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John Bound

George Johnson

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ABSTRACT

Between 1979 and 1987 there were three significant changes in the wage structure in the United States. The pecuniary returns to schooling increased by about a third; the wages of older relative to younger workers with relatively low education increased to some extent; and the wages of women relative to men rose by almost ten percent. It is important for policy purposes to know why these changes occurred and whether they are temporary or permanent. The paper investigates several alternative explanations of these wage structure phenomena, including the most popular ones that their principal causes were shifts in the structure of product demand, skilled-labor saving technological change, and changes in the incidence and level of rents received by lower skilled workers. Our reading of the evidence suggests that the major cause of the dramatic movements in the wage structure during the 1980's may have been some combination of changes in both production technology and the average relative nonobserved quality of different labor groups.

John Bound
Department of Economics
University of Michigan
Ann Arbor, MI 48109
313-763-7149

George Johnson
Department of Economics
University of Michigan
Ann Arbor, MI 48109
313-764-2374

During the 1980's there were three major changes in the wage structure in the United States. First, from 1979 to 1987 the estimated average within-sex, experience-adjusted hourly wage differential per year of completed schooling increased from about six to eight-and-a-half percent, or a rise by almost a half in the unadjusted rate of return to education. Second, for both men and women in the lower half of the educational distribution there was a widening of the wage differential by experience. Third, over this period the wages of women relative to men, adjusting for education and potential experience, rose by almost ten percent, which eliminated about a third of the adjusted gender wage gap.

Changes in the distribution of earnings of this magnitude in such a short period of time (over the course of a single business cycle) are unprecedented in recent history. They have given rise to a concern about the "vanishing middle class" (see Horrigan and Haugen), and they have understandably received notice in the political arena (for example, the abortive slogan of the 1988 political campaign, "good jobs at good wages"). Slogans aside, the changes raise several important policy issues (concerning, for example, resource allocation to education, trade policy, affirmative action, and income taxation). The question of <u>why</u> the wage structure exhibited such profound changes is therefore as important to policy makers as it is interesting to economists <u>per se</u>. There are several possible explanations of these wage structure developments, ranging from a focus on changes

in the composition of product demand, particularly those due to foreign trade factors, to changes in production technology that were biased toward intellectual as opposed to physical characteristics of workers. The differences in the implications of these alternative explanations for educational policy, for example, are fairly obvious. If the technical change explanation story is correct, society should allocate more resources to education (and, perhaps, increase the equity of educational financing). If, on the other hand, the foreign trade version of the product demand shift explanation is correct, the increase in the rate of return to schooling during the 1980's is temporary (in the sense that it will disappear when the foreign trade deficit is eliminated), and no major increase in expenditure on education is justified.

The purpose of this paper is to assess the merits of various explanations of changes in the wage structure from 1979. The facts about these changes are described in detail in Section I; the alternative hypotheses that can be advanced to explain the changes and the procedures for testing among the explanations are set out in Section II; the results of them of these procedures are reported in Section III; and the major conclusions of our investigation, as well as several qualifications, are set out in Section IV.

I. Wage Structure Changes During the 1980's

Our first task is to document the major changes in the structure of wages that occurred between 1979 and 1987. To do this we took all observations of nonagricultural employees between the ages 18 and 64 from the 1979 and 1987 Current Population Surveys.[1] The data were sorted into 32 separate groups for each year: four educational splits, <11, 12, 13-15, and 16+ years of schooling; four potential experience splits, 0-9, 10-19, 20-29, and 30+ years; and two sexes. For each of the 32 groups for both of the years, the logarithm of the wage rate was regressed on potential experience (X), dummy variables for years of schooling (where appropriate), and dummy variables for nonwhite, part-time, and location. The resultant estimated log wage rates and their estimated standard errors that are reported in Table 1 refer to four educational levels (E), 8, 12, 14, and 16, and four values of potential experience, 5, 15, 25, and 35, for each sex, as well as to white, full-time workers in SMSA's in a weighted average of regions. The sample size for each regression is listed below the standard error of each estimated average wage.

The three stylized facts mentioned above are clear from inspection of the table. The difference in the value of the estimated average log wage of each of the 32 education/experience/sex groups between 1979 and 1987 and its estimated standard error are reported under the relevant ch column. For example, the log of the ratio the average wage

of a male with 16 years of schooling and five years of potential experience (27 years of age) to the average wage of male high school graduate with the same experience (age 23) is estimated to have increased by .439 - .256 = .183(.015). This implies an increase in the male college/high school relative wage from 1.30 to 1.57. The equivalent ratios for all such comparisons across educational groups, save the 16/14 relative for workers with 25 years of experience, rose during the 1980's.

Although less pronounced than the increase in wage differentials by education, there was an increase in differentials by age for six of the eight sex/education groups. For example, for male high school graduates the estimated ratio of those with 25 to those with 5 years of potential experience rose from 1.43 to 1.61 (±.01). Only for both men and women college graduates did the age differential remain constant over this period.

Using the sample size numbers in Table 1 as weights and taking the estimated values of the log wage of each group as the mean for each of the 32 education/experience/sex groups, the change in the average log wage from 1979 to 1987 was .418 for the entire sample, .386 for men and .487 for women. The implied gap between the wages of men and women declined between 1979 and 1987 from .388 to .287, a decline in the percentage gender wage gap from 32.2 to 24.9. Both the male and female labor force distributions were more educated and slightly older in 1987 than 1979, and .048 of

the wage change for men and .053 of that for women were attributable to compositional effects. This leaves adjusted changes in log nominal wages of .345 for men and .434 for women.

A convenient way to summarize the stylized facts about changes in the structure of wages that we will ultimately seek to explain is to regress the estimated change in the logarithm of wages for each of the 32 groups in Table 1 on a relevant set of dummy variables. This set includes one/zero variables for education equal to 12, 14, and 16, women, and, for those groups with less than 16 years of schooling, experience equal to 15, 25, and 35. The point estimates of the slope coefficients of this regression (using the square root of 1979 employment as the weight for each group) are reported in column (i) of Table 3. We are thus seeking to explain why the ceteris paribus college/high school logarithmic wage differential increased by an average of .161 (the difference between the coefficients on E≥16 and E=12) between 1979 and 1987, why the high school/elementary differential increased by .081, why the female/male differential increased by .097, and why the differential among those non-college attenders with 35 years of experience to those with 5 years increased by .114.[2]

It is interesting to point out that the change in the logarithm of the CPI during this period was .448. This means that estimated average real hourly earnings, adjusted for education/experience composition, grew at annual rates of

-1.3 percent (100*(.345-.448)/8) for men and essentially zero for women between 1979 and 1987. This is probably a slight underestimate of the rates of growth of total employee compensation, for employer-provided fringe benefits, which are not included in CPS wages, grew slightly faster over this period than gross hourly pay. Further, taxes per dollar of compensation also fell during the 1980's (shifted to future wage recipients), so the relevant rate of growth of net hourly compensation, especially for groups with relatively high wage rates, grew slightly faster than the above rates. Nevertheless, these figures point out that the observed changes in the distribution of wages during the 1980's was much more than some groups receiving a larger share of the historical "growth dividend." For example, the implied annual rate of growth of real wages from 1979 to 1987 for males with E = 8 and X = 5 was -3.5 percent, which means that the average 21 year old high school high school dropout in 1987 earned 25 percent less in real terms than did his counterpart in 1979.

Since nonwhites have, on average, lower levels of educational attainment than whites, a general increase in educational wage differentials would be expected to increase the gap in average wages by race. Using 1979 education/experience weights by sex for whites and nonwhites, the estimated changes in nominal wages by group in Table 1 imply that the nonwhite/white average wage ratio would have declined by .019 for men and .012 for women due to general

changes in the structure of wages. Further, the weighted average change in the coefficients on nonwhite in the regressions underlying Table 1 imply an additional change in the nonwhite/white average wage ratio of -.011 for men and -.032 for women.

