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Price Behavior in Primary Manufacturing Industries, 1958-73

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Introduction

The U.S. economy is still feeling the consequences of the sharp acceleration of inflation in 1973-74. While the rate of increase in prices slowed considerably -- by half -- in 1975, the reduced pace is still high by historical standards and is having a significant effect on the speed with which policies to reduce unemployment are being adopted. There is concern that if policies designed to reduce unemployment promptly and significantly are adopted, they will push inflation rates quickly from their already high levels back into the double-digit range.

It is widely accepted that the acceleration of inflation to rates above 10 percent is attributable directly to the sharp rise in prices of primary commodities -- food, fuel and basic industrial materials. Studies by Nordhaus and Shoven [1976] and Popkin [1974] show that most of the acceleration in the Consumer Price Index and GNP deflator during 1973 and 1974 is attributable to the pass-through of the rise in prices of primary commodities. Such attribution can be accepted regardless of one's view about the basic causes of inflation. It could be that the overall price level is not independent of a change in relative prices,

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such as that which occurred when prices of primary commodities rose relative to those of other goods and services. Or it could be that monetary policy was geared, at least at first, to the validation of the sharp rise in primary commodity prices, rather than to risking a decline in output and employment that typically occurs when monetary tightening is significant.

Forecasts of a return to double-digit inflation are usually based on the assumption that commodity inflation will reemerge, rather than that unit labor costs and unit profits will accelerate. The term commodity inflation as used in describing the 1973-74 experience is loosely applied. In fact there were three components of inflation each of which is attributable to a different cause. The most widely remarked component is the rise in prices of farm foods, retail food purchases of which have a very large weight in the CPI. Based on the 1967 Input-Output Table, the agricultural industries producing these products have a weight of 7.1 percent in GNP. The sharp increase during 1973-74 is, like most large movements in farm prices, attributed to changes in supply. In 1973-74 worldwide supply of grains was down markedly and this affected directly, and indirectly through animal feed costs, the prices of foods as they left the farm.

The successful imposition of cartel pricing is the reason for the sharp rise in the price of imported crude oil and competing fuels--the second component of the 1973-74 commodity inflation. The domestic crude oil and natural gas industry and coal mining have a weight of 1.2 percent in GNP; the importation of crude oil and refined petroleum products increases this percentage when domestic consumption rather than production is considered.

The third element of the recent commodity inflation is concentrated in primary commodities other than food and fuel. The composition of this group requires definition. If defined similarly to food and fuel, the group would consist of raw commodities like ores, quarry products, cotton and trees. Many such commodities are owned by firms that do the initial processing of them, i.e., they are owned by manufacturers of primary commodities. Few such commodities are priced for the wholesale price index, and except for a few items, like cotton, for which supply shifts are important, the prices of the mineral and forestry products reflect the derived demand for them. What is in fact meant when reference is made to the nonfood, nonfuel component of commodity inflation, is the behavior of those commodities that are produced in the first stages of the processing of the raw commodities. Such commodities can properly be termed primary manufactures. They consist of items like industrial chemicals, woodpulp, lumber, cement, and steel and aluminum ingots. Their production requires real fixed capital of which there was some indication of shortage. The shortage of capital input rather than of the basic raw materials input is central to the distinction and led to the characterization of the industries producing many of these primary manufactures as bottleneck industries.

In 1967 the value of shipments in these industries was 13.1 percent of GNP. That their importance exceeds that of raw farm products and raw fuels reflects the fact that to the value of the raw materials these industries consume is added payments to labor, capital and other factors comprising value added. In 1967 value added accounted for one third of the value of shipments in these industries.

It is the price behavior in these primary manufacturing industries and its implication for general inflation that is the subject of this paper. The industries comprising primary manufacturing are quite diverse. They differ with respect to labor and capital intensity, domestic and international market structure and the markets that they supply -- consumer goods manufacturing, producer goods manufacturing and construction. To shed light on the price behavior of the group as a whole it is necessary to disaggregate the total somewhat. In this study they are broken down into eight separate industries. The exact definition of each, both in terms of 4-digit SIC industry and I-O cell, is available on request. In general, the eight separate industries consist of the primary manufacturers producing (1) textiles, (2) wood, (3) paper, (4) chemicals, (5) fertilizers, (6) stone, clay and glass, (7) iron and steel, and (8) nonferrous metals.

The Model Framework

This paper is concerned with the dynamics of price movements in certain industrial markets; focus will be on the rate of change of prices. In the simplest case it can be assumed that a change in price reflects the movement from one equilibrium price to another. In other words it is entirely explained by shifts in supply and demand curves. There are many factors that cause shifts in demand curves. In most empirical work such shifts are attributed to changes in relative prices and income. In a smaller but important number of studies changes in stocks of real and financial assets have been added. In still more complex descriptions of demand shifts, usually associated with demands for durable goods where intertemporal considerations are relevant, rates of interest play a role.

The specification of the supply function is less clear cut, particularly with respect to sorting out the various hypotheses about the structure of markets. The variables that enter the supply function under the assumption of perfect competition are known because the function is derived by positing short-run profit maximization. In imperfect markets the variables that enter the supply function, and the form of their functional relationship, cannot be determined unambiguously because for one reason or another, firms in the industry may not be establishing supply schedules with the objective of achieving short-run profit maximization. The variables that enter supply functions under both profit maximizing and nonprofit maximizing assumptions may look similar, so it becomes difficult to reject many of the hypotheses about price formation.

When the notion is introduced that any kind of market need not be in equilibrium, the problems of identification intensify. Upon comparison of price equations that purport to reflect competitive markets that are not always in equilibrium because of (1) uncertainty (Arrow [1959] and Debreu [1959]), or (2) search costs (Phelps and Winter [1970] and Okun [1975]), with those reflecting full cost pricing hypotheses in which markups vary to achieve a target return, it becomes even more difficult to reject hypotheses about the nature of markets. What follows is a discussion of the determinants of price behavior in two kinds of markets and how equations that look alike under various assumptions about market structure may nonetheless be distinguished, albeit, in most cases, weakly.

Diagram 1 depicts price changes in a market that behaves competitively and is always in equilibrium. Demand shifts may be attributable to factors discussed above. Changes in factor prices shift supply curves when the market is competitive and the analysis takes place over a time period long enough for factor inputs to vary. If there are three factors of production, labor, capital and materials, changes in the position of the supply curve in price-quantity space will be determined by Δw, the change in straight-time labor compensation per unit of time, Δpm, the change in materials input prices, and Δr, the change in the rental price of capital.

Diagram 2 depicts a competitive market in which price is not always in equilibrium. That disequilibria arise is usually attributed to variable lags on the part of sellers in changing prices. The same variables shift the supply and demand curves, but price may be other than at equilibrium. To pursue this case further it is useful to define the demand curve as reflecting a schedule of orders that will be placed at various prices and the supply curve as a schedule of production that will be undertaken in response to various prices. In equilibrium, production is equal to incoming orders, and price changes occur as the production and orders curves shift.

But if price departs from equilibrium, if, for example, it fails to rise promptly in response to an increase in demand, orders (net of cancellations) will exceed production. The short run result is some combination of a build-up in unfilled orders and decline in finished goods inventories (Eckstein and Fromm [1968]). Prices, of course, would rise. The degree of disequilibrium is measured by the magnitude of the changes in unfilled orders and finished goods inventories. The relationship between the degree of disequilibrium and the amount of price rise needed to eliminate it includes supply and demand elasticities. If demand and supply curves are characterized by constant price elasticities (α for demand, β for supply) the relationship is

$$\frac{p_e}{p} = \left(\lambda\right)^{\frac{1}{\alpha+\beta}}$$

where λ is the ratio of orders placed $\left(X^D\right)$ to production $\left(X^S\right)$ at any given price.[1/] X^D equals X^S plus the change in unfilled orders less the change in

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1/ $X^D = Ap^{-\alpha}$, $X^S = Bp^{\beta}$. In equilibrium $X^S = X^D$ so equilibrium price, $p_e = \left(\frac{B}{A}\right)^{\frac{1}{\alpha+\beta}}$. In disequilibrium $X^D = \lambda X^S$, so $p = \left(\lambda\right)^{\frac{-1}{\alpha+\beta}} \left(\frac{B}{A}\right)^{\frac{-1}{\alpha+\beta}}$. $p_e/p = \lambda^{-\left(\frac{-1}{\alpha+\beta}\right)} = \lambda^{\frac{1}{\alpha+\beta}}$. So for any quantity disequilibrium gap λ, the size of the price gap to be closed varies inversely with the values of the elasticities of supply and demand.

