HUMAN CAPITAL AND LABOR TURNOVER IN MANUFACTURING INDUSTRIES: THE CASE OF A RELATIVELY UNDEVELOPED REGION IN SOUTHEAST OHIO

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Since 1970, increased attention has been devoted to examining the development potential of rural areas. Among the contributing factors are the reversal of population migration trends which began about 1970 [2], the increasing dispersion of manufacturing activities, and the congestion and population losses of central urban cities. This study, as part of Title V research in Ohio, is an examination of labor force behavior in manufacturing.[1] Although manufacturing employment has declined in relation to total employment in the region, the manufacturing sector has been and continues to be one of the major sources of income and employment. The characteristics and behavior of labor in this region are expected to be similar to those of many other rural areas in the United States, particularly areas of the Appalachian region.

The purpose of this study is to examine the role of manufacturing in the human capital formation and economic development of a rural area. A model developed by Parsons [7] is used to test the statistical hypothesis that the layoff rate is related negatively to a firm's investment in specific human capital, whereas the quit rate is related negatively to workers' investment in specific human capital.[2]

The distribution of personal income is related to investment in human capital. The pure contribution of education to income levels has been questioned because of the possible contribution of other factors such as "ability" and quality of schooling that are included in "contributions of education" [5]. However, even if downward adjustments are made to account for the impact of "ability" and other factors, the contribution of years of schooling to income differentials is still significant.

The quality of inputs in a production activity has been recognized as a very important determinant of the productivity of such inputs. Changes in labor quality have been used to account for changes in labor productivity growth [4]. Low labor quality may be one factor accounting for low income and low productivity in many rural regions. Human capital might therefore be a constraint on the general development potential of these regions. If quality of labor is a constraint to economic development, policy makers will have to make decisions about how human capital formation could be increased to improve development potential.

One way of assessing the impact of labor quality in the manufacturing industries and of providing economically meaningful information to local decision makers is to analyze labor force behavior by examining quit decisions by workers and layoff decisions by management. Parsons [7] applied this technique successfully to three-digit manufacturing industries to derive important policy implications about labor force behavior. What it might reveal about the labor force in the manufacturing sector of relatively undeveloped rural regions is essentially untested. In this study, it is tested on and implications are developed for a five-county region in southeast Ohio.

The primary set of data are cross-sectional microlevel data on manufacturing plants for calendar year 1974 or a fiscal year with greatest overlap of 1974. Questionnaires were mailed to 127 manufacturing firms which were identified in the region. Of 53 questionnaires that were returned, 49 were usable for testing the hypothesis.[3] It is expected that responding

[1] Under Title V of the Rural Development Act of 1972, Ohio has expanded research and extension programs in a five-county region in southeast Ohio consisting of Athens, Gallia, Jackson, Meigs, and Vinton Counties. Title V research in Ohio had focused on examining the potential for increased employment in the region.

[2] Specific human capital is defined as the difference between the discounted sum of worker's marginal product in his present firm and his greatest discounted marginal product net of transfer cost in alternative firms [7].

[3] Extensive telephone followup was used to increase the response rate.

firms are smaller than all firms because many of the larger firms refused to participate in the study. However, the responding firms are representative of the region's distribution of firms by industry. About 75 percent of the Standard Industrial Classification (SIC) two-digit manufacturing industries are present in the region with concentration in food and kindred products; lumber and wood; printing and publishing; stone, clay, and glass; and machinery.

CHARACTERISTICS OF THE REGION AND SAMPLE

The region is in a state which lags the nation in population and employment growth [11]. It is part of the Appalachian region of the United States. Population in the region increased between 1970 and 1975 (Table 1). The 1970 unemployment rate in the region was 6.5 percent compared with 4 percent for Ohio. However, the labor force participation rate in the region is low compared with that of Ohio. Use of the Ohio rate as an estimate of potential labor force participation in the region gives an adjusted unemployment rate of over 31 percent (Table 1). This figure is probably an overestimate of unemployment in the region because of an expected higher incidence of poverty, poor health, and other factors which affect labor force participation, but it does provide an upper bound estimate [8].

