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ENERGY PRICING AND EMPLOYMENT IN NEW YORK STATE MANUFACTURING, 1964 TO 1973

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I. INTRODUCTION

In recent years, the economic impact of rising energy prices has attracted increasing attention from economists, political scientists, labor groups, and a host of other interested parties. High energy prices are blamed for the inflation and unemployment plaguing the economy, and seen as the root of future slow growth and widespread economic troubles. A prevalent assumption has been that growth and increased energy consumption go hand in hand.

A growing body of recent literature contradicts this view. Technical studies of energy efficiency in various sectors, studies of the European experience, and econometric tests of factor substitutability in manufacturing and other industries have all demonstrated that the relationship between growth, employment, and energy consumption is probably considerably more flexible than previously it was thought to be.

The present study focuses on one small corner of the universe of questions about the impact of higher energy prices on the economy. It attempts to measure the response of demand for labor in New York state manufacturing industries, at the SIC 2-digit level, to changes in energy prices, to evaluate the demographic composition of labor demand shifts associated with energy price changes, and briefly to examine the suitability of energy price manipulation as a tool for job creation. The first of these goals is approached through econometric estimation, while the latter two are dealt with through comparison and discussion. In estimating elasticities of demand for labor, I have disaggregated both labor (production and nonproduction) and energy (electricity and aggregate fossil fuels). The results thus obtained indicate that the low elasticities of demand for labor with respect to energy prices estimated by other authors arise from incorrect aggregation of functionally distinct factors of production. This argument is expanded in the paper.

The state, rather than the nation, is chosen as a unit of investigation for several reasons. First, the high levels of energy, and particularly electricity, prices in New York are widely recognized, and suspected by some to have accelerated job losses in the state; New York is one of few states to have lost both jobs and population in recent years [Foltman and McClelland, 1977]. Second, estimates of labor demand elasticities at the national level cannot automatically be assumed to obtain for the state: differences in absolute and relative factor price levels, in industry mobility, and in industry mix may result in state-level elasticities differing markedly from national averages. Third, factor prices that are endogenous to the nation may be exogenous to the state, as may demand for output. All these considerations indicate the importance of examining labor demand response at the state as well as the national level.

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Estimates made for all U.S. manufacturing indicate that labor and energy were only slightly substitutable over the period 1947-1971. Econometric estimation of the response of labor demand to energy prices in New York state manufacturing, however, using appropriately disaggregated variables, suggests that between 1964 and 1973 the elasticity of demand for labor with respect to the price of electricity was significantly positive, while the comparable statistic with respect to fossil fuel price was significantly negative. This is interpreted in real terms as indicating that both labor and fossil-fuel-powered equipment were replaced with electrically powered machinery. Since the state has some control over electricity prices, whereas fossil fuel prices are essentially exogenous, this finding may be of relevance to policy makers.

The results of econometric estimation also indicate that the sensitivity of labor demand to energy prices varies inversely with the energy-intensiveness of manufacture: demand for labor in the most energy-intensive industries is not significantly elastic with respect to energy prices, while in the least energy-intensive industries both electricity/labor substitutability and fossil-fuel/labor complementarity appear to have been strong.

The finding that labor demand elasticities vary among groups of industries leads to some interesting conclusions about the demographic impact of energy-price-induced shifts in labor demand. Data on the demographic compositions of the work forces in different industries show that energy-intensive industries employ disproportionate numbers of white males, while labor-intensive industries employ greater-than-average numbers of females and minority males. Thus it may be conjectured that the long-run effect of lowering electricity prices in the state would be to displace a disproportionate number of the latter two groups.

At the same time, evidence from a survey of management perceptions of the state business climate suggests that energy prices may be less important in determining manufacturing employment levels than are several other variables. Comparatively high wages and union membership, a widely unpopular tax structure, and the attitudes of labor and state officials all seem to influence industry's choice of location more strongly than do energy cost and supply factors. The conclusion drawn from this is that New York should not attempt to expand manufacturing employment by unilaterally manipulating energy, particularly electricity, prices, but rather should improve other aspects of its business climate, increase the availability of skilled labor, and encourage Federal efforts to raise and equalize energy prices across the nation.

II. TRENDS IN FACTOR DEMAND AND PRICING, NEW YORK STATE MANUFACTURING, 1964 TO 1973

Observed trends in labor, energy, and capital pricing and demand in New York state manufacturing indicate that changes in technology have involved substitution of energy for labor. This section summarizes available data illustrating these trends, providing both a background and to some extent a testing ground for the set of estimations which follows.

Demand for and Cost of Labor

Employment in manufacturing in New York has declined fairly steadily since 1953, though with some cyclical variation. In 1964, manufacturing employment reached a trough, from which it rose through 1966; it then resumed a decline from which it has not yet recovered. Manufacturing employment in 1973 was approximately 10 percent below its 1964 level, and 14 percent below its 1960 level [New York State Division of the Budget, 1974, p. 81]. By contrast, employment in manufacturing at the national level grew by 19 percent between 1960 and 1973, and by approximately 11 percent between 1965 and 1973 [Statistical Abstract of the United States: 1976, p. 366]. Thus the loss of employment in New York is somewhat extraordinary, deviating not only in magnitude but also in direction from the national trend.

Employment in manufacturing, relative to employment in other sectors, has, however, dropped in both the state and the nation. In 1964, manufacturing employment comprised 28.2 percent of total nonagricultural employment in New York; by 1973, it accounted for just 22.8 percent [New York State Division of the Budget, 1974, p. 81]. Manufacturing employment in the U.S. comprised 29.7 percent of the whole in 1965, and 26.1 percent in 1973 [Statistical Abstract.... 1976, p. 366].

Indicative of the severity of New York's employment problem is the fact that job loss in manufacturing has been great enough to offset increased employment in retail and wholesale trade, services, and government [New York State Division of the Budget, 1974, p. 81]. Yet deterioration within the manufacturing sector has by no means been uniform. Table 1 illustrates changes in employment in each of the eighteen SIC 2- digit industries used in the study.[1] It may be seen here that by 1973 only six manufacturing industries were employing more people than they had in 1964; employment in twelve other industries had dropped. Employment increased in Rubber and Miscellaneous Plastics Products (SIC 30), Instruments (SIC 38), Lumber and Wood Products (SIC 24), Fabricated Metal Products (SIC 34), Textile Mill Products (SIC 22), and Machinery, Except Electrical (SIC 35). The greatest losses in employment were sustained in Leather and Leather Products (SIC 31), Food and Kindred Products (SIC 20), Apparel (SIC 23), and Transportation Equipment (SIC 37).

Real wages trended upward quite steadily but fairly slowly over the decade, aside from some cyclical variation. Table 2 depicts real wages per production-worker manhour in the different manufacturing industries, from 1964 to 1973. Although nonproduction-worker compensation is not shown, that too trended upward over the decade. Average real wages for the state manufacturing sector are graphed in figure 1, below.

Data in table 2 indicate that between 1964 and 1973 real wage increases averaged 21 percent, but ranged from 10 to 28 percent. Gains were greatest in Fabricated Metal Products (SIC 34), Printing and Publishing (SIC 27), Chemicals and Allied Products (SIC 28), Primary Metal Industries (SIC 33), Food and Kindred Products (SIC 20), and Miscellaneous Manufacturing Industires (SIC 39). They were lowest in Apparel (SIC 23), Furniture and Fixtures (SIC 25), Lumber and Wood Products (SIC 24), Electrical Machinery (SIC 36), and Textile Mill Products (SIC 22). It is interesting to note that total employment increased in SICs 24, 34, and 22, but decreased sharply in SICs 20 and 23. There is no one-to-one correspondence between wage increases and demand for labor, in either direction.

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[1] Tables follow text.

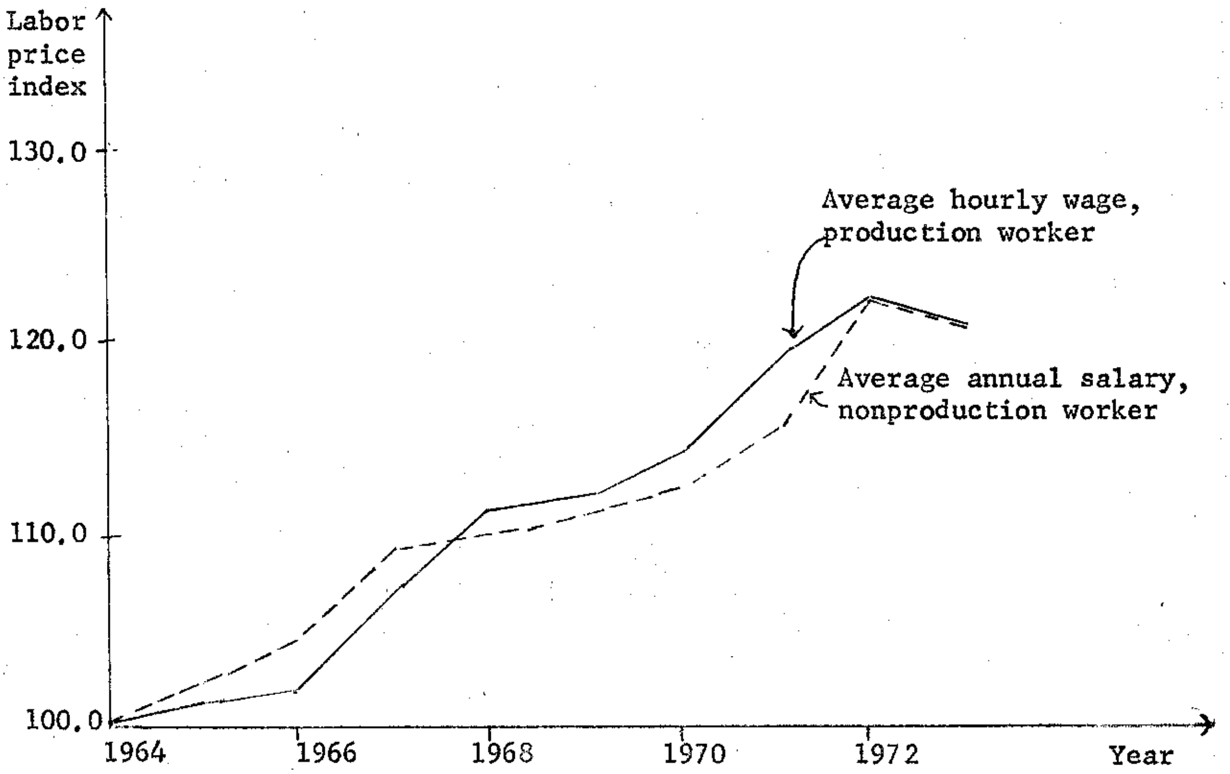

Figure 1. Real Labor Price Indices, 1964 to 1973.
(Average, all New York state manufacturing industries; 1964 = 100.0)

Demographic Composition of the Manufacturing Work Force

One more aspect of manufacturing employment deserves mention here. The demographic composition of the manufacturing work force varies markedly between industries, a fact which is of some significance in determining the social impact of changes in energy prices. Table 3 shows the percent distribution of the manufacturing work force, by race and sex, by industry, in 1970. While the manufacturing categories used in the Census of Population, from which these figures are calculated, do not correspond exactly with the SIC classifications used elsewhere, one may obtain a rough idea of the distribution of employees from the data given.