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finished goods inventories. The smaller the elasticity of demand and/or supply, the larger the gap between the equilibrium and actual price for any given size of λ.

In deriving the relationship between demand and price change it was assumed that the elasticities of supply and demand are fixed. In a short run model of a competitive market such an assumption about the supply curve is subject to question. A competitive supply curve with a constant elasticity implies marginal cost is always proportional to average variable cost.[2/]

2/ Price = marginal cost = AX^{α}.

Total costs = $c + \frac{A}{1+\alpha}\left(X\right)^{1+\alpha}$.

Average variable costs = $\frac{A}{1+\alpha}\left(X\right)^{\alpha}$.

Marginal costs divided by average variable costs = $(1+\alpha)$.

If that is the case, capital (fixed factor) utilization does not affect the rate of price change resulting from disequilibrium, except, of course, in the unique case of vertical marginal cost when capital is fully utilized. However, in the mor typical case, because of the law of variable proportions, it is usually assumed that the short-run supply curve becomes increasingly less elastic as full capacity is approached (Arrow [1959]). There has been much debate, based on empirical results, about the way in which capacity utilization should enter price equations -- level or change, and the expected sign of the coefficient. For the competitive case the level is relevant in explaining price change and the sign of the coefficient should be positive.[1/]

[1/] For a more general discussion of the appropriate dimensionality of excess demand variables in price change equations see Laidler and Parkin [1975].

The foregoing suggests that to explain price change in a market that behaves competitively requires three sets of variables: (1) changes in income, relative prices and other variables that effect changes in the orders (demand) schedule; (2) changes in the prices of the variable factors of production that cause repositioning of the production (supply) curve; and (3) a set of variables, frequently termed excess demand measures, that reflect the magnitude of disequilibrium and the price adjustment required to eliminate it. Changes in unfilled orders and finished goods inventories determine the magnitude of the quantity gap at any price. The rate of utilization of capacity must also be included as an explanatory variable to put the gap into perspective with respect to the utilization level at which it is occurring, to test the assumption that the elasticity of the supply curve decreases as production approaches capacity.

Unlike competitive pricing, there is no unambiguous way to describe pricing under conditions of imperfect competition. A typical description of such behavior is that firms in the industry are assumed to calculate the normal or standard total cost per unit of producing in the range of demand they experience normally. If such a basis for pricing is to be practicable to the firm, the actual unit cost of producing in this range should be fairly constant. This requires that marginal costs be falling and rising slowly and that when they are rising, their contribution to raising total unit costs is at least partly offset by declining unit fixed costs.

To normal unit cost is applied a markup.[1/] Since standard unit

1/ The introduction of the word "markup" in a discussion of imperfect competition should not be interpreted as implying markup pricing is a hypothesis relating to behavior in such markets. Markup pricing is, of course, simply a rule used by firms in the absence of information. What distinguishes perfect from imperfect markets, as has been most recently demonstrated by de Menil [1974] is whether price is a markup over marginal costs (competitive) or average costs.

costs are likely to vary among firms while price must be roughly similar among sellers (particularly in homogeneous oligopolistic markets), normal markups will vary among firms. On average for the industry they will probably be set so as to achieve some target rate of return on investment. It is when price behavior appears geared to the achievement of some target rate of return on investment that the inference is usually drawn that perfect competition does not obtain.

As long as demand remains in the range consistent with normal unit costs, price (markup) will not change. When demand moves outside the range there are three basic possible kinds of behavior. The first is that markups always behave procyclicly, that they rise when demand exceeds the output on which normal unit costs were calculated and that they fall when demand drops below normal output. A second possibility is that markups remain constant even when demand deviates from the normal output range -- markups are neutral cyclicly. The third possibility is that markups rise when demand is below normal output but fall when demand exceeds normal output; in other words markups behave anticyclicly.

There are, of course, variants of these three behavioral possibilities. One may obtain when demand exceeds the normal output range, another when demand falls below it. Such combinations of behavior are usually referred to as asymmetries (Schultze and Tryon [1965]). In all there are nine combinations of the three basic patterns.

The connection between the achievement of a target rate of return and the various types of markup behavior needs to be touched upon. In situations in which demand exceeds normal output, the selection of procyclical, anticyclical or cyclicly neutral markup behavior depends on the differences between the elasticities of total revenue and total costs with respect to changes in volume. The elasticity of costs with respect to volume can be assumed to be greater than one for changes in volume beyond the normal output range. The size of the elasticity will depend on the size of fixed costs relative to variable costs. If fixed costs are large, their decline will likely offset more of the rise in variable costs than if fixed costs are small. The elasticity of total revenue with respect to volume will depend on the price elasticity of demand. If it is greater than one a rise in total revenue will be associated with an expansion of sales volume. Therefore if the price elasticity of demand is large in the range beyond normal output and the total cost elasticity, though greater than one, is small (because fixed costs are large relative to variable costs), it may be that a reduction in markups will cause absolute profits to be maintained or even rise. In that case constant or declining markups will be consistent with the achievement of target returns. If total revenue is inelastic, or less elastic than total costs, a rising markup is required to achieve the target.

When demand falls below the normal output range it is likely that average variable costs, and of course, average fixed costs, are rising with each unit reduction in output. However, total costs may be rising or falling. Total revenues may also rise or fall in response to a reduction in sales volume depending on the elasticity of demand. Again it is possible that procyclical, anticyclical or cyclicly neutral behavior of markups will be consistent with maintaining target returns.

The foregoing analysis has assumed that firms continue to strive for target returns even when demand falls outside the range of normal output. However, if firms in an industry regard such demand shifts as cyclical and are striving to earn a long run target return, they may not change markups at all, regardless of the relationship of demand to normal output. In such instances markups would be cyclicly neutral, but would vary secularly with changes in the target and the capital-output ratio. 1/

1/ Nordhaus and Godley [1972] found that for the UK manufacturing sector (excluding food, beverages and tobacco) markups were cyclicly neutral.

There is no single variable uniquely appropriate for explaining changes in markups. But any such variable should reflect the relationship of demand to potential supply. Potential supply can be represented by

$$X_{C,t} + I_{FG,t-1}$$

where the first term is capacity output and the second, the quantity of finished goods inventories on hand. Demand consists of unfilled orders of the preceding period plus new orders of the current period:

$$UO_{t-1} + NO_t .$$

The difference between the last two expressions, expressed as a ratio to either, is a measure of excess demand (ED), a variable proposed as a measure of the level of markups:

$$\frac{UO_{t-1} + NO_t - I_{FG,t-1} - X_{C,t}}{I_{FG,t-1} + X_{C,t}} \quad \text{or} \quad \frac{UO_{t-1} + NO_t}{I_{FG,t-1} + X_{C,t}} -1.$$ [1/]

[1/] This formulation, somewhat modified, is attributable to the comments of Black on Eckstein and Fromm [1968].

