OPERATIONAL EFFICIENCY IN FOOD AND TOBACCO MANUFACTURING

by

Christina M.L. Kelton

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The author is currently a visiting assistant professor in the Department of Economics at Wayne State University; formerly a project associate at the Food System Research Group, University of Wisconsin-Madison. This research was supported by a North Central Project 117 grant. The author appreciates the comments and suggestions of Bruce Marion, John Culbertson, Richard Rogers, and Jack McEowen, and the assistance of Stephen Schultz in data collection and computer work.

INTRODUCTION

A rather large body of theoretical and empirical literature suggests that operational efficiency of manufacturing firms is affected by product- and labor-market characteristics. It is often argued that firms in oligopolistically organized industries pay higher wage rates than those in more competitive market structures. Concentrated industries in food and tobacco manufacturing are more likely to be the targets of unionization campaigns, as they offer employee organizations greater monetary rewards if the campaigns are successful. Firms in oligopolistic industries are better able to pay higher wages, especially if they can largely pass on these higher costs to consumers. Moreover, it has been argued that higher wage-rate increases can be expected under imperfect competition, implying that oligopolistic firms contribute more to inflation than do the competitive firms. The evidence presented below, in this paper, lends support to both of these hypotheses. Not only are highly concentrated food and tobacco product classes seen to have higher average hourly earnings, for various years (1958, 1963, 1967, 1972, and 1977), but they have shown the largest percentage increase in these earnings, as well, from 1958 to 1977. Further, the empirical evidence does not show any off-setting higher productivity increase in the concentrated sector.

Any market-structure-wage relationship has potentially multiple economic effects. First, the estimated allocative inefficiency implied by empirical results from numerous concentration-profit-rate studies (see Weiss [1971] for a review of the literature) may be understating the actual inefficiency induced by oligopolistic structure; allocative inefficiency would include a wage component as well as a profit component. Second, higher wage rates in highly concentrated industries may distort firms' input mix decisions, causing the labor intensities (with respect to other inputs) to be lower than they would be under competition. Third, the higher wage rates may be indicative of operational slack or technical ("X-") inefficiency, since oligopolistic firms may be under less pressure to minimize costs than are competitive firms. Finally, since unit labor costs are, in general, such an important component in unit variable cost and, thus, price, wage changes over time (in excess of productivity changes) affect macroeconomic stability, and, in particular, the rate of inflation. Temporal and interindustry ratchet effects (see Kahn [1975] for a discussion) reinforce wage-based inflation, enhancing the importance of initial wage changes. One such effect embedded in many collective bargaining agreements in the food system is the cost of living adjustment (or COLA) provision. See McEowen (1982, Chapter III) for a detailed discussion of the various types of COLA provisions encountered in these agreements.

The empirical approaches taken to evaluate the wage-market-structure relationship are varied, including both time-series and cross-sectional studies, and including both intraindustry and interindustry analyses. The single-equation wage-rate model has come to have the general form

$$w = f(s, i, l)$$

or (1)

$$\ln w = g(s, i, l),$$

where w is the individual or average industrial (depending on the data source) wage rate or average hourly earnings; s is a vector of structural variables, such as market-share concentration; i is a vector of additional industrial variables, including such factors as the proportion of "large" establishments in the industry and the percentage of workers covered by collective bargaining agreements; and l is a vector of employee characteristics related usually to education or skill. (1) tries to capture, in one equation, both "demand forces" and "supply forces" in the labor market. As examples of such studies, see Bailey and Schwenk (1971), Brown (1962), Dalton and Ford (1977, 1978), Haworth and Rasmussen (1971), Haworth and Reuther (1978), Masters (1969), McEowen (1982), Pugel (1980), and Weiss (1966). Further, for a review of the literature relating wage rates and unionization specifically, see Parsley (1980). In several studies (see Ashenfelter and Johnson [1972] and Rosen [1969]), simultaneous systems of equations have been estimated, with unionization rates and average industrial skill levels, in the case of the former paper, and number of hours worked, in the case of the latter, as additional dependent variables. Most of the wage-rate studies have, in general, found a positive relationship between wage rates and concentration, but the estimated effect is diluted by the addition of other industrial as well as labor-market characteristics and by using a simultaneous-equations model.

As distinguished from prior industry-level studies, (1), in the analysis below, is specified for five-digit product classes within food and tobacco manufacturing. (Details are provided in the next section.) Four-firm concentration for the product class is taken as an important indicator of market power and ability to pay high wages. Industrial characteristics considered include the extent of unionization as well as the size distribution of establishments and regional distribution of employment. Median years of education, percentage male, and percentage white employees are considered important labor characteristics. The expected effects of each of these factors are discussed in the following section.

A wage-change model, on the other hand, emphasizes the performance implications for macro stability or inflation. See Allen (1968), Garbarino

(1950), Greer (1975), Hamermesh (1972), and Schwenk (1980). Garbarino (1950) suggested a direct relationship between productivity (output per hour) change and wage rate change as workers captured some of the gains from decreased unit costs. Garbarino argued further that oligopolistic market power in the product market as well as union bargaining power in the labor market would influence the exact wage change within the general limit imposed by productivity change. He found strong empirical support for positive associations between percentage wage change and productivity change and between percentage wage change and concentration; he found weaker support for a positive relationship between wage change and unionization.

Allen (1968), however, argued that the wage-change hypothesis was not supported by, and indeed contradicted, economic theory. Neither a more inelastic demand for labor in concentrated industries nor a generally wage-increasing reaction (as opposed to price-decreasing behavior) by oligopolistic firms could theoretically support continually higher wage increases vis-a-vis the competitive sector. Nevertheless, despite what he considered to be lack of true theoretical motivation, Allen (1968) found strong statistical evidence of a positive association between concentration and annual increase in average hourly earnings, for the period 1951 to 1962. Allen found that the statistical importance of concentration as an explanatory factor increased during expansionary times; but, the result of positive correlation was obtained for contractions as well. After reestimating the model with an abbreviated sample of industries from three industry groups only and observing no generally significant relationship between concentration and wage rate change, Allen concluded that the relationship he observed for the larger sample could have been spurious or a temporary oligopolistic catch-up phenomenon.

In a more complex formulation of the wage inflation issue, Hamermesh (1972) found that the long-term effect of market power discretion on wage rate change was not statistically different from zero. Instead, however, through their empirically evidenced unresponsiveness to changing market factors, firms with market power could frustrate governmental attempts to reduce wage inflation. In response to Hamermesh, Greer (1975) showed that high-discretion sectors in the economy may build in an inflationary bias by establishing a high "general reference pattern" for all industrial sectors which impacts on the rest of the economy through product and labor market interdependencies. Further, Greer (1975) showed the potential importance of market power in the inflationary process through its effects on unemployment; Greer indeed found evidence for a significant ratchet effect with respect to unemployment in the high discretionary sector.

Although the Hamermesh-Greer approach explains the overall inflationary process in some detail, it is particularly well suited to a time-series analysis, and the study below follows more from Allen (1968). As such, it is restricted to explaining the interindustry differences in wage rate change, and does not ascribe explicitly a broader role to concentration in the inflationary process. Any ratchet or spillover effects would lead the model to underestimate the full effect of concentration on inflation. Besides concentration, productivity change and the extent of unionization, which are assumed to exert positive impacts on wage change (as discussed in Garbarino [1950] and in the next section), other factors considered are change in concentration, the size distribution of establishments and regional distribution of employment, and three variables which attempt to capture the characteristics of labor: percentage male, percentage white, and median years of education. The expected directional effects of these elements on long-term percentage wage change are detailed in the next section.

If it can be shown that high wage rate increases are always associated with high productivity increases, then the two economic phenomena should be studied concurrently before any conclusions with respect to potential inflationary bias can be drawn. Moreover, high productivity growth in the concentrated sector may imply a tradeoff between dynamic and static allocative efficiency, possibly frustrating antitrust policy in its efforts to achieve both objectives.

Scherer (1980) argued that the expected effect of market power on technological change, as, for example, expressed by an increase in labor productivity, is not theoretically obvious. On the one hand, excess monopoly profits or operational slack can allow more industrial resources to be devoted to process innovation or development. Oligopolistic firms may be more able and willing to undertake potentially risky investments of this sort. Further, these oligopolistic firms may be found most frequently in industries having the greatest technological opportunities associated with them:

> "...there may be a tendency for concentrated industries to enjoy richer opportunities to improve productivity -- e.g., because labor-saving technical change is biased in favor of industries for which minimum optimal scales are large in relation to market size." (Scherer [1980, p. 434])

Finally, oligopolists may view innovation as a non-price means of competition, akin to advertising.

However, in response to these arguments, a more competitive environment can offer more potentially innovative sources. It may also be shown in some cases that a particular process innovation is more beneficial (greater increase in profits) to a competitive firm as opposed to one in an oligopolistically structured industry. Finally, the threat of entry or the new entrant itself may encourage rapid technological change, arguing against a purely monopolistic firm's being generally the most technologically progressive.