A glance at this table reveals significant differences in the demographic composition of employment in the different manufacturing industries. Proportionately more males were employed in durable-goods manufacturing than in nondurable goods: males comprised 76.6 percent of durable-goods employees, and only 57.5 percent of nondurable-goods employees, in 1970. Conversely, females were proportionately overrepresented in the nondurables sector. This pattern obtained for both whites and negroes; workers of Puerto Rican descent, however, were concentrated in nondurables, particularly in the low-wage apparel and leather products industries.

When demographic distributions are compared with inter-industry variations in the energy-intensiveness of manufacture, an interesting generalization emerges: women and minorities tend to cluster in low-wage, labor-intensive industries, while white males occupy the more remunerative skilled jobs in the energy- and capital-intensive sectors. For instance, in 1971, the most energy-intensive industries (in terms of energy consumption per production-worker manhour; see table 6) were Food and Kindred Products (SIC 20), Papter and Allied Products (SIC 26), Chemicals and Allied Products (SIC 28), Stone, Clay, and Glass Products (SIC 32), and Primary Metal Industries (SIC 33). The predominance of white males in each of these industries (table 3) is striking. Similarly, the least energy-intensive industries: Apparel (SIC 23), Leather Products (SIC 31), Printing and Publishing (SIC 27), Miscellaneous Manufacturing (SIC 39), Furniture and Fixtures (SIC 25), and Lumber and Wood Products (SIC 24); employed disproportionate numbers of females and minorities, though with some variation (SIC 24 was largely white male, SIC 27 predominantly white, though with a greater-than-average proportion of females). Thus, if the price elasticity of labor demand differs between manufacturing industries, the impact on manufacturing employment of increasing (or decreasing) energy prices may be expected to be unequally distributed across different demographic groups in the labor force.

Energy Prices and Consumption

Total energy consumption in New York state manufacturing grew by approximately 10 percent between 1962 and 1971.[1] This increase was small, taken without reference to changes in the labor force. The composition of energy consumption has, however, shifted appreciably over the decade, in ways which have great significance when probable future trends in real energy prices are taken into account.

The real price of energy in New York state is one of the highest in the nation. In 1971, the average price of purchased energy used in New York manufacturing (therefore a price based on actual consumption, and weighted by fuel type) was the fifth highest in the United States, 46 percent higher than the overall average [Census of Manufactures: 1972]. By 1974, due to the effects of rapid increases in the price of imported oil, New York had dropped to eleventh place, behind the northern and central eastern coastal states and Hawaii; but the average price was still 41 percent higher than the national mean for all manufacturing industries [Annual Survey of Manufactures: 1974].

Industrial prices of the various energy types behaved quite differently over the period of the study. Table 4 presents real average prices paid by industrial customers in New York, 1964 to 1973, for electricity and various fossil fuels; figure 2, below, depicts price indices for electricity and aggregated fossil fuels. The price of electricity dropped by about 9 percent between 1964 and 1969, then rose by 14 percent between 1969 and 1972, decreasing slightly in 1973 as the rate of inflation began to exceed the rate of increase of nominal electricity prices. Fuel oil prices vacillated through 1969, without any major changes in magnitude; thereafter they rose precipitously through 1973. The 1973 real price of fuel oil was almost 94 percent higher than the 1969 price. Coal prices dropped between 1964 and 1966, rose by 52 percent between 1966 and 1971, and then fell by 10 percent between 1971 and 1973. Natural gas prices followed electricity prices quite closely, decreasing by 12 percent between 1964 and 1969, rising by 18 percent

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[1] 1962 and 1971, rather than 1964 and 1973, are used because they are the years for which energy costs and consumption are reported in the 1963 and 1972 Census of Manufactures. Comparable data for 1964 and 1973 are not available.

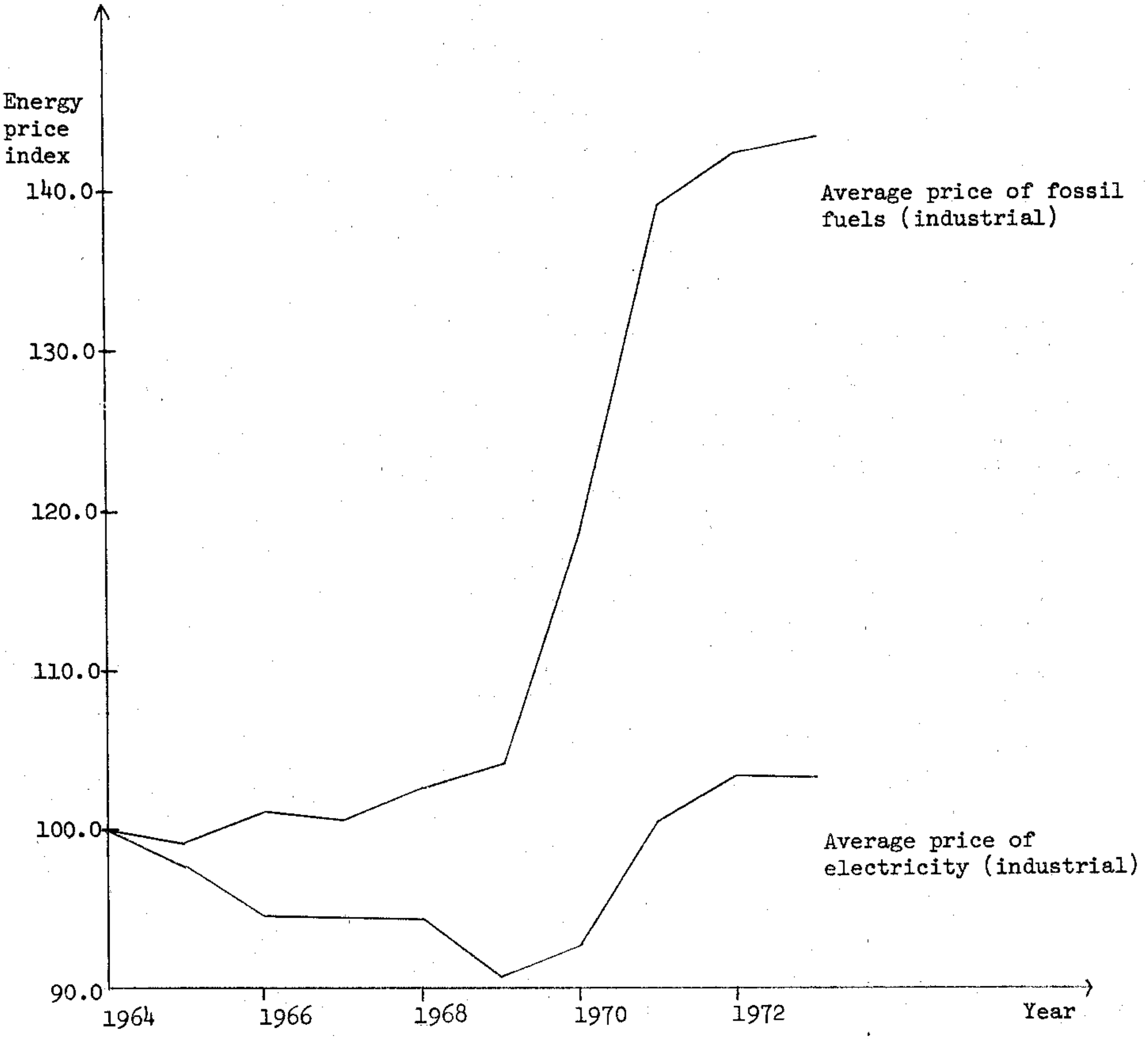

Figure 2. Real Energy Price Indices, 1964 to 1973.
(Prices to industrial customers, New York State; 1964 = 100.0)

between 1969 and 1972, and dropping off slightly in the last year. The average price of all fossil fuels together, which is of course a weighted average based on actual patterns of consumption, rose throughout the decade; apparently changing patterns of fuel consumption overshadowed price decreases in some fuels.

Some of the shifts in the composition of fuel consumption can be observed in table 5, which details patterns of energy consumption by fuel type and by industry in 1962 and 1971. Because of differences in sampling scope and technique in the two censuses, fuel consumption data in the two years are not reliably comparable;[1] but major shifts, particularly towards consumption of electricity, can be identified.

The data show that the major shifts in energy consumption in New York manufacturing were towards the use of electricity, fuel oil, and natural gas, and away from coals and coke. Only the shift towards electricity was consistent across industries; shifts towards fuel oils and natural gas did not occur in all industries. Presumably the availability of different technologies, specific characteristics of manufacturing processes, and pollution control requirements all helped to determine choice of fossil fuels. As noted, the Census fossil fuel data cannot reliably be compared over time; note the importance of 'fuels not specified by kind' in 1971; and it would be unwise to draw too many conclusions from them.

Industry's preference for electricity is interesting in light of the fact that fossil fuels remained considerably less expensive than electricity over the whole decade (see table 4), even though the relative fossil fuel/electricity price rose rather rapidly. Perhaps this behavior reflects industry's expectations both of future difficulties in obtaining certain fossil fuels, and of unpredictable revisions in pollution control legislation and enforcement. These two sets of factors create incentives to switch to one energy source which, however expensive it might become, will always be available. In this way industries shift the burden of technological change onto the utilities, and avoid incurring unforeseen costs of pollution abatement and of refitting machines to burn different fuels.

Capital Price and Demand

The behavior of the implicit rental price of capital[2] contrasted dramatically with the behavior of labor and energy prices. Capital prices doubled between 1964 and 1970, after which they dropped to somewhat lower levels.

The capital price used here behaves very differently from the capital price variable constructed by Berndt and Wood [1975] in their study of factor demand in U.S. manufacturing. Rather than doubling between 1964 and 1970, the Berndt-Wood capital price rose by 13 percent between 1964 and 1968 and then declined, so that the 1971 price was 10 percent below the 1964 price [Berndt-Wood, 1975, p. 263]. Yet capital price values published in the Wharton Annual and Industry Forecasting Model [Preston, 1972, p. 11] behave similarly to the ones calculated in the present study. The reasons for discrepancies are unknown; in the course of making econometric estimations it became quite

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[1] The Census of Manufactures: 1963 did not report any energy consumption as 'Fuels, Not Specified by Kind,' while in the Census of Manufactures 1972 this was a major category (see table 5 of this paper.) It appears, from the Census text, [Census of Manufactures: 1963, Volume 1, Summary and Subject Characteristics, p. 7-3] that small establishments were not asked to report energy expenditures where they could not detail the fuel type; small establishments were a major source of 'Fuels, Not Specified by kind' data in the Census of Manufactures: 1972. See Fuels and Electric Energy Consumed (Supplement), p. VIII.

[2] Construction of this variable is discussed in Section III, under 'Data'. Note that it is a capital price for all U.S. manufacturing rather than for New York alone.

clear that had my price series resembled Berndt's and Wood's, the capital price coefficient would probably have behaved as expected.