Covered employment for purposes of unemployment compensation is equal to total employment in manufacturing [6]. Manufacturing employment increased in the region from 1970 to 1975, but declined for Ohio (Table 1). The changes in employment and establishments indicate a relative increase in smaller manufacturing plants in both the region and Ohio. Though the region had a larger increase in payroll than Ohio (Table 1), payroll per worker increased by only 31 percent in the region compared with 43 percent in Ohio.

Of the 53 firms which responded to the questionnaire, 68 percent were corporations and 32 percent were individual proprietors or partnerships. About 83 percent of the firms were established before 1970 and 17 percent were established in or after 1970. Sixty-nine percent of the firms reported an average increase of 41 percent in total sales for 1974 compared with sales five years earlier, or the first full reporting period if the plant was less than five years old. Twenty-six percent of the firms reported no change in sales and 6 percent had a decrease in sales with a mean of 15 percent.

About 56 percent of total output of the sample manufacturing plants was sold within the five-county region. However, only 26 per-

cent of intermediate inputs were purchased within the region. About 94 percent of the employees resided in the region.

Only 10 firms employed professional and subprofessional workers in addition to plant managers. About 42 percent of the production workers were classified by management as skilled. The mean wage rate for skilled production workers was $3.74 per hour compared with $2.69 for semi- and unskilled workers.

LABOR TURNOVER ANALYSIS

Human capital can be in either general form, specific form, or both at a point in time [3, 7]. If an individual accumulates skill or knowledge which is peculiar to a specific firm and hence finds it economically difficult to move into an alternative job, such an individual is thought of as having specific human capital. The greater the cost of adjusting (information, transfer, and retraining costs) to an alternative job, the greater the specificty of the human capital formed. Two major features affect the relationship between specific human capital and labor turnover: the volume, and its division into

TABLE 1.   COMPARATIVE CHARACTER-
ISTICS OF THE REGION AND
OHIO[a]

	Region	Ohio
Population (No.)		
1970 [9]	137,379	10,657,423
1975 Est. [10]	140,100	10,759,000
Percent Change	2.0	1.0
Unemployment, 1970 (%)		
Census [9]	6.54	4.05
Adjusted[b]	31.13	4.05
Median Family Income ($)		
1970 [9]	7,100	10,313
Manufacturing [6]		
Employment (No.)		
1970	5,112	1,403,801
1975	5,460	1,266,728
Percent Change	6.8	-9.8
Establishments (No.)		
1970	128	13,612
1975	165	16,228
Percent Change	28.9	19.2
Payroll ($ million)		
1970	32.5	12,511.9
1975	45.6	16,100.0
Percent Change	40.3	28.7

[a]Sources of data cited in brackets.

[b]Adjusted by Ohio labor force participation rate; see text.

Sources: [6, 9, 10]

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worker- and firm-financed human capital. The distinction between firm-financed and worker-financed specific human capital, and the breakdown of labor turnover into quit and layoff components, makes possible a determination of how the turnover components are influenced by the type of specific human capital and a test of the quit and layoff rate hypothesis.

It is assumed that an entity (worker or firm) wants to maximize the returns on its investment in human capital. Quit behavior (an act which is initiated by an individual worker) is expected to be influenced by worker-financed specific human capital (S_w), whereas layoff behavior (an act which is initiated by a firm) is influenced by firm-financed specific human capital (S_f),

$$(1) \qquad q = q(S_w, D),$$

$$(2) \qquad ly = f(S_f, D),$$

where q is the quit rate, ly is the layoff rate, and D is a set of variables which cause specific capital to change seasonally or cyclically [7]. Under the investment hypothesis, the expected relationships between ly and S_f, and q and S_w are negative.

Because S_f and S_w cannot be estimated directly, Parsons [7] develops an indirect approach which uses total marketable human capital (T) and total specific human capital (S). The human capital approach holds that the wage rate (W) is a function of general human capital (G) and worker-financed specific human capital (S_w) embodied in a worker. A linear approximation to the wage function is

$$(3) \qquad w = k_1 G + k_2 S_w,$$

where k_1 and k_2 are positive rates of return to G and S_w, respectively. Solving for S_w,

$$(4) \qquad \frac{w}{k_2} - \frac{k_1}{k_2} G = \frac{w}{k_2} - G = \frac{w}{k_2} - (T - S),$$

where $k_1 = k_2$ is assumed because the rate of return to the worker from the two forms of human capital should be similar, (w/k_2) is the capitalized value of the worker's income stream, and general human capital (G) is set equal to the difference between total and specific human capital.

