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The Impact of Aggregate Demand on Prices

DIFFERING IMPLICIT assumptions regarding the response of the aggregate price level to changes in aggregate demand underlie many of the most important disputes in the field of macroeconomics, both at the abstract level of theoretical discussion and at the practical level of policy recommendation. When aggregate demand shifts in either direction, so does the "market-clearing" aggregate price level at which output remains fixed. A "perfectly flexible" actual price level shifts instantaneously to the market-clearing level in response to a shift in demand, but an "imperfectly flexible" price level changes only gradually toward the market-clearing level, thus allowing real output to vary in the same direction as the demand shift during the transition to complete price adjustment.

The resolution of several important issues depends on the speed of price adjustment:

1. Some have applied the theory of rational expectations to stabilization policy to conclude that the monetary authority cannot affect real output by systematic policy reactions if these depend in a regular way on past events and thus can be anticipated by economic agents.[1] This conclusion depends

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1. Robert E. Lucas, Jr., "Expectations and the Neutrality of Money," *Journal of Economic Theory*, vol. 4 (April 1972), pp. 103–24; Thomas J. Sargent, "Rational Expectations, the Real Rate of Interest, and the Natural Rate of Unemployment," *BPEA, 2: 1973*, pp. 429–72; Thomas J. Sargent and Neil Wallace, " 'Rational' Expectations, the Optimal Monetary Instrument, and the Optimal Money Supply Rule," *Journal of Political Economy*, vol. 83 (April 1975), pp. 241–54.

for its validity on the perfect flexibility of prices; when prices are imperfectly flexible, firms and workers will be constrained from selling all the goods and labor they want to sell at the actual price and wage level even though they know the precise path of the money supply this year; and the monetary authority thus retains control of real output even in the face of perfect knowledge of its actions.[2]

2. When policymakers inherit an inflation rate well above the optimum, as in 1969–70, they must compare the long-term benefits of lower inflation with the short-run costs of the recession required to bring it about.[3] Inflation can be eliminated instantaneously without recession when the aggregate price level is perfectly flexible, but the recession that occurs with imperfect flexibility may impose short-run costs sufficient to restrain policymakers from attempting to reduce inflation all the way to its optimum rate.[4]

3. The optimal response of policy to a supply shock such as the increased oil prices of 1974 is a *reduction* in the rate of monetary growth if other prices are perfectly flexible and an *increase* if these prices are absolutely rigid.[5]

4. The extra inflation that would be associated in 1976–77 with the temporary but substantial monetary acceleration recommended by many nonmonetarist commentators could range from substantial to negligible, depending on the short-run response of prices to higher aggregate demand.[6]

2. Stanley Fischer, "Long-Term Contracts, Rational Expectations, and the Optimal Money Supply Rule," Working Paper (Massachusetts Institute of Technology, June 1975; processed); Edmund S. Phelps and John B. Taylor, "Stabilizing Properties of Monetary Policy under Rational Price Expectations," Discussion Paper 74–7507 (Columbia University, July 1975; processed); Robert J. Gordon, "Recent Developments in the Theory of Inflation and Unemployment," *Journal of Monetary Economics* (forthcoming, April 1976).

3. Assuming they have a positive rate of time discount.

4. Robert E. Hall, "The Phillips Curve and Macroeconomic Policy," *Journal of Monetary Economics*, vol. 2 (January 1976 supplement). The degree of price flexibility affects the optimum inflation rate selected by a vote-maximizing representative government in William D. Nordhaus, "The Political Business Cycle," *Review of Economic Studies*, vol. 42 (April 1975), pp. 169–90, and in Robert J. Gordon, "The Demand for and Supply of Inflation," *Journal of Law and Economics*, vol. 18, no. 2 (October 1975, supplement).

5. Robert J. Gordon, "Alternative Responses of Policy to External Supply Shocks," *BPEA, 1:1975*, pp. 183–204.

6. An example of a recommendation for temporary monetary acceleration is contained in James Tobin, "Monetary Policy and the Control of Credit," in Albert T. Sommers, ed., *Answers to Inflation and Recession: Economic Policies for a Modern Society* (The Conference Board, 1975), pp. 2–19.

Aims of the Paper

The basic aim of this paper is to look inside the "black box" model that relates prices to aggregate demand in an attempt to isolate the relative size of the demand effect on particular sectors of final demand. In contrast to most recent empirical work on inflation, which has concentrated on the size and stability of coefficients in the wage equation (1 below), this paper concentrates on a reexamination of the price equation for final output (3 below). The following questions are addressed:

1. Given the behavior of wages, is there any evidence that the rate of change of prices of final output in the U.S. economy depends on aggregate demand? Or is the finding by Nordhaus and Godley for the United Kingdom that "demand did not contribute in either a systematic or a significant way . . . after normal cost changes were accounted for"[7] also true for the United States?

2. Is there any evidence that the response of prices to changes in aggregate demand, again given wage rates, has weakened during the postwar period, thus increasing the length and severity of the recession required to achieve a given reduction in the rate of inflation?[8]

3. Does the "standard" cost that is marked up by businessmen include capital as well as labor costs? Is there any evidence that changes in any or all of the three main components of capital cost—interest rates, tax rates and credits, and the relative price of investment goods—cause changes in the price of final output?

4. How does a reduced-form relationship between the rates of change of prices and the money supply perform, in comparison with a structural markup equation in which wages are exogenous? Is the effect of money on prices instantaneous, as required by the rational-expectations literature, or does it operate with a long lag?

5. Do disaggregated equations confirm earlier results that the U.S. price

7. William D. Nordhaus and Wynne Godley, "Pricing in the Trade Cycle," *Economic Journal*, vol. 82 (September 1972), p. 873.

8. Cagan recently presented evidence of a weaker downward response of prices in recessions but made no attempt to decompose the change between the labor and commodity markets. See Phillip Cagan, "Changes in the Recession Behavior of Wholesale Prices in the 1920's and Post-World War II," *Explorations in Economic Research*, vol. 2 (Winter 1975), pp. 54–104.

controls of 1971–74 significantly reduced prices relative to wages?[9] If so, did the controls have this effect across the board or only in particular sectors?

6. Does disaggregation provide benefits that outweigh the costs of data collection and equation specification? Do the disaggregated price equations either fit the sample period or forecast beyond the sample period better than does a single aggregate-price equation?

7. Finally, does the unprecedented price experience of 1974, with an average annual rate of increase in the private product deflator during the year of 11.9 percent, demonstrate that time-series econometrics has failed to provide a stable and reliable explanation of the inflation process? Or, rather, is it possible to explain the events of the past few years with equations estimated for a time period ending in mid-1971?

