MARKET STRUCTURE AND WORKER QUALITY*

DALE BELMAN and JOHN S. HEYWOOD

It is frequently asserted, although never directly tested, that firms in more monopolistic industries hire better qualified workers. This paper presents two new results. First, worker quality (education in particular) is a strong determinant of whether a worker is employed in a concentrated industry when using a traditional data source. Second, upon expanding the data to include measures of research and development, workers of better quality are actually no more likely to locate in concentrated industries. These results fit with theories claiming that industries subject to technological opportunities may be more concentrated and that those opportunities demand higher quality workers.

I. INTRODUCTION

At least a score of articles since the 1960s test the hypothesis that more concentrated industries pay workers higher wages, other things equal. This investigation has been part of a more general examination of whether or not concentrated structure generates inefficiencies beyond the deviation of price from cost. Unfortunately, this large scale effort has not been rewarded with consistent results. Separate researchers both confirm and fail to confirm an independent role for industrial concentration in wage determination.¹

Among those who fail to confirm the concentration-earnings hypothesis, one explanation is offered most often. While concentrated industries pay higher wages, they obtain better qualified workers. The generally acknowledged simple correlation between wages and concentration becomes an insignificant partial correlation in the presence of a vector of controls. While some of the typical controls could be considered measures of worker quality, others clearly are not. It may be one or more of these “non-quality” controls, which frequently include industry characteristics, which eliminates the significance of concentration. For example, plant size and unionization, known to be correlated with both wages and concentration, are among the more likely “non-quality” variables which could explain the lack of

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significance. In any event, there have been no studies specifically designed to test the claim that concentrated industries hire workers who are better educated, with more experience or superior skills, once other individual traits, and industry and occupational controls are introduced.

II. CONCENTRATION AND WORKER QUALITY

While wide acceptance has not been gained for any single theory, the past arguments for an association between concentration and worker quality fall into two broad groups. The first group depends on an assumption that concentration is evidence of monopoly power and profit. The second group makes no such assumption, suggesting instead that the technological factors leading to concentration may also lead to higher demands for worker quality. Thus, proponents of the second group of arguments implicitly contend that any partial correlation between concentration and quality would vanish with a correct accounting for the underlying technology. Seen in this light, the debate over the concentration-earnings hypothesis reflects the more general debate in industrial economics over the importance of concentration as an indicator of monopoly.

Following the assumption that concentration is associated with monopoly rents, a series of researchers have suggested that such rents are shared with workers. In turn, these higher wages attract workers with better training, education and skills. The higher wages may be used to maintain a good image (Weiss [1966]), ensure a large queue of workers (Ross and Wachter [1973]) or promote good relations with labor unions (Segal [1964]). In each of these examples monopolistic industries, as proxied by concentration, are thought to use some of their rents on workers, rents which may result in higher quality workers. This line of causation has been labeled the “ability to pay hypothesis”.

One form of the ability to pay hypothesis suggests that hiring better workers is a primary objective of concentrated industries, not a by-product of rent sharing. To the degree that concentration is associated with monopoly power, managers of firms in concentrated industries may hire workers with excessive quality to reduce the burden of management. The presumption is that higher quality workers pose fewer administrative problems and accept

While unionization is not conventionally a dimension of worker quality, research by Allen [1984, 1987], Brown and Medoff [1978], Freeman and Medoff [1984], and Clark [1984] suggests that unions may raise realized worker quality through apprenticeships, screening, and altering the organization of work. To the extent these studies are correct, unionization may help determine worker quality.

This more general debate enjoys both prominence and longevity. See the papers in Goldschmid, Mann, and Weston [1974] for an early distillation of the different points of view. More recent contributions include Smirlock, Gilligan and Marshall [1984], Shepherd [1986] and Heywood [1987].
MARKET STRUCTURE AND WORKER QUALITY

delegated duties. Such "expense preference" behavior may explain the tendency of concentrated industries to offer higher wages and hire the superior workers such wages attract.