The way in which this measure of excess demand (ED) is introduced (along with variables that measure changes in normal unit costs -- labor and materials) into price change equations depends on the assumption about the behavior of markups. If it is assumed that markups change in the same direction regardless of whether demand is less than or greater than normal output, the change in ED is the appropriate variable. If it is positive or negative and significant the presumption is that markups behave either pro or anticyclicly, respectively. If the term is not significant markups are cyclically neutral. Nonlinearities in these relationships may be tested by including the level of ED along with the change.

To test the hypothesis that the behavior of markups depends on whether demand is greater than or less than normal output, markups could be posited as a third order function of ED:

$$MU = a + bED + cED^2 + dED^3.$$

Then: $$\frac{dMU}{dt} = b\frac{dED}{dt} + 2cED\frac{dED}{dt} + 3d(ED)^2\frac{dED}{dt}.$$

But such a form is difficult to test in a meaningful way because of multicollinearity among the three variables, all of which contain $\frac{dED}{dt}$. A more promising avenue is to construct two different variables. One would measure $\frac{dED}{dt}$ when ED is less than its mean, or less than a range around its mean, and be set to zero otherwise. A similar variable would measure $\frac{dED}{dt}$ above the range of normal levels of ED.

In summary it appears that noncompetitive and competitive disequilibrium price change models can be distinguished in two ways. The first is with respect to the way in which excess demand is introduced and the expected sign of the coefficient. The target return model appears to call for variables measuring the change in excess demand. By using such variables, separated to test for asymmetries, or along with level variables to test for nonlinearities, the broad spectrum of noncompetitive hypotheses can be evaluated. In competitive markets price change would appear to be positively related to the <u>change</u> in unfilled orders and the <u>level</u> of capacity utilization and negatively to the <u>change</u> in finished goods inventories.

The second respect in which the models differ is in the form the supply shifters take. In competitive models, changes in wage rates and material prices perform this function. In the model of imperfect competition described above, the role is assumed by changes in standard unit costs, perhaps separated into unit labor and unit materials cost.[1/] The methods

[1/] Changes in capital costs are excluded because appropriate measures have not yet been constructed; the findings of Nadiri [1976] are that such a variable plays a very small role, if significant at all, in short-run models of price change.

usually used to estimate changes in standard unit costs are tantamount to subtracting from the changes in the various factor prices, say, wage-rates, the trend rates of change in productivity. If the trend in productivity is constant, the resulting series resembles the wage rate series itself. Therefore, it is difficult to distinguish markets based on the alternative uses of factor prices and normal unit factor costs in industries in which the trend growth of productivity is constant.[2/] Because of this, and the

[2/] Even when productivity trends change, a rigorously derived competitive price equation based on a production function with nonconstant rates of technological progress would produce a productivity-adjusted wage rate that resembles estimates of standard unit cost derived in the ways described above.

lack of quarterly unit material cost data, the weighted average of wage rates and materials prices will be used in all models.

Four price equations will be estimated. For the competitive disequilibrium model the equation is:

$$(1)\quad \%\Delta p = \alpha_0 + \alpha_1[\gamma(\%\Delta w) + (1-\gamma)\%\Delta p_m] + \alpha_2\%\Delta I_{FG} + \alpha_3\%\Delta UO + \alpha_4 \frac{X}{X_c} + u.$$ 1/

1/ Variables other than commodity and factor prices in this equation are, of course, deflated. γ is the weight of labor costs in the total of labor and materials costs.

In the noncompetitive case the equations to be tested are:

$$(2)\quad \%\Delta p = \alpha_0 + \alpha_1[(\gamma)\%\Delta w + (1-\gamma)\%\Delta p_m] + \alpha_2\%\Delta ED + u.$$

$$(3)\quad \%\Delta p = \beta_0 + \beta_1[(\gamma)\%\Delta w + (1-\gamma)\%\Delta p_m] + \beta_2\%\Delta ED + \beta_3 ED + v.$$

$$(4)\quad \%\Delta p = \delta_0 + \delta_1[(\gamma)\%\Delta w + (1-\gamma)\%\Delta p_m] + \delta_2\%\Delta ED^{(-)} + \delta_3\%\Delta ED^{(+)} + w.$$ 2/

2/ $\%\Delta ED^{(-)}$ is a variable measuring the percentage change in ED when the level of ED is less than $\overline{ED}$ −.5(std.dev.of ED), zero otherwise. $\%\Delta ED^{(+)}$ is a similar measure that takes on nonzero values when ED> $\overline{ED}$ +.5(std.dev.of ED) .

Explicit demand shifters are not specified in the equations. However, in the competitive case, shifts in demand, when there are no disequilibria, are reflected in the numerator of the capacity utilization variable. The new orders variable plays a similar role in the target mark-up equations.

The Data

The data are taken from five primary sources: Censuses and Annual Surveys of Manufactures (Census Bureau), monthly series on manufacturers' inventories, shipments, new and unfilled orders (Census Bureau), component series of the monthly wholesale price index (Bureau of Labor Statistics), monthly series on employment, hours and earnings (Bureau of Labor Statistics) and components of the monthly industrial production index (Federal Reserve Board). Data at the three and four digit SIC level (six and eight digit wholesale price index categories) are combined to form aggregates for each of the eight primary manufacturing sectors. The four-digit composition of each of the eight sectors is available on request. For flow variables, the monthly series is seasonally adjusted and quarterly averages are formed. For stock variables, monthly series are seasonally adjusted and the observations for the terminal months of each calendar quarter are used. The series have been constructed for 1958-75 and most are available monthly.

Some special series and methods of construction of particular series require further amplification.

Prices -- The BLS concordance between its eight-digit WPI commodity codes and the Census Bureau's seven-digit codes is used to select the index components for each of the eight sectors. The indexes are combined using 1967 shipments weights from the Census of Manufactures. Shipments among the four-digit industries in each sector are netted out of the weights, using information on interindustry sales from the 1967 Input-Output table. A number of series have some missing monthly observations within the length of the series and/or either begin or end within the sample period. Missing monthly observations are interpolated. When a series ends within the sample period, a substitute is linked in. When a new series is introduced after the beginning of the sample period, a weight is allocated to it (by splitting a relevant weight) and the new series is linked in. To avoid this procedure as much as possible, six and sometimes four-digit rather than eight-digit indexes are used; the higher the level of aggregation, the fewer the discontinuities. When this is done, advantages, both computational and with respect to introducing judgments about which series are substitutes for others, are offset to some extent by the imprecision stemming from the fact that the four- and six-digit indexes that are used have been aggregated by BLS, using 1963 rather than 1967 weights.

Capacity utilization -- The method is that originally used at the Wharton School. FRB monthly production indexes are plotted and linear trend lines fitted to their peaks. The trend lines are assumed to reflect output at capacity in each period. Some judgment is introduced in setting the trend line prior to the first peak in the production series and after the last one.

Finished goods inventories -- The Census Bureau's monthly survey of inventories, shipments, new and unfilled orders does not provide data on inventories by stage-of-fabrication in the detail required by this study. Such data are available for the end of each calendar year from the Censuses and Annual Surveys of Manufactures. So, too, are annual data on shipments and the value of production (shipments plus change in inventories of finished goods and goods-in-process). Annual shipments data are interpolated monthly by using the monthly shipments data. The annual value of production is interpolated monthly, using an index that is the product of the monthly FRB production indexes and the price indexes described above. The year-end stock of inventories of finished goods and goods-in-process is then moved forward a month at a time by adding the value of production and subtracting shipments.

Because annual control totals from the Census and Annual Surveys are used, the resulting stock at the end of year t + 1 ties into the Census data. Since the production and shipments series used are seasonally adjusted the implicit seasonal in the derived inventory series is December = 1.00. The measure just described is of inventories of finished goods and goods-in-process because only that total can be interpolated by shipments and production data.