Price Flexibility and Wage Inflexibility

The flexibility of the aggregate price level (P) depends on the degree of price flexibility in the three major submarkets for labor, crude commodities, and final output. The process of price adjustment in the economy may be described, first, by an "expectational Phillips curve" wage equation:

$$w_t = p_t^e + a(Z_t), \qquad a(0) = 0. \tag{1}$$

Here and in what follows, variables designated by lower-case letters denote percentage rates of change. Thus, w_t and p_t^e are, respectively, the current rate of change of the wage rate and of the expected price level, and Z_t is the current excess demand for labor. Second, changes in the price of crude materials, v_t, relative to the expected general price level ($v_t - p_t^e$), may depend on the excess demand for commodities, X_t:

$$v_t - p_t^e = b(X_t), \qquad b(0) = 0. \tag{2}$$

Finally, neglecting productivity change and indirect taxes, the rate of change of prices of final output can be written as the weighted average change in factor costs, which here are confined to wages and costs of crude materials, plus the rate of change of the markup over factor cost, which in turn is assumed to depend on the rate of change of the excess demand for commodities:

$$p_t = c_1 w_t + (1 - c_1) v_t + f(X_t), \qquad f(0) = 0. \tag{3}$$

9. Robert J. Gordon, "The Response of Wages and Prices to the First Two Years of Controls," *BPEA, 3:1973*, pp. 765–78.

Adding the assumption that the expected rate of inflation is determined adaptively,

$$(4) \qquad p_t^e = dp_t + (1 - d)p_{t-1}^e,$$

permits solving for the actual rate of inflation as a function of two sets of predetermined variables, the expected rate of inflation in the previous period, and the excess demands for labor and commodities:

$$(5) \qquad p_t = p_{t-1}^e + \frac{c_1 a(Z_t) + (1 - c_1)b(X_t) + f(X_t)}{1 - d}.$$

Even if the short-run Phillips curve for wages were completely flat, with the slope of the $a(Z_t)$ function equal to zero, the overall response of the price level to a change in aggregate demand might nevertheless be substantial if the slopes of the $b(X_t)$ and $f(X_t)$ functions were steep enough. Some commentators have argued that the downward rigidity of wage rates means that restrictive monetary policy can cause a very deep and long recession with little downward adjustment of prices, neglecting entirely the possible impact of demand on prices of crude materials and on the margins between prices and factor costs.[10]

The Theory of Markup Pricing

The optimal long-run price net of indirect taxes for a "neoclassical" profit-maximizing firm in a closed economy has been shown by Nordhaus to be based on factor cost:[11]

$$(6) \qquad (1 - \tau_t^I)P_t = M_t \hat{Q}_t\ {}^1 N_t{}^{\alpha_1} W_t{}^{\alpha_2} V_t{}^{(1-\alpha_1-\alpha_2)},$$

10. See especially Tobin's 1974 simulations, in which the downward response of the inflation rate is based entirely on the adjustment coefficient in the wage equation—$a(Z_t)$—with no allowance at all for an effect of demand on the prices of crude and final commodities. James Tobin, "Monetary Policy in 1974 and Beyond," *BPEA, 1:1974*, pp. 219–32.

11. William D. Nordhaus, "Recent Developments in Price Dynamics," in Otto Eckstein, ed., *The Econometrics of Price Determination*, A Conference Sponsored by the Board of Governors of the Federal Reserve System and the Social Science Research Council (Board of Governors, 1972), equation 28, p. 29, with time subscripts and the indirect tax term added here.

The particular form of 6 assumes a Cobb-Douglas production function with constant returns to scale. As Nordhaus points out, an important limitation of 6 is the unrealism of the underlying demand function for industries that are neither monopolistic nor competitive.

where

τ^I = the indirect tax rate
P = the sales price
$\hat{Q}$ = index of neutral technical change
N = the price of capital services
W = the price of labor
V = the price of raw materials
M = a scale term
α_1, α_2 = share of capital and of labor, respectively, in total sales.

The coefficient on materials cost would be zero if 6 were applied to an aggregate closed economy and greater than zero for a subsector of the economy or an economy with material imports. Nordhaus notes three important differences between 6 and price equations that are often fitted empirically. First, a 1 percent increase in the wage rate should cause an increase in the price level net of taxes of only α_2 percent, where α_2 is the share of the wage bill in total sales, in contrast with the higher long-run elasticities found in many empirical tests. Second, the service price of capital is an important component of price, which has typically been excluded in empirical tests. Finally, the optimal-pricing rule in 6 does not, in general, coincide with an equation that embodies "target return" markup pricing except when markets are competitive.

The Nordhaus formulation in 6 can be rewritten in a form more convenient for estimation. First, the technical change can be assumed to be labor-augmenting rather than neutral, so that a 1 percent increase in the wage rate *relative to the productivity trend* raises price by α_2 percent. Second, the price of capital services can be decomposed into three components, the price of capital goods (P_t^k), the gross real rate of return to capital (R_t), and a tax factor (J_t):[12]

$$N_t = P_t^k R_t J_t. \tag{7}$$

When 7 and the new productivity assumption are substituted into 6, the result, after some algebraic manipulation, is

$$P_t = \left(\frac{M_t}{1-\tau_t^I}\right)^{1/\alpha_2} \frac{W_t}{\hat{Q}_t} \left(\frac{P_t^k R_t J_t}{P_t}\right)^{\alpha_1/\alpha_2} \left(\frac{V_t}{P_t}\right)^{(1-\alpha_1-\alpha_2)/\alpha_2}. \tag{8}$$

12. The components of the service price can be further decomposed into $R = \rho + \delta$ and $J = (1 - \eta - \tau^C \mu)/(1 - \tau^C)$, where ρ is the real rate of interest, δ is the depreciation rate, η is the rate of investment tax credit, μ is the present value of the depreciation deduction, and τ^C is the corporate tax rate. This model of the cost of capital is developed in Robert E. Hall and Dale W. Jorgenson, "Tax Policy and Investment Behavior," *American Economic Review*, vol. 57 (June 1967), pp. 391–414.

The particular form of the rearrangement in 8 is designed to clarify the conditions under which the elasticity of the gross sales price to a change in standard unit labor cost ($W/\hat{Q}$) will be unity, not the smaller value α_2 as in the Nordhaus version, equation 6. In the long run one would expect an increase in the wage rate to raise price not simply through the direct labor-cost elasticity (the α_2 term), but also indirectly by forcing up the price of capital goods and of materials; if the costs of these inputs rose proportionately with wage costs, so would the overall price level. Stated in another way, Nordhaus implicitly assumes that the relative price of capital goods and materials is reduced when the wage rate increases; I assume that the two relative prices are independent of changes in the wage rate.[13]

SHORT-RUN PRICING

The attempt to convert the long-run price equation 8 into a form suitable for estimation of short-run price changes makes it clear that firms may not base their estimate of the underlying "standard" rate of technological change solely on an exponential trend. Instead, they may consider deviations in the actual level of productivity (Q_t) from trend (Q_t^*) partially as temporary and partially as calling for an adjustment in the "standard" productivity level:

$$\hat{Q}_t = Q_t^{*\sigma} Q_t^{(1-\sigma)}, \tag{9}$$

where σ is a parameter.