The second group of arguments do not rely on the presence of monopoly profits but instead claim that underlying technology or organization leads to both concentration and high worker quality. For example, Brogan and Erickson [1975] posit an underlying complementarity between physical and human capital. Concentrated industries are thought to be the result of relatively large scale economies with consequently large physical capital requirements. The production technology is assumed such that with the physical capital requirements come large human capital requirements. Hence, the more concentrated firm can be expected to hire workers with greater skills.

In a related argument, the conditions associated with industrial concentration—large production facilities, complex, joint output, and bureaucratic organization—may make monitoring of worker productivity impossible. Managers will only observe worker effort, and that only imperfectly. In response, it may be profitable for concentrated industries to hire workers who are more likely to self-monitor and less likely to shirk. These characteristics may be highly correlated with observable measures of worker quality. Thus, concentrated industries, characterized by difficult monitoring environments may be observed to hire more educated or skilled workers.

Both groups of arguments can be challenged on logical grounds. The contention that concentration reflects monopoly power remains open to debate. Even if concentration does reflect such power, the association with worker quality may not be convincing. If the hiring of better qualified workers is more profitable for monopolistic firms, it should also pay less concentrated industries to hire such workers. On the other hand, the managerial arguments depend not only on concentration reflecting market power but also on concentration resulting in a failure in capital markets and a failure in the market for corporate control.

The two technological arguments rest on a series of associations rather than the contention that concentration directly leads to workers of better quality. The posited complementarity between physical and human capital seems subject to two challenges. First, there is nothing in the theory of the firm that states labor quality and capital are necessarily complements. It is possible that capital may replace more skilled workers. Operators rather than

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4 This is not offered as a defense of the existence of expense preference behavior. Rather, if such behavior exists, worker quality and wages seems a likely dimension for managerial expense taking as these directly alter the environment in which management happens. For evidence on the existence of such behavior see Edwards [1977], Hannan and Mavinga [1980] and Smirlock and Marshall [1983].
craftsmen may be needed in more capital intensive production. Second, available evidence suggests actual patterns of market structure in the United States can not be explained by scale economies (see Pratten [1971], Scherer [1975] and Shepherd [1982]). As a consequence, the link between capital requirements and concentration may not be as strong as suggested. In turn, this emphasizes that the association between human capital and concentration is an empirical issue.

More generally, note that arguments in the second group rest on the close association of technology with concentration. Clearly it remains an open question whether concentration would still be associated with a superior work force after accounting for these other industry variables. For instance, there may be no reason to suppose concentrated industries have a more severe monitoring problem once the dimensions of the underlying technology have been accounted for.

In the first modern empirical study of these issues, Leonard Weiss demonstrated a simple correlation between concentration and wages. However, the concentration coefficient became insignificant when a vector of thirty-one personal and industry characteristics were included. On the basis of this, Weiss concluded that "firms in concentrated industries do pay their employees more, but that they get higher quality labor in the bargain" (Weiss [1966, p. 108]). As a consequence, such firms pay no more for specific worker characteristics and hence do not actually "overpay" workers.

Yet, left unresolved is which of the characteristics were responsible for eliminating the earnings gap seen in the simple correlation. Are the employees of concentrated industries more highly educated and more fully trained? Or are the employees of concentrated industries more predominately union, white and located in the North? Or are concentrated industries also ones with large plants and high capital to labor ratios? Given the wide variety of controls that Weiss entered in the regression, few conclusions about the dimensions of worker quality can be drawn. Nonetheless, the notion that workers in concentrated industries are more able remains popular and several more recent researchers interpret their own results as additional confirmation. However, neither Weiss nor those who have followed him directly examine whether concentrated industries actually hire workers of

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5 For example, our sample demonstrates that both the aircraft and motor vehicle industries have lower capital to labor ratios but a higher proportion of craftsmen in their production labor force than the chemical industry.

6 The empirical results from the present research indicate that the capital to labor ratio is positively correlated with industrial concentration in the non-union sector, but is unrelated to concentration in the unionized sector. The difference in these results is unexpected; it may indicate that unions play a more important role in determining industrial structure than is commonly allowed.

7 Among those making such claims are Rapping [1967], Brogan and Erickson [1975] and Pugel [1980].
better quality. As a result, no one has gone the further step to examine if concentrated industries hire better quality workers once accounting for other industry characteristics, the issue of contention between the two groups of explanations offered by past examiners.

