of working close to highly combustible materials. It also seems likely that some portion of these higher earnings is actually a skill differential associated with specialized skills and training that equip welders to work under such conditions with maximum safety.

Efficiency wage theories. Some research suggests that certain industries provide wage differentials to ameliorate workplace problems, such as high rates of employee turnover, absenteeism, or shirking. Efficiency wage theories argue that higher wages reduce the incidence of such problems, and thus increase productivity, by increasing the effective cost of job loss to the employee. According to the efficiency wage argument, a portion of the observed wage differentials between industries reflect differences in the costs of such problems, and thus in the wage payments that are made in an effort to deal with them.[21]

One variant of the efficiency wage approach suggests that higher wages increase efficiency by insulating the internal labor market of the firm from the external labor market. Above-market wage rates may increase efficiency by eliminating the need for frequent and costly adjustment of the firm's wage schedules, in response to fluctuations in the external labor market. Another argument suggests similar savings for multiplant firms that pay uniform above-market wages across all plants regardless of location. Such a policy has the advantage of increasing the firm's flexibility in transferring workers between locations.[22]

Other explanations. Some other explanations of interindustry wage differentials represent a more dramatic departure from the standard competitive assumptions of most economic theorizing on this issue. *Rent sharing* models suggest that, under certain conditions including the existence of a discretionary margin of profits and worker bargaining power, firms choose to pay workers wages above the competitive wage. The size of the noncompetitive wage premium in given industries is affected by the degree of worker bargaining power across the occupational spectrum, the size of the profit margin, and the degree of managerial altruism.[23]

Also representing a departure from the standard competitive assumptions normally applied to this issue are sociological models, such as that proposed by G. Akerlof, which incorporate elements from both the efficiency wage and rent sharing models. Akerlof suggests that higher wages are a positive incentive for work effort that affects workers' subjective feelings about the job, in addition to providing an economic reward. The now long standing experience with the use of team production in most industries has, indeed, convinced many that above average wage rates improve group work norms by raising morale and loyalty.[24]