The effect of short-run changes of aggregate demand can be introduced into 8 in two ways. First, it might be assumed that the level of the scale term, M_t, which can now be thought of as the markup fraction, depends on the level of excess demand (X_t);[14] noncompetitive firms—that is, those with some short-run monopoly power—might raise their markup margins to a high level during a boom of a given intensity and shift to a lower level during a recession in which demand exhibits a given degree of weakness.

$$M_t = X_t^{\beta}, \text{ or } m_t = \beta x_t, \tag{10}$$

where lower-case letters again represent rates of change. An alternative ap-

13. Detailed information on the labor intensity of capital goods and materials would be required before a choice could be made between these two possibilities, let alone the further possibilities that the two relative prices are increased or change in different directions.

14. The symbol X_t is defined as a ratio—excess demand divided by capacity.

proach is the assumption that the price adjusts to eliminate excess demand:[15]

(11) $$m_t = \gamma X_t.$$

In 11, the rate of change of prices relative to cost depends on the *level* of excess commodity demand, an assumption with the appealing feature that it parallels the form of the expectational Phillips curve for wages in equation 1 above. There is no need to make an a priori choice between 10 and 11, however, since they can be combined, and the data can make the choice:

(12) $$m_t = \beta x_t + \gamma X_t.$$

When 9 is substituted into 8, the result converted into an equation for the growth rate of prices, and the rate of change of the markup allowed to depend on both the rate of change and the level of excess demand as in 12, the result is the "core" price equation:

(13) $$\begin{aligned} p_t = {} & w_t - q_t^* - (1 - \sigma)(q_t - q_t^*) \\ & + \frac{1}{\alpha_2}[\beta x_t + \gamma X_t + \alpha_1(p_t^k - p_t + r_t + j_t) \\ & + (1 - \alpha_1 - \alpha_2)(v_t - p_t) + h_t], \end{aligned}$$

where h_t is the rate of growth of $1/(1 - \tau_t^I)$. The price equation estimated in my previous work on inflation and price controls appeared in exactly the same form as 13 but restricted several of the coefficients to be zero and separated wages from other compensation.[16]

DISAGGREGATION BY SECTOR

Previous empirical work on prices has taken the form of either aggregate studies, which in general have attempted to explain the U.S. Department of Commerce's deflator for nonfarm private output (DPN), an integral variable in all large-scale econometric models of the U.S. economy, or disaggregated studies of components of the two basic indexes compiled by the U.S. Bureau of Labor Statistics, the consumer price index (CPI) and the

15. Equation 11 has been used previously in this context in Otto Eckstein and Gary Fromm, "The Price Equation," *American Economic Review*, vol. 58 (December 1968), pp. 1159–83.

16. See Robert J. Gordon, "Inflation in Recession and Recovery," *BPEA, 1:1971*, pp. 105–58. The price equation on p. 129 of that paper makes the restrictive assumptions that $\gamma = r_t = j_t = h_t = 0$, and that $p_t^k = v_t = p_t$.

wholesale price index (WPI).[17] This paper attempts a modest disaggregation within the framework of the national income accounts (NIA) compiled by the Department of Commerce. The aim is to examine the process of price determination within the major sectors of the private economy; in contrast to disaggregated studies of the CPI and WPI, the predictions of my sectoral price equations can be averaged and compared with predicted and actual values of the NIA aggregate private deflator.

Although a wide variety of *annual* series are published, the scope for disaggregation within the NIA framework is quite limited for *quarterly* data. Quarterly deflators are published for three breakdowns of gross national product: type of expenditure (consumption, investment, government expenditure, and net exports); type of product (durables, nondurables, services, and structures); and producing sector (nonfarm business, farm business, private nonbusiness, and government). The last can hardly be classified as disaggregation, since the dominant nonfarm business sector is not split up at all. In this paper a disaggregation by type of product is chosen over that by type of expenditure because most of the extra distinctions between indexes in the expenditure breakdown are based on faulty data—for example, the distinction between producers' and consumers' durables, and between residential and nonresidential structures.[18]

The actual data used in this paper, then, refer to four types of product, durables, nondurables, services, and structures—with nondurables then split, for reasons described below, into food and nonfood components, thus giving five sectors for analysis. Wage payments to government employees

17. Research published through 1970 is reviewed by Nordhaus in "Recent Developments in Price Dynamics." Among the more recent papers on the DPN are my "Inflation in Recession and Recovery"; George de Menil, "Aggregate Price Dynamics," *Review of Economics and Statistics*, vol. 56 (May 1974), pp. 129–40; and Charles L. Schultze, "Falling Profits, Rising Profit Margins, and the Full-Employment Profit Rate," *BPEA, 2:1975*, pp. 449–69. Of the recent disaggregated studies of the CPI and WPI, the most comprehensive are Otto Eckstein and David Wyss, "Industry Price Equations," in Eckstein, ed., *Econometrics of Price Determination*, and Joel Popkin, "Consumer and Wholesale Prices in a Model of Price Behavior by Stage of Processing," *Review of Economics and Statistics*, vol. 56 (November 1974), pp. 486–501.

18. Published indexes show a steady increase in the relative price of producers' relative to consumers' durables that is mainly fictitious due to the omission of the declining price of electronic computers and to the greater attention paid to quality changes for consumer durables. In the case of structures, the residential and nonresidential indexes make productivity adjustments that are arbitrary, capricious, and incomplete. See Robert J. Gordon, *The Measurement of Durable Goods Prices* (National Bureau of Economic Research, forthcoming).

are excluded from services, so that the aggregate and disaggregated indexes refer to the private economy only. The official deflator for private product is subject to erratic quarter-to-quarter movements when the mix of output shifts between sectors with high and low deflators, particularly when auto production drops during recessions or strikes.[19] This problem is minimized in this paper by two procedures. First, the deflators for durables and nondurables refer to final sales, not actual production, and exhibit smaller quarter-to-quarter changes during recessions or strikes. Second, the aggregates of the price-change variables are calculated by a chain-index procedure, equivalent to the use of a moving weighted average of the price changes in individual sectors.[20]

THE ENERGY ADJUSTMENT

The markup of final-output prices over wage rates has been strongly influenced in the 1970s by the increased relative prices of food and energy. An attempt is made in this paper to treat the deflator for food prices in a fashion parallel to deflators for other final outputs, and to identify the role of demand shifts on the price of food. But the magnitude and timing of the 1973–74 explosion in energy prices can only be regarded as noneconomic and exogenous. The various behavioral hypotheses regarding price determination should thus be tested using price variables that have been purged of the direct and indirect effects of higher energy prices.