When the behavior of capital prices over time is compared with in-state trends in new investment in manufacturing (see figure 3, below), one sees that capital price has a pronounced tendency to follow demand for capital. Investment rose fairly steadily from 1964 to 1969, with a slight dip in 1968, then plummeted between 1969 and 1971, and began a weak recovery in 1972-73. The capital price rose continuously through 1970, fell through 1972, and rose again in 1973. It thus followed each movement of investment, except the small decrease in 1968, by one year.

Relative Energy/Labor/Capital Use in New York State Manufacturing, 1962 and 1971

Capital stock, energy demand, and employment data can be combined to determine trends in relative factor use both across industries and over time. In this case, where energy consumption is aggregated, the Census data should be reasonably reliable.

In general, New York state manufacturing has become notably more capital-intensive over the past decade; both the capital/labor and energy/labor ratios have risen. The energy/capital and energy/value-added ratios (not shown) have, however, declined, reflecting increased efficiency in energy use.[1]

These trends are documented in table 6, which shows energy/labor, energy/capital, and capital/labor ratios for each of the eighteen industries in 1962 and 1971. The table shows that the overall increase in energy-intensiveness of manufacture originated almost entirely in less- or moderately energy-intensive industries; highly energy-intensive industries increased their energy/labor usage relatively little. In the case of Primary Metal Industries (SIC 33), this ratio actually decreased over time.

Furthermore, study of the simultaneous behavior of the three ratios over the decade 1962-1971 suggests that two rather different sorts of technological change have occurred in the state manufacturing sector. One group of industries appears to have undergone both labor-augmenting and energy-augmenting technological change, while another has only undergone labor-augmenting technological change. This is deduced by noting that energy/labor ratios changed very little in some industries, while capital/labor ratios increased; in the second group of industries, both ratios increased significantly over the decade. The industries in which technological change was both labor- and energy-augmenting were Chemicals and Allied Products (SIC 28), Textile Mill Products (SIC 22), Stone, Clay, and Glass Products (SIC 32), Primary Metal Industries (SIC 33), and Machinery, Except Electrical (SIC 31). This sort of technological change is absolutely more efficient than the other, and is clearly preferred if energy conservation, or abatement of growth in energy consumption, is a societal goal.

The empirical evidence of different kinds of technical change suggests that the use of a formal production function with this data would be inappropriate.

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[1] The energy/value-added ratio for all New York state manufacturing, calculated from data in the 1963 and 1972 Census of Manufactures, declined by 11 percent between 1962 and 1971. Value added was deflated by the Wholesale Price Index for Industrial Commodities, 1970 = 1.000. This is consistent with national trends: The Conference Board (1974, p. 2) reports that "...(e)nergy use per unit of product declined at a 1.6% average annual rate from 1954 to 1967."

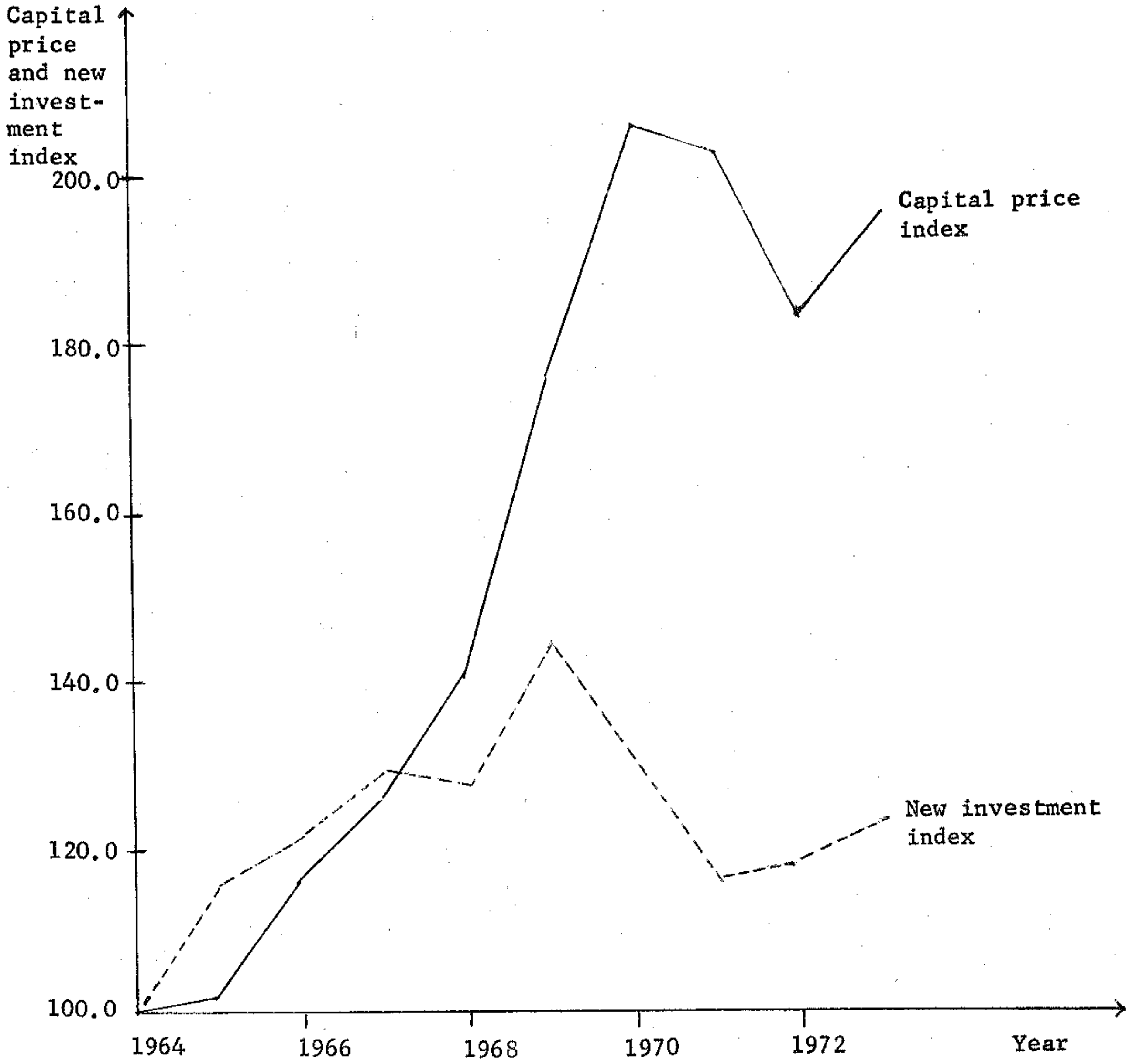

Figure 3. Capital Price Index and Index of Real New Investment in Buildings, Structures, and Equipment, New York State Manufacturing, 1964 to 1973 (1964 = 100.0)

In fact, it strongly suggests that each industry should be studied separately. Since available time series are too short to permit this (there are too few degrees of freedom), estimation in this study is done with the pooled sample and with some smaller subgroups; but, in future work, an effort should be made to study industries one by one.

III. A MODEL OF THE RESPONSE OF DEMAND FOR LABOR TO CHANGES IN ENERGY PRICES, NEW YORK STATE MANUFACTURING, 1964 TO 1973

The data summarized in section II suggest that energy replaced labor in New York state manufacturing between 1964 and 1973, and that electricity replaced other energy sources over the same period. In this section, a partial adjustment model is used to estimate short- and long-run elasticities of demand for production and nonproduction labor, with demand for labor being determined by the level of output and the prices of electricity, fossil fuels, labor, and capital. Separate intercept terms are used for each of the eighteen SIC 2-digit industries in the sample. Demands for production and nonproduction labor are estimated separately, the two being considered functionally distinct. Demand for nonproduction labor is also modeled as being derived from the level of production-worker employment and the productivity of the production workforce, a specification which is logically preferable to the first.

Estimations of the models yield results which suggest that over the decade under study, technological change was such that electrical energy and human labor were substitutable, while fossil fuels and human labor were complementary. This is interpreted as reflecting the replacement of old, fossil-fuel using machinery with new, labor-saving, electrically powered equipment. Also of interest are indications that labor/electricity substitutability varied according to the energy-intensiveness of manufacture. Substitutability was strongest in the least energy-intensive industries and insignificant in the moderately and strongly energy-intensive industries.

Preceding the description and estimation of the models is a discussion of some of the extant literature and theoretical issues which prompted the study. Note is also taken of the shortcomings of price elasticities as measurements of the determinants of factor demand and as indicators of probable responses to future price shifts. I then turn, in section IV, to a discussion of some policy issues raised by my own and other studies.

Theoretical Issues: Factor Aggregation in the Estimation of Price Elasticities of Demand, and Observations on the Meaning of Price Elasticities of Demand for Factors of Production

In recent years, three major studies of long-run factor substitutability in U.S. manufacturing have appeared. These are the study by Hudson and Jorgenson [1976], which covers nine sectors (of which manufacturing is one) in the U.S. economy, using annual data for 1964-1971; the Berndt and Wood study [1975], also employing annual data for all U.S. manufacturing, 1947-1971; and the work by Griffin and Gregory [1976], which deals with the manufacturing sectors of nine OECD countries, including the U.S., using four 'benchmark' years in the period 1955-1969. Several other empirical studies of substitution between energy and non-capital inputs have recently appeared, but were not readily available when the present study was completed [August 1977]; these works and their findings are tabulated in a later paper by Berndt and Wood [1977, pp. 15-16].

The three studies cited above use transcendental logarithmic ("translog") functions to estimate both long-run elasticities of substitution between, and price elasticities of demand for, various factors of production. All include both labor and energy among these factors.

All three studies find elasticities of demand for labor with respect to energy price to be positive but exceedingly small, with estimated values ranging from .03 to .11 [see Berndt and Wood, 1975, pp. 264-265; Griffin and Gregory, 1976, pp. 851-852]. The small size of these elasticities suggests to me that incorrect aggregation of functionally distinct factors of production might be obscuring more elastic responses where they exist; my own estimations, based on disaggregated factors, tend to support this argument.

Two forms of aggregation are occurring when 'energy' and 'labor' are used as factors of production. 'Energy' comprises several energy types, the uses of which are generally tied to specific technologies. 'Labor' comprises production and nonproduction labor, the former being directly involved in the productive process, the latter performing managerial, supervisory, clerical, and other services which facilitate production but are not part of it. To the extent that factors within aggregate categories respond differently to price shifts, aggregation may conceal real factor substitutions where they occur.

Other literature suggests that aggregation of both labor and energy in estimation of production functions may be incorrect. Berndt and Christensen [1974] have found that production and nonproduction labor cannot consistently be aggregated for purposes of estimating production functions in U.S. manufacturing, since production labor and capital have been substitutes in this sector, while nonproduction labor and capital have been complements. Capital, however, <u>can</u> be represented by an aggregate of equipment and structures capital. [Berndt and Christensen, 1973] It is quite possible that the two types of labor will respond differently to shifts in energy prices, although this can not be determined <u>a priori</u> even if it is accepted that energy and capital have been complementary in U.S. manufacturing over the past few decades, as Hudson-Jorgenson [1976] and Berndt-Wood [1975] found them to be.