III. EMPIRICAL STRATEGY

This section outlines our testing strategy and our first set of empirical results. We merge a major micro data set which has measures of worker quality with a variety of industry characteristics to isolate the factors influencing the concentration of the industry in which a worker is hired. The work of Weiss and others suggests quality factors such as education are important in determining whether or not the worker is employed in a concentrated industry. This section provides our first tests of that suggestion.

The Current Population Survey (CPS) of May 1983 is chosen as the primary data set because it includes detailed information on approximately 4000 manufacturing workers. In addition to questions routinely asked in the May survey, the 1983 May survey has questions on plant size and worker tenure making it a particularly valuable data source. Further, each worker is assigned an industry definition at approximately the three digit SIC level. There are eighty-three such definitions in the manufacturing sector. Thus, by aggregating the relevant four digit SIC information from the Census of Manufacturers we merge information on industrial concentration, the capital to labor ratio, and whether the industry produces a durable good. The concentration ratio is generated as the employment weighted average of the four-firm concentration ratios in the relevant three digit industries. Other explanatory variables from the CPS include years of experience, years of education, occupation, race, gender, residency in an urban area, and region of the country in which the worker is employed.

We employ a testing strategy which uses concentration as the dependent variable to be explained by an increasingly large set of independent variables. At each stage the correlation between fundamental quality variables, such as years of education, is examined. We replicate this procedure separately for workers in the union and nonunion sectors.

The division by union status is important as the characteristics of workers also vary by union status. Indeed, some past results might flow from inappropriate treatment of the union variable. Specifically, union jobs command higher wages attracting surplus workers which, in turn, may allow firms to hire the best quality of workers from the union queue. To the extent that concentration and unionization are positively correlated, the concentrated industries would appear to hire better qualified workers. The truth could be concentration plays no independent role. We remedy this by examining union and nonunion workers separately and introducing the percent of the industry which is unionized as an independent variable.
We estimate log-odds equations in which the concentration variable, which runs between zero and one, is transformed to the log of the ratio (concentration/[1 − concentration]). This provides a continuous dependent

<table>
<thead>
<tr>
<th>Table I</th>
<th>Prediction of Concentration in Nonunion Sector</th>
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<tr>
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Note: T-statistics are in parentheses.
variable and eliminates the problem of predicted values outside the range of zero to one. 8

Finally, we do not presume to be examining anything other than a reduced form which is the combined result of supply decisions by workers and demand decisions by industries. As such, we will not be able to distinguish whether better qualified workers in concentrated industries result from increased demand for such workers by concentrated industries or increased supply of such workers to these same industries. While this distinction may be important for some purposes, it is largely irrelevant to the issue raised by previous empirical studies of whether or not better qualified workers end up in concentrated industries for whatever reason.

We first estimate a parsimonious specification which includes only individual characteristics. The first column of Table I shows the results for the nonunion workers, while the first column of Table II shows the results for the union workers. The nonunion workers in concentrated industries appear to be disproportionately educated, male, urban, outside the south and with greater tenure. The union workers in concentrated industries appear to share similar characteristics at this stage. They are more educated, urban, male, in the north central region, and they have greater tenure. Of these education and tenure would be typically considered measures of worker quality. 9

Despite the similarities in the estimations, we can reject the hypothesis that the coefficients in the union and nonunion equations are the same at better than the 1% level of significance ($F = 4.469$). This remains true for all sets of equations and becomes more obvious in the most complete estimations.10

Next we add a set of occupational dummies to the previous list of explanatory variables. While these dummies show slightly different patterns between the two subsamples, they do not alter the earlier results. As column 2 of Tables I and II demonstrate, those workers with greater tenure and education continue to be disproportionately represented in more concentrated industries. The patterns of the gender, urban and region variables also remains identical.