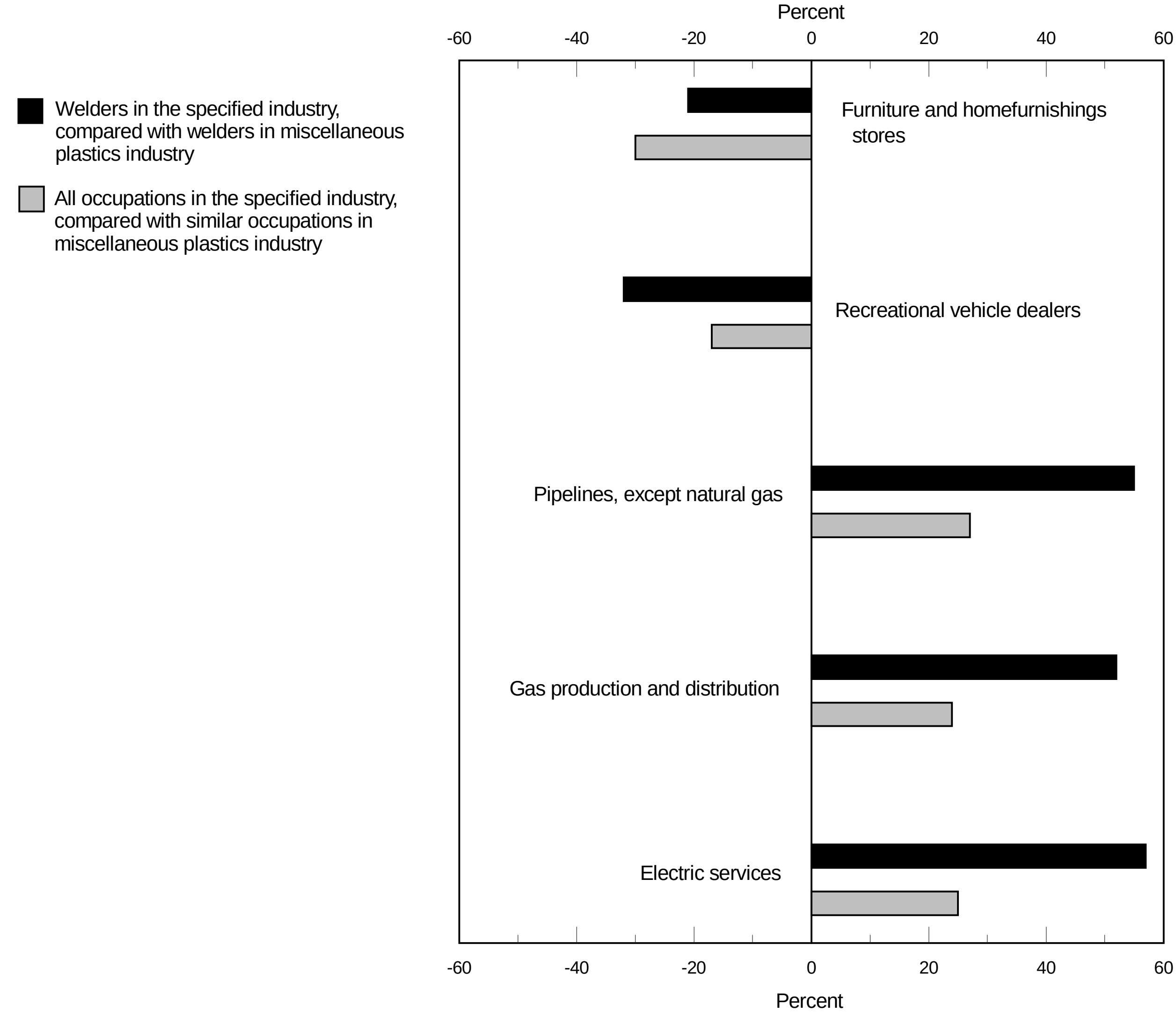
Models of worker *sorting* suggest that individual employers consistently hire workers from a single quality stratum, regardless of occupation. In this view, establishments tend to hire only high, average, or low skill workers, depending on factors that affect the competitive strategy of the firm, such as the skill-sensitivity of the technology used.[25] The theoretical framework for such a divide between firms is provided by Lawrence R. Klein, who argues that firms have only two choices of how to compete: on the basis of cutting costs or on the basis of improving productivity.[26] The former strategy involves the use of low-skilled workers who earn low wages, and the high productivity strategy involves the use of higher skilled workers who earn higher wages, along with a host of other workplace innovations affecting work organization, organization structure, and culture.[27] Worker sorting models suggest that wage differences between industries partially reflect differences in technology and other factors that affect worker sorting, and thus, the proportion of firms within industries that choose to pay high wages.[28]

Several recent studies have emphasized the role of technology in the worker sorting model. While the technologies used in the services sector certainly vary among firms and industries, some of the most basic differences are seen in the manufacturing sector, in which production processes are relatively easily identifiable as either mass production, batch production, or continuous process production. Shoshona Zuboff and others argue that a dynamic similar to a sorting model explanation may be especially important in explaining high wages in the continuous process industries, in which the characteristics of the production process tend to require a high level of commitment, competence, and skill from most workers.[29] Recently, some economists have argued that the sorting model also might apply in the case of alternative strategies for employing microprocessor technologies in the workplace. According to a study by Timothy F. Bresnahan, Erik Brynjolfsson, and Lorin M. Hitt, alternative strategies that employ microprocessor technologies in the workplace differ in the degree to which decisionmakers recognize and are guided by complementarities that exist when employing high skilled workers, decentralized decisionmaking, and information technology.[30]

Potential uses of OES data

The various explanations of industry wage differentials have

Chart 2. Industry wage differentials for welders in specified industries and for all occupations within selected industries, compared with the miscellaneous plastics industry, 1998



NOTE: This chart shows, for example, that the average wage of welders in the pipelines industry is 55 percent higher than the average wage of welders in the miscellaneous plastics industry, and the wages of occupations in the pipelines industry are on average 27 percent higher than the wages of similar occupations in the miscellaneous plastics industry.

differing implications for the wage characteristics that we should expect to observe for particular occupations. These explanations differ with respect to which occupations should be most affected by industry characteristics such as capital intensity, or which occupations should have wage differentials of similar magnitude. While the theory of rent sharing suggests that wage differentials should accrue relatively evenly across differing types of occupations, explanations that emphasize the role of unmeasured abilities suggest that occupations requiring similar types of such unmeasured skills should have wage differentials that are similar to each other. Examples might include the negotiation skills of managers and team leaders, the computer skills needed of clerical occupations, or the skill of certain production occupations that use auditory cues to detect errors in the settings of a machine.