The situation is further complicated if energy types cannot consistently be aggregated. There is evidence for this in Chern's study [1975], which demonstrates the probable existence of substitution between electricity and other (fossil) fuels in U.S. manufacturing. Previously discussed data for New York state certainly suggest the presence of this kind of substitution.

The net result of aggregation may thus be to obscure real substitutions where they occur, and to yield the result that labor demand is inelastic with respect to energy price. However, even where total employment is in fact unresponsive to an aggregate energy price, it may be that employment responds differently to changes in electricity and fossil fuel prices, or that production and nonproduction labor demand respond differently to shifts in energy prices. For purposes of policy formulation these differential responses should be identified. The production and nonproduction work forces are, in general, drawn from different skill, and often demographic and economic, groups, so that the conclusion that energy price shifts will not induce a net shift in labor demand may be misleading. Disaggregation of labor and energy factors permits identification of the aforementioned forms of factor substitution, facilitating estimation of and response to real demand shifts where they occur. This is why I have use disaggregated energy and labor factors in my study of New York state manufacturing; and my results indicate that much is gained by doing so.

Even when factor aggregation problems are partially resolved, other problems persist in interpreting price elasticities generated by estimation of the model. These arise from a series of 'real world' forces which ensure that the price elasticity does not measure what it purports to measure, and that the measured elasticity will not have any constant relationship to the 'true' one over time.

The price elasticity of demand for a factor is defined as the percentage change in demand for that factor resulting from a one-percent change in some factor price. In 'textbook' economics, where the existence of an equilibrium is assumed, the price elasticity measures factor demand shifts which occur <u>without</u> technical change: i.e., without any change in the machinery through which labor and energy work to create output. When price elasticities are estimated for a time series, however, technological changes will obviously affect estimation. Price elasticities then become (at best) measures of changing factor demand as embodied in changing technology, with the latter being determined by relative factor prices.

There are, however, at least three reasons why price elasticities based on time series are not even reliable estimators of the response of technological change to changing prices. These are, first, that such elasticities are sensitive to the frequency of observation; second, that expectations will probably play key roles in the selection of new technologies; and third, that a host of noneconomic forces either constrain or facilitate technical change, and that these forces themselves vary over time. The third point does not require amplification, but the second, and particularly the first, do.

Frequency of observation affects estimation because it affects the probability of detecting short-, medium-, or long-run responses to relative price shifts. In the short run, increasing an input's price increases the unit cost of output, decreasing demand for output and hence for all inputs (the capacity utilization affect). In the medium run, small shifts in relative factor use are made; and in the long run, technological changes which embody an industry's chosen response to new factor prices are completed [see Berndt, Wood, 1977, pp. 5-7]. When annual data are used, all three sorts of responses will be picked up, since all go on simultaneously and presumably at different rates in different industries.[1]

With three different sorts of responses occurring simultaneously, estimated price elasticities will be biased away from their 'true' long-run values. The own-price elasticity of demand will tend to be underestimated, given that the short-run elasticity is assumed to be smaller than the long-run one. Cross-price elasticities - for example, of labor with respect to energy price - will have a serious downward bias in the case of substitutable factors (which, theoretically, all factors are in the long run). In the short run, the capacity utilization effect ensures that the elasticity will be negative. The medium-run elasticity should be positive, but smaller than the long-run elasticity. The net measured elasticity is thus a sum of opposites, and likely to be small.

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[1] Note that even a single 2-digit SIC classification aggregates several quite different industries and manufacturing processes.

Estimated elasticites will also be affected by price expectations, in such a way that they are likely to be useless for forecasting whenever the future is unlikely to resemble the past (the usual state of affairs). Since choice of a new technology implies investment in new capital, and hence commitment to a relatively fixed factor ratio over the life of the new capital, such choices must be assumed to reflect capitalists' expectations of future factor price configurations. In a period when price trends are steady, actual and expected prices will be closely related, so that the former will be an acceptable proxy for the latter in estimations. If, however, expected future prices diverge sharply from observed prices during the sample period, observed shifts in factor demand will be misinterpreted. Thus, for instance, if electricity prices are expected to begin to climb steeply in the future, one might observe capitalists responding in the present with appropriate investment in electricity-saving equipment --even though past electricity prices stagnated or fell.

In summary, price elasticities estimated in the conventional manner derive from apparent and superficial relationships between factor prices and levels of factor demand. Given that many of the unmeasured variables must alter radically over the time periods used, one cannot assume that measured elasticities bear approximately constant relationships to true ones. At best one can hope that what is measured is something like a medium-run elasticity; but it is likely to be description of the past rather than of the future.

Models of Labor Demand in Manufacturing

A loglinear partial adjustment model similar to those employed for energy demand estimation by Mount, Chapman, and Tyrrell [1974] Houthakker *et. al.*, [1974] and Chern [1975] is used separately to estimate demand for production and nonproduction labor in New York state manufacturing over the period 1964 to 1973. Demand for nonproduction labor is also estimated with a simple loglinear model using only current variables. In all cases, a separate intercept term for each industry appears. Both models are applied to a pooled sample of eighteen SIC 2-digit manufacturing industries, and to two different groupings of the same industries.

The estimating equation is of the following form, resembling that used by Mount *et. al.* [1974, p. 325]:

$$(1)\quad \ln L_{it} = \lambda \ln L_{i,t-1} + b_1 \ln V_{1it} + \ldots + b_N V_{Nit} + a + d_1 D_1 + \ldots + d_{M-1} D_{M-1}$$

where

i denotes the i^{th} industry; $i = 1, \ldots 18$
t denotes the t^{th} year; $t = 1, \ldots 10$
L denotes the quantity of labor
V_n denotes the level of the n^{th} factor (here, output and price variables)
D_m is an industry intercept; $m = 1, \ldots 18$
λ, a, $b_1 \ldots b_N$, $d_1 \ldots d_{M-1}$ are unknown parameters

This formulation furnishes both short- and long-run elasticities of demand, the former being measured simply as b_n, the latter as $b_n/(1-\lambda)$. Assuming λ takes a value between zero and one, the two elasticities will always have the same sign, and the long-run elasticity will be greater than the short-run one.

This latter characteristic poses a problem when, as in the case of the response of labor demand to energy price, the short-run and long-run elasticities are hypothesized to have opposing signs (the capacity-utilization effect versus the impact of technological change). The estimated short-run elasticity clearly is not the same as the hypothesized capacity-utilization effect. Hence, in interpreting the results, long-run elasticities are stressed.

A concommitant problem is that annual observations are really neither short- nor long-run, but somewhere in between. In one year an industry can make minor adjustments to the energy-utilization characteristics of its capital stock, but on the average it cannot make major technological changes. What this model probably measures, then, are medium-term responses. The latter may well, however, be the most useful for policy formulation.

The other model used in this study is the simple loglinear demand model for nonproduction labor. In this model, the size and productivity of the production work force and the average annual wage of nonproduction workers determine demand for nonproduction labor:

$$(2) \quad \ln L2_{it} = b_1 \ln L1_{it} + b_2 \ln QL_{it} + b_3 \ln WG_{it} + (a + d_1 D_1 + \dots + d_{M-1} D_{M-1})$$

where

i denotes the i^{th} industry; $i = 1, \ldots 18$
t denotes the t^{th} year; $t = 1, \ldots 10$
L2 denotes demand for nonproduction labor
L1 denotes demand for production labor
QL is a measure of labor productivity
WG is the average annual salary of a nonproduction worker
D_m is an industry intercept for the m^{th} industry; $m = 1, \ldots 18$
a, $b_1 \ldots b_3$, $d_1 \ldots d_{M-1}$ are unknown parameters

Use of this model assumes a recursive relationship between nonproduction and production labor, with demand for nonproduction workers depending on characteristics of demand for production labor.

Data

Data used in estimating the foregoing models consist of production and nonproduction labor prices and quantities, energy prices, the dollar value of output, and the price of capital. With the exception of capital price, all data are specific to New York and vary by industry and over time. Capital prices are constructed with national, not state, data, so that they vary by national SIC 2-digit industry rather than by state industry.

Numbers of production and nonproduction employees, and production-worker manhours, are obtained from the Census of Manufactures in census years and from the Annual Survey of Manufactures in the intervening years. Labor price variables are obtained from the same sources. Labor quantity and price variables are not adjusted to reflect the changing quality of the labor force, as they are in Berndt-Wood [1975] and Berndt-Christensen [1974].

Energy price variables are created by combining data from the Annual Survey of Manufactures and the Census of Manufactures with energy price and quantity series compiled by Mount and Tyrrell [1977] for the New York state industrial sector. This is a complex procedure, and is explained in detail in my thesis, where Mount's and Tyrrell's own sources are also listed [Hornig, 1977, pp. 124-127].

Demand for output is measured by the 'value of product shipments', taken directly from the Annual Survey of Manufactures and the Census of Manufactures.

Labor productivity in each industry is measured as the value of output per manhour of production labor, both statistics being drawn from the Annual Survey and the Census.

Labor prices, energy prices, and the value of product shipments are all deflated by the Wholesale Price Index for Industrial Commodities, 1970 = 1.000.

Capital prices are the only data used which are not specific to the state, but rather pertain to the nation. Capital prices are constructed from the identity

$$(3) \quad c = g(r + d)(1 - s - uB)(1 - u)^{-1},$$

where

c denotes the implicit rental price of capital
g denotes the current replacement value of a dollar's worth of capital stock
r denotes the market rate of return to investment
d denotes the rate of depreciation of a unit of capital stock
s denotes the rate of the investment tax credit
u denotes the corporate tax rate
B denotes the present value of depreciation, using sum-of-the-years' digits depreciation

This is the form used by Coen [1968] in his study of investment demand, and in the Wharton Annual and Industry Forecasting Model [Preston, 1972]. Sources for each of the component variables in the identity are listed in my thesis [Hornig, 1977, Appendix B].

Method of Estimation

All models are estimated with least squares, using constant intercept terms to capture what are assumed to be fixed differences between industries. This method is known to be preferable to ordinary least squares, but inferior to generalized least squares if the fixed-effects assumption is incorrect [see Hornig, 1977, pp. 80-82].

Results of Estimation

Application of the models previously summarized to data for eighteen New York state manufacturing industries, aggregated in 1964-1973 and 1968-73 and disaggregated by groups in 1964-73, yields the long- and short-run elasticities of demand presented in tables 7 and 8 respectively. Because the derived-demand model for nonproduction labor does not yield long-run elasticities, results of estimations made with this model appear only in table 8. The equations in their complete form, including estimated industry intercepts, appear in my thesis [Hornig, 1977, Appendix B].

Estimations made with grouped industries tend to yield results which are both more informative and more conformable to prior expectations than do estimations made with all industries aggregated. However, the latter are more easily compared with other authors' estimations, so they are included for that purpose and for completeness.