Greer and Rhoades (1976) reviewed a number of empirical studies (see, for example, Weiss [1963]) finding no statistically significant relationship between long-term productivity change and concentration. They, however, evidenced a small but significant positive influence of concentration on labor productivity growth. Scherer (1980) suggested that this was a surprising result in view of the limited amount of general innovative activity devoted to new process development and interpreted the result as indicative of greater technological opportunity for the concentrated sector. Gisser (1982) found a strong positive relationship between change in concentration and productivity change for food manufacturing industries but an insignificantly negative effect of the concentration level. Sveikauskas and Sveikauskas (1982) found that only research and development expenditures (not market structure) had a consistently positive effect on productivity growth.

In the sections below, the productivity model is specified similarly to Greer and Rhoades (1976) but modified according to the nature of five-digit data (which precludes, for example, construction of a reasonable capital-intensity variable) and according to a sector-specific analysis (food and tobacco manufacturing only). Besides concentration and change in concentration, other considered factors include growth in physical output, the percentage of workers in large establishments, percentage unionization coverage, percentage of workers in the South, and median years of education. As in the Greer-Rhoades (1976) study, output growth is found to be the most important influence on productivity change, but neither concentration nor change in concentration is seen to have a statistically significant influence in the empirical results which follow.

Finally, it is important as well to look at interindustry differences in unit labor cost, since this measure is but the average hourly earnings for the industry divided by hourly labor productivity. Thus, unit labor costs are increased by either rising wages or falling productivity. As labor costs are clearly an important component of unit variable cost (and unit variable cost change is of prime importance in determining the extent of price change over time -- see Kelton [1982]), it is interesting to examine the effects of market structure on this "summary variable." From the discussion above and to the extent that oligopolistic firms use discretionary power to grant large wage increases in comparison with competitive firms, one expects higher unit labor cost increases as concentration rises. However, since there is no unambiguous prediction concerning the directional relationship between concentration and productivity change, the overall effect of market power on unit labor cost change is also undetermined theoretically. In the empirical analysis below, the same explanatory factors are considered in the unit-labor-cost-change model as for productivity change, with the addition of percentage male and percentage white employees in the case of unit labor cost change.

In the remainder of this paper, the four models discussed are further developed and specialized, and, then, estimated, with food and tobacco manufacturing product classes as relevant observations. In the next section, the dependent and independent variables are defined and briefly discussed. Some descriptive results are also presented. The following section contains empirical analyses of the industrial organization questions posed above. General conclusions are drawn in the final section.

DATA, VARIABLES, AND DESCRIPTION

The analyses which follow are based on a cross-sectional sample of 59 product classes in the food and tobacco manufacturing groups (SIC groups 20 and 21) which did not undergo serious definitional changes over the period 1958 to 1977, and for which cost, quantity, and other census data were available.[1] For a list of specific product classes sampled, see Appendix A. The primary data source employed was the Census of Manufactures, various years.[2] Additional data sources are cited where appropriate throughout the discussion below. These 59 product classes represent approximately 70% of total shipments value for food and tobacco manufacturing establishments for each of the five census years considered: 1958, 1963, 1967, 1972, and 1977.

Average Hourly Earnings (AHE).[3] Average hourly earnings or approximate "wage rate" for product class i is calculated as the production worker wage bill (W_i) divided by production worker hours (H_i). For the relevant regression analysis, an exponential model is postulated, with (2) below as its linear transformation for estimation. Thus, as opposed to absolute interindustry differences in wage rates, the various factors considered are assumed to affect percentage differences. For an early justification, from human capital theory, of the exponential function, which can take into account hypothesized diminishing returns to education or training, see Mincer (1970).

Table 1 shows the average hourly earnings for the three-digit major industries in food and tobacco manufacturing. The values in Table 1 (and in the other tables below as well) are unweighted averages of product class values to reflect the cross-sectional, as opposed to more macroeconomic, nature of the analysis. Consistently, throughout the time period 1958 to 1977, the beverage product classes have shown the highest average hourly earnings, followed closely, and again consistently, by grain mill products.

Table 1. Unweighted Average Major Industry* Hourly Earnings: Various Years

(number of product classes sampled in parentheses)

Industry	1958	1963	1967	1972	1977
	Year				
Meat Products (10)	$2.03	$2.28	$2.71	$3.67	$5.63
Dairy Products (8)	1.97	2.46	2.89	4.00	5.78
Canned and Preserved Fruits and Vegetables (8)	1.57	1.85	2.26	3.18	4.69
Grain Mill Products (4)	2.15	2.63	3.06	4.35	6.93
Bakery Products (1)	2.06	2.53	2.94	4.15	6.22
Sugar and Confectionery Products (5)	1.96	2.38	2.78	3.74	5.62
Fats and Oils (5)	1.96	2.30	2.65	3.64	5.47
Beverages (8)	2.28	2.73	3.25	4.58	6.96
Miscellaneous Food Preparations (6)	2.02	2.45	2.77	4.00	5.72
Tobacco Manufactures (4)	1.63	1.93	2.24	3.20	4.94
All Food and Tobacco (59)	1.96	2.34	2.75	3.83	5.75

*Major industry group in the case of Tobacco Manufactures.

In 1977, beverages and grain mill products showed averages of \$6.96 and \$6.93, respectively. Both of these major industries also had above average (i.e., above 49.5) concentration ratios, in 1977; the average for beverages was 65.3; for grain mill products, 61.8. Of the 59 product classes sampled, malt beverage production workers received the highest average wage rate of \$9.64 in 1977, followed by an \$8.42 wage for workers in wet corn milling. The lowest ranked major industries have been, consistently, tobacco manufactures and canned and preserved fruits and vegetables. The averages across all 59 product classes can be found at the bottom of Table 1. The overall average rose from \$1.96 in 1958 to \$5.75 in 1977. These averages compare with \$2.11 in 1958 and \$5.68 in 1977 as averages for all manufacturing production workers, and with \$1.91 in 1958 and \$5.11 in 1977 as averages for total nondurable manufacturing production workers (from the 1980 Handbook of Labor Statistics).

Percentage Change in Average Hourly Earnings (ΔAHE). As opposed to the average level of wages received by workers in a given food industry, which, if "too high," could represent a type of allocative inefficiency, ΔAHE attempts to capture the potential contribution of that industry to wage inflation. Table 2 shows average percentage changes in hourly earnings by major food manufacturing industries for various subperiods over the years 1958-1977. It is seen that the beverages and grain mill products have the highest average percentage wage increases over the entire time span 1958 to 1977. Note that these are the same two groups with the highest average hourly earnings for each year in the study, seen from Table 1 above. The meats and oils show the lowest average percentage increases. The rankings, however, are not consistent over the four subperiods: 1958-1963, 1963-1967, 1967-1972, and 1972-1977. Only for the most recent time span, 1972-1977, do the grain mill

Table 2. Unweighted Average Major Industry* Percentage Change in Average Hourly Earnings: Various Years

Industry	Years				
	1958-63	1963-67	1967-72	1972-77	1958-77
Meat Products	12.0	20.1	35.8	52.6	177.7
Dairy Products	25.1	17.3	38.7	45.0	193.3
Canned and Preserved Fruits and Vegetables	17.2	22.7	39.8	49.5	198.1
Grain Mill Products	22.3	16.7	41.8	60.1	223.7
Bakery Products	22.7	16.2	41.5	49.9	202.2
Sugar and Confectionery Products	21.0	17.3	34.6	50.5	187.0
Fats and Oils	17.0	15.6	37.1	51.5	180.3
Beverages	19.5	19.7	40.9	52.7	206.7
Miscellaneous Food Preparations	21.1	13.4	44.2	42.7	182.9
Tobacco Manufactures	18.3	15.1	42.2	52.1	196.1
All Food and Tobacco	18.9	18.1	39.2	50.3	192.8
All Nondurable Manufacturing	16.2	15.8	35.4	46.8	167.5
All Manufacturing	16.1	15.1	35.5	48.7	169.2

*Major industry group in the case of Tobacco Manufactures.

and beverage product classes have the highest average percentage increases in average hourly earnings. Meat products have lower than average increases in two of the four periods, and higher than average increases the other two periods. Table 2 also presents the overall average increases for the 59 product classes in the sample. These are consistently higher than the average increases for the same periods for either all manufacturing production workers or all nondurable manufacturing production workers as reported in the 1980 Handbook of Labor Statistics, and presented in the last two lines of Table 2.

Percentage Change in Labor Productivity (ΔP). Let Q_i be the actual physical quantity shipped of product class i, measured in appropriate physical units from the census. Note that Q_i is not an index number as it is in most studies requiring measurement of an output variable.[4] The percentage change in labor productivity over a specified time period is calculated as follows:

$(Q_{iT}/H_{iT})/(Q_{i0}/H_{i0}) - 1$, where time 0 represents the initial year, and time T, the final year.

If wage rate increases over time are primarily a reflection of productivity changes, one would expect that those product classes showing high percentage wage rate increases would also have experienced high labor productivity increase. This theoretical expectation is partially supported by the descriptive results presented here.