II. Alternative Explanations

Several hypotheses can be (and have been) put forward to explain the various wage structure change phenomena described in Section I. These include the following eight sets of explanations:

#1. Demographic Changes. The first thing that one looks for in explaining changes in the structure of wages of the magnitude of those that occurred during the 1980's is a set of large changes in the demographic distribution of the labor force. There is now a large amount of evidence that intra-factor own elasticities of substitution are large but finite (see the survey by Hamermesh), and the depressing effect of the baby boom cohort on the wages of young workers and of increases in the fraction of workers with college degrees on college/high school relative wages during the 1970's have been well-documented (see Welch (1979) and Freeman). Given that the relative wages of more educated, older, and female workers increased during the 1980's, a relative supply explanation (a leftward shift in the relative supply function in Figure 1 with an unchanged relative demand function) would lead one to look for evidence that the composition of the labor force shifted toward less educated, younger, and male

workers. Unfortunately for this explanation, the opposite happened: the work force got more educated, slightly older, and more female. One would have to spin a very weird story about the pattern of cross partial elasticities of complementarity to reconcile the comovement of relative wages and employment across demographic groups. Accordingly, in the most detailed analysis of intra-factor substitution to date, Murphy and Welch (1987) conclude that the labor market went off its demand function during the 1980's.[5]

A potentially important qualification to this quick rejection of the supply shift hypothesis arises from the fact that there may have been a large increase in the relative number of illegal immigrants into the United States during the 1980's. Because of language difficulties and legal barriers to their employment in "visible" jobs, these immigrants would have been likely to have been employed in very unskilled occupations and thus have been most competitive with the youngest and least educated of the native population, thus driving their wages down (see, for example, Borjas).

#2. Shifts in Product Demand. An explanation that has received much recent attention from economists is that the composition of product demand shifted during the 1980's toward industries that are both education and female intensive. This would (in a two dimensional sense) shift the relative labor demand function to the right, and, if the product demand changes were of sufficient magnitude, this

shift would, as in Figure 1, overwhelm the rightward shift in the relative labor supply function. Assuming, as certainly appears to be true of the United States in the post-Depression period, real and relative wages are free in the medium run to adjust so that all markets are cleared, the relative wages of groups whose employment distributions are sufficiently correlated with the product demand shifts should rise.

The most obvious cause of potential shifts in the composition of product demand during the 1980's is the drastic change in the international trade position of the United States. Murphy and Welch (1987 and 1988) conclude that the increased openness of and large trade deficits incurred by the U.S. economy are the principal cause of the major observed changes in the structure of wages (and, indeed, stress that it is a temporary problem). To find evidence in favor of the general hypothesis that product market shifts are the root cause of the changes in relative wages over this period, it is necessary to show that these shifts are sufficiently positively correlated with the initial industrial distributions of those groups whose wages increased to overwhelm the effects of observed demographic changes. This a major task of Section III of this paper.

#3. Changes in the Incidence of Rents. Whatever their source, it is well-known that there is large variation, observable characteristics held constant, in wage rates across industries (see Dickens and Katz, Murphy and Topel,

and Krueger and Summers). It follows that a candidate to explain at least part of the wage structure developments of the 1980's is the possibility that changes in the industrial distribution of employment, caused by shifts in the composition of product demand or by changes in technology, reduced the average industry wage premium received by certain groups. Throughout this paper we shall refer to these premia as "rents" even though they could reflect, following the existing literature, compensating differentials, selection on unobserved labor quality differences, or an absence of wage discrimination against certain groups, which are not rents in an economic sense, as well as union wage effects or implicit sharing of monopoly profits, both of which are.

Like explanation #1, the changing rent incidence story has been put forward in the context of foreign trade developments (see, for example, Katz and Summers). If, for example, a large fraction of low educated males traditionally worked at high relative wages in industries like manufacturing and mining, a flood of imports would force many individuals in this group out of their "good jobs" into "bad jobs" (i.e., rent-free) in trade and services, and the average wage of this group would fall relative to others who were less represented in the trade-sensitive sector. This is distinct from the effect on relative average wages through the effect of this disturbance on wages in competitive markets (the reduction of wages in trade and services for men with low education due to their having been "crowded into"

these industries). The test of the incidence explanation versus #2 involves the determination of how much of the change in the average relative wages of different groups can be accounted for by changes in industry employment weights as opposed to within-industry wage changes.

#4. Changes in the Average Level of Rents. It is also possible that some of the changes in relative wage rates during the 1980's are directly attributable to changes in the rents received by some groups in particular industries. Reductions in rents could occur, among other reasons, because of a reduction in the power or coverage of unions in those industries or of an improvement in working conditions that previously forced employers to pay large compensating differentials.[5] They may also have been caused by shifts in product demand, perhaps reflecting increased foreign competition, that necessitated "givebacks" of rents in order for firms in certain industries to stay in business (see Freeman and Katz). To test for this explanation, whatever the story behind it, it is necessary to see if the within-group variance of wage rates across industries fell for relevant groups. Did, for example, the wage for low educated males in relatively unionized and/or trade-sensitive industries fall relative to those in industries with competitive labor markets?

#5. Technological Change. A very different potential explanation of some of the wage structure phenomena is that the nature of production processes changed systematically in

such a way that the relative demand for certain groups increased. An example of this is the widespread adoption during the 1980's of computer technology in a large segment of the economy. More educated are presumably better able than less educated workers to adjust to this new (and rapidly changing) production environment and would be therefore in greater demand than would be the case with the pre-computer technology.[6] It is not possible with our conventional data set to test directly for this explanation; it is, as in the analysis of the sources of economic growth, a story about residuals. However, a major difference between the technical change explanation and its principal competitor, the product demand shift story (#2), is that the latter implies that the direction and magnitude of the shift in the relative demand function can be explained by observable variables whereas the former implies that they cannot. A rejection of explanation #2 is consistent with the technological change explanation, but, of course, it would not prove it.

#6. Changes in Relative Labor Quality. This potential explanation is similar to explanation #5 except that it involves the average worker in particular groups rather than the production environment. A very likely explanation of at least part of the increase in the average wages of women relative to men during the 1980's is that the average employed woman with X' years of potential experience in 1987 had more actual experience and longer job tenure than did her

counterpart in 1979 (see Smith and Ward). Similarly, the average levels of unobserved characteristics (innate ability and motivation) of young high school dropouts in 1987, who composed a much lower fraction of their cohort than previously, could have been much lower than that of those who were in this group in 1979. With the overall disappearance of the per worker growth dividend since the mid-1970's, tastes for consumption relative to job amenities on the part of college graduates may have increased. This explanation, that the relative intensity or work or unobserved quality of certain groups has changed, predicts, like explanation #5, that the solution for 1987 lies off the labor demand function after accounting for explanations #2-#4.

#7. Discrimination. It is also possible that there has been a reduction in the extent of labor market discrimination against certain groups such that the ratio of their wages to their marginal products has risen. In the empirical analysis of this paper this would be a potential explanation of the gender differential. The problem with it is similar to that with explanations #5 and #6; its effect is through the residual. If a large part of the increase in the relative earnings of women cannot be explained by explanations #1-4, it could be argued either that women's unobserved labor quality has increased (Smith and Ward, O'Neill) or that discrimination against women has decreased (Blau and Beller).

#8. Differential Adjustment. A final possibility is that shifts in product demand or technology are likely to

have had a greater impact on the labor market status of younger than of older workers because of (explicit or implicit) contractual constraints. For example, a set of firms that changed to some sort of robotic-centered may have elected (or been required) to retain and retrain most of its production workers over the age of forty, but it now specifies that its new hires must have post-secondary technical education. A general development of this sort would cause the wages of younger less-educated workers to fall relative to their older counterparts.

For purposes of evaluating the relative merits of these eight explanations, it is useful to set out a simple (admittedly stylized) model that includes all of them. There are I labor groups that work in J industries. The production function for industry j is C.E.S. in the I labor inputs, or

$$(1) \quad Q_j = [\sum_i \delta_{ij}(b_i N_{ij})^{(\sigma-1)/\sigma}]^{\sigma/(\sigma-1)},$$

where Q_j is the output of the j^{th} industry, N_{ij} is the employment level of group i in industry j, b_i an index of the efficiency level of group i, σ is the elasticity of intra-factor substitution (following Hamermesh's Law, $1 < \sigma < \infty$), and the δ_{ij}'s are share parameters. The marginal physical product of N_{ij} is

$$(2) \quad MP_{ij} = \delta_{ij} b_i^{1-1/\sigma} (Q/N_{ij})^{1/\sigma}.$$

The wage rate of group i in industry j is

$$(3) \quad W_{ij} = R_{ij}W_{ic},$$

where W_{ic} is the competitive wage for that labor group. R_{ij} is the rent of group i workers in industry j in the sense used in the above discussion of explanation #3, and a value of unity implies a zero deviation of the wage from the competitive norm for that group.