Three characteristics of the industry wage differentials of detailed occupations provide useful information for understanding the causes of wage differences among the industries. The first characteristic is the association between the industry wage differential of given detailed occupations and the all-occupation average wage differential for the industry as a whole. This analysis provides information about which occupations contribute most strongly and consistently to the overall industry effect. A clear pattern wherein the wages of some occupations are more highly correlated with the all-occupation average wage differential would suggest that these occupations are more strongly affected by one or more of the industry-specific factors mentioned earlier. Any similarities in the characteristics of these occupations would further provide important clues about the type of mechanism responsible for the pattern. If, for example, the wages of occupations sharing particular types of skills are more highly correlated with the overall industry wage differential, this could suggest the importance of skill-based explanations such as those emphasizing unmeasured abilities or efficiency wages. Alternatively, a similar degree of correlation between the wages of a broad array of occupations and the all-occupation differential would suggest a rent sharing model or one emphasizing other sociological considerations.

The second characteristic is the association between the industry wage differential of given detailed occupations and a measure of capital intensity of the industry in which the occupation is employed. Because, as mentioned earlier, the pattern of wage differences among industries is correlated with the degree of industry capital intensity, information about which occupations appear to be most important in this relationship also should help narrow the range of plausible explanations for wage differences.[31] And, because capital intensity is a rough proxy for production technology, a clear pattern whereby certain types of occupations are more correlated with capital intensity would seem to argue in favor of explanations emphasizing the role of technology, such as the worker sorting model.

The third characteristic is the degree of correlation between the industry wage differentials of detailed occupations. Identification of groups of occupations for which the industry wage effect is similar also should provide valuable information for understanding this issue. A clear pattern of correlation among the industry wage differentials of similar types of occupations would seem to argue in favor of a skills-based explanation, such as those emphasizing unmeasured abilities or efficiency wages. A clear pattern whereby only certain groups of occupations have highly correlated wage differentials could further indicate the types of skills driving the pattern, and thereby suggest particular efficiency wage or unmeasured skills explanations. Alternatively, a similar degree of correlation between occupations across broad occupational groups would suggest a rent sharing or other sociological explanation.

The degree of association between the variables in all three sets of analyses was measured using the Pearson product moment coefficient of correlation (r).[32] This statistic equals 1 (–1) for variables that positively (negatively) covary exactly, and has a lesser magnitude for variables that only partially covary.

Table 3 shows the correlations between the industry wage differential of selected occupations and the all-occupation wage differential for manufacturing and services combined and for the manufacturing and services sectors separately.[33] The pattern for the combined manufacturing and services sectors shows a rather evenly high degree of correlation between the wages of most occupations and the all-occupation industry differential, with a few exceptions. Most highly correlated with the all-occupation industry wage differential are occupations involved in coordination activities, including purchasing managers, general managers, personnel, training, and labor relations specialists, and clerical worker supervisors. Least correlated with the all-occupation differential are engineering managers, purchasing agents, systems analysts, computer support specialists, plastic molding machine operators, and machinists. These latter results appear to be driven by the low correlations in the services sector between the wages of these occupations and the all-occupation industry differential.

Within the services sector, most of the occupations having the lowest correlation with the all-occupation wage differential are related to physical production activities, while those having the highest correlation are occupations engaged in coordination functions, including purchasing managers, general managers, personnel, training and labor relations specialists, and clerical worker supervisors. Within the manufacturing sector, occupations having the highest degree of correlation with the all-occupation wage differential are occupations that coordinate production activities, including industrial production managers, personnel, training, and labor relations specialists, supervisors of operators, and production inspectors. Occupations having the lowest degree of correlation

Table 3. Correlation between the all-occupation industry wage differential and the industry wage differential of selected detailed occupations, 1998

Occupation	Services and manufacturing	Services	Manufacturing
Purchasing managers	0.80	0.75	0.69
Engineering managers	.21	(1)	.73
Industrial production managers	.35	.26	.84
General managers	.81	.78	.66
Accountants and auditors	.73	.68	.72
Purchasing agents	.12	(1)	.73
Personnel, training, and labor relations specialists	.79	.75	.80
Systems analysts	.13	(1)	.61
Computer support specialists	.40	.32	.45
Clerical worker supervisors	.82	.78	.77
Adjustment clerks	.79	.75	.52
Secretaries	.61	.54	.76
Receptionists	.74	.71	.51
Supervisors of mechanics	.55	.43	.72
Supervisors of operators	.64	.59	.79
Production inspectors	.46	.43	.83
Machinery maintenance mechanics	.59	.52	.70
Machinists	.08	.09	.62
Plastic molding machine operators	.34	(1)	.26
Machine feeders	.61	(1)	.69
Truck drivers	.48	.43	.52

[1] The calculation is not statistically significant at p = 0.1.