It may first be noted, by comparison of Tables 2 and 3, that, for every subperiod investigated, except for the years 1958 to 1963, average percentage increase in hourly earnings exceeded average percentage productivity increase. Moreover, the difference between the two percentage increases has itself been increasing over time. From 1972 to 1977, in fact, wage rates, on average for the food and tobacco product classes, increased approximately 50% compared with an approximate 19% average increase in productivity. For the entire

Table 3. Unweighted Average Percentage Change in Labor Productivity by Major Industry*: Various Years

Industry	Years				
	1958-63	1963-67	1967-72	1972-77	1958-77
Meat Products	9.0	4.8	3.8	13.8	38.9
Dairy Products	54.5	7.5	7.3	57.0	162.5
Canned and Preserved Fruits and Vegetables	25.7	9.0	45.5	8.4	121.2
Grain Mill Products	16.2	14.3	17.7	26.3	113.3
Bakery Products	9.5	18.7	15.9	19.4	79.7
Sugar and Confectionery Products	32.2	8.4	7.6	16.7	76.1
Fats and Oils	42.4	17.1	24.3	3.3	108.9
Beverages	29.9	35.4	32.0	24.4	222.6
Miscellaneous Food Preparations	23.3	2.7	14.4	4.8	54.7
Tobacco Manufactures	34.3	9.4	44.0	0.8	114.0
All Food and Tobacco	28.7	12.2	20.8	18.9	113.2
All Manufacturing	21.3	10.5	15.7	9.9	70.5

*Major industry group in the case of Tobacco Manufactures.

period 1958 to 1977, average hourly earnings increased 192.8% compared with a 113.2% rise in labor productivity. This comparison appears to hold, in general, for individual major industries, especially for the long-term comparison. Only for the beverage product classes does the average measured productivity increase (222.6%) exceed the average percentage earnings increase (206.7%).

In further comparisons of productivity and average hourly earnings changes, it appears that, as a major industry, meat products have shown lower than average productivity increases during all time periods shown in Table 3, and generally low average wage increases as well (Table 2). For the most recent years, 1972 to 1977, the beverages and grain mill product classes averaged relatively high productivity as well as wage rate increases. Other such direct relationships are more difficult to observe at this level of aggregation. For example, again for the most recent time period, the dairy products industry showed relatively high productivity change coupled with a low average earnings increase. Clearly, there is some direct relationship between productivity and earnings change in food manufacturing, but the evidence indicates that productivity change is not the only factor responsible for wage increases. Following Garbarino (1950), however, it is hypothesized that an increase in labor productivity will lead to a wage increase.

Percentage Change in Unit Labor Cost (ΔULC). The percentage change in unit labor cost over a specified time period is calculated as

$(W_{iT}/Q_{iT})/(W_{i0}/Q_{i0}) - 1$, where time 0 represents the initial year, and time T, the final year.

Average hourly earnings and labor productivity are essentially the two components of unit labor cost since $W_i/Q_i = (W_i/H_i)/(Q_i/H_i)$. Hence, one can think of unit labor cost as a "summary measure" of the cost of the labor component in food and tobacco manufacturing. Table 4 shows average change in unit labor costs by major food manufacturing industry. Meat products and miscellaneous food preparations show the highest average increases over the entire time period; grain mill products also show a high increase over this period. Meat products have had higher than average increases for each of the subperiods considered as well. The oil and beverage product classes on average have experienced the lowest increases in unit labor costs.

In a three-way comparison of Tables 2, 3, and 4, one sees that the long-term change in unit labor cost (81.7%) has been lower than change in either productivity or in average hourly earnings. For the various individual subperiods, there is some evidence of the expected inverse relationship between productivity change and change in unit labor costs, but there does not seem to be as much evidence of the expected direct relationship between wage rate change and change in unit labor cost.[5]

<u>Concentration Ratio</u> (CR_4). Four-firm market-share concentration is the primary structural variable considered in the various models below. The basic theories, as stated above, are that higher levels of concentration induce higher average hourly earnings, greater increases over time in these average earnings, and ambiguous effects, for reasons discussed above, on productivity and unit labor cost change.

Table 5 shows average hourly earnings of food manufacturing product classes broken down by market-share concentration categories: 0 - 24, 25 - 49, 50 - 74, and 75 - 100, corresponding loosely to competitive, weak oligopolistic, tight oligopolistic, and monopolistic market structures. Except for 1958, the highest average hourly earnings are found in the most concentrated classification, and, in 1958, the highest average is found in the next most concentrated class. The lowest earnings are found in the

Table 4. Unweighted Average Percentage Change in Unit Labor Costs by Major Industry*: Various Years

Industry	Years				
	1958-63	1963-67	1967-72	1972-77	1958-77
Meat Products	11.6	17.6	38.7	39.8	169.5
Dairy Products	-13.1	14.5	34.2	18.1	61.6
Canned and Preserved Fruits and Vegetables	-5.3	15.3	1.9	38.9	58.7
Grain Mill Products	5.8	5.4	22.5	37.1	98.1
Bakery Products	12.1	-2.1	22.1	25.6	68.2
Sugar and Confectionery Products	-5.6	9.7	30.1	31.1	71.7
Fats and Oils	-14.3	0.7	11.2	47.5	40.8
Beverages	-4.2	-1.6	7.4	26.3	30.1
Miscellaneous Food Preparations	-1.3	13.6	31.2	37.2	108.2
Tobacco Manufactures	-7.7	6.5	5.5	53.2	63.1
All Food and Tobacco	-2.9	9.8	21.4	35.0	81.7

*Major industry group in the case of Tobacco Manufactures.

Table 5. Product Class Average Hourly Earnings by Concentration Class: Various Years

Year	Concentration Classes				
	0 - 24	25 - 49	50 - 74	75 - 100	All
1958	$1.78	$1.91	$2.14	$2.06	$1.96
1963	2.08	2.31	2.43	2.67	2.34
1967	2.66	2.63	2.85	3.02	2.75
1972	3.74	3.56	3.99	4.32	3.83
1977	5.53	5.34	5.96	6.48	5.75

competitive and weak oligopolistic classes. Thus, the hypothesis that concentration positively influences wage rates is given some support by Table 5.

Table 6, which follows the same format as Table 5 above, shows percentage average hourly earnings change by four-firm concentration-ratio class. The table indicates that for the entire time period, as well as for three out of four of the subperiods studied, the highest percentage wage rate increases have occurred in the most concentrated product classes. Table 7 shows product class productivity change by concentration class. Lower productivity increases are generally observed for the most concentrated classes, but there appears to be no strong, temporally consistent pattern. Finally, Table 8 indicates an increase in unit labor cost change as concentration rises. For each of the time periods studied, with the exception of 1972-1977, the most highly concentrated product classes ($CR_4 \geq 75$) evidenced the greatest unit cost increases. (From 1972-1977, this group showed above-average cost increases.) From 1958-1977, cost increase is seen to rise consistently with concentration, a result supported by the regression analysis of the next section.

<u>Change in Concentration</u> (ΔCR_4). This variable is calculated simply as $CR_{4T} - CR_{40}$, for initial time 0 and final time T, and attempts to measure the extent to which market power is changing over time for any given food or tobacco product class. It is hypothesized to have a positive impact on ΔAHE, and inconclusive effects on productivity change as well as change in unit labor cost.

In Table 9, product classes are categorized according to whether concentration increased or decreased during the period in question. For each subperiod as well as for the entire 1958-1977 time span, wage rate increases

Table 6. Product Class Average Hourly Earnings Percentage Change by Initial Year Concentration Class*: Various Years

Years	Concentration Classes				
	0 - 24	25 - 49	50 - 74	75 - 100	All
1958-63	16.4	19.0	18.9	21.8	18.9
1963-67	20.5	17.8	18.7	13.8	18.1
1967-72	36.1	40.0	38.5	42.6	39.3
1972-77	49.8	49.4	51.1	51.7	50.3
1958-77	183.7	193.9	193.0	200.0	192.8

*For 1958-77, the 1967 concentration ratio is used.

Table 7. Product Class Percentage Change in Labor Productivity by Initial Year Concentration Class*: Various Years

Years	Concentration Classes				
	0 - 24	25 - 49	50 - 74	75 - 100	All
1958-63	29.6	33.9	28.9	10.0	28.7
1963-67	16.8	8.0	23.0	-5.2	12.2
1967-72	10.4	22.3	25.8	12.0	20.8
1972-77	56.9	9.3	16.7	11.7	18.9
1958-77	161.7	87.5	151.9	37.7	113.2

*For 1958-77, the 1967 concentration ratio is used.

Table 8. Product Class Percentage Change in Unit Labor Cost by Initial Year Concentration Class*: Various Years

Years	Concentration Classes				
	0 - 24	25 - 49	50 - 74	75 - 100	All
1958-63	-6.4	-7.2	0.1	11.0	-2.9
1963-67	7.2	12.0	3.2	22.5	9.8
1967-72	27.3	18.1	20.5	30.6	21.4
1972-77	24.3	39.2	34.2	37.3	35.0
1958-77	43.5	79.5	80.4	146.4	81.7

*For 1958-77, the 1967 concentration ratio is used.