Determinants of labor demand; the aggregated sample

Demand for production and nonproduction labor are first estimated with the aggregated sample of eighteen industries, for the period 1964 to 1973. In conjunction with a failed attempt to use Almon lags, production labor demand for 1968-73 is also estimated; the results of this illustrate the instability of the elasticities when the sample period is altered. Estimated long-run elasticities appear in columns (1) and (2) of table 7 (the short-run elasticities on which they are based appear in columns (1) and (2) of table 8, parts I and II); estimated coefficients of the derived-demand model for nonproduction labor appear in columns (1) and (2) of table 8, part III.

Long-run elasticities of demand for both sorts of labor with respect to energy prices show electricity to have been a significant substitute for labor over the sample period, and fossil fuels to have been significant complements. The estimated long-run elasticity of demand for production labor with respect to electricity price, 1964-1973, is .24; for nonproduction labor, .78. With respect to fossil fuel prices, the comparable statistics are -.37 and -.30. When the sample period is shortened, elasticities (for production labor) are appreciably larger: .32 and -.58. All these elasticities are derived from coefficients significant at the 1 percent level.

The behavior of the elasticities with respect to disaggregated energy prices tends to support my argument that low elasticities between labor demand and energy price can arise simply from aggregation. Were aggregate measures of labor and energy used here, the estimated elasticity would probably be close to zero, as it is in the other studies previously cited. The elasticities also accord with observations, made from state-level data, that electricity appears to have replaced other energy sources in manufacturing over the decade, and that energy replaced labor in most industries.

Other estimated elasticities are not all so well-behaved. While elasticities with respect to output take on the expected positive and large values, wage and capital price elasticities are not as expected. The estimated elasticity of demand for production labor with respect to its own wage is positive, though not significantly so, for 1964-73 (the comparable statistic for nonproduction labor is significantly negative: -.55) and the elasticity of demand for production labor with respect to capital price is significantly negative (-.19), rather than positive, as one would expect if capital were a substitute for labor and had the assumed negative own-price elasticity of demand.

The problem with the wage coefficient appears to arise directly from the large number of industries aggregated in the sample, and from failure to model the effects of factor price levels outside the state. Over the sample period, an important structural shift occurred in New York state manufacturing: traditionally low-wage, low-skill industries left the state, presumably for lower-cost areas elsewhere, while some higher-wage industries remained and grew, drawing upon New York's supply of skilled labor (see data in tables 1 and 2). Thus an apparent positive relationship between wages and employment persists for manufacturing as a whole. Disaggregation into similar groups of industries tends to yield the expected negative coefficients on wage variables for production labor.

The behavior of the capital price coefficient is also puzzling: it is significantly negative for production labor, and positive (but insignificant) for nonproduction labor. Grouping of industries does not change the signs on these coefficients and results in their being significantly positive for nonproduction labor.

The fact that the coefficients take on opposing signs when labor is disaggregated accords with Berndt's and Christensen's [1974] previously cited finding that labor cannot consistently be aggregated in estimation of production functions in U.S. manufacturing; however, the signs are the opposite of what is expected if it is assumed that the own-price elasticity of demand for capital is negative. In fact, as is illustrated in figure 3, capital investment and the calculated implicit price of capital in New York do have a strong positive correlation. As I noted in section II, were my capital price series to resemble Berndt's and Wood's, the coefficients might have the expected signs. Perhaps the capital price variable is incorrectly constructed; or the use of a national, rather than state, price series may cause problems.

Disaggregation of labor and energy variables does seem to yield more information about the response of labor demand to other factors, as I hypothesized it would. Aside from confirming my argument, however, estimation of demand for the two types of labor using the same model seems illogical. Demand for nonproduction labor should not be determined directly by prices of factors of production. Hence I employ the derived-demand model to estimate demand for nonproduction labor, with the results shown in table 8, part III.

The results here are as expected, with nonproduction labor demand being highly elastic with respect to production-worker manhours (.93) and moderately elastic with respect to the productivity variable (.52). In the eighteen-industry sample nonproduction labor shows a significant but very inelastic response to its own wage (-.08), but this coefficient changes considerably with grouping. The results of estimations made with grouped industries follow.

Determinants of labor demand: different groupings of industries

Two different groupings of the eighteen industries are made in order to determine whether more information about the response of labor demand to energy prices can be obtained. The attempt is largely successful, aside from some problems with insignificant coefficients.

In the first experiment with grouping, industries are evenly grouped according to the level of energy consumption per production-worker manhour in 1971 (see table 6). Group 3.1 contains the six industries with the highest ratios (SICs 20, 26, 28, 32, 33, 38); group 3.2, those in the middle (SICs 22, 30, 34, 35, 36, 37); and group 3.3, those with the lowest ratios (SICs 23, 24, 25, 27, 31, 39). This grouping is thus somewhat arbitrary.

In the second case, industries are grouped according to the nature of the technological change they underwent over the decade. This yields two unequal groups: group 4.1 contains the thirteen industries in which technological change appears to have been labor-augmenting but increasingly energy-intensive over time (SICs 20, 23, 24, 25, 26, 27, 30, 31, 34, 36, 37, 38, 39), and group 4.2 contains the five industries where technological change appears to have been both labor- and energy-augmenting (SICs 22, 28, 32, 33, 35).

After grouping, the same models are estimated as are applied to the aggregated sample. The resulting coefficients and calculated long-run elasticities appear in tables 8 and 7 respectively, in columns (3.1), (3.2), (3.3), (4.1), and (4.2).

The most interesting result of grouping is that definite patterns of response to energy prices emerge; furthermore, these patterns have some significance for policy formulation, a point which is discussed below. Disaggregation by energy/labor ratio indicates that sensitivity of labor demand to energy prices declines with an increase in this ratio: in the most energy-intensive industries, demand for labor is inelastic with respect to energy prices, while in the least energy-intensive industries it is quite elastic. Estimated long-run elasticities of demand for production labor with respect to energy prices range from -.28 (electricity) and -.02 (fossil fuels), both insignificant, in group 3.1, to .08 and -.33 in group 3.2, and to .82 and -.61 in group 3.3 (see table 7). Elasticities of demand for nonproduction labor follow a similar pattern, the elasticity with respect to electricity price becoming large, positive, and significant in group 3.3, and the elasticity with respect to fossil fuel price remaining negative throughout. The apparent substitutability between electricity and labor detected in the aggregate sample thus originates almost entirely in this one group of energy-extensive industries. Labor/fossil-fuel complementarity appears in both groups 3.2 and 3.3, but is much stronger in group 3.3.

The apparent insensitivity to energy prices in group 3.1 can perhaps be explained by reference to the data. Three of the six industries in this group are industries in which technological change has been both labor- and energy-augmenting, and in which capital stock has grown while energy and labor inputs have remained relatively static. One would not expect to observe much sensitivity of labor demand to energy prices in these three industries. In the other three industries, it may be that the replacement of labor with energy has gone as far as it can go, barring quantum leaps in technology.

The behavior of elasticities in group 3.3 is consistent with the observation, made in part II, that energy/labor growth has been proportionately greatest in the least energy-intensive industries. These industries are presumably the ones with the greatest scope for change. The policy implications of this finding are quite striking.

The findings for the second grouping tend to follow the results of the first, given the overlap between group 3.1 and group 4.2. Where technological change has replaced both labor and energy with capital, the response of labor to energy price is insignificant. Elsewhere, electricity appears to substitute for production labor, and fossil fuels to complement it.

Grouping also produces significant changes in wage and capital price coefficients. Both production and nonproduction labor demand are most elastic with respect to their own wages in high energy/labor ratio industries, and least elastic in low enery/labor ratio ones. All but one of the estimated elasticities takes on the expected negative sign. Only two of the estimated coefficients in the production-labor demand model are significant (see table 8), but all of the nonproduction-labor demand ones are. Overall, results suggest that either criterion for grouping helps to overcome problems created by structural shifts when all industries are included in the sample.

The other notable outcome of grouping is the preservation of both the significance and the perverse signs of the capital-price coefficients. Grouping does not produce trends in elasticity of response for production-labor demand, and all estimated elasticities, even where significant, are small.

Application of the derived-demand model for nonproduction labor to the two groupings of the data yields the coefficients shown in table 8, part III, columns (3.1) - (4.2). Some rather puzzling differences arise between these and the coefficients generated with the aggregated sample. The relationship between labor demand and the size of the production work force remains elastic, except in group 4.2. The coefficient of the productivity variable is highest in energy-intensive industries, but drops inexplicably in group 4.2. The coefficient of the wage variable shows the same pattern observed in estimation of the other model: a highly elastic response in group 3.1, and decreasing elasticity in less energy-intensive groups. All coefficients are highly significant.

Discussion: Differential Responsiveness to Energy Prices and the Demographic Composition of the Manufacturing Labor Force

Estimated elasticities made with grouped data indicate that demand for labor is energy-price-elastic only in less energy-intensive industries, while it is decidedly inelastic in energy-intensive industries. Practically speaking, this result is thought to reflect the relatively rapid replacement of both labor and older fossil-fuel powered machinery in less energy-intensive industries with new, labor-replacing, electrically powered equipment.

If future responses in labor demand were to resemble past ones, this finding would have interesting implications for the distribution of labor-demand shifts across different demographic segments of the manufacturing work force. As is shown in section II, energy-intensive industries employ disproportionate numbers of white males, whereas energy-extensive industries employ proportionately greater numbers of females and minority males. In five of the six least energy-intensive industries (SICs 23, 25, 27, 31, 39), females and minority males account for more than 40.7 percent of the work force, the latter being those groups' share in the whole manufacturing work force (in 1970); shares range from a low of 41.9 percent in SIC 27 to a high of 71.6 percent in SIC 23 (see table 3).

The obvious implication of this is that the demographic groups which in general bear the highest rates of unemployment are also most susceptible to job loss through increased electricity intensiveness of manufacture. A 10 percent decrease in electricitiy prices would, in the long run, displace approximately 8 percent of the workers in the six industries in group 3.3. Taken at face value, estimated elasticities also suggest that increasing electricity prices to industry would, in the long run, have a salutary effect on the employment of women and minorities. But this conclusion is suspect, particularly because the model does not account for low factor prices outside the state. Were state electricity prices further to increase, industries might move elsewhere rather than adapt to new relative prices in-state by resorting to more labor-intensive methods of production. My results can more properly be interpreted as indicating the inadvisability of lowering industrial electricity prices than as demonstrating the social usefulness of raising them.

IV. CONCLUSION: ELECTRICITY PRICING AND EMPLOYMENT POLICY IN NEW YORK STATE MANUFACTURING

Estimation of a positive relationship between electricity prices and labor demand in New York state manufacturing raises the question of whether the state should deliberately manipulate electricity prices in order to affect manufacturing employment, or whether it should resort to other means to do so.

To answer this question one must know, first, whether significant shifts in labor demand can be effected through price shifts, and second, whether the same goals can more effectively be met through other policies. I will argue that the latter is the case, using as evidence a recent survey of management perceptions of New York's business climate. I will also show that while my study does not adequately answer the first question posed, both my results and my omissions point to the inadvisability of using electricity prices alone as policy tools; though they could be used as one of a package of tools designed to promote job growth in manufacturing.