The introduction of the industry variables yields both differences between the two sectors and differences from the earlier pattern. In the nonunion sector all of the industry variables emerge as highly significant. Concentration is positively correlated with the percent of the industry which is unionized the

8 For additional advantages of such a logistic formulation see Amemiya [1981].
9 Tenure is typically taken as a measure of worker quality, proxying skills acquired on the job and a mastery of the disciplines required to be productive on the job. This interpretation may not be appropriate where some firms pay wages above those generally offered for similar jobs. Workers would tend to remain with the high wage firms longer of their own volition. We would observe longer tenure even if the firm gained nothing from increased tenure. In the context of this study, it may be that firms in concentrated industries pay wage premia resulting in longer tenure.
10 The $F$ ratio is 2.58 in the system with occupation variables and 4.469 in the system with occupation and industry variables. In each case, the null of no difference between coefficients can be rejected at the 1% level.
capital to labor ratio, the two plant size dummies and the portion of the industries output which is a durable good. Moreover, as column 3 of Table I shows, some of the earlier results change. The worker’s gender, and

### Table II

**Prediction of Concentration in the Union Sector**

<table>
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<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
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<tbody>
<tr>
<td>Constant</td>
<td>-1.142</td>
<td>-1.474</td>
<td>-2.338</td>
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<tr>
<td></td>
<td>(3.215)</td>
<td>(3.523)</td>
<td>(3.998)</td>
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<td>Experience</td>
<td>-0.0004</td>
<td>-0.0004</td>
<td>-0.0001</td>
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<tr>
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<td>(0.145)</td>
<td>(0.139)</td>
<td>(0.049)</td>
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<td>Education</td>
<td>0.0411</td>
<td>0.0423</td>
<td>0.0317</td>
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<td></td>
<td>(3.408)</td>
<td>(3.403)</td>
<td>(3.193)</td>
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<td>Tenure</td>
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<td>0.0101</td>
<td>0.0004</td>
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<td>(2.867)</td>
<td>(2.986)</td>
<td>(0.158)</td>
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<td>(0.135)</td>
<td>(0.114)</td>
<td>(0.272)</td>
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<td>Male</td>
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<td>-0.0032</td>
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<td>(2.760)</td>
<td>(2.306)</td>
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<td>(0.280)</td>
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<td>(3.085)</td>
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<td>(0.424)</td>
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<td>(0.708)</td>
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<td>(0.351)</td>
<td>(0.076)</td>
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<td>(2.203)</td>
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<td>(0.878)</td>
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<td>(2.260)</td>
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</tr>
<tr>
<td>Percent</td>
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<td>Union</td>
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<td>Capital to Labor</td>
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<td>Medium</td>
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<td>0.1005</td>
<td>0.4564</td>
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<td>N</td>
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<td>1201</td>
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*Note: T-statistics are in parentheses.*
region of the country no longer help determine the concentration of the industry in which he or she is employed. Similarly, the significance of all but one of the occupational dummies vanishes. Yet, despite the long list of industry, occupational, and personal controls, both years of education and years of tenure retain significance in the estimation. Even though the introduction of the industry variables substantially increased the explanatory power of the equation, the measures of worker quality continue to play a substantial role. An $F$ test for the joint significance of tenure and education allows rejection of the null of zero coefficients at better than the 1% level ($F = 9.018$).

The effect of the industry variables is even more marked in the union sector than in the nonunion sector. Four of the five industry variables are highly significant with only the capital to labor ratio failing conventional tests. Beyond the industry variables, few factors emerge as significant. Again, only one of the occupational variables retains significance and both region and urban status lose their statistical significance. Importantly, the years of education continues to be a strong and significant indicator of the concentration of the industry in which the worker will be employed. It retains roughly the same size and significance as in the absence of the industry variables. However, the point estimate of tenure drops to a small fraction of its previous size and is statistically insignificant, suggesting that tenure plays a fundamentally different role in the union sector.11

This decline in the point estimate and significance of tenure is closely related to the measure of union strength, $POW$. Introduction of just this variable into an equation with individual traits and occupation dummies is sufficient to cause tenure to become statistically insignificant in the union equation.12 It may be that tenure in the union sector is a function of job security language, which is closely tied to union bargaining strength. In this case, $POW$ represents an omitted variable correlated with both concentration and tenure. Its inclusion reveals that tenure is actually not correlated with concentration in the union sector and indicates large differences between the union and nonunion sectors.