NOTE: Service sector industries include SICS 400–899; regulated, trade, and service industries.

with the all-occupation industry wage differential tend to be non-production-related occupations, including computer support specialists, adjustment clerks, and receptionists.

Overall, the analyses in table 3 suggest that the occupations most strongly affected by factors resulting in wage differentials among industries are those having duties and tasks that are most closely related to the primary mission of the firm. Systematic differences between industries in the wages paid to the occupations most closely involved in the primary activity of the firm are suggestive of attempts by the firms in some industries to increase the productivity of these workers by paying higher wages. These results seem to suggest the importance of either the sociological version of the efficiency wage explanation (suggested by G. Akerlof, which emphasizes the positive effect of higher wages on the morale and productivity of workers) or a version of the sorting model.

Table 4 shows the correlations between the industry wage differential of detailed occupations within the manufacturing sector and a measure of capital intensity of the industry in which the occupation is employed.[34] The table shows that occupations for which the wage differential is most highly correlated with capital intensity include stock clerks, supervisors of operators and mechanics, machinists, machine forming operators, production inspectors, and machinery maintenance mechanics. Occupations having wages that are least correlated with capital include engineering managers, purchasing agents, secretaries, and computer support specialists These patterns suggest that manufacturing sector occupations for which wages are closely associated with capital intensity are production occupations and occupations engaged in the coordination of production activities.

The results of the analyses in table 4 are consistent with those reported in table 3 for the manufacturing sector. They further suggest, in the case of manufacturing industries, that the relatively larger role of production occupations in accounting for interindustry wage differentials is related to the production technology, for which capital intensity is a rough proxy. The relatively high correlations between the wages of skilled production workers and capital intensity suggest a dynamic along the lines of a sorting model, in which factors such as the production technology affect the proportion of firms that choose to organize work in accordance with a high wage strategy.

Tables 5 and 6 show the correlations between the industry wage differentials of detailed occupations, produced separately for the manufacturing and services sectors.[35] Both sectors reveal a pattern of association between the wages of similar types of workers. The wages of occupations engaged in coordination functions, including general managers; purchasing managers; personnel, training, and labor relations specialists; and clerical worker supervisors are all highly correlated. The wages of clerical worker supervisors are most highly correlated with other occupations engaged in either

Table 4. Correlations between the industry wage differential of selected occupations and industry capital intensity in manufacturing, 1998

Occupation	Correlation coefficient
Engineering managers	0.13
Industrial production managers	.31
General managers	.23
Purchasing agents	.20
Personnel, training, and labor relations specialists	.24
Computer support specialists	.21
Clerical worker supervisors	.28
Adjustment clerks	.26
Secretaries	.21
Supervisors of mechanics	.46
Supervisors of operators	.50
Production inspectors	.32
Machinery maintenance mechanics	.35
Machinists	.34
Machine forming operators	.36
Machine feeders	.30
Janitors	.25
Stock clerks	.50

NOTE: All calculations are statistically significant at p = 0.1.

Table 5. Pearson coefficients of correlation between the wages of occupations in service sector industries