Table 9. Product Class Average Hourly Earnings Percentage Change by Change-in-Concentration Class: Various Years

Years	Decrease or No Change in Concentration	Increase in Concentration	All
1958-63	18.4	19.8	18.9
1963-67	16.4	19.8	18.1
1967-72	38.4	40.1	39.3
1972-77	48.4	51.9	50.3
1958-77	187.7	197.8	192.8

on average are seen to be higher for those product classes which were becoming more concentrated than for those which were not.

Table 10 shows product class productivity change by change-in-concentration class. As seen also from the regression results below, those industries which showed rising concentration over time tended to show higher productivity increases as well (with 1963-1967 as an exception). Table 11, consistent with Table 10, indicates a generally negative relationship between change in concentration and change in unit labor cost (again, note that the period 1963-1967 is an exception).

Percentage of Large Establishments (L). For the purposes of this analysis, a "large" food manufacturing establishment is defined to be one with 500 or more employees.[6] The percentage of large establishments can be constructed from census data at the four-digit SIC level and assigned (in the manner described and evaluated statistically in Haworth and Reuther [1978] and followed in much of the empirical literature) to five-digit product classes.[7] Table 12 shows average hourly earnings broken down by percentage-of-large-establishments classes. To create a roughly uniform frequency distribution of product classes in each of the five years considered, the following variable classisifications were selected: 0% - 10% large establishments, 10.01% - 50%, and 50.01% - 100%. Consistently, the highest average hourly earnings are found for those product classes with the highest percentage of large estahlishments, as is expected theoretically (see Masters [1969]). It is further expected that those industries with the highest percentage of large establishments have been able to grant the highest wage increases over time. Sveikauskas and Sveikauskas (1982) suggest that large firms have the advantage in routinizing and applying their innovations so that L is expected to have a positive influence on productivity change, and, hence, an ambiguous effect on change in unit labor cost.

Table 10. Product Class Percentage Change in Productivity by Change-in-Concentration Class: Various Years

Years	Decrease or No Change in Concentration	Increase in Concentration	All
1958-63	23.3	38.0	28.7
1963-67	14.1	10.4	12.2
1967-72	19.5	22.0	20.8
1972-77	10.6	25.4	18.9
1958-77	103.0	123.2	113.2

Table 11. Product Class Percentage Change in Unit Labor Cost by Change-in-Concentration Class: Various Years

Years	Decrease or No Change in Concentration	Increase in Concentration	All
1958-63	0.7	-8.8	-2.9
1963-67	6.3	13.2	9.8
1967-72	24.1	18.7	21.4
1972-77	39.2	31.8	35.0
1958-77	96.1	67.8	81.7

Table 12. Product Class Average Hourly Earnings by Percentage of Large Establishments: Various Years

Year	Percentage of Large Establishments			
	0 - 10	10.01 - 50	50.01 - 100	All
1958	$1.83	$1.85	$2.22	$1.96
1963	2.14	2.23	2.68	2.34
1967	2.69	2.52	3.07	2.75
1972	3.89	3.58	4.22	3.83
1977	5.55	5.58	6.85	5.75

Percentage of Production Workers in the South (S). This variable introduces the potential role of geographic difference in wage rates. The Census of Manufactures provides information on the percentage of production workers in four major regions of the country: Northeast, North Central, South, and West.[8] Again, these data are generally available at the industry level and must be assigned to appropriate product classes. The percentage of production workers in the generally lower-wage South is taken as the proxy of geographic influence on wage. Indeed, one notes from Table 13 that, for all time periods, product classes with a rather high percentage of workers in the South consistently pay the lowest average wages, again as expected a priori. As for Table 12, the percentage-South classes were chosen to produce a roughly uniform distribution of observations across categories. It is also hypothesized that a high value for S is associated with a high increase in average hourly earnings as wage rates tend toward geographic equalization. There are no a prioi predictions for productivity change or unit labor cost change, although S appears in both the latter two regression models to capture any regional long-term productivity differences which may exist.

Median Years of Education (E). This variable is measured as median years of completed schooling attained in the industry from the 1960 and 1970 Census of Population, Subject Report PC(2)-7F (1960) and PC(2)-7B (1970), "Industrial Characteristics." E, and W and U below, are found only at the three-digit or major-industry level of analysis (E and W are reported for the experienced civilian labor force[9]), and their values are assigned to five-digit product classes (see footnote 7). They are the least "accurate" of the data and introduce a certain amount of "unavoidable" multicollinearity (see Appendix B). The 1960 values for E are used only for the 1958 and 1963 AHE regressions. Otherwise, the 1970 values are used. One would expect that the

Table 13. Product Class Average Hourly Earnings by Percentage of Production Workers in the South: Various Years

	Percentage of Production Workers in the South			
Year	0 - 20	20.01 - 30	30.01 - 100	All
1958	$2.13	$2.00	$1.67	$1.96
1963	2.56	2.42	2.02	2.34
1967	3.02	2.79	2.40	2.75
1972	4.17	3.85	3.52	3.83
1977	5.96	5.76	5.52	5.75

higher the average level of education (or human capital) in the industry, the higher the average hourly earnings, the greater the increase in average hourly earnings, and the greater the productivity increase over time, implying again an ambigous result with respect to change in unit labor cost.

Percentage Male (M). M is taken from Employment and Earnings, various issues, and is found at the three- or four-digit level. The 1967 values for M are employed for the years 1958, 1963, 1967, and for the earnings-change model (earlier disaggregated data for M were not available). 1972 and 1977 values are used for the 1972 and the 1977 regressions, respectively. It is hypothesized that the higher the percentage of male employees in the industry, the higher the average hourly earnings, the greater the percentage increase in average hourly earnings, and, thus, the greater the increase in unit labor cost, assuming no discernible effect on productivity change.

Percentage White (W). W is taken from the same source "Industrial Characteristics" as E above, and has the same limitations. Again, its 1960 value is used only for the 1958 and 1963 AHE regressions; otherwise, its 1970 value is employed. As for M, the theory is that the greater the percentage of white employees in the industry, the higher the average hourly earnings. The same directional influences on the other three dependent variables are postulated for W as for M. Although both M and W attempt to capture potential discrimination, they are really just further explanatory variables for wage differentials. Not all individual labor qualities can be accounted for in the model (which would theoretically leave a discrimination effect as a residual). Further, basic earnings data are product class averages across male and female, white and nonwhite employees for various years. They do not show male and female, or white and nonwhite wage rates in the same industry (let alone for the same occupation within an industry).

Percentage Union Coverage (U). This variable is the percentage of workers covered by collective bargaining agreements (Table 14). The values for major industries were taken from Freeman and Medoff (1979). U is expected to be positively related to wage levels, as well as to change in those levels. Sveikauskas and Sveikauskas (1982) discuss the various possible impacts of U on productivity change. Unions may indeed increase productivity if they reduce labor turnover or increase worker cooperation but may restrict resource flexibility required for productivity rise. Thus, the coefficients representing the effects of U on productivity change and change in unit labor cost remained unsigned a priori.

Percentage Change in Quantity (ΔQ). This variable is measured simply as $Q_{iT}/Q_{i0} - 1$, where time 0 is the initial year, and T, the final year. It appears as an independent variable only in the productivity change and unit labor cost change regressions below to attempt to account for a dynamic scale economy effect of growth on productivity change. It is hypothesized that change in output will have a positive influence on productivity change, and, thus, a negative effect on change in unit labor cost.

REGRESSION RESULTS

Wage-Rate-Level Model

For estimation, (1) above is specified as

$$\ln AHE = \alpha_1 + \alpha_2 CR_4 + \alpha_3 L + \alpha_4 S + \alpha_5 E + \alpha_6 M + \alpha_7 W + \alpha_8 U + \varepsilon, \qquad (2)$$

where all variables are as previously defined, and ε is a stochastic error term.[10] It was argued above that all variables, except S, should exert a positive effect on ln AHE, and that S should have a negative impact. Table 15 presents the results from seemingly unrelated regressions of (2), for 59 product classes, for five different years. This particular regression

Table 14. Percentage of Production Workers Covered by Collective Bargaining Agreements by Major Industry*

Industry	Percent Coverage
Meat Products	78
Dairy Products	50
Canned and Preserved Fruits and Vegetables	65
Grain Mill Products	60
Bakery Products	65
Sugar and Confectionery Products	53
Fats and Oils	66
Beverages	62
Miscellaneous Food Preparations	66
Cigarettes	95
Cigars	26
Tobacco Stemming and Redrying	89

*Source: Freeman, Richard B. and Medoff, James L. "New Estimates of Private Sector Unionism in the United States." Industrial and Labor Relations Review 32 (January 1979), p. 149.