On the basis of [7], the variables expected to influence total and specific human capital are

$$(5) \qquad T = t(\overset{+}{EDUC}, \overset{-}{BRTEN}, \overset{+}{UNION}, \overset{-}{FEM},$$

$$\overset{-}{YOUNG}, \overset{?}{OLD}),$$

$$(6) \qquad S = s(\overset{+}{WAGE}, \overset{+}{EDUC}, \overset{-}{BRTEN}, \overset{+}{UNION},$$

$$\overset{?}{FEM}, \overset{-}{YOUNG}, \overset{+}{OLD}),$$

where the signs above the variables indicate the expected relationship, and WAGE is the average rate of production workers, EDUC is mean years of school completed, BRTEN is the percentage of production workers with the firm for less than six months, UNION is the percentage of production workers unionized, FEM is the percentage of female workers, YOUNG is the percentage of production workers under 24 years of age, and OLD is the percentage of production workers over 55 years of age.[4]

Using equations 1, 4, 5, and 6, the quit rate equation is derived from

$$(7) \qquad \frac{\partial q}{\partial x_i} = \frac{\partial q}{\partial S_w} \frac{\partial S_w}{\partial X_i},$$

where X_i is a variable from equation 5 or 6. From 4

$$(8) \quad \frac{\partial S_w}{\partial X_i} = \begin{array}{l} \frac{1}{k_2} + \frac{\partial S}{\partial X_i}, \, X_i = WAGE \\[8pt] -\frac{\partial T}{\partial X_i} + \frac{\partial S}{\partial X_i}, \, X \neq WAGE. \end{array}$$

Substitution in equation 2 gives the quit equation

$$(9) \qquad q = q(\overset{-}{WAGE}, \overset{?}{EDUC}, \overset{?}{BRTEN}, \overset{?}{UNION},$$

$$\overset{?}{FEM}, \overset{?}{YOUNG}, \overset{?}{OLD}),$$

where the expected signs are above the variables. The negative sign for WAGE, based on equations 6, 7, and 8, is derived from the negative sign of $(\partial q/\partial S_w)$ underlying the investment hypothesis and the positive sign of $(\partial S_w/\partial WAGE)$ in equations 6 and 8. The sign of EDUC is uncertain because the two components of $(\partial S_w/\partial EDUC)$ in equation 9 are of opposite sign. If EDUC has a larger impact on total (T) than on specific (S) human capital, the coefficient of EDUC in equation 11 will be positive $(\partial q/\partial S_w$ and $\partial S_w/\partial EDUC$ both negative). The signs of the other variables are uncertain and are interpreted similarly.

Using equations 2, 4, and 6, and the definition $S_f = S - S_w$, one can derive the layoff rate equation. Substituting for S_w in equation 4,

$$(10) \qquad S - S_f = \frac{w}{k_2} - (T - S),$$

$$S_f = T - \frac{w}{k_2}.$$

Then,

(11)
$$\frac{\partial ly}{\partial X_i} = \frac{\partial ly}{\partial S_f} \frac{\partial S_f}{\partial X_i}$$

and

(12)
$$\frac{\partial S_f}{\partial X_i} = \begin{cases} -1/k_2, & X_i = WAGE \\ \\ \dfrac{\partial T}{\partial X_i}, & X_i \neq WAGE. \end{cases}$$

With $(\partial ly/\partial S_f)$ negative under the investment hypotheses in equation 2, and the signs of $(\partial S_f/\partial X_i)$ from equations 5 and 12, the derived layoff rate equation is

(13)
$$ly = f(\overset{+}{WAGE}, \overset{-}{EDUC}, \overset{+}{BRTEN},$$
$$\overset{-}{UNION}, \overset{+}{FEM}, \overset{+}{YOUNG}, \overset{?}{OLD}),$$

where expected signs are above the variables. For EDUC, the negative $(\partial ly/\partial S_f)$ times the positive $(\partial T/\partial EDUC)$ from equations 5 and 12 yields the expected negative relationship with