Firms maximize profit subject to the possible constraint that they must set employment levels such that the marginal revenue product of each labor group equals the competitive rather than the negotiated wage. Assuming competitive product markets, this implies that

$$(4) \quad P_jMP_{ij} = P_j\delta_{ij}b_i^{1-1/\sigma}(Q_j/N_{ij})^{1/\sigma}$$
$$= W_{ic}R_{ij}^{1-\mu},$$

where P_j is the price of the output of industry j relative to that of, say, industry 1. The parameter μ equals one if the constraint mentioned above is binding (union-management bargaining or some other form of rent-sharing is Pareto optimal) and zero if firms are free to set employment levels so as to maximize accounting profit.

The relative demand for the output of industry j relative to that of industry 1 is given by

$$(5) \quad Q_j/Q_1 = \beta_jP_j^{-\sigma}$$

where β_j is an exogenous parameter reflecting tastes and other factors (like foreign competition) affecting industry j and ε is the absolute relative price elasticity of product demand. To complete the model, it is specified that the effective (fixed) supply of labor of each of the I labor groups equals the sum of its employment in the J industries, or

$$(6) \quad N_i = \sum_j N_{ij}.$$

This is a rather messy model to solve analytically (unless one makes the rather uninteresting assumption that I = J = 2), but it turns out that it can be manipulated to suggest approaches to the data that are informative of the merits of some of the alternative explanations without too much difficulty. First combine the marginal conditions, (4), for industries j and 1 to obtain

$$(7) \quad (R_{ij}/R_{i1})^{1-u} = P_j(\delta_{ij}/\delta_{i1})(Q_j/Q_1)^{1/\sigma}(N_{ij}/N_{i1})^{-1/\sigma}.$$

Substituting (5) for P_j in (7) and solving the result for N_{ij} gives

$$(8) \quad N_{ij} = N_{i1}[(\delta_{ij}/\delta_{i1})^{\sigma}(R_{ij}/R_{i1})^{-\sigma(1-u)}\beta_j^{\sigma/\varepsilon}(Q_j/Q_1)^{1-\sigma/\varepsilon}].$$

By (6) $N_i = N_{i1} + \sum_{j \neq 1} N_{ij}$, which allows one to solve for N_{i1} and thence for N_{ij}, which is

$$(9) \quad v_{ij} \equiv N_{ij}/N_i = \delta_{ij}^{\sigma} x_j R_{ij}^{-\sigma(1-\mu)}/D_i,$$

where

$$x_j = \beta_j^{\sigma/\varepsilon} Q_j^{1-\sigma/\varepsilon}$$

and

$$D_i = \sum_j \delta_{ij}^{\sigma} x_j R_{ij}^{-\sigma(1-\mu)}.$$

v_{ij} is the fraction of workers in group i who are employed in industry j.[7]

As will shortly become evident, the denominator of (9) for the case of $\mu = 1$ is of considerable interest in this exercise. Note that its total logarithmic derivative is given by

$$(10) \quad d(\ln D_i) = \sum_j (\delta_{ij}^{\sigma} x_j/D_i)\, d(\ln x_j)$$

$$= \sum_j v_{ij}\, d(\ln x_j).$$

This means that the proportional change in each D_i is the average proportional change in the x_j's across industries weighted by the group's industry employment distribution. To identify the proportional changes in the x_j's, take the logarithmic derivative of (9), that is

$$(11) \quad d(\ln v_{ij}) = (1 - \delta_{ij}^{\sigma} x_j/D_i) d(\ln x_j) - \sum_{m \neq j} (\delta_{ij}^{\sigma} x_m/D_i) d(\ln x_m)$$

$$= (1 - v_{ij}) d(\ln x_j) - \sum_{m \neq j} v_{im}\, d(\ln x_m).$$

This implies that the log changes in the x_j's, which are a weighted average of log changes in the industry demand shift parameters and the industry output levels, can readily be estimated econometrically.[8]

Now consider the average wage of group i relative to group k workers. This is

$$(12) \quad W_i/W_k = (\Sigma_j W_{ij}v_{ij})/(\Sigma_j W_{kj}v_{kj})$$

which is the product of the ratio of their average wages rates in the competitive sector to the ratio of their average rents across industries, R_i/R_k. Substituting (9) (with $\mu = 1$) for N_{ic} and N_{kc} into the ratio of these two groups' marginal products, the ratio of their competitive wages is seen to be

$$(13) \quad (W_{ic}/W_{kc}) = (\delta_{ic}/\delta_{kc})(b_i/b_k)^{1-1/\sigma}((D_i/D_k)/(N_i/N_k))^{1/\sigma}.$$

The logarithmic total derivative of this is

$$(14) \quad d(\ln(W_{ic}/W_{kc})) = (1-1/\sigma)d(\ln(b_i/b_k)) + (1/\sigma)\Sigma_j(v_{ij} - v_{kj})d(\ln x_j) - (1/\sigma)d(\ln(N_i/N_k)),$$

and the derivative of the log of the ratio of rents is

$$(15) \quad d(\ln(R_i/R_k)) = \Sigma_j[(R_{ij}dv_{ij}/R_i) - (R_{kj}dv_{kj}/R_k)]$$

$$+ \sum_j [(v_{ij} dR_{ij}/R_i) - (v_{kj} dR_{kj}/R_k)].$$

The proportional change in the ratio of observed average wage rates of groups i and k is, of course, the sum of (14) and (15).

The five terms on the right hand sides of (14) and (15) reflect the eight explanations set out verbally in the beginning of this section. Since $\sigma > 1$, the first term in (14) will be positive if technological change has been more favorable toward group i than toward group k or if the unobserved labor quality of the i's has grown faster than that of the k's.[9] As mentioned in the initial discussion of explanations #5 and #6, one turns to them (and thence to alternative data sets, anecdotal evidence, etc.) only if the other explanations fail to explain movements in the wage structure. The second term in (14) reflects, among other things, the effect of changes in the structure of product demand on relative competitive wages. If (as is, in fact, not true) industry employment distributions were identical for all groups, its value would be zero and product demand shifts would have no impact on the competitive wage structure. The Murphy-Welch story is that the $d(\ln x_j)$'s in the 1980's were sufficiently positively correlated with the industrial distributions of certain groups to shift their demand functions far enough to the right to make up for the fact that their relative supply increased. It is relatively straightforward --- given our assumptions --- to test this

hypothesis.

The third term in (14) reflects explanation #1, changes in relative supply. Although we already know that this goes in the wrong direction, it is important to reiterate that the magnitude of the other explanations must be sufficiently large to overcome the "perverse" supply effects.

The two terms in (15) reflect explanations #3 and #4 concerning possible changes in the incidence and level of rents received by some groups relative to others. Given a plausible assumption about which industries compose the competitive sector of the labor market (a task that is easier in theory than in practice), it is a straightforward matter to estimate the magnitudes of these terms by what is, essentially, a Oaxaca decomposition.

To summarize the empirical strategy suggested by the model, it is useful to set out a regression equation of the form

$$(16) \qquad d(\ln W_i) = \beta_0 + \beta_1 d(\ln N_i) + d(\ln R_i) + U_i + e_i.$$

β_1 is equal to $-1/\sigma$, $d(\ln R_i)$ is the logarithmic change in the average rent of the group, and e_i is a random error term. U_i represents changes in relative product demand, technological intensity, and labor quality, as well as possible changes in discrimination and differential labor market adjustment, explanations #2 and 5-8. We have already shown (see fn. 4) that for the 1979-87 period the simple

correlation between $d(\ln W_i)$ and $d(\ln N_i)$ was positive, which implies that U_i and/or $d(\ln R_i)$ was positively correlated with $d(\ln N_i)$ during that time. Our task in the next section is to see if we can explain that positive correlation with those parts of U_i and $d(\ln R_i)$ that are readily observable.