The magnitude of the correlation between years of education and concentration can be explored by evaluating the log-odds model at the mean values for explanatory variables except education. By examining a move from one standard deviation below the average education to one standard deviation above the average we can predict the concentration level of the worker's industry.13 The standard deviation for education in the sample is

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11 Despite the decline in the statistical significance of tenure, the null hypothesis of zero coefficients for both tenure and education is rejected in a 1% $F$ test ($F = 4.909$) of joint* significance.

12 In the union equation the coefficient on tenure declines to 0.00379 and has a $t$-ratio of 1.280. In the non-union equation the coefficient is 0.011 with a $t$-ratio of 5.07.

13 This is a nonlinear computation as the log-odds model defines concentration ($Cr$) as a function of the explanatory variables ($X$) in the following manner: $Cr = (e^{X\theta})/(1 + e^{X\theta})$. 
approximately 2.7 years while the average concentration for the workers' industry is 0.375. Thus, the increase in education for a nonunion worker would increase concentration from approximately 0.35 to 0.39 while for the unionized worker that increase would be from approximately 0.35 to 0.40. Higher education levels do, indeed, seem to predict being hired by a more concentrated industry. It is important to emphasize that these predictions are based on the full regressions which included all the personal, occupational and industry characteristics.

Thus, to the extent that years of education can be taken as an exogenous measure of worker quality, concentrated industries do hire a better quality of worker. These results would seem to support the inference of previous research. For example, in the work of Pugel [1980] inclusion of education and human capital variables causes the concentration coefficient to lose significance in wage equations, a result attributed to the correlation between concentration and worker quality. While Pugel's work was based on highly aggregated measures, the current results appear to stand as evidence that, indeed, more concentrated industries hire better qualified workers.

IV. THE ROLE OF TECHNOLOGICAL OPPORTUNITY

The role of technological opportunity provides an additional explanation for the association between worker quality and concentration. While this explanation has never been explicitly stated, it remains inherent in the examination of the connections between market structure and technological progress. Nelson and Winter [1978 and 1982], in particular, have proposed a model in which market concentration increases in those industries which are technologically progressive. Thus, like earlier researchers (see Philips [1971]) they stress that concentration is endogenous and responds to technological change. Such an argument differs from the contention that technological progress somehow flows inherently from concentrated structure. As Nelson and Winter argue "industries with rapid technological progress ought to be marked with high average R&D intensity and, as the industry matures, a more concentrated industry structure than industries where technical progress is slower."

To the extent this argument is correct, these same progressive industries are likely to have better qualified workers. This could happen either because those industries with technological progress demand workers of higher

14 Mean education for the full sample is 12.14 years. It is 11.54 years in the union subsample and 12.43 years in the non-union subsample. Mean tenure is 9.05 years for the full sample, 12.07 years for the union subsample, and 7.61 years for the non-union subsample. Also note that the mean concentration for our data set, 0.375, is employment weighted and may differ from those estimates which use the industry as the unit of observation.

15 Debate over the exact nature of the correlations between technological progress and market structure remains lively. Among others, see Scherer [1984] and Mukhopadhyay [1985].
quality or because higher quality workers are attracted to dynamic industries. While this has not been tested, earlier work by Scherer [1967] suggest that an examination may be fruitful. In his investigation of a large sample of heterogenous firms Scherer demonstrated a positive and significant correlation between the proportion of employment in research and development and industry concentration. Thus, if R&D workers are of higher than average quality, the correlation established in the previous section may be spurious. That is, higher quality workers are not correlated with concentration but with the prevalence of research and development.

To examine this alternative hypothesis we attempted to match each of our industries with data on R&D expenditures and to include this as an additional explanatory variable. This marks a sharp departure from the studies examining the association of concentration and earnings which gave rise to the issue of worker quality. Those studies do not typically include R&D as a wage determinant. We use as an R&D variable the intensity as measured by an expenditure to sales ratio which we aggregate from the Federal Trade Commission, Line of Business Statistics.