Occupation	Purchasing managers	General managers	Accountants	Personnel, training, and labor relations specialists	Systems analysts	Computer support specialists	Clerical worker supervisors	Ajustment clerks	Secretaries	Receptionists	Supervisors of mechanics	Production inspectors	Machinery maintenance mechanics
Purchasing managers	1.00												
General managers	.76	1.00											
Accountants and auditors	.66	.75	1.00										
Personnel, training, and labor relations specialists	71	.78	.69	1.00									
Systems analysts	.17	([1])	.28	.15	1.00								
Computer support specialists	.43	.42	.45	.31	.51	1.00							
Clerical worker supervisors	.73	.76	.76	.80	([1])	.33	1.00						
Adjustment clerks	.64	.69	.49	.78	([1])	.19	.71	1.00					
Secretaries	.63	.71	.60	.58	.19	.58	.58	.44	1.00				
Receptionists	.65	.67	.54	.71	.15	.40	.70	.62	.65	1.00			
Supervisors of mechanics	.47	.42	.49	.44	.20	.35	.57	.35	.41	.48	1.00		
Production inspectors	.33	.39	.51	.30	([1])	.30	.36	.24	.46	.36	.39	1.00	
Machinery maintenance mechanics	.52	.62	.36	.63	([1])	–.04	.51	.69	.37	.34	.38	.12	1.00

[1]Indicates calculation not significant at p = 0.1.

Table 6. Pearson cooefficient of correlation between the wages of occupations in manufacturing sector industries

Occupation	Purchasing managers	Industrial production managers	General managers	Accountants and auditors	Purchasing agents	Personnel, training, and labor relations specialists	Clerical worker supervisors	Ajustment clerks	Secretaries	Supervisors of mechanics	Supervisors of operators	Machinery maintenance mechanics	Machinists	Plastic molding machine operators
Purchasing managers	1.00													
Industrial production managers	.71	1.00												
General managers	.65	.79	1.00											
Accountants and auditors	.77	.67	.65	1.00										
Purchasing agents	.84	.67	.54	.80	1.00									
Personnel, training, and labor relations specialists	.77	.79	.57	.70	.79	1.00								
Clerical worker supervisors	.68	.78	.81	.71	.64	.71	1.00							
Adjustment clerks	.52	.59	.67	.47	.50	.48	.58	1.00						
Secretaries	.78	.85	.83	.75	.72	.77	.80	.55	1.00					
Supervisors of mechanics	.59	.73	.64	.57	.59	.69	.73	.54	.68	1.00				
Supervisors of operators	.57	.79	.56	.53	.61	.71	.68	.60	.63	.76	1.00			
Machinery maintenance mechanics	.59	.68	.51	.66	.67	.73	.60	.41	.68	.68	.67	1.00		
Machinists	.56	.66	.58	.46	.50	.63	.62	.47	.67	.62	.69	.62	1.00	
Plastic molding machine operators	.24	.22	.19	.30	.29	.26	.22	.10	.25	.11	.13	.17	.12	1.00

coordination activities or clerical functions, including purchasing managers; general managers; accountants; personnel, training, and labor relations specialists; adjustment clerks; and secretaries. In the manufacturing sector, the correlation coefficients between the wages of each pair of occupations in the group including supervisors of mechanics, supervisors of operators, industrial production managers, and machinery maintenance mechanics, are all above 0.5. The wages of purchasing managers are most highly correlated with the wages of purchasing agents and secretaries, and the wages of industrial production managers are most highly correlated with the wages of general managers; personnel, training, and labor relations specialists; supervisors of mechanics; supervisors of operators; and clerical worker supervisors, and secretaries.

The results reported in tables 5 and 6 suggest that occupations having similar wage differentials tend to be either interrelated in the production process or require similar types of tasks and skills. These results suggest a skill-based explanation of industry wage differentials such as an efficiency wage or unmeasured ability argument. The generally high intercorrelations among the wages of most occupations are also suggestive, however, of a rent sharing explanation, in which all occupations share relatively equally in the wage differential of the industry.

IN SUMMARY, the analyses of OES survey data suggest that industry wage differentials are associated with occupations most closely associated with the primary mission of the firm. These results suggest that interindustry wage differentials might reflect a motivational role in the use of higher wages. The results of table 4 further suggest that this motivational effect might be somewhat contingent on the production technology, as is emphasized in a sorting model. The results of tables 5 and 6 are consistent with these results and further suggest a pattern of association among the wages of similar types of occupations. □

Notes

[1] See for example, David H. Autor, Lawrence F. Katz, and Alan B. Krueger, "Computing Inequality: Have Computers Changed the Labor Market?" *Quarterly Journal of Economics*, vol. 113, no. 4, 1998, pp. 1169–1213. Also see Eli Berman, John Bound, and Zvi Griliches, "Changes in the Demand for Skilled Labor Within U.S. Manufacturing Industries: Evidence From the Annual Survey of Manufacturers," *Quarterly Journal of Economics*, vol. 109, no. 2, 1994, pp. 367–97; and Mark Doms, Timothy Dunne, and Kenneth R. Troske, "Workers, Wages, and Technology," *Quarterly Journal of Economics*, vol. 112, no. 1, 1997, pp. 253–90.