III. Evaluation of Explanations

The tests of the first four of the six explanations implied by the preceding section require disaggregation of the data by industry, a task for which the C.P.S. is well-suited. We have disaggregated our sample by the following 17 industries:

1. construction
2. durable mfg. & mining
3. nondurable mfg.
4. transportation
5. public utilities
6. wholesale trade
7. retail trade
8. finance, ins., & r.e.
9. business serv.
10. personal serv.
11. entertain. & rec. serv.
12. medical serv.
13. hospitals
14. welf. & relig. serv.
15. education
16. professional serv.
17. public admin.

These correspond to the usual C.P.S. "major industries" except that mining had to be folded into durable goods because of the presence of empty cells for some female education/experience groups in 1987.

The distributions of employment by industry by education and sex are shown in Table 2. Although most of our subsequent empirical analysis uses the industry by experience as well as the other two characteristics, the major "action" in terms of assignment of workers to industry is due to

education and sex, so these numbers provide a reasonably accurate impression of what happened between 1979 and 1987. Men with low education tend to be concentrated in the those industries that are the traditional employers of blue collar labor (at relatively high wages), construction, mining, manufacturing, transportation, and utilities, and these industries declined in relative importance during the 1980's. Higher educated men are much more likely to employed in employed in white collar private sector industries like FIRE and professional services, which increased in relative importance, and in the public and nonprofit sector, which decreased in relative importance. Women are much more likely than men to be employed to be employed in the rapidly growing service sector, but it is interesting to note that a large fraction of women college graduates are employed in the education sector, an industry that declined in relative importance during the 1980's.

A. Product Demand Shifts

The first task in the evaluation of explanation #2 is the estimation of the industry demand change parameters, the $d(\ln x_j)$'s, along the lines of (11). This involves regressing the 1979 to 1987 change in the logarithm of the weight of group i in industry j on one minus its weight in that industry in 1979 and the negative value of its weight in each of the other industries. The parameters of this regression, with the demand change in construction arbitrarily suppressed to zero, were estimated with weights

equal to the square root of $v_{ij}N_i$ for 1979 and are reported in column (i) Table 4. Each of these coefficients is interpreted as the change in log x in that industry relative to that for construction, so, for example, the change in the value for retail trade relative to durable goods is .018 - (-.313) = .351(.029). As would be expected from a casual attention to the news of the 1980's, demand for manufacturing declined relative to trade and service industries. Two of the other three large employers of males with relatively low education, transportation and public utilities, also declined. However, two of the large employers of college men and women, education and public administration, declined as well. We also estimated this equation separately for men and women, and, although the test of equality of coefficients was rejected at the five percent level, use of the alternative demand change indices made no difference.

The next step is to employ these estimates to calculate the estimates of the effect of demand changes on wages, the second term in (14). These are reported in column (iii) of Table 5, which also gives the estimated average wage changes (at the particular education/experience values employed in Table 1) and the proportional change in group supply, $d(\ln N_i)$. It is clear from glancing at the table that the demand shift hypothesis does not stand up very well. That its variation is small relative to the variation in relative supply changes is not terribly troubling, for there are many potential alibis on this score (e.g., aggregation

bias, errors in variables, and a more complex pattern of cross partial elasticities of complementarity than that allowed by the C.E.S.). What is more disturbing to acceptance of the demand shift hypothesis is the fact that relative demand changes generally go in the wrong direction. For example, the group with by far the lowest wage increase, males with 0-9 years of experience and <12 years of schooling, had, by these estimates, the second most favorable industry demand change conditions (as well as one of the largest decreases in supply). The reason for this is that, although this group is well represented in mining and manufacturing, it is also very highly represented in construction and retail trade and have very little exposure to the public sector.

The inadequacy of the product demand explanation of the relative wage change phenomena of the 1980's (given our maintained assumptions concerning functional form) is illustrated by comparing columns (i), (ii), and (iii) of Table 3. The numbers in column (ii) are the estimated slope coefficients in a weighted regression of $d(\ln N_i)$ on dummy variables for three education groups, three experience categories interacted with s dummy for the two lower education categories, and women; column (iii) is the same thing with $d(\ln x_i)$ as the dependent variable. Column (i) is thus the estimated ceteris paribus effect of a characteristic on the 1979-87 wage change and columns (ii) and (iii) the analogous effects on supply and demand. For

example, holding experience and sex constant, the college/high school logarithmic wage differential increased by .152, but college/high school relative supply increased by .805 - .331 = .474 and relative demand by -.096 - .003 = -.099. By (14) the relative wage change is the reciprocal of the intrafactor elasticity of substitution times the difference between the changes in relative demand and supply. It is, accordingly, clear that there is little insight in the equation $.152 = (1/\sigma)[-.099 - .474]$. The same conclusion follows from the application of the product demand shift hypothesis to the other major relative wage change facts.

Column (iv) of Table 5 reports a recomputation of the demand change index by removing four industries that are primarily governmental or non-profit (hospitals (28 percent government in 1979), welfare and religious (39%), education (79%), and public administration). The confinement of the index to the private sector yields results that are much more favorable to the demand shift hypothesis, at least qualitatively. Its value is highest for college graduates, and it is higher for women than for men. The reason for the difference with respect to education is that college graduates are employed in large numbers in education and public administration, and the removal of these industries gives heavier weight to industries like durable goods and FIRE, developments in which have been clearly relatively favorable to more educated workers. We are aware, however, of no theory of labor market behavior that implies that one

can ignore the public sector --- especially when, as with older women college graduates, it employs two-thirds of the labor force.

A second alternative to estimation of the effect of product market demand shifts on the structure of labor demand is to calculate the average of rates of growth of total employment by industry weighted by the 1979 employment distribution for each group. This index (which was used by Murphy and Welch) is equal to $\Sigma\, v_{ij} d(\ln N_j)$. It is straightforward to show that it is a biased estimate of the true demand shifts in the sense that it will be positively correlated with shifts in relative supply if, as is the case, the v_{ij}'s differ across demographic groups.[6] The values of $d(\ln N_j)$ from 1979 to 1987 are given in column (ii) of Table 4 and the resultant demand change index in column (v) of Table 5. As expected, this demand change index is slightly more favorable to explanation #2, for it is biased toward such an acceptance. It is clear, however, that even this measure does not come close to overwhelming the perverse supply changes that occurred during the 1980's. Column (iv) in Table 3 reports the slope coefficients of a weighted regression of this demand change index on the demographic characteristics of particular interest in the light of wage structure developments, and their size is such that they perform little better than the preferred demand change index.

A further insight into the usefulness of explanation #2 is provided in Table 6, which reports relative annual rates

of growth of employment by industry aggregates for 1947 to 1955, 1955 to 1970, 1970 to 1979, and 1979 to 1987. With the exception of the increase in the shift from durable goods/mining to FIRE and services, the changes in industry employment from 1979 are, in the main, a continuation of past trends. By the demand shift argument, there should have been some downward pressure on unskilled/skilled relative wages during the 1970's, but there was not.

In sum, shifts in product demand during the 1980's do not seem to have been either sufficiently large or in the right direction to have been the major source of the observed movements in the wage structure in the 1980's. Foreign trade (and perhaps other factors) did cause manufacturing and mining industries to decline, which is obviously consistent with the demand story. Other shifts of different origins, however, such as the decline in the public sector and the rise in construction, seem to have had approximately equal effects in the other direction.

B. Changes in the Incidence and Level of Rents

To test explanations #3 and #4, we first added dummy variables for 16 industries to the basic regression model described in Section I in order to obtain estimated wage rates for 1979 and 1987 by industry by education, experience, and sex. This provides a set of estimated logarithmic deviations of the wage rate in each of the J industries relative to an arbitrarily excluded industry, other factors (location, etc.) held constant, for each group, say α_{ij}. One

interesting feature of these results is that, as has been noted by several previous investigators of this topic, the relative wage structure across industries is highly correlated among labor groups (for example, the estimated coefficients on durable goods manufacturing are high and those in retail trade low for all 32 demographic groups in both years). There are, however, several interesting exceptions to this general pattern.