Table 15. Seemingly Unrelated Regressions for the Natural Logarithm of Average Hourly Earnings: Various Years (t statistics in parentheses)

Independent Variable	Coefficient Estimates 1977	1972	1967	1963	1958
Constant	0.8059 (1.2982)	-0.2708 (-0.4165)	-0.4536 (-0.7438)	-0.0713 (-0.1718)	-0.1292 (-0.3525)
CR_4	0.0019[a] (3.4083)	0.0022[a] (3.7148)	0.0018[a] (3.2325)	0.0019[a] (3.3886)	0.0018[a] (3.5535)
L	0.2198[a] (4.7932)	0.0922[a] (2.4596)	0.0733[b] (2.2550)	0.0761[b] (1.9760)	0.0776[a] (2.4820)
S	-0.1647[a] (-2.5208)	-0.2410[a] (-3.1622)	-0.2630[a] (-3.6426)	-0.2490[a] (-3.1840)	-0.2876[a] (-4.3728)
E	-0.0219 (-0.5371)	0.0210 (0.4653)	-0.0018 (-0.0448)	0.0267 (0.4394)	0.0029 (0.0534)
M	0.0112[a] (6.4949)	0.0077[a] (4.3577)	0.0065[a] (4.0804)	0.0075[a] (4.2490)	0.0074[a] (4.8125)
W	0.0028 (0.6638)	0.0066[c] (1.4803)	0.0093[a] (2.4250)	0.0003 (0.0642)	0.0009 (0.2159)
U	0.0002 (0.0753)	0.0024 (0.9820)	0.0024 (1.0746)	0.0002 (0.0853)	0.0018 (0.8954)
R^2 [d]	0.6799	0.6196	0.6176	0.5969	0.6495
F[d]	15.4729[a]	11.8689[a]	11.7647[a]	10.7883[a]	13.5013[a]

N = 59

[a]Significant at the 0.01 level.

[b]Significant at the 0.05 level.

[c]Significant at the 0.10 level.

[d]From the OLS regressions in Appendix C.

technique is appropriate since it is expected that error terms for each product class sampled are correlated over time.[11] See Appendix C for ordinary-least-squares results.

The hypothesized wage rate effects are indeed generally confirmed by Table 15. Concentration is seen to have a positive and significant effect (at the 1% level) on average hourly earnings for each year considered, and this result is obtained despite the inclusion of labor characteristics in the model (as contrasted with Weiss's [1966] result of no significant effect of concentration). The estimated coefficients for CR_4 range from 0.0018 to 0.0022, implying that a one-percentage-point rise in the concentration ratio results in about a 0.2% higher wage rate for the product class, <u>ceteris paribus</u>. Perhaps in a more useful comparison, according to these results, and setting all other independent variables at their average values, an oligopolistic industry (CR_4 = 75) would have paid an average wage of $5.90 in 1977, compared with $5.37 for a more competitive industry (CR_4 = 25), implying a "premium" of $0.53. Table 16 shows that this premium has risen consistently since 1958, in nominal terms, but that as a percentage of the competitive wage, it has remained fairly stable at around 10%. Unionization is seen to have a positive but insignificant effect on earnings, implying that the organization of the product market influences wage rates more strongly than the structure of the labor market.

Further, the regression results indicate a positive and significant relationship between the proportion of large establishments in a product class and wage rates; this is consistent with Masters' (1969) results. This finding confirms the importance of the firm size distribution to observed average industrial earnings levels. As anticipated, moreover, the proportion of production workers in the South is seen to have a consistently negative and

Table 16. Oligopolistic Earnings Premiums: Various Years*

Year	AHE (CR_4=25)	AHE (CR_4=75)	Premium	Premium as a Percentage of Competitive Earnings
1977	$5.37	$5.90	$0.53	9.9%
1972	3.57	3.98	0.41	11.5
1967	2.58	2.82	0.24	9.3
1963	2.19	2.41	0.22	10.1
1958	1.86	2.04	0.18	9.7

*Estimated from the regression results of Table 15, setting all other independent variables at their mean values.

significant effect on average hourly earnings.

Of the three labor characteristics,[12] the percentage of male workers seems to show the strongest effect on average hourly earnings. Its coefficient is always positive and statistically significant, at the 1% level. This result in itself does not necessarily imply discrimination either for all food industries or particularly for oligopolistically structured markets. The result does, however, show a strong enough wage differential to be of potential policy or further research interest. A one-percentage-point increase in the percentage of male employees is seen to give rise to over a 1% increase in wage rates for 1977, all else constant.

The percentage of white production workers has had a consistently positive effect on ln AHE, as expected, and its coefficient is statistically significant for both 1967 and 1972. Finally, median years of education has had only a slight effect (sometimes positive and sometimes negative) on average hourly earnings.

Thus, controlling for other potential influences on average hourly earnings, the concentration-wage-rate hypothesis is upheld. The results further suggest that the influence of concentration on wage rates is an important cause of allocative and technical inefficiencies. Moreover, these results are relatively robust using alternative model specifications and observation sets,[13] and are generally consistent with McEowen's (1982) results for food industries.

Wage-Rate-Change Model

In order to investigate the potentially macroeconomic impact of the wage decision, a wage-change model is specified particularly as

$$\Delta AHE = \beta_1 + \beta_2 \Delta CR_4 + \beta_3 L + \beta_4 S + \beta_5 M + \beta_6 W + \beta_7 E + \beta_8 \Delta P + \beta_9 CR_4 + \beta_{10} U + u, \qquad (3)$$

where u is the error term. The model is estimated for the period 1958 to 1977, with all level variables proxied by their 1967 values.[14] Since the theory of industrial organization or previous empirical studies are not as useful in the exact specification of (3) as they were in (2), (3) is selected on the basis of including essentially the same controlling industrial and labor characteristics as in (2) in order to allow comparison of the effects of these factors on levels and changes of average hourly earnings.

One additional variable in (3), but not in (2), is change in concentration from 1958 to 1977. One might postulate that those food and tobacco classes which have experienced the largest increases in concentration, i.e., have become increasingly oligopolistic over these nineteen years, would also show the steepest percentage increase in average hourly earnings. First, if the static wage-concentration relationship is valid, as it seems to be empirically for five different years, then the direct long-term comparative static relationship between change in average hourly earnings and change in concentration is also expected. Second, based on at least one set of empirical results from a test of the theory of administered pricing for the same time period (see Kelton [1982]), change in concentration was seen to exert a positive and significant influence on percentage price change, implying a possible inflationary impact of concentration change. Since wage-rate change is clearly an important ("cost-push") component of price change, in general, one might expect a positive relationship between wage rate change and concentration change as well.

The other variable which distinguishes (3) from (2) is percentage change in labor productivity between 1958 and 1977. Theoretically, the change in the marginal physical product of labor should effect a direct change in the wage rate.[15] If workers are producing more output per hour over time, their hourly compensation should rise accordingly. ΔP is an important variable in the sense that only wage rate increases in excess of productivity increases can be said to contribute to inflation.

Table 17 presents empirical results from estimation of (3). The signs and significance levels of the coefficients are strikingly similar to those found in Table 15, implying that wage rate levels and long-term wage rate change may be affected by essentially the same set of factors. Wage rate increase is seen to be more pronounced the more concentrated the product class, the greater the union coverage of production workers in that class, and the greater the increase in concentration over time. All three variables' coefficients are significant at at least the 10% level, with the estimated effect of change in concentration significant at the 1% level. These results suggest three separate structural inflationary factors. Based on the regression estimates, and setting all other explanatory variables at their mean values, an oligopolistic industry (with CR_4 = 75) would have shown an increase in average hourly earnings of 199% from 1958 to 1977, compared with a 189% increase for a product class with CR_4 = 25, a difference of 10 percentage points.

Further, the proportion of large establishments in a product class has an estimated positive and significant effect on ΔAHE, as does the proportion of production workers classified in the South. This latter result "contrasts" with that in Table 15, indicating some general catch-up of wages in the South. This trend can be noticed also in Table 15, where the estimates of $|\alpha_4|$ are seen to decrease from 1958 to 1977.

The labor characteristics M, W, and E have the same estimated directional effects on ΔAHE as they did on ln AHE; E has a negative, but statistically insignificant, effect on ΔAHE; W has a significant (at the 1% level) positive

Table 17. Percentage Change in Average Hourly Earnings: 1958-1977

Independent Variable	Coefficient Estimate	t statistic
Constant	-1.3991	-1.0652
ΔCR_4	0.0074[a]	3.2846
L	0.2243[b]	2.4324
S	0.3877[b]	2.6516
M	0.0021	0.6881
W	0.0311[a]	3.3011
E	-0.0178	-0.1715
ΔP	0.0122	0.7455
CR_4	0.0020[c]	1.4034
U	0.0057[c]	1.4184

N = 59

R^2 = 0.4630

F = 4.6935[a]

[a]Significant at the 0.01 level (for one- or two-tail test).

[b]Significant at the 0.05 level (for one- or two-tail test).