[2] See *Standard Industrial Classification Manual, 1987*, Office of Management and Budget.

[3] The full Occupational Employment Statistics sample includes, with certainty, all Federal and State government employees and all establishments employing more than 250 workers, together making up approximately one-third of total U.S. employment. The remaining two-thirds of all workers are surveyed with probability equal to the reciprocal of the probability of selection of the establishment in which they are employed. The average number of workers included in the sample for any given three-digit SIC industry/occupation cell is roughly 1,500 individuals.

[4] Data for these 3 years were combined by first adjusting the 1996 and 1997 wage rates to reflect wage change over the 1996–98 period, using wage change indices obtained from the Employment Cost Index program.

The Occupational Employment Statistics (OES) survey is a cooperative Federal/State effort that provides occupational employment and wage data for more than 760 occupations in detailed industrial sectors. The Department of Labor provides the funding and technical support for the program, and the States collect the data as well as provide the results in published form. OES was initiated in 1971, with 15 participating States, and has expanded throughout the years to include all 50 States and U.S. territories. As a result of a redesign effort in 1996, the OES survey now also provides occupational wage data by detailed industry. The 1996 redesign effort also expanded the scope of the OES sur-vey to include all industries every year. For more information on the technical aspects of the OES survey, contact the Office of Employment and Unemployment Statistics, room 4840, 2 Massachusetts Avenue, NE, Washington DC 20212; telephone (202) 691-6569; or e-mail at: **oesinfo@bls.gov.**

[5] For a survey of studies, including data references, see William T. Dickens and Lawrence F. Katz. "Inter-industry Wage Differences and Industry Characteristics," in Kevin Lang and Jonathan S. Leonard, eds., *Unemployment and the Structure of Labor Markets* (New York, Basil Blackwell, 1987), ch. 3, pp. 41–54.

[6] For examples of studies using establishment data, see Alejandra Mizala and Pilar Romaguera, "Wage Differentials and Occupational Wage Premia: Firm-Level Evidence for Brazil and Chile," *Review of Income and Wealth*, vol. 44, no. 2, 1998, 239–57; and Andrew K.G. Hildreth and Andrew J. Oswald, "Rent Sharing and Wages: Evidence from Company and Establishment Panels," *Journal of Labor Economics*, vol. 15, no. 2, 1997, pp. 318–37.

[7] See David I. Levine, "Can Wage Increases Pay for Themselves? Tests With a Production Function," *Economic Journal*, vol. 102, no. 414, 1992, pp. 1102–15. Also see Erica L. Groshen, "Sources of Intra-Industry Wage Dispersion: How Much do Employers Matter?" *Quarterly Journal of Economics*, vol. 106, no. 3, 1991, pp. 869–84; and Jonathan S. Leonard, "Executive Pay and Firm Performance," *Industrial and Labor Relations Review*, vol. 43, no. 3, 1990, pp. S13–29.

[8] A more detailed discussion of theories of interindustry wage differentials appears later in the article.

[9] The Bureau of Labor Statistics has another data set—the National Compensation Survey—that does address some of the issues of scope and responsibility, albeit for a smaller number of occupations. See Brooks Pierce, "Using the National Compensation Survey to Predict Wage Rates," *Compensation and Working Conditions*, Winter 1999, pp. 8–16.

[10] See Erica L. Groshen, "Five Reasons Why Wages Vary Among Employers," *Industrial Relations*, vol. 30, no. 3, 1991, pp. 350–81. Goshen used Current Population Survey data to show that about 50 percent of the variation in wages among industries is accounted for by worker education, age, sex, race, union affiliation, industry (two-digit SIC), and occupation. Also see Alan Krueger and L. Summers, "Efficiency Wages and the Inter-Industry Wage Structure," *Econometrica*, vol. 56, no. 2, 1988, pp. 259–93; and K. M. Murphy, and R. H. Topel, "Efficiency Wages Reconsidered: Theory and Evidence," in Y. Weiss, and G. Fishelson, eds., *Advances in the Theory and Measurement of Unemployment* (London, Macmillan, 1990), pp. 204–42.