In order to estimate the two terms on the right hand side of (15), it is necessary to establish which industries compose the competitive sector so that W_{ic} and then the R_{ij}'s can be identified. Several attempts at doing this revealed that there does not seem to be a set of industries that serve the function of providing a reference wage that has consistent properties across all groups. For example, when considering the labor market for males with high school and less, the competitive sector might consist of all the trade and service industries (the providers of "bad" as opposed to "goods" jobs), and the other industries can be grouped into three other sectors: manufacturing and mining, the other relatively unionized industries (construction, transportation, and public utilities), and the government/nonprofit sector employed in the analysis of demand changes above. The (weighted) variance of the 17 estimated industry effects is almost entirely picked up, for males with relatively low education, by the variance across these four sectors. For women and males with high

educational attainment, however, this four-sector approach performed poorly in the sense that the variance of average wage effects across the four sectors was much lower than the variance across all 17 industries. Without going into superfluous detail, there seem to be several different explanations of adjusted between-industry wage differentials that apply to different groups.

Since rents, in the very general sense we used in Section II, are not readily observed, we must make approximations of the two terms on the right hand side of (15) in order to assess the relevance of explanations #3 and #4. With respect to the first of these, estimates of the direct effect of industry composition changes on average wage levels by group can be obtained by calculating $\Sigma \alpha_{ij} dv_{ij}$ for each group, where α_{ij} is the estimated logarithmic industry wage effect in 1979 for group i in industry j and dv_{ij} is the change in the weight from 1979 to 1987. These calculations are reported in column (vi) of Table 5.

The estimated impact of changes in industry weights on the change in a particular average wage differential is obtained by subtracting the value in column (vi) for the denominator group from the numerator group. For example, the change in the logarithm of the average wages of male college to high school at X = 5 was .428 -.245 = .173, and from column (v) the estimated amount of that due to changes in industry weights is .022 - (-.021) = .043, or about a quarter of the change.

To get an overview of the contribution of compositional changes to the explanation of the major changes in wage differentials of interest in this study, the values in column (vi) of Table 5 were regressed on the three education dummies, the three experience dummies interacted with education less than college, and the sex dummy variables. The resultant coefficients, which are reported in column (v) of Table 3, represent the estimated partial contribution of compositional changes to the explanation of wage changes of the relevant group relative to young males with low educational attainment. With respect to the change in relative wages by education, very little of the change in the high school/elementary differential (.002 out of .077) is attributable to compositional change. However, 16 percent (.025 out of .152) of the change in the college/high differential can be explained by this factor.[7] For workers with less than college, about 12 percent of the increase in the X=35/x=5 differential (.014 out of .123) is due to the compositional effect.[7] This factor explains none of the increase in the relative wages of women.

The task of estimating the second term in (15), which reflect explanation #4 that the average level of rents changed during the 1980's in a manner that contributed significantly to the major wage structure developments, is subject to the same difficulty as explanation #3 concerning the identification of the R_{ij}'s. It is, however, interesting to note that differences in wages changes from 1979 to 1987

appear to be dominated by group rather than industry-specific trends. In line with this, the weighted (by 1979 education/experience/sex proportions) variance of the 544 $d(\ln w_{ij})$'s, .0088, is equal to the sum of the within-industry variation of the 32 groups, .0028, and the variance of average industry wage changes across groups, .0060. Thus, despite the fact that the estimated wage changes within industries is much noisier than those for across the averages for the groups, the latter accounts for 2/3 of the variation.

A direct approach to this problem is to estimate industry specific effects for 1979-1987 wage changes on the assumption that abnormally high or low wage increases in industry j will be experienced by all I groups. To test for this, d(ln Wij) was regressed on dummy variables (with 1979 industry employment of group i as a weight) for each of the industries. The resultant estimated parameters, with construction as the excluded group, are reported in column (vi) of Table 4. These estimates show that relatively skill-intensive industries like FIRE, education, and professional services had significantly larger wage increases during the 1980's than did those industries that traditionally hire blue collar males.

This, of course, does not bear directly on explanation #4, for the skill-intensive industries had to increase their age levels in order to stay competitive in the labor market. (It is subject to a deficiency similar to the use of the second demand change index above.) To estimate industry

effects on wage changes independent of what we are trying to explain, the seven control variables used throughout Table 3 were added to this regression, and the resultant estimated coefficients on the industry dummies are reported in column (vii) of Table 4. Although the industry dummies are still jointly significant (F = 10.4), the magnitudes of the effects fall appreciably. A few industries, like public utilities FIRE, and hospitals, increased their wages significantly relative to others, but the sizes of the differences are insufficient to provide a complete explanation of the changes in demographic wage differentials.

Nevertheless, industry wage effects do explain a small part of the major wage structure developments of the 1980's. Column (vi) of Table 3 reports the reduction in the estimated coefficients on the dummy variables for education, experience (for non-college workers), and sex attributable to the addition of the 16 industry dummy variables. For example, .020 of the .161 increase in the college/high school differential is due to changes in industry wage effects, .006 of the .114 increase in the X=35/X=5 for non-college workers, and .009 of the .097 decrease in the gender gap.

Another way of looking at changes in average rents by different demographic groups is to examine what happened to the extent of unionization (as is done in some detail by Blackburn, Bloom, and Freeman). For males with high school or less, the groups that have the majority of union membership, the fraction of workers who are union members

(from the May C.P.S.) fell from .39 in 1979 to .27 in 1987. The estimated logarithmic wage effect of union membership, however, increased from about .16 to .23. This means that the average rent of males without college attributable to unionism changed by .16·(.27 - .39) = -.019 due to the decline in union membership, by .39·(.23 - .16) = .023 due the rise in the union premium, and by -.12·.07 = -.001 due to the interaction of the two effects. Thus, although much publicity has been given to the decline of the unionism as a potential cause of the plight of working people in the U.S., the net effect of a declining membership proportion and an increasing wage premium was approximately zero.

IV. Conclusions

In the preceding section we examined the data to assess the power of the three explanations of wage structure developments that could be tested fairly straightforwardly. As we noted at the outset, their quantitative magnitude would have to be very large, for the changes in the demographic structure of the labor force have been decidedly in the wrong direction. However, we found no "smoking gun" among explanations #2-4. Product demand changes appear to be at most neutral with respect to the phenomena we have sought to explain, and the estimated combined effects of changes in the incidence and level of rents for only a tenth to a fifth of them. What, then, does explain changes in the wage structure during the 1980's?

First, the large and systematic increase in the relative wages of women relative to men must surely be due in some part to increases in the relative quality of the former (explanation #6). Based on trends in the actual labor market experience of women in the labor force, Smith and Ward predicted that women's wages would rise at least 15 percent faster than men's from 1980 to 2000. Our estimate of the gender difference in percentage wage increases between 1979 and 1987 of 10 percent suggests that either women's actual experience gap narrowed much more quickly than Smith and Ward expected or that something else is going on.[11]

Second, there is also the possibility that technological change, explanation #5, accounted for some of the major changes in the wage structure. There is a great deal of anecdotal evidence that production processes have changed significantly over the past decade in a manner that favors more relative to less educated workers. A recent report on a B.L.S. survey of changes in techniques in firms describes technological changes that imply "lower demand for manual dexterity, physical strength for materials handling, and traditional craftsmanship" (Mark). This, probably reflecting the widespread adoption of computer technology across industries, certainly could have had some effect on the relative demand for labor by education and, by $d(\ln b_i)$ in (14), on the position of the relative demand function.[12]

The explanation may also explain <u>some</u> of the increase in the wages of women relative to men. At the lower end of the

educational spectrum, jobs that are traditionally filled by women (e.g., secretarial) rank higher in job evaluations on "intellectual challenge" attributes than do jobs traditionally held by men; men's jobs, on the other hand, rank higher with respect to "physical exertion" and "required strength" (see Johnson and Solon). A reasonably widespread change in production processes such as described in the B.L.S. studies would accordingly increase the market wage of women's relative to men's jobs.