TABLE 2. ESTIMATED QUIT AND LAYOFF EQUATIONS[a]

	Arithmetic Mean	Quit Rate (10)	Layoff Rate (14)
q	12.63		
ly	9.45		
BRTEN	8.98	1.18* (0.13)	1.02* (0.23)
EDUC	11.19	3.22* (1.04)	-4.98** (2.58)
WAGE	3.59	-5.89* (2.12)	7.24 (5.27)
OLD	10.95	0.16** (0.09)	-0.48** (0.24)
YOUNG	13.42	-0.13 (0.14)	
FEM	12.94	-0.05 (0.05)	0.06 (0.06)
UNION	51.84	0.06* (0.02)	-0.06 (0.06)
Constant		-15.0	37.0
R^2		0.91	0.57
F		33.1*	5.6*

[a]Standard errors are in parentheses. There are 32 observations on firms with 8 or more employees.

Two-tail significance levels are *=.05, **=.10

layoff rates. The expected signs for the other variables are derived similarly.

Estimates of the quit and layoff equations and the arithmetic mean of each variable are presented for 32 firms with eight or more employees (Table 2). The 32 firms with eight or more employees show stable and consistent results, whereas the 17 firms with seven or fewer employees yield unstable and inconsistent results when treated alone or when added to the sample of larger firms. In the small firms a small change in the number of quits or layoffs represents a large change in quit or layoff rates. The 17 small firms differ from the larger firms only in having no production workers unionized and a lower mean layoff rate; they have similar means for the other characteristics used in the quit and layoff equations. Following Parsons [7], both equations are estimated in arithmetic linear form.

In the quit rate model, the young and female variables for which the expected signs were uncertain have small and insignificant coefficients. The regression coefficient of the wage variable is negative as expected; a unit ($/hour) increase in the wage rate depresses the quit rate by about 5.9 percentage points.

The estimated coefficient for BRTEN is positive. An increase of one percentage point in the proportion of production workers who had been with a firm for less than six months increases quits by 1.18 production workers in every hundred. The length of the reporting period (one year) makes it possible to have more than one quit for each position for the reporting period, and hence makes a coefficient of BRTEN greater than one plausible. The positive coefficient of EDUC implies that education has a greater effect on total than on specific human capital. On the basis of equations 7 and 8, the results imply that an increase in years of formal schooling completed, which indicates an increase in general human capital, is not accompanied by significant increases in specific human capital, and leads to higher quit rates.[5]

The coefficient for the proportion of production workers over 55 years of age (OLD) is positive. This finding indicates that older workers have more total human capital than younger workers, but that it is composed of relatively more general than specific human capita.[6] The estimated coefficient of the union variable (for which the sign was uncertain) is positive. This

[5]From equations 7 and 8, general human capital is expected to increase quit rates and specific human capital is expected to reduce them. A negative coefficient of EDUC would imply that increases in formal schooling (general human capital) were accompanied by sufficient increases in specific human capital to reduce quit rates [7].

[6]The positive coefficient of OLD implies that $(\partial T/\partial OLD)$ is positive and greater than $(\partial S/\partial OLD)$. In addition an anonymous journal reviewer has pointed out that potential left-out variables such as health status and retirement could have generated this result if they are highly correlated with OLD. Data are not available to test this proposition.

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finding suggests that labor unions do perform other duties, such as provision of information on alternative or better job opportunities, which increases quit rates. These results based on microlevel data are consistent with those of Parsons [7] who used national aggregate data.

The fit for the layoff equation is not as good as that for the quit rate. This outcome can be explained partly by various dynamic factors that may not be controlled properly in a cross-section analysis [7, p. 1136]. Parsons [7, p. 1137] also obtained lower R^2s for the layoff equation than for the quit equation.

The coefficient of the variable OLD, for which the expected sign was uncertain, is negative. The variable YOUNG is excluded because its coefficient is about one-half its standard error and its omission does not change coefficients of other variables by more than 10 percent. All of the signs of the other estimated coefficients are the same as those expected. The negative sign of the variable OLD implies that it is related positively to total human capital through firm-financed specific human capital among workers in the five-county area, i.e., firm-financed specific human capital is greater for older workers than for younger workers.