For early research on interindustry wage differentials, see Sumner H. Slichter, “Notes on the Structure of Wages,” *Review of Economics and Statistics,* vol. 32, 1950, pp. 80–91.

[11] This ratio provides a measure of the share of industry sales accounted for by the largest four firms.

[12] For an exhaustive investigation of the characteristics of interindustry wage differentials, see Dickens and Katz, “Inter-industry Wage Differences and Industry Characteristics.” This article also contains a review of the empirical research on interindustry wage differentials, including data sources.

[13] *Ibid.*

[14] For a discussion of changes in the nature of product markets that have altered the imperatives of competition for firms in most industries over the last two decades, see Ray Marshall, "Job and Skill Demands in the New Economy," in Lewis C. Solmon and Alec R. Levenson, eds., *Labor Markets, Employment Policy, and Job Creation* (Oxford, The Westview Press, 1994). Also see Michael Piore, and Charles F. Sabel, *The Second Industrial Divide: Possibilities for Prosperity* (New York, Basic Books, 1984); and Thierry J. Noyelle, *Beyond Industrial Dualism; Market and Job Segmentation in the New Economy* (Oxford, The Westview Press, 1987). For a discussion of case studies examining the implementation of new technologies in pulp mills, see Shoshona Zuboff, *In the Age of the Smart Machine: The Future of Work and Power (*New York, Basic Books, 1988).

[15] The department store industry also is used as the base for the calculation of the all-occupation industry wage differential.

[16] For information about the average level of vocational preparation of photographers employed in different industries, see *The Dictionary of Occupational Titles* (U.S. Department of Labor, Employment and Training Administration, 1991), vols. 1–2.

[17] For a description of explanations of both inter-industry wage variation and inter-establishment wage variation, see Groshen, “Five Reasons Why Wages Vary Among Employers,” *Industrial Relations.*

[18] See Michael Keane, “Individual Heterogeneity and Inter-industry Wage Differentials,” *Journal of Human Resources,* vol. 28, no. 1, 1993. Also see McKinley Blackburn, and David Newmark, “Unobserved Ability, Efficiency Wages, and Inter-industry Wage Differentials,” *Quarterly Journal of Economics,* vol. 107, no.4, 1992, pp. 1421–36. Keane and Blackburn and Newmark have recently estimated the proportion of industry wage differentials that is due to unobserved worker characteristics. Keane found that 50 percent of industry wage variation is explained by variation in unobserved worker skills, and Blackburn and Newmark found that 20 to 30 percent of the variation is explained by unobserved worker characteristics. Also see K. M. Murphy and R. H. Topel, “Unemployment, Risk, and Earnings: Testing for Equalizing Differences in the Labor Market” in Kevin Lang and Jonathan S. Leonard, eds., *Unemployment and the Structure of Labor Markets* (Oxford, Basil Blackwell, 1987).

Unmeasured skills also play a role in other theories of industry wage differentials. Hae-shin Hwang and others, for example, argue that failure to adequately account for unmeasured skills has led to the underestimation of the importance of compensating differentials in explaining wage differentials among industries. See Hae-shin Hwang, Robert W. Reed, and Carlton Hubbard, “Compensating Wage Differentials and Unobserved Productivity,” *Journal of Political Economy,* vol.100, no. 4., 1992.

[19] For a general discussion of compensating wage differentials, see S. Rosen, “The Theory of Equalizing Differences,” in O. Ashenfelter, and R. Layard, eds., *Handbook of Labor Economics* (New York, Elsevier Science Publishers, 1986). For a discussion of compensating differentials in the case of occupational hazard, see Jean Michel Cousineau, Robert Lacroix and Anne-Marie Girard, “Occupational Hazard and Wage Compensating Differentials,” *The Review of Economics and Statistics,* vol. 74, no. 1, 1992.

[20] The miscellaneous plastics industry also is used as a base for the calculation of the all-occupation wage differential for each industry.

[21] See Alan B. Krueger, and Lawrence H. Summers, “Efficiency Wages and the Inter-industry Wage Structure,” *Econometrica,* vol. 56, no. 2, 1988, pp. 259–93.

[22] Peter B. Doeringer, and Michael J. Piore, *Internal Labor Markets and Manpower Analysis* (Lexington, MA, D.C. Heath and Co., 1971).