The technological change explanation also leads to a reinterpretation of the role of relative supply changes during the 1980's. Consider the difference between the change in wage rates by demographic group over the 1979-87 (period 2) and 1973-79 (period 1) intervals. By (16) this is equal to

$$(17)\quad d(\ln W_i(2)) - d(\ln W_i(1)) = (\beta_0(2) - \beta_0(1)) + \beta_i(d(\ln N_i(2)) - d(\log N_i(1))) + (U_i(2) - U_i(1)) + (d(\ln(R_i(2)) - d(\ln R_i(1)) + (e_i(2) - e_i(1)).$$

Now assume that (i) most of the source of the $U_i(t)$'s is due to variation in rates of technological change across groups, the $d(\ln b_i)$'s, (ii) rates of technical change are equal for each group in the two periods, and (iii) differences in changes in average group rent levels are uncorrelated with differences in relative supply changes across groups. (i) and (ii) imply that $U_i(2) \approx U_i(1)$, which means that technical

change drops out as fixed effect. (iii) implies that the slope coefficient on a simple regression of $d(\ln W_i(2)) - d(\ln W_i(1))$ on $d(\ln N_i(2)) - d(\ln N_i(1))$ is an unbiased estimate of $\beta_1 = -1/\sigma$.

When this procedure is followed (after converting the changes in the logarithms of wages and employment over the intervals into per annum terms), the estimated slope coefficient is -.186(.047), implying a (somewhat large but plausible) elasticity of intrafactor substitution of 5.4. By this story, what is responsible for the large increase in educational wage differentials is the slowdown in the rate of increase in the rightward shift of the distribution of educational attainment. For example, between 1973 and 1979 the fraction of workers with 16+ years of schooling increased from .111 to .193, a per annum growth rate of .092. Between 1979 and 1987, however, this growth rate fell to .026, hence the dramatic increase in the pecuniary returns to schooling. It is, of course, not clear from the preceding that technological change biased toward relatively skilled labor will continue into the 1990's. If it does and college enrollment rates do not rise substantially, the widening of the wage structure observed over the last decade is likely to continue.

Footnotes

* - We are indebted for useful suggestions on an earlier draft of this paper to several participants in seminars at Michigan and N.B.E.R. We have also benefitted from several discussions with Larry Katz and Ana Ravenga, who have been studying this problem from a somewhat different perspective.

1 - The sample includes all persons in the annual CPS whose principal activity was working (i.e., excluding full-time students) in all nonagricultural industries (with the exception of private household services). The wage rate is defined as the ratio of the responses to questions concerning "usual weekly earnings" and "usual weekly hours." Potential experience is defined as age less years of schooling less six for those with educational attainment in excess of nine years; otherwise, experience equals age less 16. One problem is that the response to the question on usual weekly earnings was capped at $999.99, which was relevant for many highly educated males in 1987. Based on data from the March C.P.S., David Card has estimated that the actual earnings of those at the cap were on average 1.165 times the maximum recorded value, and we used this adjustment for the 1987 data.

2 - We also estimated wage profiles by this demographic breakdown for 1973 CPS data and analyzed the 1973-79 changes in relative wages. The regression of the change in estimated log wage across the 32 groups on a similar set of dummy variables (with the exception that the three experience variables were specified to have the same effect for all groups) showed that the return to schooling fell and the return to experience rose slightly during this period. The coefficients on high school, some college, and college were, respectively, -.027, -.080, and -.097, implying that the college/high school logarithmic relative wage fell by .070 as contrasted with its .161 increase during the 1979-87 interval. The slope of the experience/earnings profile increased by a small amount (e.g., an increase in the wage of workers with X = 35 relative to those with X = 5 of .034). There was a slight increase, .028, in the adjusted logarithmic relative wage of women. Apparently the decline in the wage gap, which has continued through the 1980's, began around 1975 (see O'Neill).

3 - The increase in composition-adjusted real wage rates during the 1973-79 interval was -0.7 percent per annum for men and slightly under -0.2 percent per annum for women.

4 - It is "off its demand function" in the sense that the changes in the relative wages of demographic groups are not negatively related, as was true in the 1970's, to changes in their relative supply. Indeed, a weighted (by the square root of 1979 employment) regression of the 1979-1987 change in the log of the estimated W_i in Table 1 on the change in the log of employment yields a slope coefficient of +.183(.043). This is consistent with an elasticity of intrafactor substitution of minus 5.5 as compared to conventional estimate of about +1.5. For the 1973-79 period, on the other hand, the estimated coefficient on the change in log employment was -.081(.010). Obviously, some omitted variable was correlated with employment changes during the 1980's (and possibly during the 1970's) that caused this perverse result.

5 - An increase in the rent of a particular group in a set of industries will only have a positive effect on the average wage of that group relative to others under certain circumstances; roughly, the demand elasticity for that group in those industries must be less than unity.

6 - This view of the inter-relationship between human capital and technical change was developed in the context of a formal growth model by Nelson and Phelps. Welch (1970) applied this basic idea --- that education is the more productive the more volatile is the state of technology --- to an empirical analysis of the effect of schooling on earnings in agriculture.

7 - The absolute value of the logarithmic derivative of N_{ij} with respect to R_{ij}, with $\mu = 0$ and holding the value of the denominator of (9) constant, is

$$a_{ij}\varepsilon + (1-a_{ij})\sigma,$$

where a_{ij} is the output share of group i in industry j. This is, of course, Hicks' well-known formula for the wage elasticity of demand in a competitive industry in a partial equilibrium setting.

8 - The econometric estimation of (11) is more easily envisaged when it is written in matrix form, i.e.,

$$\begin{bmatrix} d(\ln v_{11}) \\ d(\ln v_{12}) \\ \cdots \\ d(\ln v_{1J}) \\ d(\ln v_{21}) \\ \cdots \\ d(\ln v_{IJ}) \end{bmatrix} = \begin{bmatrix} 1-v_{11} & -v_{12} & \cdots & -v_{1J} \\ -v_{11} & 1-v_{12} & \cdots & -v_{1J} \\ \cdots & \cdots & \cdots & \cdots \\ -v_{11} & -v_{12} & \cdots & 1-v_{1J} \\ 1-v_{21} & -v_{22} & \cdots & -v_{2J} \\ \cdots & \cdots & \cdots & \cdots \\ -v_{I1} & -v_{I2} & \cdots & 1-v_{IJ} \end{bmatrix} \begin{bmatrix} d(\ln x_1) \\ d(\ln x_2) \\ \cdots \\ d(\ln x_J) \end{bmatrix}.$$

An error term can be added to the equation by assuming, for example, that there is variation across industries in changes in the technological coefficients (say, $d(\ln b_{ij}) = d(\ln b_i) + u_{ij}$).

9 - To compare the properties of this "intuitive" demand change index, DI_2, with our index, DI_1, consider the example with two labor groups ($i=1,2$), two industries ($j=a,b$), and $\sigma = \varepsilon$ (so that $x_j = \beta_j$). It is easily shown that

$$DI_1 = (v_{2b} - v_{1b})d(\ln \beta_b),$$

which is the correct index in the sense that the change in the logarithm of W_2/W_1 equals $(1/\sigma)$ times this index less $d(\ln(N_2/N_1))$. The intuitive demand change index, under the above assumptions, equals

$$DI_2 = (v_{2b} - v_{1b})(1 - K)d(\ln \beta_b) + Kd(\ln(N_2/N_1)),$$

where

$$K = (v_{2b} - v_{1b})^2 N_1 N_2 / N_a N_b.$$

In other words, DI_2 is a weighted average of our demand index and the proportionate change in relative supply. The weight K is equal to one when both groups have the same industry employment distributions ($v_{1b} = v_{2b}$), but it is equal to zero when the two groups are perfectly segregated by industry (say $v_{2b} = 1$ and $v_{1b} = 0$ so that $N_a = N_1$ and $N_b = N_2$). The intuitive demand change index, therefore, is biased toward reflecting labor supply shifts rather than product demand shifts.

10 - These results are based on the inclusion of 16 dummy variables for major industries, and a natural question arises about the appropriateness of this level of aggregation. To check for this, we replaced this set of industries with 44 dummies for detailed industry (principally the addition of two-digit manufacturing) in regressions for men and women that included all education and experience groups. The results showed that most of the effect of industry on the 1979-1987 changes in the estimated coefficients on education and experience were picked up by the 16 major industry dummies. For example, 89 percent of the reduction in the fall in the estimated college/high school differential due to adding detailed industry was captured by adding major industries. Thus, the true effect of explanation #3 is only slightly greater than that reported in Table 3.