[c]Significant at the 0.10 level (for one- or two-tail test).

effect on ΔAHE; and M has a positive (but insignificant) effect on ΔAHE. Finally, ΔP's effect on ΔAHE is seen to be positive, but again insignificant. When structural and labor characteristics are considered, it is seen that productivity change itself has no additional significant impact. All of these results, incidentally, are fairly robust against minor respecifications of (3).[16]

Taken together, Tables 15 and 17 argue strongly that product market structure and, to some extent, labor market organization are important components of interindustry wage and wage change differentials. Not only does market concentration help to explain wage differentials across food and tobacco industries at one point in time, but concentration and change in concentration also help to explain differential wage increases across these same industries, and, thus, their potential contributions to wage inflation. No earnings catch up over time is observed for the product classes with low concentration.

Productivity-Change Model

In contrast to average hourly earnings, or even to change in those earnings, there is little precedent in the literature for explaining interindustry productivity-change differentials (see Allen [1969], Gisser [1982], and Greer and Rhoades [1976] for exceptions). Thus, (4) below reflects the argument used in the specification of (3) that one might expect market structure as well as certain labor qualities (omitting M and W[17]) to affect productivity change over time:

$$\Delta P = \gamma_1 + \gamma_2 \Delta CR_4 + \gamma_3 L + \gamma_4 S + \gamma_5 E + \gamma_6 \Delta Q + \gamma_7 CR_4 + \gamma_8 U + e, \quad (4)$$

where e is a stochastic error, and ΔQ is growth in physical output over the nineteen-year period. Food and tobacco manufacturing industries which have grown more in size may also be becoming more labor productive -- essentially a dynamic argument for the existence of scale economies. The directional effects of CR_4 and ΔCR_4 are not predicted a priori, although the basic Schumpeterian hypothesis of a positive relationship between firm size and productivity change might suggest positive market structural influences in this case as well. Note that all level variables are again proxied by their 1967 or mid-period values.

In Table 18, one notices first that $R^2 = 0.1902$, a result which is not nearly so encouraging as the R^2 statistics from Tables 15 and 17. All of the independent variables in (4) together explain less than 20% of the variation in labor productivity change across product classes. Individual t statistics show that only ΔQ and U are significant at the 10% level or better. CR_4 has an insignificant negative relationship with ΔP; ΔCR_4 has an insignificant positive effect on ΔP. One interpretation of these results is that neither more concentrated product classes nor those which experienced greater rises in concentration had productivity changes to offset their statistically higher average hourly earnings increase. There is no tight relationship between equation (4) and Gisser's (1982) model specification (because Gisser's structural variables are measured differently); and the conclusions from the two studies are distinct indeed. With respect to CR_4 (see Gisser [1982, p. 620]), both studies report negative effects on productivity change. However, whereas Gisser created two variables to represent change in concentration and concluded that there was a significantly positive effect of concentration change on productivity change on the basis of one of these two variables, the present study reports an insignificant effect of concentration change.

On the basis of Table 18, it appears that productivity change differentials, at least in food and tobacco manufacturing, are difficult to explain by market structure or labor characteristics. Gisser (1982, p. 618)

Table 18. Percentage Change in Labor Productivity: 1958-1977

Independent Variable	Coefficient Estimate	t statistic
Constant	0.2177	0.0360
ΔCR_4	0.0006	0.0305
L	-0.1607	-0.2166
S	0.0802	0.0774
E	0.2171	0.4664
ΔQ	0.5672[a]	2.4974
CR_4	-0.0004	-0.0362
U	-0.0302[c]	-1.4146

N = 59

R^2 = 0.1902

F = 1.7114

[a]Significant at the 0.01 level.

[b]Significant at the 0.05 level.

[c]Significant at the 0.10 level.

argued that one may observe a low R^2 "because technological innovation is, to some extent, a random process." It may be, however, that technological innovation, progressiveness, or productivity change may simply be firm-specific and more difficult than other important variables of interest in industrial organization to analyze at the industry or product class level.

The more concentrated product classes do not show higher productivity changes than more competitive product classes. In fact, a negative effect is actually observed. On the basis of these results, there is no reason to conclude that progressiveness of monopolistic industries compensates in some sense for any allocative inefficiency observed empirically for these industries from wage or profit-rate studies (see, for example, Parker and Connor [1978]). Further, since there also is no statistically significant effect of ΔCR_4 on ΔP observed, there is no off-setting progressiveness of product classes which have become increasingly oligopolistic.

Unit-Labor-Cost-Change Model

In this analysis, the estimated model is as follows:

$$\Delta ULC = \pi_1 + \pi_2\Delta CR_4 + \pi_3 L + \pi_4 S + \pi_5 E + \pi_6 \Delta Q + \pi_7 CR_4 + \pi_8 U + \pi_9 M + \pi_{10} W + v, \quad (5)$$

where v is a stochastic error. The relevant explanatory variables include both those which were hypothesized to effect a change in hourly earnings and those which might affect change in productivity, the two components of unit labor cost.

Again, as for change in productivity, one notes the relatively low R^2 statistic from Table 19 (R^2=0.2943), implying that differentials in unit labor cost change are also difficult to explain by structural and labor characteristics. However, CR_4 is seen to exert a significantly positive effect on unit labor cost change. In other words, those food and tobacco

Table 19. Percentage Change in Unit Labor Cost: 1958-1977

Independent Variable	Coefficient Estimate	t statistic
Constant	5.3564	0.7317
ΔCR_4	0.0002	0.0158
L	0.0708	0.1386
S	-0.3118	-0.3846
E	-0.7748	-1.3433
ΔQ	-0.3571[b]	-2.2899
CR_4	0.0138[b]	1.7392
U	0.0187	0.8403
M	0.0243[c]	1.4503
W	0.0127	0.2450

N = 59

R^2 = 0.2943

F = 2.2700[c]

[a]Significant at the 0.01 level.

[b]Significant at the 0.05 level.

[c]Significant at the 0.10 level.

product classes which are oligopolistic as opposed to competitively organized have shown the greatest increase in these unit costs over time. Even more than Table 17, which shows concentration's positive impact on hourly earnings increase, Table 19 suggests an inflationary pressure induced by market structure. Change in concentration and the extent of unionization are seen to exert small positive effects on change in unit labor cost. Besides concentration, the percentage of male employees is also seen, from Table 19, to have a positive significant effect on unit cost change, as was expected from the preceding section. Also, as predicted above, output change or growth has a significantly negative effect on percentage change in unit labor cost.

<u>Summary</u>

Table 20 summarizes the regression results from the four models considered.[18] Concentration exerts a significant positive influence on hourly labor earnings, on percentage change in those earnings, and on percentage change in unit labor cost. Moreover, the percentage-male, percentage-white, percentage-union-coverage, and large-establishment factors show similar positive (and often significant) effects in all three equations. The latter two factors as well as concentration are seen to affect labor productivity inversely. Change in concentration does not appear as a factor in the earnings level model, but positively impacts on all three of the other dependent variables. A regional wage catch-up effect is evidenced by southern employment's negative effect on earnings yet positive effect on earnings change. Education does not appear to be an empirically strong variable in any of the models. Change in output, however, is a strong variable, having a positive impact on productivity change, and a negative effect on unit labor cost change. Finally, it is noted that the two earnings relationships are the strongest empirically, explaining the greatest proportion of variance in the

Table 20. Summary Table of Regression Results

Independent Variable	Dependent Variable			
	AHE	ΔAHE	ΔP	ΔULC
CR_4	(+)[a]	(+)[c]	(-)	(+)[b]
ΔCR_4	--	(+)[a]	(+)	(+)
L	(+)[a]	(+)[b]	(-)	(+)
S	(-)[a]	(+)[b]	(+)	(-)
E	(+)[e]	(-)	(+)	(-)
M	(+)[a]	(+)	--	(+)[c]
W	(+)[d]	(+)[a]	--	(+)
U	(+)	(+)[c]	(-)[c]	(+)
ΔQ	--	--	(+)[a]	(-)[b]
ΔP	--	(+)	--	--
R^2	0.68[f]	0.46	0.19	0.29

-- = omitted variable.

[a]Significant at the 0.01 level.

[b]Significant at the 0.05 level.

[c]Significant at the 0.10 level.

[d]Significant in 2 out of 5 years.

[e]Positive in 3 out of 5 years.

[f]R^2 for 1977.

Source: Tables 15, 17, 18, and 19.

dependent variable.

CONCLUSIONS

High and rising labor costs are important phenomena in food and tobacco manufacturing. Ever-rising wage rates in excess of labor productivity increases exert inflationary pressure on the economy as a whole, while high wage rates in certain oligopolistic industries are indicative of operational inefficiencies. If industrial structure affects wage determination, microeconomic policies, in general, and antitrust policies, in particular, take on added importance and could effectively supplement the traditional macroeconomic anti-inflation policies.

The results of this analysis provide support for the allocative and technical inefficiency hypotheses. The descriptive findings and regressions above argue that average hourly earnings are positively related to market-share concentration, even controlling for other variables which are expected to impact as well on hourly earnings. This result is very strong since it is observed consistently for five different years.

There also is support for the macro stability, inflationary hypothesis. The most concentrated product classes tend to be those which have experienced higher wage rate increases (and higher unit labor cost increases) than those classes which are less concentrated. In addition, those product classes which have had rising concentration have shown greater wage rate increases than those which have not. Finally, the results provide no support for the notion that increases in productivity are greater in large firms or in concentrated markets.