Average hourly earnings -- These are data for production workers, and are adjusted by BLS to exclude the effect of overtime and interindustry shifts. They have been adjusted further for purposes of this study to incorporate fringe benefits; the average hourly earnings series are multiplied by the ratio of labor costs to payrolls for production workers. These monthly ratios are the linear interpolation of similar ratios, obtained annually from Censuses and Annual Survey for the years 1957 and 1967-71. The ratio of labor costs to payrolls does have a cyclical component because fringe payments are related to the number of production workers employed (full time) rather than to hours worked. The use of the annual average however appears to eliminate much of the cyclical component. The basic straight-time wage data -- so adjusted -- are published at the two digit level only. Accordingly the particular series used for each of the eight sectors had to be estimated based on average hourly earnings and hours worked and overtime hours data at the three and four digit SIC level.

Materials prices -- With the exception of the price of cotton in the textile sector, phosphate in the fertilizer sector, iron ore and coal in the steel sector, and sand, gravel, and stone in the stone, clay, and glass sector, the only prices that enter are those of commodities purchased by the eight sectors from each other and from utilities and the petroleum industry. Prices for some of the forestry and mineral products purchased by the eight industries -- copper ore, trees, etc. -- are not available; many forests and mineral deposits are owned by the manufacturers that process them. Even if prices for a broader range of crude industrial materials were available it is likely that, in the absence of cartel arrangements, they would move primarily with demand (derived demand case) because supply is relatively fixed. Of course, this is not true of cotton; there are substantial fluctuations in each year's crop. Prices of purchased services other than labor are ignored as are purchases of intermediate and finished manufactured goods. The latter are very small, a reflection of the fact that the I-O structure of the U.S. economy is nearly triangular.

Deflation -- Each quarter's new orders are deflated by that quarter's price index, since the WPI components more nearly reflect the prices at which orders are taken rather than those at which shipments are made. Both unfilled orders and inventories (finished goods and goods-in-process) at the end of each quarter are deflated by the average price index for the quarter. The ratios of unfilled orders and inventories to new orders are almost always less than one, except in the case of steel. Therefore the stock of unfilled orders at the end of a quarter reflects primarily orders placed during the quarter and the finished goods and goods-in-process inventories, production undertaken during the quarter.

Some Preliminary Quantitative Analysis

The sharp increase in prices of primary manufactured goods that began in the second half of 1972 amounted to 27 percent before it ended in April 1974. This increase together with those in farm and crude oil prices comprise the commodity inflation that wreaked havoc on the U.S. economy, as well as those of other industrialized countries of the free world. One can argue that because of the exogenous nature of the events in the farm and crude oil sectors, the tools of economics are not geared to predict the resulting inflation in those sectors. The same cannot be said of the rise in prices of primary manufactured goods. It was the unpredicted nature of this development that would appear to be a major element in the recent criticisms focusing on the shortcomings of economics.

It is the purpose of this paper to determine whether, with the help of hindsight, the inflation in the primary manufacturing sector can be explained through the use of econometric models. But not all economic analysis, particularly forecasting, is based on econometric method. So it is useful to see whether a less formal analysis of relevant data provides any hints of the emergence of the inflation in prices of primary manufactured goods.

The rate of capacity utilization is usually a key variable in price forecasts for specific commodity-producing sectors of the economy. Capacity utilization rates rose to very high levels during 1973-74 -- virtually 100 percent -- but they had done so in 1965-66 as well, without producing a significant acceleration of inflation. In Chart 1 are found data on capacity utilization for the primary manufacturing industries, constructed as described above, and those for total manufacturing, as measured by the Wharton index. Both series plotted on the chart are deviations from trend calculated by regressing the log of the capacity utilization rate on a linear time trend. These data confirm that trend deviations of capacity utilization in primary manufacturing were only slightly larger than those for total manufacturing in 1973-74; in 1965-66, trend deviations in both series were about the same. In both 1973-74 and in 1965-66, trend deviations in both series were positive and large.

It is clear that the full capacity rates of utilization alone cannot explain the differences in the inflation in primary prices between 1965-66 and 1973-74 experiences. When capacity utilization nears 100 percent it will fail to capture the full extent of excess demand, if demand exceeds potential output. When this happens one would expect inventories of primary materials -- finished goods inventories of primary producers and materials and supplies inventories of users of primary materials -- to decline, and/or unfilled orders placed with primary producers to rise.

In Charts 2 and 3 are plotted trend deviations of unfilled orders-shipments ratios and inventory-shipments ratios (based on finished goods and goods-in-process inventories of primary manufacturers) for primary manufacturers and for the total manufacturing sector. Inventory-shipments ratios of primary manufacturers show much larger negative deviations from trend in 1973-74 than 1965-66, both absolutely and vis-a-vis manufacturing as a whole. They were the largest for the entire sample period except for one quarter in 1959 in which steel producers' finished goods inventories were drawn down by orders in anticipation of a strike. It is also interesting to note that while capacity utilization was high in manufacturing as a whole in both periods, negative deviations from trend in the inventory-sales ratios were no larger on average during 1973-74 than during 1965-66, so manufacturers of goods beyond the primary stage were able to keep up with demand without drawing on inventories.

Similar signs of the high degree of excess demand facing primary manufacturers are found in the behavior of the unfilled orders-shipments ratios in Chart 2. Except for the effect of the steel strike in 1959, the size of the positive deviations (from trend) during 1973-74 of the unfilled orders-shipments ratio for primary manufacturers its trend is unparalleled in the sample period. Again it is of interest that for manufacturing as a whole deviations of the ratio from trend were no larger in 1973-74 than in 1965-66.

When capacity utilization, inventory-shipments ratios and unfilled orders-shipments ratios are considered jointly, it is clear that in 1973-74 demand for primary commodities exceeded supply by substantially more than it had at any time during the 1958-72 period. 1/ And it also appears that

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1/ Unfortunately, data are not available that would permit this kind of analysis for the Korean War period.

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in 1973-74 excess demand for primary products was far greater than for other manufactures -- a situation that was not attendant to the high rates of capacity utilization in 1965-66.

The analysis that led to these conclusions could not have been carried out with data on inventories, shipments and unfilled orders at the level at which they are published by the Census Bureau. The closest one can come to approximating values for the primary industries, as defined in this study, is to analyze the behavior of shipments, inventories and unfilled orders for published market classification groupings "construction, ... and other materials and supplies." These categories are very broad, covering all manufacturing except finished goods production. And only total inventories, not finished goods inventories, are available for the groupings. Use of these data, such as they are, to infer behavior in the primary industries that are included in these broad aggregates turns out to understate the extent of excess demand primary producers faced. The data indicate that the magnitude of the rise in unfilled orders-shipments ratios and decline in inventory-shipments ratios were only half as large during 1973-74 as those that obtained for the primary groupings.

Regression Results

Two general comments are appropriate at the outset -- one about the sample period, the other about lags. The data required for the analysis are available beginning in 1958, the first year for which detailed data on orders, inventories and shipments are obtainable. The first observation, however, reflects the lag terms used for the variables in each sector, with the result that the sample period begins in 1959 in most industries. The terminal point is 1973-IV. The reason for ending the sample period in 1973 is to provide extra actual observations with which to compare forecasts generated by each of the four equations for each sector. Thus, conditional forecasts will be reported for 1974 and 1975, admittedly a rigorous period over which to test price equations.

With respect to lags, two different strategies are employed. The first relates to the input price variable. The current output price may be affected by changes in input prices that have taken place over a considerable period of the past.[1/] Firms may adjust their own prices relatively slowly to

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[1/] It may even reflect expected future input prices, but this is ignored in the equations tested above, except to the extent past price changes are proxies for expected future price changes.

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changes in factor prices for various reasons: frequent price changes are not costless; firms may not mark up existing materials' inventories when prices rise for materials ordered currently; etc. Indeed wage rates and materials prices may have different lag structures. Accordingly, the input price change variable was inserted as a second order polynomial running from "t" to "t-7". Examination of these Almon lag coefficients, some of which were negative, and their stability over various time periods, led to some modifications, unique to each industry. In general lag terms with negative or small positive weights were dropped. In two industries, fertilizers and nonferrous metals, separate lag structures were developed for materials price and wages. Once the lag terms and their weights were so decided, they were combined into one variable.