The extraordinary loss of manufacturing jobs suffered by New York in recent years can only partially be explained by energy price trends. My estimations do not indicate that the in-state response of labor demand to energy price shifts differs appreciably from national averages: had I estimated an elasticity using aggregated labor and energy variables, it would probably have been close to zero, as were those estimated by other authors. The unusual loss of jobs seems to originate elsewhere.

A valuable source of information regarding the outflow of jobs from New York is Foltman's recent survey of management perceptions [1977]. The survey results suggest that variables excluded from the model do more to explain extraordinary losses than do energy prices. At the same time they provide empirical evidence that energy, particularly electricity, supply and cost considerations, while of concern to the business community, are not the leading determinants of decisions to locate in, and presumably to leave, New York. Drawing on Foltman's results and my own, I therefore conclude that the state might either maintain electricity prices at their present levels, or, while simultaneously offering appropriate tax incentives and training more skilled labor, might raise electricity prices; it whould not attempt to lure new industry by lowering prices, nor should it use higher prices alone as a policy tool.

Estimated Elasticities as Evidence of Impact of Changing Electricity Prices

My estimations of the elasticity of demand for labor with respect to electricity prices imply that electricity and labor have been moderately substitutable in recent years. The brunt of the substitution that has occurred, when electricity prices have decreased, has been borne by female and minority male workers.

Were electricity prices to fall further, it is quite probable that these same groups would bear the burden of being replaced by automated machinery, as I indicated in the preceding section. It is unlikely, however, that the state would ever consider lowering electricity prices as a policy move; the only rationale for doing so would be to induce in-migration of new industry, and with an industrial electricity price well above the national mean, prices would have to fall considerably to have this effect.

On the other hand, deliberately increasing electricity prices in the absence of other policy measures might induce outmigration of industry, a possibility which my simple model does not examine and which should not be discounted. My elasticities are estimated from a period when electricity prices did not change rapidly or drastically (see figure 2), and should be employed with great caution in forecasting the impact of major price changes.

There is evidence, in Foltman's study, that moderate increases in electricity prices might be tolerated if other aspects of the business climate were improved. If this policy were pursued, then, it might have favorable distributive effects in several senses. First, electricity prices could be increased to industry but decreased to residential and small commercial users, perhaps as part of a levelling-off of rate structures. New rates could be designed to ease the burden currently borne by small households. Second, moderate increases to industry might in fact lead, over time, to increased hiring of currently underemployed demographic groups as the incentive towards automation was removed. In so doing it would probably not increase demand for skilled white males, who are generally in short supply, and therefore would not exert inflationary pressures on the state labor market.

Evidence that some electricity price manipulation might be tolerated by the manufacturing sector, particularly if accompanied by other policies more favorable to business interests, is found in Foltman's study, summarized below.

The Foltman Study of Management Perceptions of New York's Business Climate

In late 1975 and early 1976, questionnaires were sent to a sample of labor and business managers in New York state, asking the respondents for their evaluation of the state business climate. The results of the survey appear as part of a broader study of the New York economy [see Foltman, 1977].

The responses of the business managers provide interesting evidence that energy cost and supply factors, while matters of concern and some discontent, are not of great importance in affecting decisions to locate in the state. This is particularly true when only electricity cost and supply factors, over which the state has some control, are taken into account.

The survey results thus imply that energy factors have not been instrumental in causing extraordinary job losses in state manufacturing. At the same time, the survey shows great discontent among businessmen over the levels of state income and corporate taxes, and comparative satisfaction with the availability of skilled labor.

When asked to rank business climate factors on a 'poor' to 'excellent' basis, business managers most frequently gave low ratings to the levels of the state income tax, the state sales tax, the county or city sales tax, and the state corporate income tax. State unemployment insurance laws and the cost of electricity were jointly ranked fifth in the list of most unfavorable factors [see Foltman, 1977, pp. 139-142].

The businessmen were next asked to list the five factors they felt to be most important in determining where to locate or expand a business. Interestingly, energy-related factors did not appear anywhere among the eighteen factors most frequently cited. 'Supply of skilled labor' and other labor supply variables led the list, followed by tax variables and the attitudes of labor and state officials [Foltman, 1977, p. 148].

When asked to identify the five factors which they considered to be most disadvantageous to operating in New York, businessmen did mention the cost of electricity, but it ranked fifteenth among the sixteen most frequently mentioned factors [p. 151]. Supply of electricity was never considered a problem; it ranked last when factors were rated on a 'poor' to 'excellent' basis, as mentioned above.

The conclusion I draw from this is that New York has plenty of scope for creating direct incentives for industry to expand employment, without necessarily resorting to such indirect and risky methods as manipulating electricity prices. The most positive policy would probably be to increase the supply of skilled labor by training women and minorities; this would have beneficial distributive effects as well. Some tax programs could also be changed, although the impact on state finances and spending would of course have to be examined in detail. A possible course of action is outlined below.

Electricity Pricing and Employment Policies for New York State Manufacturing

Studies of aggregate factor substitutability, my own work in this paper, and the results of Foltman's survey lead me to conclude that there are two different approaches New York could take to the problem of using electricity pricing to improve the long-run manufacturing employment situation in the state. The first requires active participation on the part of the state, and entails some risk; the second is essentially passive, and is unlikely to have much impact on jobs.

The first strategy is designed to help accelerate the transition towards energy-efficient manufacturing, while at the same time altering the composition of the manufacturing sector by attracting high-skill industries and easing the demise of low-skill ones. It would require the state to do three things: increase industrial electricity prices, offer tax incentives (to be phased out over time) to offset increased energy prices and perhaps to attract new industries, and implement extensive job training and placement programs designed to increase the skills of the female and minority labor force and to facilitate transfer of workers from deteriorating industries to new ones.

The combination of higher electricity prices with lower taxes would do two things. First. since energy-intensive industries appear to be relatively insensitive to energy prices, it would increase revenues from electricity sales without inducing job losses. An increase in the industrial price of energy could be part of a general leveling-off of electric rates, financing rate concessions to smaller commercial and residential customers. Second, higher rates would encourage substitution towards energy-efficient and labor-using technologies. If higher rates also tended to induce outmigration of some firms the state could offer compensating tax incentives, to be phased out over time. to help the industries make technological adjustments instead.

A program of labor training and placement would be an important corollary of the tax/electricity-rate-increase package proposed above, as it would offer a strong inducement to industry to settle in the state. The Foltman study shows that the supply of skilled labor is the single most important factor affecting the decision to locate a business. If New York could increase its supply of skilled labor while maintaining high electricity prices, it could perhaps accelerate the inevitable transition towards more labor-intensive manufacturing while attracting firms seeking highly skilled and relatively highly paid labor.

If the state shied away from deliberately raising already high electricity prices, it could opt for a passive approach instead. Rather than manipulate electricity prices in either direction, it could promote Federal legislation to raise and equalize energy prices across the nation. This would remove whatever incentive firms now face to move to other regions solely in search of cheaper energy, would perhaps encourage greater efforts at researching and developing energy-efficient technology, and would encourage firms in New York to update their capital stock and perhaps make plans for expansion.

It appears, though, that the business community's concerns are not with energy prices as much as with other factors. The price of electricity is low on the list of locational disadvantages obtaining in New York, and is probably not a suitable, or powerful, tool in the package of employment policy options. New York seems to have more pressing problems to solve before it can hope to reverse the outflow of industries and jobs.

TABLE 1. QUANTITY INDICES OF TOTAL EMPLOYMENT IN NEW YORK STATE MANUFACTURING INDUSTRIES, SIC 2-DIGIT LEVEL, 1964 TO 1973

Industry	Employment thous., 1964	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Nondurable goods											
SIC 20 - Food and kindred products	127.4	100.0	94.7	89.6	88.4	84.8	84.6	82.8	76.7	72.4	71.2
SIC 22 - Textile mill products	53.5	100.0	105.2	106.2	103.9	104.8	103.2	90.6	86.9	103.9	104.5
SIC 23 - Apparel, other fabricated textile prod.	316.3	100.0	101.9	94.7	91.8	89.1	90.9	85.1	79.3	78.2	77.7
SIC 26 - Paper and allied products	60.3	100.0	101.6	101.5	98.7	96.7	100.7	101.3	92.4	84.1	82.2
SIC 27 - Printing, publishing, allied indus.	177.0	100.0	103.3	107.1	106.4	110.0	113.0	104.2	98.2	93.2	94.0
SIC 28 - Chemicals and allied products	63.5	100.0	100.5	101.1	99.8	97.3	97.8	97.0	90.7	83.6	86.8
SIC 30 - Rubber and misc. plastics products	28.1	100.0	113.2	119.6	118.9	123.8	128.8	121.0	110.0	132.0	139.1
SIC 31 - Leather and leather products	51.3	100.0	102.1	96.9	94.0	91.2	92.4	76.4	71.0	69.8	64.5
Durable goods											
SIC 24 - Lumber and wood prod., ex. furniture	14.6	100.0	114.4	112.3	102.7	111.0	110.3	101.4	91.1	120.5	126.0
SIC 25 - Furniture and fixtures	31.7	100.0	104.7	104.4	105.4	109.1	114.2	100.3	94.6	89.3	92.1
SIC 32 - Stone, clay, and glass products	38.1	100.0	103.1	106.6	106.0	102.4	105.5	94.0	96.1	94.5	98.7
SIC 33 - Primary metal industries	69.3	100.0	106.5	108.2	105.2	101.2	104.5	98.6	86.0	81.4	91.0
SIC 34 - Fabricated metal products	87.2	100.0	101.8	101.9	109.9	108.9	110.3	101.4	92.5	106.5	113.8
SIC 35 - Machinery, except electrical	135.2	100.0	107.6	112.2	110.9	108.2	110.5	110.0	100.7	99.9	104.4
SIC 36 - Electrical machinery	181.5	100.0	108.3	113.2	118.9	117.1	115.7	109.2	92.4	88.7	92.6
SIC 37 - Transportation equipment	94.4	100.0	100.6	117.2	110.3	117.5	112.2	95.6	93.8	73.9	80.3
SIC 38 - Instruments	75.2	100.0	102.8	111.7	124.7	123.1	125.8	125.5	121.7	128.2	132.6
SIC 39 - Miscellaneous manufacturing industries	89.5	100.0	105.5	104.1	100.2	102.7	103.9	93.8	87.9	88.4	88.2

SOURCES: Calculated from data in the Census of Manufactures and Annual Survey of Manufactures.