FOOTNOTES

1 Most previous analyses of interindustry wage or wage-change differentials have been undertaken at the four-digit SIC level. Due to five-digit availability or comparability problems, 2065 (Confectionery products), 2074 (Cottonseed oil mills), 2075 (Soybean oil mills), 2082 (Malt beverages), 2095 (Roasted coffee), and 2141 (Tobacco stemming and redrying) are substituted as observations in the regression analyses. 20164 (Other poultry, small game), 20210 (Butter), 20513 to 20517 (Sweet bread-type products), 20923 (Frozen fish), and 20970 (Manufactured ice) are omitted due to data problems. (See Rogers [1980].) The following pairs of product classes are combined into one market due either to being indistinguishable for the consumer or to unavailable separate historical data: 20116 and 20136; 20117 and 20137; 20118 and 20138; 20161 and 20162; 20511 and 20512; and 20620 and 20630. 20860 (Bottled and canned soft drinks) uses 20873 concentration data (see Mueller and Rogers [1978]). Finally, 20119 and 20264 are omitted due to lack of comparability between cost and physical quantity data (see note 4 below).

2 The cost, shipments, and physical quantity data for various years are found in Volume II, Industry Statistics, in the following two basic tables: "General Statistics for Establishments, by Industry Specialization and Primary Product Class Specialization" and "Products and Product Class Quantity and Value of Shipments by All Producers."

3 It is recognized that AHE is not a true wage rate; AHE is based on all regular payroll, including paid vacations and holidays, dismissal pay, bonuses, and compensation in kind, prior to deductions of employee Social Security contributions, tax withholding, union dues, or group insurance. Also, one notes that H covers hours worked or paid for at the manufacturing plant, including actual overtime hours, but excluding hours paid for vacations, holidays, or sick leave when the employee was not at the plant. For a discussion of various alternative labor cost measures, see Hamermesh (1981).

4 In general, quantities are reported for food and tobacco product classes -- a distinct advantage for a study involving these two groups as opposed to other manufacturing sectors. When physical quantity data are lacking for some of the products within a product class, or when units of measurement differ among products, a quantity-estimation or a product-deletion procedure is employed. Deleted seven-digit products (from quantity-change, productivity-change, and unit-labor-cost-change calculations) by 1972 SIC code are 2023300, 2033665, 2033861, 2033800, 2062075, 2074400, 2075100, 2079100, 20824 (all), 2084043, 2084081, 2084085, 2084000, 2084002, 2085165, 2085100, and 2085300. Physical quantities are estimated for other seven-digit products for various years. All estimates are based on the shipments-quantity relationship for the other seven-digit products. When cases were the unit of measurement, it was assumed that they could be added. 20323, 20333, 20335, 20336, and 20860 have quantity measured in cases. It must be noted that cost data are computed on a product class basis, while quantity data are computed on a commodity-wherever-made basis (see note 1). Another source for quantity data is the <u>Census of Manufactures</u>, Volume IV, various years. These data should be highly correlated with the data used in this study but are not the same since

Volume IV data are index values.

[5] In regressing ΔULC simply on these two components, ΔAHE and ΔP, the following result was obtained (t statistics in parentheses):

$$\Delta ULC = \underset{(1.229)}{1.257} - \underset{(-5.236)}{0.413^{a}}\Delta P + \underset{(0.028)}{0.015}\Delta AHE,\ R^2 = 0.3321$$

[6] For the regression analyses, L and S (below) are measured as proportions. Only the descriptive tables are presented in percentage terms.

[7] In other words, all product classes within a given industry are assigned the same large-establishment percentage. Alternatively, for three-digit data discussed below, all product classes within a given major industry are assigned the same variable values.

[8] For 1977, due to disclosure problems, the proportion of establishments located in the South by industry was used to measure S. To check the 1977 values' reliability, a correlation coefficent was calculated between the proportion of production workers in the South and the proportion of establishments in the South -- for 1972, a year when both types of data were available. The coefficient was estimated to be 0.9276, significant at the 1% level.

[9] The "experienced" civilian labor force comprises both the employed and the experienced unemployed (those who have worked at any time in the past).

[10] None of the models in this section includes a variable which measures product class capital or change in capital over time. However, Gisser's (1982) data measuring annual percentage change in capital use (from 1963 to 1972) are ascribed to the product classes in this analysis (omitting 20471 and the tobacco products) and incorporated in the labor productivity model below. The change in capital use has an hypothesized positive effect on labor productivity change; its effect, though, is estimated to be insignificantly negative.

[11] Deleting 19 "middle" observations from the sample, ranked by 1967 value of shipments, to render the tests more powerful, the Goldfield-Quandt test for heteroskedasticity was conducted for each of the five years considered, to test the hypothesis that the larger product classes have more variation in ln AHE than the smaller product classes. The null hypothesis of equal variances could not be rejected (at the 10% level) for any of the years.

[12] The simple correlation between characteristics variables E and W is quite high (as are the absolute values of the coefficients between the characteristics variables and U), as seen from Appendix B, especially since they are observed only at the major industry level. M is also highly correlated with E and W. However, the results are essentially unchanged (for the included variables) when various one-, two- and three-way combinations of U, M, E, and W are omitted. A skill variable, such as that found in Haworth and Rasmussen (1971), is not included due to additional collinearity which would be posed by another three-digit-level variable.

[13] Alternative ordinary-least-squares specifications for each of the five years (but discussed below only for 1977) include (1) the introduction of CR_4^2, (2) the introduction of an advertising intensity variable, (3) the introduction of an interaction term between CR_4 and U, and (4) an expanded sample of 77 food and tobacco product classes. The four models represent minor changes from the "base" model (2) in the text, and are independent of each other.

(1) The variable CR_4^2 checks for additional nonlinearity. It proved insignificant at the 10% level and introduced additional multicollinearity (0.9805 is the estimated correlation between CR_4 and CR_4^2.)

(2) The major-media advertising intensity variable is to represent market power and additional discretion over wages, and is taken from Leading National Advertisers brand advertising data, prepared by assigning a five-digit SIC number to the data. This variable was also not significant at the 10% level and introduced additional multicollinearity with respect to market concentration. Advertising intensity and CR_4 have an estimated correlation coefficient of 0.5416.

(3) A concentration-unionization interaction term, following Weiss's (1966) model, proved to be positive (and significant at the 10% level), implying that an increase in concentration has a greater positive effect on wage rates when unionization is high, the opposite of Weiss's conclusion; both concentration and unionization had negative individual effects on wage rates when the interaction term was added, a result consistent with that of Martin and Rence (1983); however, $CR_4 \times U$ in this model is not as "reliable" as a pure five-digit variable (one notes its relatively high, counterintuitively positive correlation with S from Appendix B and its relatively low correlation with CR_4), and introduces substantial multicollinearity; $CR_4 \times U$ and CR_4 have an estimated correlation coefficient of 0.8971.

(4) 77 observations which had sufficient consistent, historical data back to 1963 were included in a fourth robustness check. Additional observations were 20221, 20222, 20321, 20331, 20332, 20334, 20341, 20354, 20381, 20411, 20415+20455, 20521+20522, 20610, 20741, 20742, 20744, 20752, 20761, 20762, and 20910; and omitted observations were 20740 and 20750. The conclusions drawn from Table 15 were strengthened in this case.

[14] When level variables are measured as simple averages over the five years, some of the absolute values of the t statistics, the overall F statistic, and the R^2 statistic are reduced slightly, but none of the estimated coefficients changes sign.

[15] It might be argued that average hourly earnings change and labor productivity change are determined simultaneously; an increase in wage rates over time might induce additional productivity or output per hour. This model does not take this possibility into account, nor do other previous studies.

[16] None of the directional effects is altered when 1967 major media advertising intensity is included as an additional explanatory variable. Advertising intensity's effect is positive, but statistically insignificant. Moreover, none of the directional effects of the explanatory variables is altered when U is deleted to reduce the

multicollinearity inherent in the model. When U is deleted, however, M is seen to have a significantly positive effect on change in average hourly earnings.

[17] If M and W are included in the model (in a theoretically questionable specification), they are estimated to have insignificant effects on change in labor productivity.

[18] I appreciate Bruce Marion's suggestion of including Table 20 as an appropriate summary of the study's empirical results.