In his recent paper, Schultze excluded from the nonfarm private deflator an estimate of the "relative increase in domestic fossil-fuel prices since the onset of the embargo in October 1973."[21] Although this procedure is adequate for an aggregate price equation, it cannot be used in a disaggregated study because (1) the weight of energy input differs among sectors of final output, and (2) the average price of energy inputs differs among sectors

19. Even in 1975 the deflator for gross auto product used in this paper was much lower than the deflators for services and structures. This problem of distortions arising from output shifts is much less important, at least temporarily, in the new deflators for the national income accounts, which have been rebased from 1958 to 1972, but which were released too late for use in this paper.

20. Specifically, the weights are an average of the ratios of sectoral final sales to aggregate final sales in the current and the three most recent quarters, all in current dollars. Each of the various aggregates in table 2—excluding food, energy, and both—is calculated with different weights; in each case the figures for current-dollar sales used in the weights are the same as the numerators of the sectoral deflators.

21. Schultze, "Falling Profits," p. 449.

because they use various proportions of coal, gasoline, fuel oil, natural gas, and electricity. In this paper the energy adjustment excludes from current- and constant-dollar final sales in each sector (with oil imports added to nonfood nondurable final sales) the current- and constant-dollar values of both intermediate and final purchases of energy. Adding in oil imports and then subtracting total energy purchases means, in effect, that the energy adjustment applies to the domestic economy only, and includes the effect of increases in the prices of domestic crude oil, coal, and natural gas, as well as changes in the price of value added in the petroleum-refining and electricity-generating industries. This procedure improves the timing of the energy adjustment. For instance, a firm selling final output and purchasing electricity as its only form of energy input is not affected immediately by an increase in crude oil or coal prices if the utility supplying its electricity encounters a delay when it petitions a regulatory body to raise its prices.

Energy enters the price deflators for final output by two routes. The first is the direct purchase by consumers of gasoline, fuel oil, coal, natural gas, and electricity. The energy coefficients displayed in table 1 indicate that 22.7 percent of nonfood nondurable final sales in 1975:3 consisted of gasoline, motor oil, fuel oil, and other fuel, and 6.2 percent of sales of services consisted of electricity and natural gas.[22] The energy adjustments for direct purchases are straightforward and are based on unpublished quarterly NIA data for direct energy purchases in 1947–75 in current and constant dollars.[23]

Energy enters final output prices by a second, indirect, route—as an input in the production of almost all goods and services. The 1967 input-output table was employed to allocate energy input to five sectors of final private output.[24] The first stage in the calculation was to tally, for each of the seventy-eight two-digit nonenergy industries selling final output, the value of their purchases from three energy industries—coal mining, petroleum refining, and electricity generation,[25] and then to add in the energy

22. Consumer purchases of coal are negligible.

23. Unpublished quarterly estimates of current- and constant-dollar purchases are subcategories of personal consumption. These estimates were also the source of the quarterly deflator for personal consumption of food (which was then adjusted for exports and imports). Some interpolation was necessary in earlier years. See appendix A for additional information on the energy and food adjustments.

24. "The Input-Output Structure of the U.S. Economy: 1967," *Survey of Current Business*, vol. 54 (February 1974), pp. 24–56. See especially table 1, pp. 38–43.

25. A fourth energy industry, crude oil, sells almost all of its output to the petroleum refining industry.

Table 1. Share of Direct and Indirect Energy Input in Gross Private Final Sales, by Sector, Third Quarter 1975

Sector and use of input	*Value of energy input (billions of dollars)*	*Total final sales (billions of dollars)*	*Share of energy input in total sales (percent)*
Total economy	160.7[a]	1,330.8	12.1
Durables (indirect)	16.2	269.0	6.0
Nondurables			
Food (indirect)	12.3	218.6[b]	5.6
Nonfood	71.8[a]	242.7	29.6
Indirect	16.7	...	6.9
Direct (gasoline, motor oil, fuel oil, and other fuel)	55.1[a]	...	22.7
Services	53.4	470.9	11.3
Indirect	24.1	...	5.1
Direct (electricity and natural gas)	29.3	...	6.2
Structures (indirect)	7.0	129.6	5.4

Source: See appendix A.
a. Does not exclude oil imports and thus differs from appendix table A-1.
b. Consumer expenditures on food plus food exports minus food imports.

purchases of each of their nonenergy supplying industries. Further additions were made for the purchases of the suppliers from *their* suppliers, and so on until total intermediate purchases of energy were accounted for.

Table 1 displays the results of the calculation of 1967 indirect energy input, restated in 1975:3 prices of both energy input and final output. It is perhaps surprising that the indirect energy shares are so similar for the four types of products. The major differences appear to lie in the proportions of fuel and electricity; consumer nontransportation services are relatively intensive in electricity, whereas relatively little electricity is used in producing structures.

A quarterly constant-dollar series for indirect energy use was constructed for 1947–75 for each of the five sectors on the assumption that the input-output coefficients remained fixed in real terms at 1967 levels. An energy price index was then used to create a parallel current-dollar series for indirect energy use. The direct and indirect measures of quarterly energy input in both current and constant dollars were then subtracted from final sales in each sector to yield five sectoral deflators for private final sales net of energy.

Behavior of the Private Deflators Adjusted for Food and Energy

Several interesting features of price behavior are illustrated in table 2, which displays for a number of price deflators the total of the fifteen quarterly percentage changes between 1971:4 and 1975:3, and the annual rate of change in selected subperiods. The energy adjustment reduces the 27 percent price increase for the private economy between 1971:4 and 1975:3 by about 2½ percentage points, and the exclusion of food cuts out another 2.4 percentage points. Thus, the nonfood deflator net of energy increased for the period at an annual rate of 6.0 percent, as compared with the 4.8 percent rate of increase in the nonfood deflator in the six quarters prior to the imposition of price controls in 1971.