The excess demand variables are all measured in "t-1" except for the lumber industry. The underlying assumption is that the bulk of the adjustment to excess demand is based on what has been perceived in the recent past, and the recent past is fully summarized in the most recent ("t-1") behavior of the excess demand variables. A distributed lag is not deemed appropriate. Current values of excess demand variables are used in the case of lumber, prices of which appear to adjust very quickly.

The results obtained upon estimation of the competitive disequilibrium and the three target markup models for each of the eight industries are found in Table 1. An analysis of those results by industry follows.

Textiles

Textile prices appear to be explained best by equation three. All three variables in the equation are significant at the five percent level. Markups are procyclical and nonlinear. The markup rises at an increasing rate which suggests some underlying target return objective. Over the observed range of ED it adds between 0.50 and 0.63 percent to price changes, at an annual rate, accounting on average for one-tenth of the average absolute change in price. The regression coefficient of the variable measuring wages and material's prices is less than unity. When the industry is in equilibrium, with the ED variable at its mean level, prices drift up about two percent per year, perhaps reflecting increases in the capital-labor ratio; industry analysts have noted increasing use of capital in textile manufacturing.

Lumber

Prices fluctuate more in the lumber industry than in the other seven primary sectors. Input prices are not significant. 1/ Capacity utilization

1/ The input price index consists only of wages. Tree prices are not available and their meaning would be unclear since many large lumber companies own their own natural resources.

is clearly significant in the competitive disequilibrium model, while the disequilibrium measures -- inventories and unfilled orders -- are not significant at the five percent level. None of the excess demand variables are significant in the other three equations; the input price measure is, although it has an unacceptably large coefficient. These results suggest that lumber prices behave quite competitively and are usually close to being in equilibrium. Over its observed range, capacity utilization contributes between 0.9 and 1.2 percent to price change, at an annual rate, an average about one-tenth of the average absolute change in price. The range of contribution is quite small which is reflected in the rather low percentage of variance explained by the equation. In equilibrium, with capacity utilization at its mean, prices drift upward at a rate of almost one percent per year.

Paper

Prices in the paper industry are positively related to input prices, unfilled orders and capacity utilization in the best result which appears to be given by the competitive disequilibrium model. A one percent rise in unfilled orders when capacity utilization is at its observed peak causes prices to rise at a 0.5 percent annual rate; a one percent decline in orders when capacity utilization is at its observed low results in virtually no price change. On average, the demand-related variables account for one-tenth of the average absolute change in price.

Chemicals

Chemical prices respond positively to input prices and the level of ED in the best result which is for equation 3. The level of ED over its observed range contributes between 0.29 and 0.34 percent at an annual rate, accounting on average for one-fifth of the average absolute change in price. But the range of contribution is obviously quite small so the result is similar to a cyclicly neutral outcome. However, prices of many basic industrial chemicals during most of the sample period were obtained by the BLS from trade journal sources and may not reflect transactions prices.

Fertilizers

The best explanation of changes in fertilizer prices is obtained from equation 3. Input prices are not significant but the change in ED has a significant negative sign, the level of ED, a significant positive one. The implication is that the markup rises at an increasing rate. However, contributions of the variables over the observed range of ED are in a very narrow range either side of zero, so the result is close to cyclicly neutral price behavior.

Stone, clay and glass

The results for the stone, clay and glass industry give the most clear cut outcome of cyclicly neutral price behavior. The only significant variable explaining price change is input price change (the regression coefficients of the input price variable in all four equations are not significantly different from unity). Of course, this conclusion refers to the three component industries as a whole and not to any one specifically.

Steel

The steel industry is the only one in which the percentage change in excess demand is significant with a negative sign -- a strong suggestion of target return pricing. This result is consistent with the findings of others. The change in ED is negative and significant at the ten and five percent level in equations 2 and 3 respectively. In equation 4, the sign of the change variable at below-normal-demand levels is negative. However, the decline in markup for increases in ED over their observed range is quite small. While the $\bar{R}^2$ in the competitive disequilibrium equations are slightly higher than in the target markup version, the structural estimates are subject to question, particularly the significant negative sign of the coefficient for unfilled orders.

Nonferrous metals

Nonferrous metals prices behave competitively and are best described by the competitive disequilibrium model. Changes in finished goods inventories are negatively related to price change while the level of capacity utilization is positively related. A one percent decline in inventories when capacity utilization is at its observed peak causes prices to rise at a 0.7 percent annual rate; a one percent rise in inventories when capacity is at its observed low results in virtually no price change.

* * * * *

The foregoing analysis of results in each of the eight sectors has focused on the findings with respect to structure. The findings are supported by, in addition to "t" statistics, relatively high $\bar{R}^2$'s for quarterly price change equations and, more importantly, by standard errors that are about equal to or less than the average absolute price change during the sample period in half of the industries analyzed. However, structure may change. An important indicator of the stability of structure is the results obtained when the equations are used to produce forecasts outside the sample period.

The "best" equations in Table 1 for the sample period ending in 1973-IV were used to make conditional forecasts of 1974 and 1975. The results are found in Table 3. Viewed in the absolute the results are disappointing. But in the context of the size of the price increases that occurred, the results are encouraging in one important respect. They indicate the equation structures, as estimated through 1973, were adequate to forewarn of price increases in 1974 that were clearly much higher than any that had occurred during the sample period; in every industry in which "double-digit" inflation occurred in 1974, double-digit inflation was predicted.

There is undoubtedly room to improve the analysis reported in this paper. Further experimentation can be undertaken with respect to the lag structures and the way in which nonlinearities are introduced. World-wide demand, real and speculative, for the products of many of these industries was said to be very strong in 1973 and 1974. It might be fruitful to include some additional measures of this demand, such as orders for these products placed abroad by U.S. firms or the price of the various commodities in world trade, if appropriate data can be found.[1/] Care must be taken, however, that the likely high correlation between the demand for primary commodities in the U.S. and the rest of the world and the effect of such demand on price in 1974 not be taken as the sole basis for inferring a structural relationship between U.S. and foreign demand during the entire period

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1/ Orders placed by foreigners with U.S. firms are already reflected in the orders variables in the equations.

under study.[1/] These extensions of the study are contemplated for the not-too-distant future.

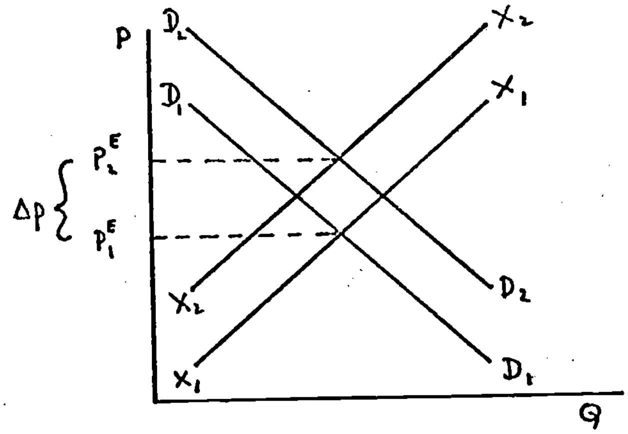
[1/] Equations have been estimated by Cooper and Lawrence (1975) for 1950-74 in which the percentage change in world prices of nonferrous metals are explained as a function of percentage changes in U.S. industrial production, industrial production in the rest of the OECD and a price index of world exports of manufactured goods. The authors conclude that demand can go a substantial way in explaining the commodity price boom of 1972-74. But it does not appear from the sketchy statistics they report that by incorporating world demand factors they can explain more of the price boom than has been explained in the regressions reported above, which rely only on demand variables for the U.S.