[23] The rent sharing explanation of industry wage differentials is discussed in A. Krueger and L. Summers, “Reflections on the Inter-Industry Wage Structure,” in Kevin Lang and Jonathan S. Leonard, eds., *Unemployment and the Structure of Labor Markets* (Oxford, Basil Blackwell, 1987), pp. 17–47. Also see S. Nickell, and S. Wadhwani, “Insider Forces and Wage Determination,” *Economic Journal,* vol. 100, no. 401, 1990, pp. 496–509; David G. Blanchflower, Andrew J. Oswald, and Mario D. Garrett, “Insider Power in Wage Determination,” *Economica,* vol. 57, no. 226, 1990; and Andrew K.G. Hildreth, and Andrew J. Oswald, “Rent-Sharing and Wages: Evidence from Company and Establishment Panels,” *Journal of Labor Economics,* vol. 15, no. 2, 1997.

[24] See G. Akerlof, “Gift Exchange and Efficiency Wage Theory: Four Views,” *American Economic Review, Papers and Proceedings,* vol. 74, no. 2, 1984, pp. 79–83.

[25] Erica L. Groshen, 1991, “Five Reasons Why Wages Vary Among Employers,” *Industrial Relations.*

[26] See Lawrence R. Klein, “Components of Competitiveness,” *Science*, vol. 241, 1988, pp. 308–15. In this article, Klein explains the competitiveness problem by decomposing output prices into unit cost, the reciprocal of labor productivity, the profit margin, and the foreign exchange value of the currency. The decomposition shows that firms have two choices for competition: the basis of competition is either cutting costs or improving productivity.

[27] See Eileen Appelbaum and Rosemary Batt, *The New American Workplace: Transformiing Work Systems in the United States, (*Ithaca, ILR Press, 1994).

[28] See Dae Il Kim, “Reinterpreting Industry Premiums: Match-Specific Productivity,” *Journal of Labor Economics,* vol. 16, no. 3, 1998, pp. 479–504. Also see Stephen G. Bronars, and Melissa Famulari, “Wage, Tenure, and Wage Growth Variation Within and Across Establishments,” *Journal of Labor Economics,* vol. 15, no. 2, 1997, pp. 285–317; and Robert Gibbons and Lawrence F. Katz “Does Unmeasured Ability Explain Inter-Industry Wage Differentials?” *Review of Economic Studies,* vol. 59, no. 3, 1992, pp. 515–35.

[29] See Zuboff, *In the Age of the Smart Machine.*

[30] See Timothy F. Bresnahan, Erik Brynjolfsson, and Lorin M. Hitt, “Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence,” NBER Working Paper no. 7136 (National Bureau of Economic Research, Cambridge, Massachusetts, 1999).

[31] The capital stock data used in this analysis were obtained from the National Bureau of Economic Research, Manufacturing Productivity Database, which covers the years 1958–94. These data were extrapolated to include the years 1995 and 1996, using Annual Survey of Manufacturer’s data on nominal investment by 4-digit SIC industry for the years 1995 and 1996, and extrapolated rates of capital depreciation by three-digit SIC industry. The capital stock figures by four-digit SIC industry were then aggregated to the three-digit SIC level. Data on capital depreciation rates and on investment expenditures for the years 1995 and 1996 were obtained from Randy Becker, U.S. Bureau of the Census.

[32]
$$R = \frac{\sum (X_i - \bar{X})(Y_i - \bar{Y})}{\text{SQRT} \sum (X_i - \bar{X})^2 \sum (Y_i - \bar{Y})^2}$$

Where:

X_i = industry wage differential for occupation X in industry i

$\bar{X}$ = mean industry wage differential for occupation X

Y_i = industry wage differential for occupation Y in industry i

$\bar{Y}$ = mean industry wage differential for occupation Y

[33] All calculations in table 3 use the miscellaneous plastics industry, SIC 308, as the base.

[34] All calculations in table 4 use the miscellaneous plastics industry, SIC 308, as the base for comparison.

[35] The calculations for the manufacturing sectors use the miscellaneous plastics manufacturing industry, SIC 308, as the base for comparison. The calculations for the services sector use the wholesale trade of motor vehicles industry, SIC 501, as the base for comparison. More information is available from the author at (202) 691-6504 or by e-mail at **Osburn_J@bls.gov**.