The effects of excluding food and energy from the aggregate chain index are quite different in timing. The relative increase in the index of food prices occurred mainly in 1973 (line 4a), whereas the energy explosion was concentrated in the first half of 1974 (line 8a). Fifty-two percent of the effect of the energy adjustment (line 2b compared with 2a) occurred in the first half of 1974, 12 percent in 1972 and 1973, and the remainder since 1974:2. Table 2 also reveals variations in the timing and magnitude of the increases in energy prices among the various sectors. The net price of energy increased much less in the nonfood nondurables sector than in other sectors, because imports of petroleum products are subtracted from direct and indirect purchases of energy in that sector. In the last half of 1973 the net energy deflator for the nonfood nondurables sector actually declined, reflecting the role of this sector as a conduit for imports. In a simple extreme case in which the nonfood nondurables sector imported refined oil and sold all of it to other sectors, reserving none for its own indirect or direct use, the net energy deflator in that sector would decline pari passu with any increase in the price of petroleum imports, reflecting the effect of energy in reducing the measured sectoral deflator for final sales.[26]

Another feature of table 2 is the somewhat greater effect of excluding

26. Putting the point another way, between early 1974 and mid-1975 the published deflator for nondurables increased substantially less than the deflator for domestic nondurables consumption because of the effect of the quadrupling of oil-import prices. Nondurable net exports during this period were strongly positive in 1958 constant dollars, and strongly negative in current dollars. (These remarks are based on an unpublished series on nondurable exports and imports kindly supplied by John A. Gorman of the U.S. Bureau of Economic Analysis.)

Table 2. Percentage Change in Alternative Price Indexes for the Private Economy, 1971:4–1975:3

Index	*Total percentage change*[a] *1971:4–1975:3*	*Average annual percentage change*					
		1971:4–1972:4	*1972:4–1973:2*	*1973:2–1973:4*	*1973:4–1974:2*	*1974:2–1974:4*	*1974:4–1975:3*
1. *Official published private product deflator*							
a. Total	27.09	3.11	6.66	8.41	10.91	12.91	6.05
b. Nonfarm	25.77	2.41	4.72	5.71	13.82	12.43	6.70
2. *Private final-sales chain*							
a. Total	27.32	3.51	6.87	8.53	10.43	12.31	6.44
b. Excluding energy	24.75	3.37	6.48	8.62	7.78	11.87	5.34
c. Excluding food	25.13	3.29	5.21	6.81	9.63	12.27	6.50
d. Excluding energy and food	22.35	3.25	4.66	6.83	6.94	11.87	5.25
3. *Durables final sales*							
a. Total	22.35	0.71	2.40	5.20	4.75	19.96	7.31
b. Excluding energy	20.23	0.54	1.87	4.59	2.66	19.80	6.95
4. *Food final sales*							
a. Total	40.18	4.16	16.88	18.59	14.95	12.42	6.13
b. Excluding energy	38.19	4.09	16.90	18.52	12.30	11.88	5.72
Addendum: Deflator for gross farm product	50.99	22.90	55.12	42.49	−48.03	28.45	−21.86
5. *Nonfood nondurables final sales*							
a. Total	28.62	3.46	6.55	7.84	14.24	9.96	7.84
b. Excluding energy	26.84	3.81	5.45	9.78	14.87	9.96	3.99

6. *Services*							
a. Total	23.51	3.54	4.80	6.55	10.59	9.17	5.89
b. Excluding energy	20.27	3.40	4.45	6.35	7.08	8.21	5.12
7. *Structures*							
a. Total	29.34	6.71	9.30	8.82	8.64	11.55	4.63
b. Excluding energy	27.09	6.75	9.07	8.41	6.01	10.97	4.15
8. *Energy deflators*							
a. Total	54.18	3.99	10.75	6.86	41.39	16.64	16.48
b. Nonfood nondurables[b]	36.51	2.49	9.51	−2.90	9.06	14.30	25.37
c. Services	54.92	4.98	8.41	8.58	47.42	17.99	11.65
d. Other sectors	82.87	5.49	16.12	20.46	74.90	23.21	13.37

Sources: Official published deflators, *Survey of Current Business*, various issues, and U.S. Bureau of Labor Statistics, "News," various releases; other data, see appendixes A and B.

a. Sum of fifteen quarterly percentage changes.

b. This deflator is the ratio of current- to constant-dollar values of the following: direct plus indirect energy input in nonfood nondurables, *minus* oil imports.

food from the aggregate final-sales chain index (line 2c compared with line 2a) than of excluding the farm sector from private product (line 1b compared with line 1a). Since net farm exports are included in both the food and the farm deflators, most of the remaining difference between the two is accounted for by the inclusion in the former of the gross product of the farm-to-market food-processing industries and of the cost of inputs purchased by farmers. Over the period covered in table 2, the implicit deflator for food minus gross farm product increased 50 percent faster than that for the private sector as a whole.[27]

I believe that the unusual increase in relative prices in this sector is a puzzle that will require a separate study to untangle. For this reason, the index of change in aggregate prices used in the econometric equations in this paper excludes from private final sales the value of food sales (that is, food consumption plus exports minus imports) both (1) to avoid attributing to the entire economy, as does Schultze, puzzling behavior that can be traced to one sector, and (2) because the farm deflator used in calculating the usual nonfarm private deflator may be unreliable.[28] A preliminary attempt to track down developments in the food-minus-farm sector suggests that labor productivity may have been part of the problem. Between 1971 and 1974 output per manhour in the industries that market food products actually *fell* by 4 percent. Unit labor cost rose over the same period by 32.8 percent, as compared with an increase of only 20.3 percent in the entire private economy.[29]

In "Falling Profits," Schultze attempted to explain the increase between 1973:1 and 1975:2 in the ratio of price to trend unit labor cost in the nonfarm sector. In contrast with the 6.0 percent increase over that period in Schultze's ratio using an energy-adjusted nonfarm price index and a trend-adjusted wage series, another ratio using my energy- and food-adjusted chain index and Schultze's labor-cost variable increased exactly half as

27. Taking the simple difference between the implicit deflators in 1975:3 and 1971:4, and dividing by the value of the deflator in 1971:4, yields the following percentage changes for the various deflators: private product, 30.7; food, 48.3; farm, 57.8; and food minus farm, 45.5.

28. The second possibility was suggested to me by Barry Bosworth.

29. Unit labor cost, output, and manhours for industries that market food products are from U.S. Department of Agriculture, Economic Research Service, *Marketing and Transportation Situation*, MTS-198 (August 1975), table 11, p. 24. Total private unit labor cost is from *Monthly Labor Review*, vol. 98 (December 1975), table 31, p. 109.

much, 3.0 percent. The difference between Schultze's and my adjusted indexes breaks down as follows:

Component of difference	*Percentage points*
1973:1–1975:2 increase in my chain-weighted nonfood net-of-energy index for private final sales	18.43
Contribution of increased relative price of the food-minus-farm sector	1.93
Contribution of excess of my energy deduction over Schultze's energy deduction	0.77
Contribution of my use of the final-sales concept (that is, exclusion of manufacturing inventory accumulation)	0.27
Effect of chain-weighted index in place of implicit deflator	−0.05
Unexplained residual	0.51
Total 1973:1–1975:2 increase in Schultze index for nonfarm sector net of energy	21.86

DATA FOR THE CORE PRICE EQUATION

In addition to data on the price level, the core price equation 13 developed above requires data for several explanatory variables.