Although the union and female variables have the expected signs, their estimated coefficients are not significant. The brief-tenure coefficient is significant. If the percentage of production workers with brief tenure is increased by one unit, there is an associated increase in the layoff rate of 1.02. A one-year increase in mean years of school completed decreases layoffs by almost five in every hundred production workers. These results are consistent with hypothesized behavior and support the results of Parsons [7] for 1959 and 1963.

The empirical results for the quit and layoff rates support the investment hypothesis that the layoff rate is related negatively to a firm's investment in specific human capital, whereas the quit rate is related negatively to a worker's investment in specific human capital.

IMPLICATIONS

Though the results of this study must be viewed as tentative because they are based on a small region and a small number of firms, several implications are suggested. There is no evidence of a shortage of needed labor skills in the manufacturing sector. Only 10 firms employed professional workers, and the demand for these workers appears small. The difference between the mean hourly wage rates of skilled ($3.74) and unskilled ($2.69) production

workers is relatively small.

There is some evidence of specific training—the major means of generating specific human capital given the background of new production workers—being provided by the firms. In the layoff equation, the negative coefficient for workers over 55 years of age implies a positive relationship between older workers and firm-financed specific training.

The positive significant coefficient of the education variable in the quit equation suggests that, relatively, not much worker-financed specific training goes on in the region. The positive coefficient of workers over 55 years of age in the quit equation suggests that older workers have higher quit rates than younger workers, and have not acquired significant worker-financed specific training. Human capital theory suggests that older workers are expected to be less mobile because they have accumulated more specific human capital. Though older workers are less subject to layoffs because of greater firm-financed specific training, they are more likely to quit jobs because of small amounts of worker-financed specific training.[7] The greater mobility of older workers is not an expected result.

Labor turnover appears to serve as a meaningful adjustment mechanism. The production workers generally have low skills. Neither the workers nor the firms have made substantial investments in specific human capital. Production workers have not had the opportunity to accumulate skills or knowledge which are peculiar to specific firms and find it economically feasible to move into alternative jobs.

Within the region, quit rates are expected to be high because costs of adjusting to alternative jobs are not large. Because the firms have undertaken relatively little firm-financed specific human capital investment, they have little incentive to retain their workers when there is a fall in demand for output. Layoff rates are expected to be high in times of slack demand. In response to increased demand for output, firms can readily replace or augment their work forces with relatively small losses in specific human capital investments.

Another implication is related to production of intermediate inputs in the region. If a competitive market is assumed, the share of intermediate inputs in the total output is about 34 percent. The region supplied only about 26 percent of the intermediate inputs, hence most of the returns to intermediate inputs (about 25 percent of total output) go out of the region. To increase economic activities in the region, it

[7]This interpretation is subject to the qualification pointed out in footnote 6.

might be useful to explore linkages with other industries to provide a greater share of the intermediate inputs locally.

The manufacturing sector is one of the major sources of employment and income in the region. The sector has potential for a major role in developing an economic base capable of sustaining economic growth in the region. The role of the manufacturing sector can be enhanced in three ways. One is to attract additional industries requiring low labor skills. Because the region has primarily low-skilled labor, manufacturing activities which require this type of labor will be easiest to attract. A second approach is to encourage increasing educational levels and per capita income through the development of manufacturing components which require skilled labor. The results of this study indicate that there is currently little manufacturing activity requiring skilled workers. If new firms requiring skilled labor could be attracted into the region or existing firms could be induced to add such activities, the effect would be to encourage increasing educational levels and higher per capita incomes. A third approach is to encourage new or existing firms to produce more of the intermediate inputs used in the region.

These approaches are not mutually exclusive; all can be pursued simultaneously. Manufacturing has provided additional jobs for low-skilled labor, and the fact that additional jobs are needed justifies efforts to expand the manufacturing sector in the region. However, the current mix of manufacturing in the region does not appear to be generating significant human capital investment through the formation of specific human capital. Thus the manufacturing sector in its current mix will not provide the basis for human capital and income growth in the region. Part of the industrial development effort needs to shift from attracting branch manufacturing plants requiring low skills and having few linkages with other regional activities to activities which will require and generate higher labor skills and increase interindustry linkages over time.

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