11 - One aspect of the performance of relative wages during the 1980's that is not favorable to a simple version of explanation #6 is that there is no observed tendency of the male/female differential to narrow with respect to potential experience. Indeed, it goes slightly (but insignificantly) in the other direction. It is possible that relatively younger women are expecting to (and are expected by employers to) behave differently with respect to the labor market --- more specific training, longer annual work hours, different "career ladders," etc. --- then their counterparts in the 1970's. An update and extension of a study like that of Corcoran and Duncan, with detailed data on actual work histories of large samples of men and women, would be necessary to test for this possibility. Even with this, however, many of the relevant changes between the 1970's and 1980's might not be measured.

12 - For direct evidence on the relation between the rate of technological innovation and the demand for education by skill across industries see Bartel and Lichtenberg. They also raise the interesting point that a particular innovation may raise the relative demand for education initially but not after the innovation has become part of the production routine. With respect to computer technology, workers with strong mathematical aptitude and training may be "essential" for a few years after its introduction into a particular firm, but subsequently most of the work can be done by high school graduates using canned programs like Lotus 1-2-3. Accordingly, whether or not the effect of computers on the relative demand for labor by education is long-lasting depends on the degree to which future generations of computers require as much adaptation as was required in the first generation.

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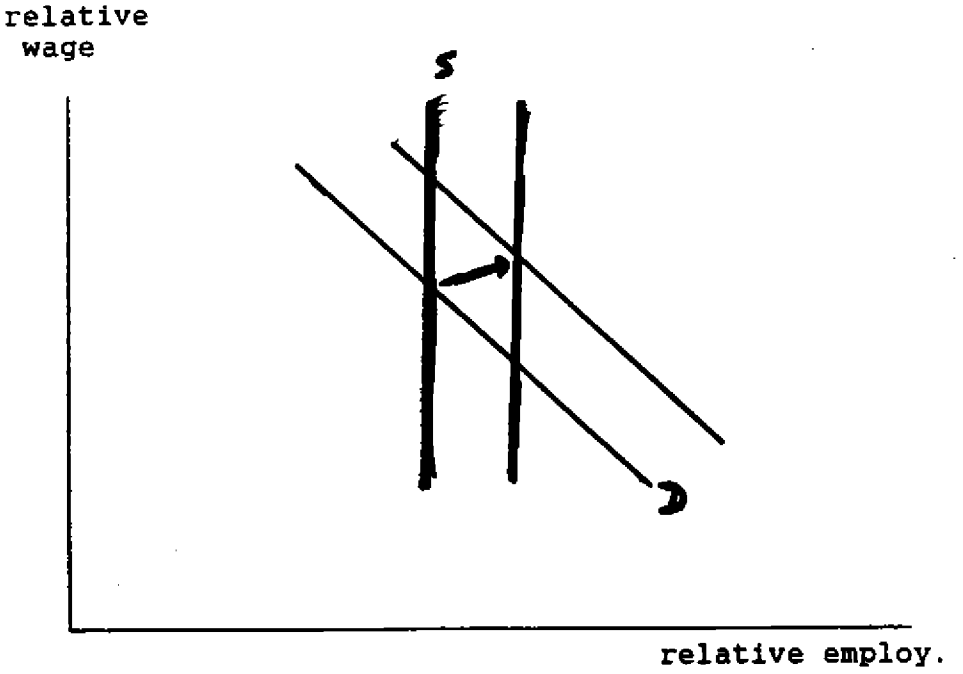

Figure 1.

Table 1.

Estimated Log Hourly Wage Rates by Education, Potential Experience, and Sex, 1979 and 1987

	Education:	8			12			14			16		
	X	79	87	ch	79	87	ch	79	87	ch	79	87	ch
Men	5	1.475 (.020) 3332	1.641 (.024) 2383	.166 (.031)	1.702 (.005) 11230	1.958 (.005) 9515	.256 (.007)	1.810 (.009) 6122	2.136 (.009) 5317	.326 (.013)	1.968 (.008) 6882	2.407 (.009) 6347	.439 (.012)
	15	1.767 (.022) 2967	1.973 (.023) 2718	.206 (.032)	1.999 (.008) 8036	2.296 (.008) 9860	.297 (.011)	2.109 (.012) 4377	2.455 (.009) 5651	.346 (.015)	2.286 (.012) 5153	2.680 (.008) 7651	.394 (.014)
	25	1.827 (.018) 3430	2.110 (.024) 2227	.283 (.030)	2.063 (.010) 5753	2.436 (.008) 6656	.373 (.012)	2.173 (.018) 2275	2.615 (.014) 3198	.442 (.023)	2.390 (.014) 3114	2.813 (.012) 4025	.423 (.018)
	35	1.895 (.008) 7667	2.235 (.015) 4689	.340 (.017)	2.088 (.010) 7310	2.467 (.009) 6453	.379 (.013)	2.201 (.018) 2203	2.607 (.017) 2252	.406 (.025)	2.359 (.017) 2129	2.837 (.016) 2518	.479 (.023)
Women	5	1.220 (.025) 1734	1.512 (.030) 1304	.292 (.039)	1.449 (.006) 10042	1.811 (.007) 8851	.362 (.009)	1.583 (.010) 5454	2.007 (.008) 6152	.424 (.013)	1.749 (.011) 5228	2.267 (.009) 6311	.518 (.014)
	15	1.309 (.020) 1854	1.643 (.022) 1733	.334 (.030)	1.575 (.009) 7140	2.024 (.008) 8946	.449 (.012)	1.736 (.015) 2800	2.241 (.010) 5113	.505 (.018)	1.877 (.018) 2438	2.386 (.010) 5412	.509 (.021)
	25	1.370 (.018) 2231	1.732 (.022) 1776	.362 (.028)	1.600 (.011) 5518	2.043 (.009) 7571	.443 (.014)	1.708 (.020) 1723	2.255 (.014) 3126	.547 (.024)	1.845 (.021) 1595	2.349 (.017) 2735	.504 (.027)
	35	1.407 (.017) 4264	1.758 (.020) 2979	.351 (.026)	1.612 (.011) 6952	2.078 (.010) 7009	.466 (.015)	1.718 (.021) 1738	2.219 (.019) 2089	.501 (.028)	1.844 (.029) 1113	2.356 (.026) 1379	.512 (.039)

Table 2.

Employment Distributions by Industry by Education and Sex, 1979 and 1987

	Men								Women							
Education:	<12		12		13-15		16+		<12		12		13-15		16+	
Industry	79	87	79	87	79	87	79	87	79	87	79	87	79	87	79	87
1. const.	.145	.177	.115	.129	.081	.082	.030	.031	.006	.009	.013	.014	.012	.014	.005	.006
2. d.g./mng.	.273	.217	.248	.201	.200	.170	.153	.145	.170	.142	.116	.093	.072	.065	.028	.044
3. nondur.	.141	.126	.123	.113	.097	.078	.086	.077	.229	.194	.098	.091	.061	.051	.036	.041
4. transp.	.077	.067	.069	.065	.062	.059	.026	.029	.012	.012	.022	.020	.026	.024	.013	.015
5. utils.	.029	.025	.052	.047	.052	.053	.031	.042	.008	.006	.035	.027	.031	.027	.017	.020
6. whole.	.042	.052	.058	.059	.065	.061	.050	.054	.016	.022	.031	.031	.031	.026	.015	.021
7. retail	.120	.147	.135	.151	.143	.155	.064	.070	.215	.239	.204	.220	.150	.154	.063	.065
8. FIRE	.019	.020	.028	.031	.059	.057	.084	.099	.031	.028	.116	.116	.118	.132	.062	.086
9. bus. s.	.041	.055	.037	.056	.036	.056	.032	.057	.023	.046	.028	.043	.029	.050	.023	.047
10. pers. s.	.012	.017	.011	.017	.013	.020	.007	.009	.055	.064	.032	.040	.020	.027	.007	.010
11. enter.	.008	.012	.007	.009	.013	.012	.007	.010	.008	.009	.007	.007	.012	.011	.008	.009
12. medic.	.005	.007	.004	.006	.009	.009	.018	.018	.057	.065	.056	.067	.034	.084	.050	.054
13. hosp.	.013	.011	.013	.014	.021	.022	.035	.035	.063	.048	.070	.058	.132	.113	.099	.111
14. w.&r.	.005	.006	.004	.007	.008	.011	.037	.031	.019	.031	.019	.028	.026	.037	.039	.047
15. educ.	.025	.025	.018	.021	.023	.026	.186	.138	.061	.054	.070	.061	.091	.072	.451	.318
16. prof. s.	.005	.006	.009	.009	.021	.021	.055	.006	.008	.010	.027	.026	.041	.042	.035	.046
17. pub.ad.	.037	.026	.074	.065	.098	.106	.099	.097	.019	.021	.058	.059	.065	.072	.050	.061

Table 3.