Commodity excess demand (X_t). A traditional problem in empirical studies of price behavior is the absence of adequate measures of the demand for commodities. Measured sales may differ from demand if supply constraints prevent the instantaneous filling of orders. This paper follows previous studies in its use of the ratio of unfilled orders to capacity as a proxy for X_t in the total economy and in durables manufacturing, because this is the only available variable that measures demand rather than supply.[30] Because the coverage of this variable is limited to durables manufacturing, the percentage gap between actual and potential output is also used below as a potential proxy. Other proxies are used in several of the disaggregated sectoral equations.

The wage rate (W_t). Two alternative comprehensive wage indexes are available, private nonfarm compensation per manhour (CMH) and average

30. This variable was used in my "Inflation in Recession and Recovery" and by de Menil. It is calculated by multiplying the ratio of unfilled orders to shipments (series 852 in *Business Conditions Digest*) by the rate of capacity utilization in manufacturing (series 850), and then detrending.

private nonfarm hourly earnings adjusted to exclude the effects of overtime pay and shifts in interindustry output (AHEA). The former is more comprehensive than the latter but suffers from its sensitivity to cyclical shifts in output. I use the ratio of adjusted to unadjusted average private hourly earnings (AHEA/AHE) to adjust the CMH series for these cyclical shifts. This procedure differs from my earlier price equations, in which the rates of change of AHEA and CMH/AHEA were introduced as two separate variables.[31]

Trend productivity (Q_t^*). This paper follows Schultze by allowing a break in the trend growth rate of productivity, with an estimated annual trend growth rate (q_t^*) of 2.81 percent for 1954–63 and 2.28 percent for 1964–74.[32] To prevent a discontinuity, the shift in the productivity trend was allowed to occur over a period of five years centered in 1964:1.

The price of capital services ($P_t^K R_t J_t / P_t$). The real price of capital services consists of three terms, the relative price of investment goods (P_t^K/P_t), the gross rate of return on capital (R_t), and a tax term (J_t). The relative-price data were obtained from the national income accounts. The gross rate of return on capital was defined as the commercial paper rate plus the constant depreciation rate used in B. G. Hickman and R. M. Coen, *An Annual Growth Model of the U.S. Economy* (Amsterdam: North-Holland, 1976), chapter 5, section 4. The tax term, exactly as defined in note 12 above, was obtained from the data bank of the Hickman-Coen model, furnished by my colleague Robert M. Coen.

The relative price of materials (V_t/P_t). The spot-market price index for thirteen raw industrials is used in the equations for the aggregate economy and for manufacturing. The WPI index for crude foodstuffs and feedstuffs products is used as an explanatory variable in the equations for the food deflator. The WPI index for nonfood materials and components for construction is used as an explanatory variable in the construction equation.

31. See "Inflation in Recession and Recovery," pp. 115–18.

32. An equation was estimated having the general form

$$q_t^* = a_0 A_0 + a_1 A_1 + \sum_{i=0}^{7} b_i g_{t-i},$$

where g_t is the quarterly difference in the ratio of the GNP gap to potential output, $A_0 = 1.0$ for 1953:1–1963:4 and 0 thereafter, and $A_1 = 1.0$ for 1964:1–1975:2 and 0 previously. The resulting estimates of the trend were $a_0 = 0.00708$ and $a_1 = 0.00570$. A similar equation was estimated for manufacturing and indicates a slight acceleration in trend productivity growth, from $a_0 = 0.00731$ to $a_1 = 0.00854$, with the equation split at 1968:4.

The indirect tax rate (τ_t^I). The effective indirect tax rate is measured as the ratio of the NIA series on indirect tax liability to total personal consumption expenditures.

Empirical Results for the Private Nonfood Deflator

COMMON FEATURES OF THE EQUATIONS

The basic results in the tables below are reported for a single common sample period, 1954:2 to 1971:2. The starting date, shared with my earlier papers for *BPEA*, was chosen to avoid the period of price controls during the Korean War and an outlying observation in the first quarter of 1954. The ending date is the final quarter before the imposition of wage and price controls in August 1971. While the price equations for disaggregated final output are estimated below only for the single common sample period, equations explaining the aggregate private nonfood deflator are estimated also for the two halves of the common sample period, and for a longer period that includes the Korean War.

The dependent price variable in all equations is in the form of a one-quarter rate of change (at a quarterly rate). All independent variables are also measured as one-quarter rates of change, with the exception of the level of aggregate demand (X_t). Although some studies by other authors have constrained all independent variables in the price equation to influence the dependent variable with the same distributed lag, through the technique of including the lagged dependent variable on the right-hand side of the estimated equations, experimentation suggests that the lag patterns of the various independent variables are actually quite different.

The Almon technique allows the estimation of different polynomial distributed lags for several independent variables. Its major disadvantage is that several initial trial runs are required to determine whether any independent variables exhibit lagged effects and, if so, for how long. In all trial runs the individual lag coefficients were assumed to lie on a third-degree polynomial and no end-point constraints were imposed. Variables with low t-ratios on the individual lag coefficients in the basic core equation for the common sample period were thereafter entered without lags. When t-ratios on the final (tail) lag coefficients were relatively large, on the other hand, the lag distribution was lengthened. Since this search procedure was not repeated for the disaggregated equations nor for the tests of the aggregate equation over the subsample periods, the length of the lag distributions may be too short or too long in some of these cases.

THE EFFECT OF AGGREGATE DEMAND

In table 3, which presents the basic results, the left panel displays the coefficients of several common "nondemand" variables, and the right panel compares the coefficients of alternative variables that serve as proxies for the effect on prices of aggregate demand. Each of the nondemand variables in columns (2) through (6) is the quarterly rate of change of a ratio, as follows:

Column 2 is compensation per manhour in the private economy, multiplied by the ratio of the adjusted to the unadjusted index for private nonfarm hourly earnings, and then divided by an estimate of trend productivity $(w - q^*)$.

Column 3 is the ratio of actual to "trend" productivity $(q - q^*)$.

Column 4 is the ratio of the investment-goods deflator to the private-product deflator $(p^k - p)$. The capital-tax and capital-cost variables were dropped after preliminary trials (see the discussion for table 6 below).

Column 5 is the ratio in the form $[1/(1 - \tau)]$, where τ is the effective indirect business-tax rate (h).

Column 6 is the ratio of the spot-market-price index of thirteen raw industrials to the private nonfood index $(v - p)$.