Our inclusion of R&D was marked with several difficulties. We could not generate a consistent series that included all of our industries. Only 68 out of the 83 industries have consistent R&D data. This limitation did not change the variance in concentration ratios which was 315.8 in the original data set and 313.6 in the smaller data set. It also did not fundamentally change the mean concentration ratio which was 37.5 in the original data set and 37.2 in the new data set. Nonetheless, to try to account for the different sample we

| Table III | Worker Quality, Concentration and R&D |
|---|---|---|---|---|
| Nonunion Sector | | | | |
| Education | 0.0373 | 0.0392 | 0.0241 | 0.0073 |
| (5.343) | (5.305) | (3.453) | (1.343) |
| R&D Intensity | 0.0425 | (14.96) |
| N | 1906 | 1906 | 1906 | 1906 |
| R-squared | 0.0856 | 0.1021 | 0.4698 | 0.5259 |
| Union Sector | | | |
| Education | 0.0442 | 0.0439 | 0.0238 | 0.0151 |
| (3.177) | (3.057) | (2.242) | (1.461) |
| R&D Intensity | 0.0645 | (10.78) |
| N | 932 | 932 | 932 | 932 |
| R-squared | 0.0875 | 0.1034 | 0.5174 | 0.5717 |

Each estimation in column 1 includes the human capital and demographic controls. Those in column 2 also include the occupational controls while those in column 3 also include both the occupational and industry controls. Column 4 adds R&D intensity to the estimation in column 3. T-statistics remain in parentheses.
reestimated the fundamental series of equations from the last section with our
new reduced data set which now included 1906 nonunion observations and
932 union observations. As the first three columns of Table III shows this
restriction does not fundamentally change our results. The correlation
between education and concentration persists as the list of additional
variables grows.

We now add our $R&D$ variable to the previous estimation. The last column
of Table III presents the results. The coefficient on the $R&D$ variable is large,
positive and highly significant. It is worth stressing that the unit of
observation is the worker and that this results in a different weighting scheme
than would be so if the industry were the unit of observation. Obviously the
typical empirical studies of the relationship between $R&D$ and concentration
are based on industry observations. Thus, while we do not feel we are
contributing strongly to that debate, the inclusion of $R&D$ stands as an
important control for examining worker quality. This is demonstrated by the
remarkable change in the coefficient on the education variable which
remained largely unchanged through all the previous regressions. The
inclusion of $R&D$ causes the coefficient to drop to a fraction of its former size
and lose significance in both the union and nonunion equations. Indeed, in
the larger nonunion sector the inclusion of the single $R&D$ variable causes the
education coefficient to drop to less than one-third of its previous size.

This final argument for the apparent correlation between concentration
and worker quality seems to be supported by the evidence. Concentrated
industries consist disproportionately of $R&D$ personnel who appear to be
workers of higher than average quality. Thus, the suspicion over the last
twenty-five years of research that concentrated industries hire workers of
higher quality seems mistaken. Once qualified by the extent of $R&D$
employment, better qualified workers are no more likely to appear in
concentrated industries.

IV. CONCLUSIONS

There are a variety of factors which determine the market structure of an
industry. These include plant and multi-plant economies, the extent of the
relevant markets, the effort to acquire monopoly power and the nature of
government intervention. Given that concentration reflects such a
complicated set of factors, most of which seem independent of worker quality,
the indirect inference from past studies that quality is correlated with market
structure should be directly tested.

We design a test in which concentration is the dependent variable in a log-
conditional model. We introduce an increasingly complete set of explanatory
variables which include personal, occupational and industry characteristics.
The complete set of variables is able to explain a large share of the variance in
concentration with the industry variables particularly important. Yet, more
years of education consistently correlates with the concentration of a worker's industry confirming the earlier, but untested inferences, that concentrated industries hire a better quality of worker.

This correlation breaks down completely in both the union and nonunion sectors when measures of research and development are included. Industries characterized by rapid technological progress are often thought to have certain firms which are successful in innovating and that this will lead to greater concentration than in less dynamic industries. These same dynamic industries are likely to have workers of greater quality either because they are necessary to innovate or because they are attracted to industries which do innovate. In any event, the evidence supports the contention that higher quality workers are associated with industries with large R & D budgets which happen to be concentrated. Thus, not only is the association between worker quality and concentration previously untested but it appears incorrect as well.

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