Changes in Grouped Relative Wages by Education, Experience, and Sex and Their Determinants

Group	d(ln W) (i)	d(ln N) (ii)	demand (iii)	change (iv)	industry comp. (v)	wages (vi)
E<12, X<10	.000	.000	.000	.000	.000	.000
E=12	.081	.368	.003	.025	.002	.007
12<E<16	.140	.542	-.020	.037	.005	.013
E≥16	.242	.755	-.096	.036	.028	.027
E≤12,10≤X≤19	.054	.372	-.032	-.019	.008	.004
E≤12,20≤X≤29	.102	.314	-.042	-.021	.013	.005
E≤12,X>29	.114	.078	-.018	-.047	.014	.006
Women	.097	.147	.003	.057	.000	.009

(i): Estimated coefficients of regression of 79-87 change in log estimated wage for 32 demographic groups (col. (i) of Table 5) on dummy variables for E = 12, 14, and 16, dummy variables for X = 15, 25, and 35 interacted with a dummy variable for E < 16, and a dummy variable for women.
(ii): Regression coefficients for group employment change (col. (ii) of Table 5) on dummy variables.
(iii): Regression coefficients for demand change index of group (col (iii) of Table 5) on dummy variables.
(iv): Regression coefficients for alternative demand change index (col (v) of Table 5) on dummy variables.
(v): Regression coefficients of industry composition effects (col (vi) of Table 5) on industry dummy variables.
(vi): Reduction in estimated coefficients on dummy variables in regression of change in log wages of 544 education/experience/sex/industry groups due to addition of 16 industry dummy variables.

Table 4.

Estimated Industry Demand Change Effects ($d(\ln x_j)$) and Wage Change Effects Relative to Construction

	Demand Change (i)	Emp. Change (ii)	Wage Change without (iii)	Wage Change with (iv)
1. Construct.	.000 -	.000	.000 -	.000
2. Dur./Mng.	-.313(.036)	-.224	.053(.016)	.019(.011)
3. Nondur.	-.235(.039)	-.168	.050(.017)	.006(.012)
4. Transp.	-.203(.048)	-.111	.004(.021)	-.028(.016)
5. Utils.	-.222(.057)	-.028	.117(.024)	.068(.017)
6. Whole.	-.071(.048)	.051	.051(.023)	.006(.015)
7. Retail	.018(.038)	.073	.041(.016)	-.012(.011)
8. FIRE	-.033(.044)	.171	.152(.020)	.066(.014)
9. Bus. Serv.	.360(.053)	.477	.058(.025)	.015(.017)
10. Pers. Serv	.175(.175)	.245	.038(.023)	-.025(.021)
11. Entertain.	.008(.090)	.141	.071(.041)	.029(.028)
12. Medical	-.021(.055)	.201	.135(.026)	.005(.018)
13. Hospitals	-.239(.048)	.034	.171(.022)	.079(.016)
14. Welf./Rel.	.050(.067)	.340	.080(.031)	-.020(.021)
15. Educat.	-.437(.043)	-.066	.185(.019)	.053(.013)
16. Prof. Ser.	-.039(.060)	.187	.139(.027)	.058(.019)
17. Pub. Ad.	-.185(.044)	.046	.162(.021)	.051(.013)

(i): Estimated coefficients of regression of 79-87 change in log employment for 32 education/experience/sex groups in 17 industries on 1979 employment weights according to (11) in text (standard errors in parentheses).
(ii): 79-87 change in log employment by industry relative to construction.
(iii): Estimated coefficients of regression of 79-87 change in log wages for 544 education/experience/sex/industry groups on industry dummy variables.
(iv): Estimated coefficients on industry dummy variables in regression as in (iii) with addition of dummy variables on education, experience, and sex described in Table 3.

Table 5.

Proportional Changes in Wages and Employment, Demand Effects, and Compositional and Wage Effects by Education, Experience, and Sex

	Exp.	Educ.	d(ln Wi) (i)	d(ln Ni) (ii)	Demand Effect All (iii)	Demand Effect Private (iv)	Change in Weights Emp. (v)	Change in Weights (vi)	Industry Wage Change Effects no contrls. (vii)	Industry Wage Change Effects controls [viii]
Men	0-9	<11	.166	-.335	-.104	-.096	-.034	-.012	.047	.008
		12	.256	-.266	-.115	-.103	-.038	-.021	.051	.010
		13-15	.326	-.141	-.109	-.086	-.011	-.018	.065	.015
		16+	.439	-.081	-.163	-.068	.008	.023	.104	.030
	10-19	<11	.206	-.088	-.138	-.133	-.064	-.010	.048	.009
		12	.297	.209	-.152	-.136	-.061	-.015	.059	.015
		13-15	.346	.255	-.142	-.112	-.030	-.008	.071	.019
		16+	.394	.395	-.186	-.078	-.005	.009	.107	.031
	20-29	<11	.283	-.432	-.150	-.143	-.071	-.007	.050	.010
		12	.373	.146	-.163	-.145	-.064	-.005	.063	.017
		13-15	.442	.341	-.150	-.112	-.029	.000	.078	.023
		16+	.423	.257	-.204	-.090	-.019	.007	.109	.032
	30+	<11	.340	-.492	-.166	-.155	-.074	-.008	.058	.013
		12	.379	-.325	-.163	-.142	-.054	-.004	.069	.019
		13-15	.406	.022	-.156	-.137	-.037	-.008	.075	.021
		16+	.479	.168	-.182	-.101	-.014	-.004	.101	.029
Women	0-9	<11	.292	-.285	-.107	-.092	-.016	-.024	.065	.008
		12	.362	-.126	-.095	-.061	.031	-.016	.086	.021
		13-15	.424	.120	-.107	-.042	.050	-.013	.103	.028
		16+	.518	.188	-.214	-.023	.029	.003	.136	.040
	10-19	<11	.334	-.067	-.135	-.119	-.032	-.013	.069	.011
		12	.449	.225	-.123	-.076	.019	-.008	.093	.024
		13-15	.505	.602	-.129	-.052	.047	-.002	.111	.032
		16+	.509	.797	-.268	-.016	.003	.006	.149	.042
	20-29	<11	.362	-.228	-.144	-.118	-.031	-.016	.075	.014
		12	.443	.316	-.131	-.072	.021	-.004	.097	.025
		13-15	.547	.596	-.145	-.053	.040	.002	.114	.033
		16+	.504	.539	-.291	-.015	-.011	-.014	.153	.043
	30+	<11	.351	-.359	-.148	-.113	-.022	-.003	.081	.016
		12	.466	.008	-.134	-.074	.019	-.003	.098	.025
		13-15	.501	.184	-.146	-.056	.037	.000	.113	.031
		16+	.512	.214	-.281	-.023	-.007	-.006	.149	.042

(i) and (ii): Changes in estimated log wages and log employment by demographic group (from Table 1).
(iii): Estimated industry demand change effect by group, average of col. (i) in Table 4 weighted by group's 1979 industry employment distribution.
(iv): Same as (iii) with industries 14-17 removed.
(v): Same as (iii) with col. (ii) replacing col. (i).
(vi): Sum of 79-87 change in industry weight times 1979 industry wage effect by group.
(vii): Sum of coefficients in col. (iii) in Table 4 times industry employment weight by group.
(viii): Same as (vii) with col. (iv) instead of (iii).

Table 6.

Relative Annual Rates of Growth of Employment by Aggregated Industries: Selected Postwar Intervals

	47-55	55-70	70-79	79-87
Construct.	.014	-.010	.004	-.001
Dur./Mng.	.003	-.013	-.010	-.033
Nondur.	-.006	-.015	-.025	-.022
Tran.&P.U.	-.010	-.017	-.011	-.010
Wholesale	.017	-.005	.008	-.003
Retail	.008	.003	.007	.009
FIRE	.024	.009	.006	.019
Services	.017	.019	.016	.027
Govt.	.020	.018	.000	-.008