The right panel of the table contains columns for the level and quarterly rate of change of two demand proxies, the gap between real GNP and potential output (*GAP*), and the detrended ratio of unfilled orders to capacity in durables manufacturing (*UFK*). Columns 11 and 12, labeled *UFK*1 and *UFK*2, illustrate coefficients on the rate of change of *UFK* split into one variable (*UFK*1) for the first half of the sample period and another (*UFK*2) for the second half. All variables are expected a priori to have positive coefficients, with the exception of materials prices $(v - p)$, the productivity deviation $(q - q^*)$, and *GAP*. Since the dependent variable is aggregate value added, the coefficient on materials prices should be zero and will be positive only if the timing of price increases is influenced by changes in materials prices. The coefficients on $(q - q^*)$ and *GAP* should be negative.

Equation 3.1 is the complete core equation without any demand variable. As is true in most of the equations for the common sample period, the coefficient on the productivity deviation $(q - q^*)$ has a low significance level. All other variables enter with the expected signs. The size of the other coefficients should be judged in comparison with the theoretical equation 13 above, in which the coefficient on $(w - q^*)$ should be unity, that on $(p^k - p)$ should be α_1/α_2, and that on h should be $1/\alpha_2$, where α_1 is the share of capital and α_2 the share of labor. If, for instance, $\alpha_1 = 0.25$ and $\alpha_2 = 0.75$, then the coefficient on $(p^k - p)$ should be 0.33 and that on h should be 1.33. Most of the coefficients on $(p^k - p)$ in table 3 are of roughly the right size, but all of the coefficients on h are much too small, perhaps indicating a measurement error in the series on effective indirect taxes.

In equations 3.2–3.5, various demand-proxy variables are added, one at a time. The distributed-lag patterns on the level variables (equations 3.2 and 3.3) are first negative and then positive for *GAP*, and the reverse for *UFK*, indicating that these variables basically enter in rate-of-change form, and explaining why the *t*-ratios on the sums of coefficients (equation 3.2, column 7, and equation 3.3, column 8) are so small in spite of the very significant reduction in the standard error achieved in comparison with 3.1. The rate-of-change variables, both *GAP* and *UFK*, also enter strongly, suggesting that aggregate demand does have a strong effect on price markups in the United States, in contrast with the Nordhaus-Godley rejection of "a systematic or significant" aggregate-demand effect in U.K. data.[33] The results also appear to counter the general impression held by many U.S. economists that the demand effect on the price markup is weak—for example, Cagan's remark that "empirical studies have long found that short-run shifts in demand have small and often insignificant effects [on prices] and that, instead, costs play a dominant role.[34] The results in table 3 by no means deny a very strong role for costs, mainly standard unit labor costs, but do allow for a demand effect that makes a significant difference in the rate of inflation between boom years and recession years, holding costs constant (see figure 2 discussed later in this section).

There is little to choose among equations 3.2 through 3.5; nevertheless, a single demand variable must be chosen for further exploration in this and other tables of the paper. The level variables (equations 3.2 and 3.3) are rejected for the expositional reason that their zigzag pattern of coefficients makes the demand effect difficult to display compactly. The choice between

33. "Pricing in the Trade Cycle," p. 873.

34. Phillip Cagan, *The Hydra-Headed Monster: The Problem of Inflation in the United States* (American Enterprise Institute, 1974), p. 22.

Table 3. Effect of Alternative Measures of Demand on Quarterly Percentage Changes in the Chain Index for Private Nonfood Final Sales Net of Energy, Various Sample Periods, 1950–71[a]

Period and equation	Constant (1)	Nondemand variable[b] (quarterly rate of change): Trend unit labor cost $(w - q^*)$[c] (2)	Productivity deviation $(q - q^*)$ (3)	Relative price of investment goods $(p^k - p)$[d] (4)	Effective excise-tax rate h (5)	Relative spot-market-price index $(v - p)$[e] (6)	Demand variable[b], Level: Ratio of GNP gap to potential output GAP[d] (7)	Level: Ratio of unfilled orders to capacity UFK[d] (8)	Quarterly rate of change: Ratio of GNP gap to potential output GAP[d] (9)	Quarterly rate of change: Ratio of unfilled orders to capacity UFK (10)	Quarterly rate of change: $UFK1$[f] (11)	Quarterly rate of change: $UFK2$[f] (12)	Summary statistic: Standard error of estimate (13)	Summary statistic: Durbin-Watson (14)
1954:2–1971:2														
3.1	...	1.020	−0.023	0.388	0.602	0.058	...	...	...	...	...	...	0.00242	1.74
		(18.33)	(−0.66)	(2.82)	(2.75)	(3.24)								
3.2	0.002	0.801	−0.045	0.374	0.599	0.036	−0.013	...	...	...	...	...	0.00217	2.11
	(2.10)	(6.65)	(−1.20)	(2.67)	(2.99)	(2.06)	(−0.87)							
3.3	0.004	1.014	−0.050	0.368	0.328	0.027	...	−0.004	...	...	...	...	0.00201	2.33
	(0.88)	(5.04)	(−1.63)	(3.11)	(1.72)	(1.60)		(−0.62)						
3.4	...	1.089	−0.083	0.556	0.608	0.029	...	...	−0.378	...	...	...	0.00214	2.06
		(20.56)	(−1.82)	(4.25)	(3.11)	(1.71)			(−4.37)					
3.5	...	1.090	−0.024	0.401	0.402	0.025	...	...	...	0.065[d]	...	...	0.00207	2.21
		(19.82)	(−0.77)	(3.37)	(2.09)	(1.46)				(2.74)				
3.6[g]	...	**1.092**	...	**0.411**	**0.416**	**0.026**	...	...	...	**0.068**[d]	...	...	**0.00207**	**2.20**
		(19.97)		**(3.49)**	**(2.17)**	**(1.54)**				**(2.89)**				
3.7	...	1.098	...	0.412	0.407	0.024	...	...	...	...	0.070[h]	0.075[h]	0.00206	2.17
		(21.79)		(3.48)	(2.11)	(1.42)					(4.06)	(4.02)		