Summary

The findings reported here indicate that changes in prices of primary industrial commodities are positively related to changes in demand in six of the eight industries studied. In the stone, clay and glass sector, pricing appears to be completely insensitive to demand, while in the steel industry price changes vary inversely with changes in excess demand. In these two industries, the results support the acceptance of the target return hypothesis. In three of the industries -- textiles, chemicals and fertilizers, one of the target return equations fits best but the behavior of markups is procyclical. In the remaining three industries -- lumber, paper and nonferrous metals, the competitive equation provides the best fit. The variables that enter the competitive and target return models, and the form in which they enter, differ mainly with respect to whether capacity utilization enters price change equations in level or change form. But, there is enough similiarity among the variables to preclude rejection of either hypothesis when the target return model yields the result that the markups behave procyclicly.

The results indicate that quantitative analysis -- econometric or noneconometric -- could have pointed up the impending large rise in the prices of primary manufactures, if the relevant data for the manufacturing sector had been available by stage of process classifications, and in particular for the primary processing stage. The high levels of capacity utilization for primary processors in 1973-74, accompanied by data reflecting the unprecedented (for 1958-73) rise in unfilled orders-shipment ratio and decline in finished goods inventories-shipments ratio, seems adequate to have warned the noneconometric forecaster that demand was unusually strong vis-a-vis supply. When these variables are introduced formally, together with input prices, into equations estimated through 1973 they provide forecasts of price increases in 1974, which, while considerably below actual increases, were larger than those of the preceding 15 years by enough to suggest an unusual burst of increase among prices of primary manufactures was imminent.

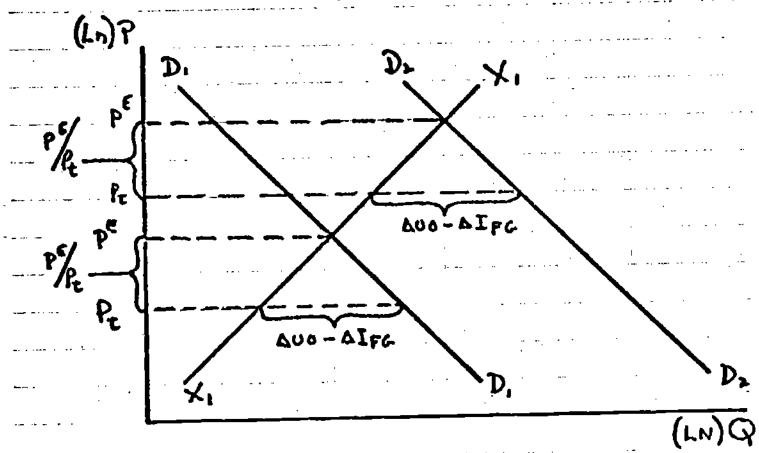
DIAGRAM 1



Q = PRODUCTION(X), ORDERS (D)

COMPETITIVE EQUILIBRIUM

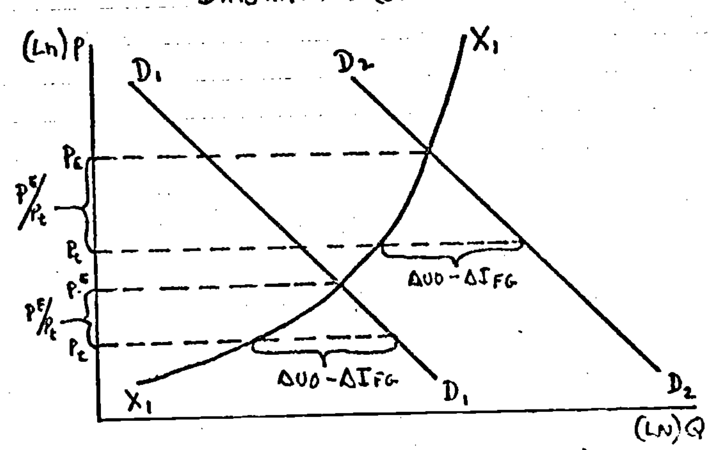
DIAGRAM 2 (a)



Q = PRODUCTION(X), ORDERS(D)

COMPETITIVE DISEQUILIBRIUM, PRODUCTION ELASTICITY CONSTANT -- EQUAL PERCENTAGE DEMAND GAP ASSOCIATED WITH EQUAL PERCENTAGE PRICE GAP

DIAGRAM 2 (b)



Q = PRODUCTION(X), ORDERS (D)

COMPETITIVE DISEQUILIBRIUM, PRODUCTION ELASTICITY FALLING -- EQUAL PERCENTAG DEMAND GAP ASSOCIATED WITH RISING PRICE GAP AS FULL CAPACITY PRODUCTION IS APPROACHED