TABLE 2. REAL WAGES PER PRODUCTION-WORKER MANHOUR, NEW YORK STATE MANUFACTURING INDUSTRIES, SIC 2-DIGIT LEVEL, 1964 TO 1973

Industry	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Nondurable goods										
SIC 20 - Food and kindred products	$2.99	$2.99	$3.07	$3.14	$3.27	$3.36	$3.35	$3.47	$3.73	$3.68
SIC 22 - Textile mill products	2.51	2.46	2.41	2.65	2.72	2.63	2.56	2.68	2.92	2.87
SIC 23 - Apparel and other fabricated textile prod.	2.35	2.35	2.35	2.58	2.67	2.73	2.65	2.77	2.67	2.59
SIC 26 - Paper and allied products	2.88	2.96	2.98	3.07	3.11	3.10	3.29	3.49	3.55	3.53
SIC 27 - Printing, publishing, allied industries	3.86	3.80	3.92	4.02	4.23	4.30	4.23	4.39	4.94	4.87
SIC 28 - Chemicals and allied products	3.22	3.23	3.31	3.33	3.38	3.48	3.51	3.72	4.03	4.06
SIC 30 - Rubber and misc. plastics products	2.48	2.49	2.54	2.73	2.80	2.73	2.93	3.14	3.06	3.04
SIC 31 - Leather and leather products	2.09	2.18	2.21	2.29	2.34	2.25	2.39	2.43	2.56	2.45
Durable goods										
SIC 24 - Lumber and wood products, ex. furniture	2.55	2.45	2.47	2.52	2.66	2.68	2.60	2.68	2.98	2.83
SIC 25 - Furniture and fixtures	2.80	2.76	2.83	2.92	2.90	2.88	3.20	3.08	3.21	3.07
SIC 32 - Stone, clay, and glass products	3.31	3.31	3.42	3.51	3.64	3.62	3.63	3.94	4.07	4.04
SIC 33 - Primary metal industries	3.71	3.77	3.80	3.87	4.01	4.11	4.01	4.22	4.55	4.62
SIC 34 - Fabricated metal products	2.95	2.99	3.00	3.23	3.44	3.44	3.63	3.82	3.87	3.79
SIC 35 - Machinery, except electrical	3.50	3.54	3.53	3.64	3.68	3.72	3.95	4.17	4.25	4.16
SIC 36 - Electrical machinery	3.20	3.20	3.07	3.31	3.40	3.44	3.59	3.62	3.74	3.60
SIC 37 - Transportation equipment	3.91	3.94	4.02	4.12	4.29	4.37	4.61	4.68	4.96	4.73
SIC 38 - Instruments	3.64	3.68	3.72	3.90	3.96	4.08	4.19	4.37	4.48	4.44
SIC 39 - Miscellaneous manufacturing industries	2.34	2.32	2.26	2.52	2.67	2.70	2.65	2.79	2.95	2.87

SOURCES: Calculated from data in the Census of Manufactures and the Annual Survey of Manufactures. Nominal wages are deflated by the Wholesale Price Index for Industrial Commodities in order to reflect the costs to employers in manufacturing of purchasing a unit of labor input.

TABLE 3. PERCENT DISTRIBUTION, BY RACE AND SEX, OF EMPLOYEES IN NEW YORK STATE MANUFACTURING, 1970

Manufacturing industry	Employment in industry as percent of total	Whites*			Negroes			Puerto Rican birth or parentage		
		Total	Male	Female	Total	Male	Female	Total	Male	Female
Total, all manufacturing, NYS	100.0%	86.6%	59.3%	27.3%	8.6%	5.4%	3.2%	4.8%	3.0%	1.8%
Nondurable goods	45.6	84.5	49.2	35.3	9.3	4.9	4.3	6.3	3.4	2.9
SIC 20 - Food and kindred products	5.6	88.1	66.4	21.7	8.0	6.0	2.0	4.0	3.2	0.7
SIC 21 - Tobacco manufactures	0.1	88.7	51.6	37.1	8.4	4.8	3.5	3.0	2.4	0.6
SIC 22 - Textile mill products	3.1	83.6	46.0	37.6	8.8	5.1	3.8	7.6	4.6	2.9
SIC 23 - Apparel and other textile prod.	11.6	78.9	28.4	50.5	10.5	3.5	7.0	10.6	3.6	7.0
SIC 26 - Paper and allied products	3.1	84.8	63.3	21.5	8.6	5.7	2.9	6.6	5.4	1.2
SIC 27 - Printing, publishing, allied ind.	9.8	90.0	58.1	31.9	6.8	4.1	2.7	3.2	2.4	0.8
SIC 28 - Chemicals and allied products	4.6	90.4	61.4	29.0	7.1	4.6	2.4	2.5	1.6	0.9
SIC 29 - Petroleum and coal products	0.6	92.7	65.9	26.8	5.9	3.6	2.3	1.4	0.7	0.7
SIC 30 - Rubber and misc. plastics prod.	1.5	81.6	53.2	28.4	11.0	7.8	3.2	7.4	5.6	1.8
SIC 31 - Leather and leather products	1.8	77.8	41.2	36.6	8.9	3.8	5.1	13.4	7.1	6.3
----- Manufacturing, nondurable goods, allocated	3.8	77.8	39.9	37.9	17.3	9.0	8.3	4.9	2.7	2.3
Durable goods	53.4	88.8	68.3	20.5	7.8	5.7	2.1	3.4	2.6	0.8
SIC 24 - Lumber and wood prod., ex. furn.	0.7	87.9	73.8	14.1	7.3	6.4	0.9	4.8	4.2	0.6
SIC 25 - Furniture and fixtures	1.6	82.8	64.9	17.9	8.1	6.7	1.5	9.0	8.2	0.8
SIC 32 - Stone, clay, and glass products	2.3	91.9	72.2	19.7	6.1	4.9	1.2	2.1	1.7	0.4
SIC 33 - Primary metal industries	3.9	86.0	76.5	9.5	11.5	10.6	0.9	2.5	2.3	0.2
SIC 34 - Fabricated metal products	4.3	85.7	69.1	16.6	8.9	7.3	1.6	5.3	4.7	0.6
SIC 35 - Machinery except electrical	9.9	94.2	76.8	17.4	4.4	3.3	1.1	1.4	1.2	0.2
SIC 36 - Electrical machinery	11.2	90.8	62.2	28.6	6.1	3.4	2.7	3.0	2.0	1.0
SIC 37 - Transportation equipment	6.3	90.0	78.1	11.9	8.4	7.5	1.0	1.5	1.4	0.1
SIC 38 - Instruments and related prod.	5.5	93.3	67.4	25.9	5.0	3.2	1.8	1.7	1.2	0.5
SIC 39 - Miscellaneous manufacturing induc.	4.1	76.1	47.7	28.4	11.8	6.0	5.8	12.1	7.8	4.3
SIC 19 - Ordnance	0.5	95.5	76.4	19.1	3.5	2.8	0.7	1.0	0.9	0.1
----- Manufacturing, durable goods, allocated	3.1	77.9	56.9	21.0	18.8	13.6	5.1	3.3	2.6	0.7
Not specified manufacturing industries	1.0	69.1	44.6	24.5	15.2	9.4	6.8	14.7	9.8	4.8

SOURCES: Calculated from data in the Census of Population: 1970, Vol. 1, Characteristics of the Population, Part 34, New York-Section 2, Table 184.

*"Whites" is the residual obtained by subtracting Negroes and Puerto Ricans from the total, and thus must contain some small proportion of other races.

TABLE 4. REAL ENERGY PRICES IN NEW YORK STATE MANUFACTURING, 1964 TO 1973

Year	Aggregated fossil fuels (dollars per thousand kilowatt-hour equivalents)	Electricity (dollars per thousand kilowatt-hour equivalents)	Coal (cents per million BTU)	Fuel oil (cents per million BTU)	Natural gas (cents per million BTU)
1973	$2.016	$12.468	45.713¢	68.875¢	83.177¢
1972	2.002	12.508	48.049	55.887	84.541
1971	1.956	12.152	51.002	49.821	81.444
1970	1.664	11.202	46.500	40.200	74.557
1969	1.464	10.963	37.357	35.593	71.737
1968	1.444	11.447	36.464	37.857	74.074
1967	1.415	11.449	35.981	36.532	78.196
1966	1.423	11.475	33.631	35.978	81.014
1965	1.396	11.829	33.904	37.671	81.859
1964	1.407	12.097	34.806	38.160	82.048

SOURCES: Nominal prices for electricity, coal, oil, and natural gas were compiled by Mount and Tyrrell (1977) for use in their study of energy demand and were furnished by the authors. The average price for all fossil fuels, aggregated, is a weighted average calculated from the price and quantity data compiled by Mount and Tyrrell, using the kilowatt-hour equivalent conversion factors published by the Bureau of the Census. These appear in the Census of Manufactures: 1972, Special Report Series, Fuels and Electric Energy Consumed (Supplement), p. VIII, as well as in other Census publications. See Hornig, 1977, Appendix A, for further discussion of the Mount-Tyrrell data and sources.

NOTE: Real prices are obtained by deflating nominal prices with the Wholesale Price Index for Industrial Commodities, 1970 = 1.000.

TABLE 5. PERCENT DISTRIBUTION OF ENERGY CONSUMPTION BY FUEL TYPE, BY INDUSTRY, NEW YORK STATE MANUFACTURING, 1962 AND 1971

Industry	Energy consumption, billion KwH equiv.		Purchased electricity		Coal		Coke		Fuel oils	
	1962	1971	1962	1971	1962	1971	1962	1971	1962	1971
Nondurable goods										
SIC 20 - Food and kindred products	15.4	14.7	9.2%	12.7%	26.7%	3.1%	--	--	32.2%	25.0%
SIC 22 - Textile mill products	3.7	3.3	11.8	16.6	19.4	--	--	--	34.9	40.0
SIC 23 - Apparel and other fabricated text.	2.0	3.5	37.0	37.0	2.0	0.4	--	--	12.7	6.7
SIC 26 - Paper and allied products	14.5	16.7	8.9	11.7	70.0	13.4	--	--	17.1	52.0
SIC 27 - Printing, publishing, allied indus.	1.7	3.8	35.6	35.9	3.2	--	--	--	23.8	9.9
SIC 28 - Chemicals and allied products	19.5	20.3	13.9	16.8	62.6	34.7	0.5	--	10.5	21.4
SIC 30 - Rubber and misc. plastics products	2.2	3.8	19.1	23.1	52.7	10.1	--	--	11.4	15.9
SIC 31 - Leather and leather products	1.2	1.0	10.8	19.7	42.6	6.4	--	--	18.6	18.3
Durable goods										
SIC 24 - Lumber and wood prod., ex. furn.	0.6*	0.8	19.4	23.5	(S)	0.7	--	--	24.6	8.4
SIC 25 - Furniture and fixtures	1.0	1.4	17.0	24.5	31.7	0.6	--	--	25.7	16.4
SIC 32 - Stone, clay, and glass prod.	14.5	14.3	7.7	9.4	48.5	15.6	(S)	(S)	16.3	28.4
SIC 33 - Primary metal industries	30.7	25.0	20.8	27.8	8.9	3.4	26.8	14.8	20.0	17.4
SIC 34 - Fabricated metal products	4.0	7.0	15.6	20.1	7.9	0.9	1.5	(S)	25.4	13.0
SIC 35 - Machinery, except electrical	7.2	7.9	12.9	20.8	42.7	6.1	1.0	(S)	17.7	14.9
SIC 36 - Electrical machinery	5.5	8.4	25.9	33.7	14.3	0.6	1.1	(S)	23.2	22.9
SIC 37 - Transportation equipment	5.6	6.6	18.5	25.2	32.0	14.5	4.9	(S)	24.7	26.7
SIC 38 - Instruments	5.5	9.0	7.5	8.5	70.8	57.2	(S)	--	7.7	16.7
SIC 39 - Misc. manufacturing industries	1.7**	3.0	26.2	24.2	14.6	6.7	(S)	--	32.9	20.4
Total	138.3	152.3	14.9	19.6	35.9	13.3	6.4	2.7	19.8	23.9