APPENDIX A

Observations Used in Regression Analysis

1972 SIC Code	Product Class Name
20111	Beef, not canned or made into sausage
20112	Veal, not canned or made into sausage
20113	Lamb and mutton, not canned or made into sausage
20114	Pork, fresh and frozen
20116[a]	Pork, processed (not canned or made into sausage)
20117[b]	Sausage and similar products (not canned)
20118[c]	Canned meats containing 20% or more meat
20161[d]	Young chickens, including broilers, fryers, roasters, capons
20163	Turkeys
20172	Liquid, dried, and frozen eggs
20231	Dry milk products
20232	Canned milk products (consumer type cans)
20233	Concentrated milk, shipped in bulk
20234	Ice cream mix and ice milk mix
20240	Ice cream and ices
20261	Bulk fluid milk and cream
20262	Packaged fluid milk and related products
20263	Cottage cheese
20323	Canned dry beans
20333	Canned hominy and mushrooms
20335	Canned vegetable juices
20336	Catsup and other tomato sauces
20338	Jams, jellies, preserves
20352	Pickles and other pickle products
20353	Meat sauces (except tomato)
20372	Frozen vegetables
20430	Cereal breakfast foods
20440	Milled rice and byproducts
20460	Wet corn milling
20471	Dog and cat food
20511[e]	Bread and rolls
20620[f]	Refined cane and beet sugar and byproducts
20650[h]	Confectionery products
20661	Chocolate coatings
20668[g]	Other chocolate and cocoa products
20670	Chewing gum and chewing gum base
20740[h]	Cottonseed oil mills
20750[h]	Soybean oil mills
20771	Grease and inedible tallow
20772	Meat meal and tankage
20791	Shortening and cooking oil
20820[h]	Malt beverages
20830	Malt and malt byproducts
20840	Wines, brandy, and brandy spirits
20851	Distilled liquor, except brandy
20853	Bottled liquors, except brandy

APPENDIX A (Continued)

Observations Used in Regression Analysis

1972 SIC Code	Product Class Name
20860	Bottled and canned soft drinks
20872	Liquid beverage bases
20874	Other flavoring agents (except chocolate syrups)
20950[h]	Roasted coffee
20980	Macaroni, spaghetti, noodles
20991	Desserts (ready-to-mix)
20992	Chips
20993	Sweetening syrups and molasses
20994	Baking powder and yeast
21110	Cigarettes
21210	Cigars
21310	Chewing and smoking tobacco and snuff
21410[h]	Tobacco stemming and redrying

[a]Represents 20116+20136.
[b]Represents 20117+20137.
[c]Represents 20118+20138.
[d]Represents 20161+20162.
[e]Represents 20511+20512.
[f]Represents 20620+20630.
[g]Represents 20668+20998.
[h]Four-digit observation.

APPENDIX B

Correlation Matrices

	ln AHE	CR_4	L	S	E	M	W	U
				1977				
ln AHE	1.000	0.252	0.315	-0.313	0.414	0.661	0.308	-0.004
CR_4		1.000	0.378	0.032	0.069	-0.052	-0.075	-0.016
L			1.000	0.036	-0.310	-0.145	-0.164	0.199
S				1.000	-0.314	-0.194	-0.547	0.491
E					1.000	0.648	0.706	-0.477
M						1.000	0.471	0.055
W							1.000	-0.630
U								1.000
				1972				
ln AHE	1.000	0.236	0.305	-0.452	0.434	0.610	0.328	-0.064
CR_4		1.000	0.265	0.007	0.073	-0.077	-0.113	0.001
L			1.000	-0.143	-0.182	-0.054	-0.073	0.039
S				1.000	-0.192	-0.235	-0.438	0.465
E					1.000	0.644	0.706	-0.477
M						1.000	0.475	0.046
W							1.000	-0.630
U								1.000

APPENDIX B (Continued)

Correlation Matrices

	ln AHE	CR_4	L	S	E	M	W	U
				1967				
ln AHE	1.000	0.172	0.297	-0.511	0.421	0.591	0.343	-0.101
CR_4		1.000	0.333	0.033	0.084	-0.077	-0.105	-0.022
L			1.000	-0.155	-0.287	-0.129	-0.195	0.079
S				1.000	-0.206	-0.260	-0.409	0.461
E					1.000	0.676	0.706	-0.477
M						1.000	0.506	0.007
W							1.000	-0.630
U								1.000
				1963				
ln AHE	1.000	0.211	0.372	-0.469	0.431	0.590	0.365	-0.117
CR_4		1.000	0.308	0.066	-0.084	-0.036	-0.092	0.001
L			1.000	-0.223	-0.166	-0.021	0.037	0.131
S				1.000	-0.291	-0.238	-0.378	0.453
E					1.000	0.685	0.887	-0.514
M						1.000	0.459	0.007
W							1.000	-0.567
U								1.000

APPENDIX B (Continued)

Correlation Matrices

	ln AHE	CR_4	L	S	E	M	W	U
				1958				
ln AHE	1.000	0.218	0.410	-0.443	0.370	0.596	0.306	-0.025
CR_4		1.000	0.306	0.118	-0.072	-0.011	-0.050	0.017
L			1.000	-0.170	-0.226	-0.060	-0.036	0.144
S				1.000	-0.266	-0.200	-0.342	0.427
E					1.000	0.685	0.887	-0.514
M						1.000	0.459	0.007
W							1.000	-0.567
U								1.000

Correlation Matrices

Percentage Change in Average Hourly Earnings: 1958-1977

	ΔAHE	ΔCR_4	L	S	M	W	E	ΔP	CR_4	U
ΔAHE	1.000	0.285	0.169	0.131	0.243	0.279	0.226	0.130	0.194	0.067
ΔCR_4		1.000	-0.049	-0.116	-0.131	0.018	-0.000	0.103	-0.010	-0.059
L			1.000	-0.155	-0.129	-0.195	-0.287	-0.120	0.333	0.079
S				1.000	-0.260	-0.409	-0.206	-0.115	0.033	0.461
M					1.000	0.506	0.676	0.099	-0.077	0.007
W						1.000	0.706	0.254	-0.105	-0.630
E							1.000	0.224	0.084	-0.477
ΔP								1.000	0.004	-0.254
CR_4									1.000	-0.022
U										1.000

APPENDIX B (Continued)

Correlation Matrices

Percentage Change in Productivity: 1958-1977

	ΔP	ΔCR_4	L	S	E	ΔQ	CR_4	U
ΔP	1.000	0.103	-0.120	-0.115	0.224	0.344	0.004	-0.254
ΔCR_4		1.000	-0.049	-0.116	-0.000	0.256	-0.010	-0.059
L			1.000	-0.155	-0.287	-0.138	0.333	0.079
S				1.000	-0.206	-0.036	0.033	0.461
E					1.000	0.116	0.084	-0.477
ΔQ						1.000	0.026	0.007
CR_4							1.000	-0.022
U								1.000

Correlation Matrices

Percentage Change in Unit Labor Cost: 1958-1977

	ΔULC	ΔCR_4	L	S	E	ΔQ	CR_4	U	M	W
ΔULC	1.000	-0.126	0.212	0.005	-0.181	-0.312	0.171	0.299	0.126	-0.167
ΔCR_4		1.000	-0.049	-0.116	-0.000	0.256	-0.010	-0.059	-0.131	0.018
L			1.000	-0.155	-0.287	-0.138	0.333	0.079	-0.129	-0.195
S				1.000	-0.206	-0.036	0.033	0.461	-0.260	-0.409
E					1.000	0.116	0.084	-0.477	0.676	0.706
ΔQ						1.000	0.026	0.007	0.027	0.068
CR_4							1.000	-0.022	-0.077	-0.105
U								1.000	0.007	-0.630
M									1.000	0.506
W										1.000

APPENDIX C

Ordinary Least Squares Results for the Natural Logarithm of Average Hourly Earnings: Various Years (t statistics in parentheses)

Independent Variable	Coefficient Estimates 1977	1972	1967	1963	1958
Constant	1.3658[c] (1.4586)	-0.4973 (-0.4708)	-1.1154 (-1.0362)	-0.3373 (-0.4710)	-0.4519 (-0.7413)
CR_4	0.0015[c] (1.3659)	0.0021[b] (1.7816)	0.0010 (0.8665)	0.0019[c] (1.5729)	0.0018[b] (1.7616)
L	0.4133[a] (4.1419)	0.2245[a] (2.7874)	0.2331[a] (3.0639)	0.2565[a] (2.8510)	0.2583[a] (3.6664)
S	-0.2442[b] (-2.2996)	-0.4023[a] (-3.2962)	-0.4292[a] (-3.6312)	-0.3498[a] (-2.6921)	-0.3527[a] (-3.3279)
E	0.0383 (0.5110)	0.1258[c] (1.4544)	0.1316[c] (1.5525)	0.1532 (1.1590)	0.1214 (1.1125)
M	0.0125[a] (5.3664)	0.0065[a] (2.5101)	0.0048[b] (1.9693)	0.0056[b] (1.9910)	0.0058[a] (2.4899)
W	-0.0113 (-1.4299)	-0.0044 (-0.5399)	-0.0002 (-0.0242)	-0.0106 (-0.9736)	-0.0086 (-0.9844)
U	-0.0022 (-0.7444)	0.0033 (0.9648)	0.0040 (1.2381)	0.0009 (0.2957)	0.0022 (0.8541)
R^2	0.6799	0.6196	0.6176	0.5969	0.6495
F	15.4729[a]	11.8689[a]	11.7647[a]	10.7883[a]	13.5013[a]

N = 59

[a]Significant at the 0.01 level.

[b]Significant at the 0.05 level.

[c]Significant at the 0.10 level.

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