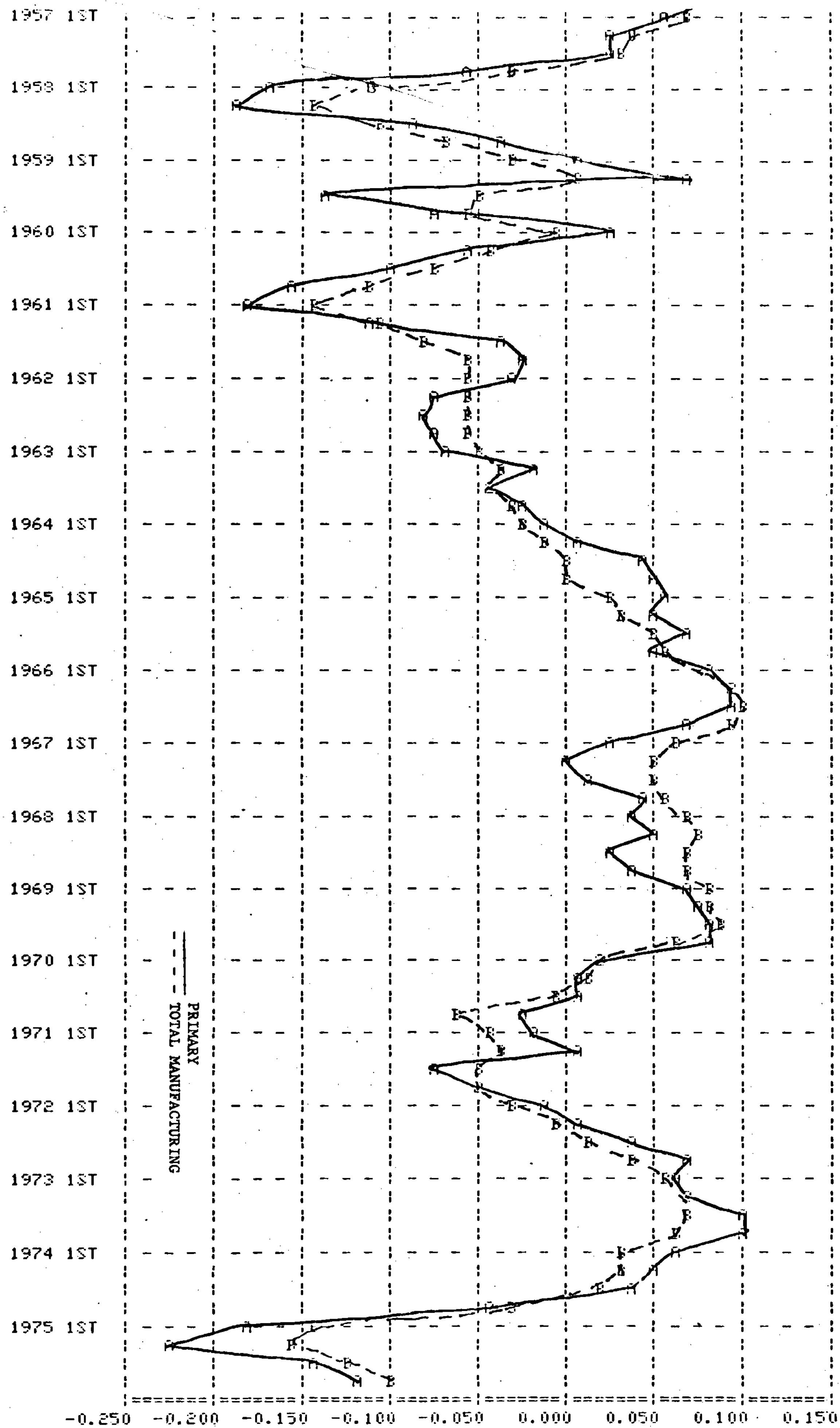
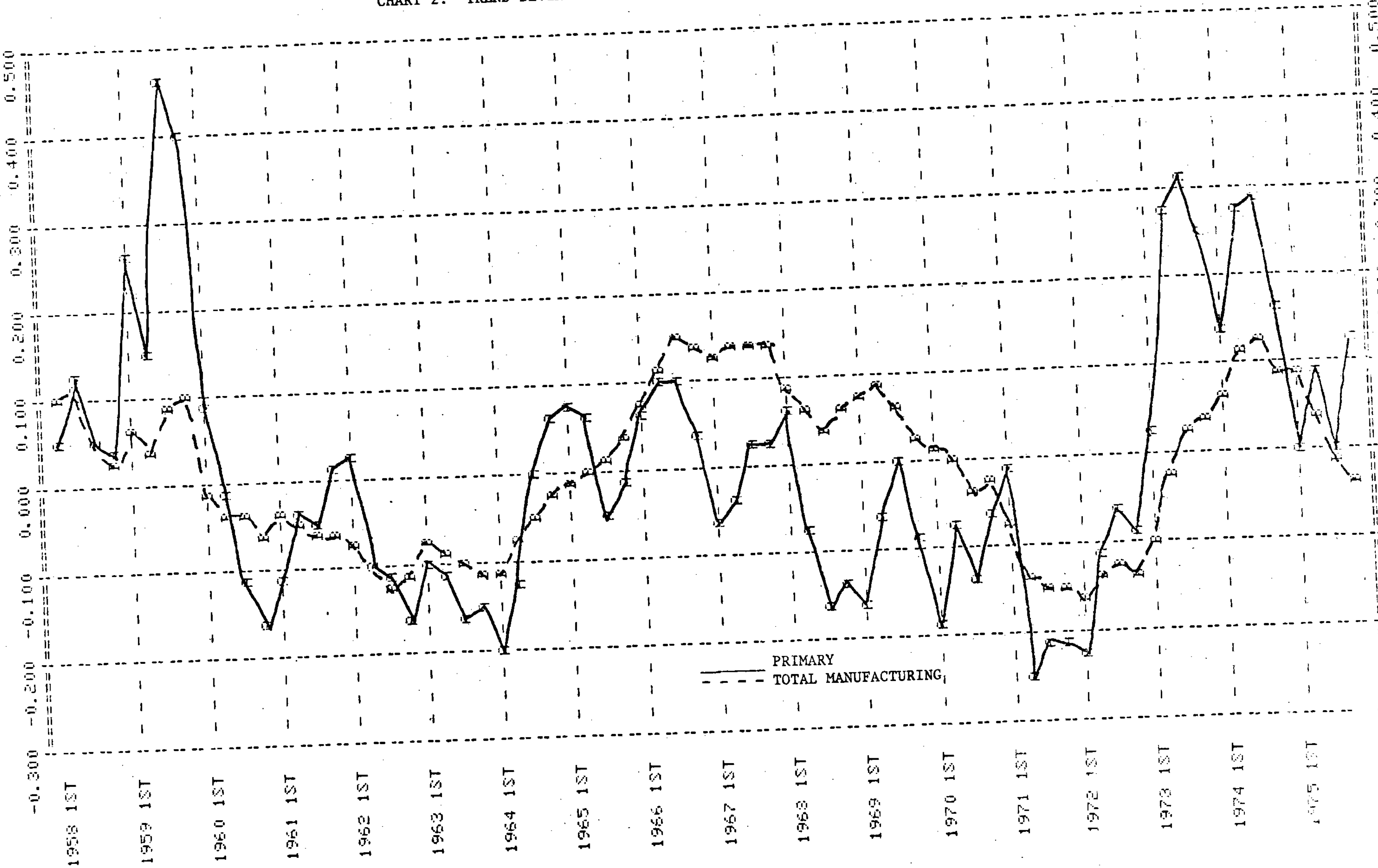