TABLE 5. Continued

Industry	Natural gas 1962	Natural gas 1971	Other fuels 1962	Other fuels 1971	Fuels not specified by kind 1962	Fuels not specified by kind 1971
Nondurable goods						
SIC 20 - Food and kindred products	26.9%	30.3%	5.0%	2.5%	This category was not used in the Census of Manufactures: 1963	26.1%
SIC 22 - Textile mill products	22.3	11.0	11.5	1.5		32.3
SIC 23 - Apparel and other fabr. text. prod.	13.8	6.9	34.6	9.2		39.6
SIC 26 - Paper and allied products	2.0	8.2	2.0	0.7		13.7
SIC 27 - Printing, publishing, allied indus.	22.3	17.6	15.1	3.1		32.5
SIC 28 - Chemicals and allied products	9.9	13.4	2.7	0.5		13.1
SIC 30 - Rubber and misc. plastics prod.	5.3	22.3	11.6	1.3		26.7
SIC 31 - Leather and leather products	9.1	12.1	18.8	3.5		39.7
Durable goods						
SIC 24 - Lumber and wood prod., ex. furn.	(S)	22.8	56.0	2.1		41.1
SIC 25 - Furniture and fixtures	13.8	17.3	11.7	1.2		42.9
SIC 32 - Stone, clay, and glass products	23.3	25.2	4.1	2.1		19.6
SIC 33 - Primary metal industries	20.7	31.7	2.8	2.1		2.7
SIC 34 - Fabricated metal products	39.2	23.8	10.4	5.0		37.2
SIC 35 - Machinery, except electrical	18.6	31.9	7.0	4.7		22.1
SIC 36 - Electrical machinery	24.6	30.0	10.9	5.3		8.0
SIC 37 - Transportation equipment	14.2	27.1	5.6	0.2		5.6
SIC 38 - Instruments	9.9	10.8	4.1	1.3		5.0
SIC 39 - Misc. manufacturing industries	(S)	16.2	26.4	1.7		31.7
Total	17.3	21.5	5.7	2.2		16.7

SOURCES: 1962 data from Census of Manufactures: 1963, Vol. 1, Summary and Subject Statistics. 1971 data from Census of Manufactures: 1972, Special Report Series, Fuels and Electric Energy Consumed, and Fuels and Electric Energy Consumed (Supplement).

(S) denotes withheld because estimate did not meet Bureau of the Census's publication standards.

*total does not include either natural gas (probably significant) or coal (probably very insignificant). Both were (S) in Census sources.

**Does not include natural gas, for which consumption in this industry in 1962 was not reported.

TABLE 6. ENERGY-LABOR, ENERGY-CAPITAL, AND CAPITAL-LABOR RATIOS IN NEW YORK STATE MANUFACTURING INDUSTRIES, 1962 AND 1971

Industry	Kilowatt-hour equivalent* per man-hour prod. labor		Kilowatt-hour equivalent* per dollar of capital stock**		Dollars of capital stock** per manhour production labor	
	1962	1971	1962	1971	1962	1971
Nondurable goods						
SIC 20 - Food and kindred products	84.3	111.5	21.9	12.3	3.8	9.1
SIC 22 - Textile mill products	38.1	42.1	24.8	10.9	1.5	3.9
SIC 23 - Apparel and other fabricated textile prod.	4.0	9.7	9.6	6.8	0.4	1.4
SIC 26 - Paper and allied products	135.5	182.0	36.6	21.8	3.7	8.3
SIC 27 - Printing, publishing, allied industries	12.9	22.6	4.5	3.2	2.9	7.1
SIC 28 - Chemicals and allied products	236.6	276.6	33.1	19.4	7.1	14.2
SIC 30 - Rubber and misc. plastic products	46.8	78.3	18.2	13.3	2.6	5.9
SIC 31 - Leather and leather products	14.4	17.7	27.2	14.3	0.5	1.2
Durable goods						
SIC 24 - Lumber and wood products, ex. furniture	25.9	35.4	15.0	8.8	1.7	4.0
SIC 25 - Furniture and fixtures	17.9	30.0	14.5	9.9	1.2	3.0
SIC 32 - Stone, clay, and glass products	228.4	255.9	45.7	25.6	5.0	10.0
SIC 33 - Primary metal industries	291.7	274.3	52.5	19.2	5.6	14.3
SIC 34 - Fabricated metal products	28.2	57.0	13.0	10.3	2.2	5.5
SIC 35 - Machinery, except electrical	39.6	47.1	9.5	5.6	4.2	8.4
SIC 36 - Electrical machinery	23.0	43.6	12.6	6.1	0.5	7.1
SIC 37 - Transportation equipment	38.0	51.8	11.8	6.2	3.2	8.4
SIC 38 - Instruments	48.5	89.5	12.6	7.2	3.8	12.4
SIC 39 - Misc. manufacturing industries	11.6	25.5	7.0	8.2	1.6	3.1

SOURCES: Census of Manufactures, 1963, 1972.

*Based on reported consumption of purchased electricity, fuel oils, natural gas, coal, coke, other fuels, and fuels not specified by kind..

**Capital stock estimates are based on the 1957 net book value of depreciable assets, obtained from the Census of Manufactures: 1958, augmented by new investment expenditures in succeeding years (Census of Manufactures, Annual Survey of Manufactures), less depreciation. Since depreciation was assumed to be 5 percent per year for all industries, the measure is a rough one.

TABLE 7. LONG-RUN ELASTICITIES OF DEMAND FOR PRODUCTION AND NONPRODUCTION LABOR, NEW YORK STATE MANUFACTURING, 1964 TO 1973

	(1)	(2)	(3.1)	(3.2)	(3.3)	(4.1)	(4.2)
I. Production-worker manhours	1964-1973, 18 industries	1968-1973, 18 industries	1964-1973, 6 industries with highest energy use per prod. manhour, 1971	1964-1973, 6 industries with intermediate energy use per prod. manhour, 1971	1964-1973, 6 industries with lowest energy use per prod. manhour, 1971	1964-1973, 13 industries with labor-augmenting technological change, 1962-1971	1964-1973, 5 industries with labor- and energy-augmenting technological change, 1962-1971
Explanatory variables:							
hourly wage, production labor	.13	.24	-.75	-.26	-.19	.09	-.41
manufacturing output	.78	.82	.57	.83	.82	.75	.94
price of electricity	.24	.32	-.28	.08	.82	.32	-.10
price of fossil fuels	-.37	-.58	-.02	-.33	-.61	-.42	-.19
price of capital	-.19	.03	-.09	-.08	-.05	-.17	-.14
II. Nonproduction worker employment							
Explanatory variables:							
average annual salary per non-production worker	-.55	not estimated	-1.73	-1.03	-.63	-.55	-.80
manufacturing output	1.00		.89	1.15	.74	1.05	.60
price of electricity	.78		.00	.31	.86	.65	.22
price of fossil fuels	-.30		-.25	-.32	-.25	-.16	-.32
price of capital	.07		.18	.15	.14	.00	.18

TABLE 8. SHORT-RUN ELASTICITIES OF DEMAND FOR PRODUCTION AND NONPRODUCTION LABOR, NEW YORK STATE MANUFACTURING, 1964 TO 1973

I. Production-worker manhours	(1) 1964-1973, 18 industries	(2) 1968-1973, 18 industries	(3.1) 1964-1973, 6 industries with highest energy use per prod. manhour, 1971	(3.2) 1964-1973, 6 industries with intermediate energy use per prod. manhour, 1971	(3.3) 1964-1973, 6 industries with lowest energy use per prod. manhour, 1971	(4.1) 1964-1973, 13 industries with labor-augmenting technological change, 1962-1971	(4.2) 1964-1973, 5 industries with labor- and energy-augmenting technological change, 1962-1971
Explanatory variables:							
production worker man-hours, lagged 1 year	.36**	.20**	.16	.12	.44**	.35**	.29**
hourly wage, production workers	.08	.20**	-.64**	-.23	-.11	.06	-.29*
manufacturing output	.50**	.66**	.48**	.73**	.46**	.49**	.67**
price of electricity	.15**	.25**	-.23*	.07	.46**	.21**	-.07
price of fossil fuels	-.24**	-.46**	-.02	-.29**	-.34**	-.27**	-.14
price of capital	-.12**	.03	-.08*	-.07	-.03	-.11**	-.10**
$\bar{R}^2$ for equation	.996	.996	.986	.995	.998	.996	.995

*denotes significant at the 5% level
**denotes significant at the 1% level

TABLE 8. Continued

II. Nonproduction worker employment	(1) 1964-1973, 18 industries	(2) 1968-1973, 18 industries	(3.1) 1964-1973, 6 industries with highest energy use per prod. manhour, 1971	(3.2) 1964-1973, 6 industries with intermediate energy use per prod. manhour, 1971	(3.3) 1964-1973, 6 industries with lowest energy use per prod. manhour, 1971	(4.1) 1964-1973, 13 industries with labor-augmenting technological change, 1962-1971	(4.2) 1964-1973, 5 industries with labor- and energy-augmenting technological change, 1962-1971
Explanatory variables:							
nonproduction-worker employment, lagged 1 year	.43**	not estimated	.48**	.40**	.07	.43**	.21*
average annual salary per nonproduction worker	-.32**		-.91**	-.62**	-.58**	-.31**	-.63**
manufacturing output	.57**		.47**	.69**	.69**	.60**	.47**
price of electricity	.45**		.00	.19	.80**	.37**	.18
price of fossil fuels	-.17**		-.13	-.19*	-.23	-.09	-.25**
price of capital	.04		.09**	.09	.13*	-.00	.14**
$\bar{R}^2$ for equation	.996		.994	.996	.998	.996	.995

*denotes significant at the 5% level
**denotes significant at the 1% level

TABLE 8. Continued

III. Nonproduction worker employment	(1) 1964-1973, 18 industries	(2) 1968-1973, 18 industries	(3.1) 1964-1973, 6 industries with highest energy use per prod. manhour, 1971	(3.2) 1964-1973, 6 industries with intermediate energy use per prod. manhour, 1971	(3.3) 1964-1973, 6 industries with lowest energy use per prod. manhour, 1971	(4.1) 1964-1973, 13 industries with labor-augmenting technological change, 1962-1971	(4.2) 1964-1973, 5 industries with labor- and energy-augmenting technological change, 1962-1971
Explanatory variables:							
production worker manhours	.93**	---	.87**	.89**	.85**	.99**	.44**
production worker employment	---	.93**	---	---	---	---	---
output per production worker manhour	.52**	.34**	.80**	.80**	.62**	.60**	.38*
average annual salary per nonproduction worker	-.08**	-.05*	-1.08**	-.76**	-.06**	-.07**	-.60**
$\bar{R}^2$ for equation	.993	.995	.988	.993	.996	.994	.993

*denotes significant at the 5% level
**denotes significant at the 1% level

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