CHART 1. TREND DEVIATIONS (LN) IN CAPACITY UTILIZATION RATES

CHART 2. TREND DEVIATIONS (LN) IN RATIO OF UNFILLED ORDERS TO SHIPMENTS



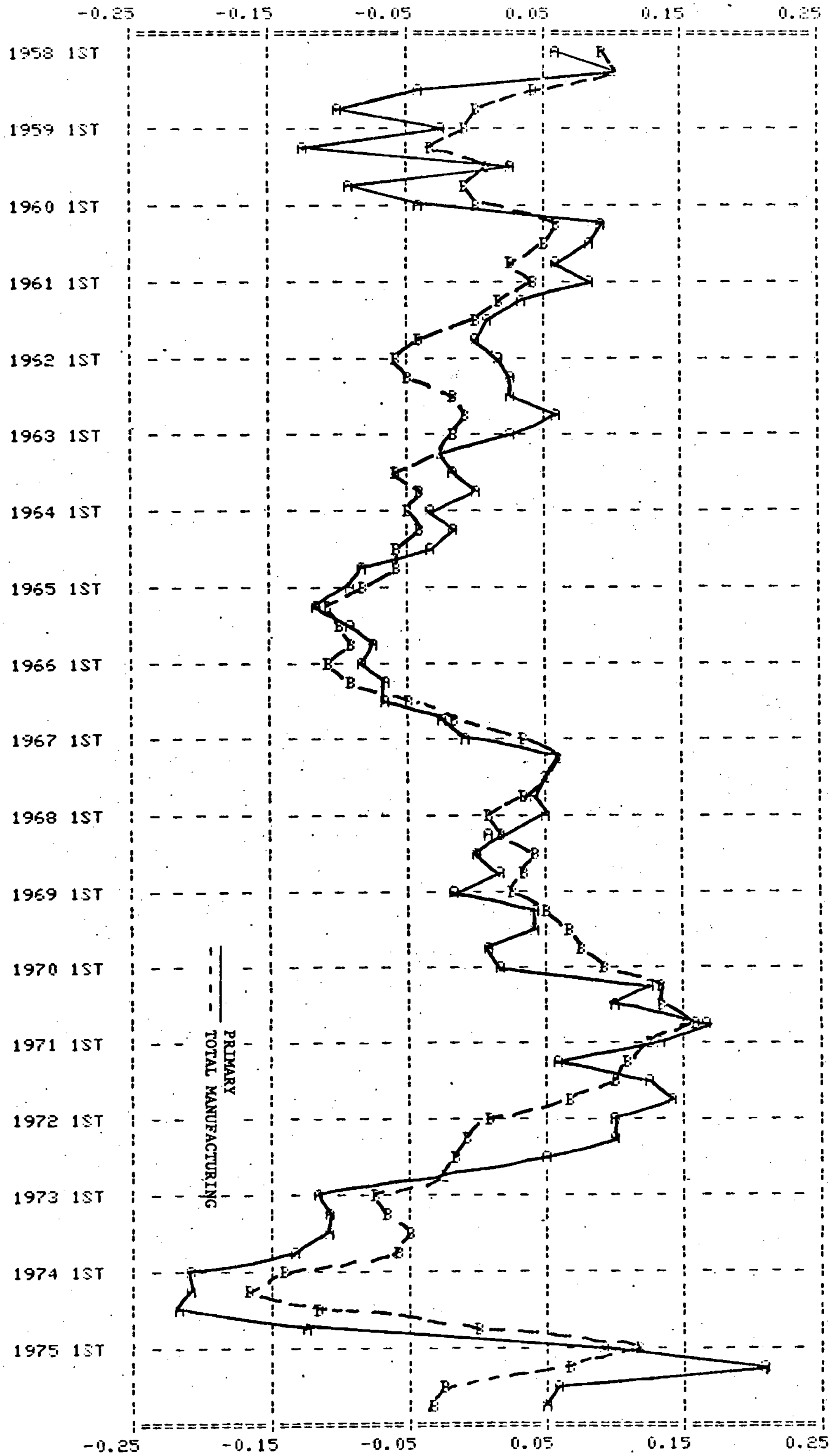


CHART 3. TREND DEVIATIONS (LN) IN RATIO OF INVENTORIES OF FINISHED GOODS AND GOODS-IN-PROCESS TO SHIPMENTS

Table 1. Regression results: Quarterly percentage

PRIMARY PRODUCING INDUSTRY	Equation Number[1/]	First Observation	Materials prices and wages, percentage change in weighted distributed lag[2/] Coef.	"t"	Finished goods inventories, percentage change, t-1 Coef.	"t"	Unfilled orders, percentage change, t-1 Coef.	"t"	Capacity utilization deviation from trend percent, t Coef	"t"
TEXTILES	1	1959-II	1.104	9.5	-.026	1.3	.048	2.8	.030	0.[illegible]
	2		1.107	10.3						
	3*		.881	6.6						
	4		1.120	10.2						
LUMBER 3/	1*	1959-III	.742	0.8	-.062	1.5	-.107	1.7	.295	3.0
	2		2.042	2.3						
	3		2.069	2.0						
	4		1.911	2.0						
PAPER	1*	1959-I	.672	3.3	.008	0.9	.038	3.0	.083	2.6
	2		1.011	5.2						
	3		1.020	4.1						
	4		1.043	5.3						
CHEMICALS	1	1959-I	.281	1.7	.001	0.1			.030	2.3
	2		.505	3.8						
	3*		.640	5.4						
	4		.485	3.7						
FERTILIZER	1	1959-III	1.437	3.1	.007	0.5			-.027	0.7
	2		1.353	3.0						
	3*		-.187	0.4						
	4		1.323	2.9						
STONE, CLAY, GLASS	1	1958-IV	1.001	7.8	-.007	0.7	-.006	0.5	-.000	0.0
	2*		1.022	8.3						
	3		1.042	7.4						
	4		1.019	8.2						
STEEL	1	1958-IV	.804	6.9	-.016	1.8	-.009	1.9	.015	2.0
	2		.838	7.0						
	3		.861	7.0						
	4*		.812	6.9						
NONFERROUS METALS	1*	1959-III	.298	0.6	-.082	2.0	.049	1.3	.089	2.8
	2		1.002	2.3						
	3		1.229	2.9						
	4		.923	2.1						

1/ Best equation marked by asterisk.

2/ The lag distribution and weights are shown in table 2.

3/ In the case of lumber, variables other than wages and materials prices are introduced with no lag.

ges in price for sample period ending 1973-IV

ED, percentage change, t-1 Coef.	"t"	ED, deviation from trend percent, t-1 Coef.	"t"	$ED^{(-)}$, percentage change, t-1 Coef.	"t"	$ED^{(+)}$, percentage change, t-1 Coef.	"t"	Constant term, percent[2/] Coef.	"t"	$\bar{R}^2$	DW	$\overline{SEE}$	Avg. absolute change in dependent variable
								.530	1.1	.667	0.9	1.10	1.35
.123	3.3							-.555	3.2	.682	1.0	1.07	
.094	2.5	.052	2.6					.324	2.9	.713	1.0	1.02	
				.072	1.1	.179	2.5	-.564	3.1	.662	1.2	1.10	
								.215	3.2	.248	1.5	3.15	2.58
.058	0.4							-1.232	1.1	.059	1.4	3.53	
.061	0.4	.006	0.1					1.265	0.2	.041	1.4	3.56	
				-.170	0.6	-.129	0.5	1.058	0.9	.049	1.4	3.54	
								-.098	2.7	.447	1.8	0.62	0.70
.093	2.3							-.332	1.8	.339	1.5	0.67	
.093	2.3	.001	0.1					-.397	0.3	.327	1.5	0.68	
				.151	2.4	.052	0.7	-.349	1.9	.337	1.4	0.67	
								-.256	2.7	.228	1.5	0.53	0.39
.031	0.9							-.481	3.2	.177	1.3	0.55	
.010	0.3	.109	4.7					-.612	5.0	.403	1.8	0.47	
				-.031	0.5	.165	2.2	-.491	3.3	.220	1.4	0.53	
								-.321	0.6	.110	1.3	1.85	1.22
.004	0.2							-.279	0.9	.115	1.3	1.85	
.053	2.4	.047	4.9					.520	4.9	.375	1.6	1.55	
				-.059	0.8	.020	0.6	-.321	1.0	.114	1.3	1.85	
								-.426	0.3	.519	1.8	0.45	0.63
.008	0.4							-.491	3.7	.531	1.8	0.44	
.009	0.5	.003	0.3					-.511	0.8	.524	1.8	0.45	
				.014	0.5	-.014	0.4	-.484	3.6	.525	1.8	0.45	
								-.144	2.2	.494	1.6	0.69	0.76
.014	1.8							-.207	1.4	.443	1.5	0.72	
.018	2.1	.006	1.0					-.302	1.3	.442	1.5	0.72	
				-.025	2.0	-.018	1.2	-.208	1.4	.455	1.6	0.71	
								.544	2.8	.265	1.1	1.59	1.49
.154	2.5							-.196	0.4	.133	0.9	1.73	
.133	2.2	.054	2.5					-.418	2.5	.206	0.9	1.66	
				.166	1.6	.054	0.5	-.084	0.2	.068	0.8	1.80	

Table 2. Distributed lag and weights for materials' prices and wages

	Relative Weight	t	t-1	t-2	t-3	t-4	t-5
Textiles							
Wages	.665	.333	.267	.200	.133	.067	-
Materials' Prices	.335	.333	.267	.200	.133	.067	-
Lumber							
Wages	.925	-	-	.250	.250	.250	.250
Materials' Prices	.075	-	-	.250	.250	.250	.250
Paper							
Wages	.515	.400	.300	.200	.100	-	-
Materials' Prices	.485	.400	.300	.200	.100	-	-
Chemicals							
Wages	.718	.400	.300	.200	.100	-	-
Materials' Prices	.282	.400	.300	.200	.100	-	-
Fertilizer							
Wages	.234	-	-	.250	.250	.250	.250
Materials' Prices	.766	.667	.333	-	-	-	-
Stone, Clay, Glass							
Wages	.677	.500	.333	.167	-	-	-
Materials' Prices	.323	.500	.333	.167	-	-	-
Steel							
Wages	.641	.500	.333	.167	-	-	-
Materials' Prices	.359	.500	.333	.167	-	-	-
Nonferrous Metals							
Wages	.765	-	-	.250	.250	.250	.250
Materials' Prices	.235	.667	.333	-	-	-	-

Table 3. Actual price changes in 1974 and 1975 compared with those forecast using the best equations in Table 1, in percent per year.

Primary Industry	1974		1975	
	Actual	Predicted	Actual	Predicted
Textiles	3.9	6.5	4.8	7.0
Lumber	-11.1	0.8	6.4	-3.4
Paper	28.5	15.6	2.3	4.0
Chemicals	53.6	12.5	9.6	-1.3
Fertilizers	52.3	16.9	-6.2	13.5
Stone, clay and glass	19.1	10.4	7.0	8.8
Steel	38.2	17.7	6.4	1.8
Nonferrous metals	34.4	12.9	-8.0	-3.5

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