1954:2–1962:4														
3.8	...	0.869	−0.019	0.697	0.563	0.063	...	...	...	...	...	...	0.00267	2.25
		(3.24)	(−0.33)	(2.23)	(1.47)	(1.46)								
3.9	...	1.025	−0.017	0.510	0.343	0.035	...	...	...	0.052[h]	...	...	0.00259	2.43
		(3.71)	(−0.19)	(1.58)	(0.87)	(0.77)				(1.67)				
1963:1–1971:2														
3.10	...	1.002	−0.025	−0.455	0.380	0.052	...	...	...	...	...	...	0.00181	1.61
		(16.08)	(−0.51)	(−1.04)	(1.63)	(2.49)								
3.11	...	1.133	−0.026	0.249	0.387	0.008	...	...	...	0.090[h]	...	...	0.00151	2.10
		(18.31)	(−0.66)	(0.62)	(1.99)	(0.43)				(3.85)				
1950:2–1971:2														
3.12[i]	...	1.052	−0.048	0.424	0.358	0.071	...	...	...	...	...	...	0.00386	1.93
		(12.56)	(−0.97)	(2.10)	(1.29)	(4.97)								
3.13[i]	...	1.112	−0.056	0.457	0.166	0.045	...	...	...	0.046[h]	...	...	0.00379	1.93
		(12.78)	(−1.14)	(2.30)	(0.58)	(2.42)				(2.14)				

Sources: Derived from text equation 13. See appendixes A and B for sources of the basic data.

a. The numbers in parentheses are *t*-ratios.

b. See text for detailed definitions of the variables.

c. Each coefficient is the sum of twelve distributed-lag coefficients.

d. Each coefficient is the sum of eight distributed-lag coefficients.

e. The four-quarter rate of change of materials prices minus the four-quarter rate of change of the private nonfood index.

f. *UFK*1 and *UFK*2 refer, respectively, to *UFK* in the first and second halves of the sample period (1954–62 and 1963–71, respectively).

g. Equation 3.6 is considered the basic estimate of the core price equation.

h. Weights on the rate of change of *UFK* were constrained to be 10/30, 8/30, 6/30, 4/30, 2/30.

i. Includes a dummy variable that equals 1.0 during the nine quarters 1951:2 through 1953:2. In equation 3.12, the coefficient on the Korean War dummy is 0.00034 and the *t*-ratio is 0.26. In equation 3.13 the coefficient is −0.00354 and the *t*-ratio is −1.61.

the rates of change of *GAP* and *UFK* was made in favor of the latter on the ground that its overall fit is better, although a case could also be made for the former on the basis that the *t*-ratios on the nondemand variables are higher in equation 3.4 than in equation 3.5.[35]

Equation 3.6 is identical to 3.5 with the insignificant productivity-deviation variable removed and is henceforth taken to be the basic estimate of the core price equation. The individual distributed-lag coefficients in this equation are displayed in table 4; the shape of the lag distribution on standard unit labor cost is humpbacked, that on the relative price of investment goods declines in two steps (in quarters 0–1 and 6–7), while that on the *UFK* demand variable declines monotonically. The respective mean lags on the three variables are 4.14, 2.94, and 1.10 quarters.

Equation 3.7 is the same as equation 3.6 but splits the rate of change of *UFK* into two separate variables for the two halves of the sample period.[36] The coefficients on the rate of change of *UFK* are almost identical in the two subsample periods. Another test of structural shift is reported in equations 3.8–3.11. The core equation as specified in equation 3.5 was run separately for the two halves of the sample period, both with and without the rate of change of *UFK*. Two important points stand out in these comparisons. First, the demand variable is only marginally significant in the first subsample period but is very significant in the second period. Second, a formal Chow test yields *F*-ratios of 1.71 for the equations without a demand variable (that is, equation 3.1 compared with 3.8 and 3.10) and of only 0.68 for the full equations (3.5 compared with 3.9 and 3.11). However, the term for the relative price of capital goods has the wrong sign in the second period when the demand variable is omitted. Thus, with the demand variables in the equation, the hypothesis that the structure was identical in the two periods cannot be rejected.[37]

In short, there is no evidence that the effect of demand on prices has become less important in the second half of the sample period as compared

35. Two other considerations favoring the change in *UFK* are that it was used in my 1971 "Inflation in Recession and Recovery," and thus preserves some continuity of specification, and that the level and rate of change of *UFK* were emphasized in the version of this paper presented at the panel meeting.

36. The distributed-lag coefficients are not estimated freely, but instead are constrained to follow the linear pattern specified in note *h* of table 3.

37. The critical *F*-values are 1.87 at the 5 percent level and 2.40 at the 1 percent level.

Table 4. Estimates of Lag Coefficients in the Core Price Equation[a]

Lag	*Trend unit labor cost* $(w - q^*)$	*Relative price of investment goods* $(p^k - p)$	*Ratio of unfilled orders to capacity* *UFK*
0	0.0461	0.0804	0.0258
	(0.77)	(1.24)	(3.84)
1	0.1095	0.0604	0.0188
	(2.77)	(1.51)	(5.11)
2	0.1474	0.0513	0.0127
	(4.41)	(1.25)	(3.11)
3	0.1636	0.0491	0.0077
	(5.30)	(1.39)	(1.96)
4	0.1623	0.0497	0.0037
	(6.05)	(1.71)	(0.96)
5	0.1474	0.0491	0.0009
	(6.64)	(1.42)	(0.18)
6	0.1229	0.0433	−0.0007
	(5.71)	(1.04)	(−0.13)
7	0.0929	0.0282	−0.0010
	(3.49)	(0.83)	(−0.25)
8	0.0614	...	...
	(1.84)		
9	0.0323	...	...
	(0.87)		
10	0.0097	...	...
	(0.28)		
11	−0.0024	...	...
	(−0.10)		
Sum	1.0929	0.4114	0.0676
	(19.97)	(3.49)	(2.89)
Mean lag (quarters)	4.1	2.9	1.1

Sources: Derived from table 3, equation 3.6, the core equation.
a. The numbers in parentheses are *t*-ratios.

with the first, a conclusion that conflicts with Cagan's research.[38] Further, the structure of the price equation remains quite stable over the 1954–71 period when the demand variable is allowed to enter. The major differences appear to be an increase in the coefficients on trend unit labor cost and on the demand variable from the first subsample period to the second, together with a decrease in the coefficients on the relative price of investment goods and of materials.

38. Cagan, "Changes in the Recession Behavior of Wholesale Prices." Since this paper holds wage behavior constant, while Cagan's does not, the conflicting results may be reconciled if the response of wages to recessions has become weaker, but that of prices *given wages* has not.

A final pair of equations, 3.12 and 3.13, is presented, including all of the variables in equations 3.1 and 3.5, respectively, but extending the sample period back to include the Korean War period. To allow for the effect of price controls during 1951–53, a dummy variable is added to the specification for both equations 3.12 and 3.13 (for details and coefficients, see note *i* to table 3). The longer sample period confirms the basic conclusion that aggregate demand, in the form of the *UFK* variable, adds significantly to the explanation of postwar price behavior. Another feature of the longer sample period is that the relative price of materials has larger and more significant coefficients. As is true in all the sample periods, the coefficient on the relative price of materials drops substantially when the demand variable is introduced, as would be expected if the two are positively correlated.

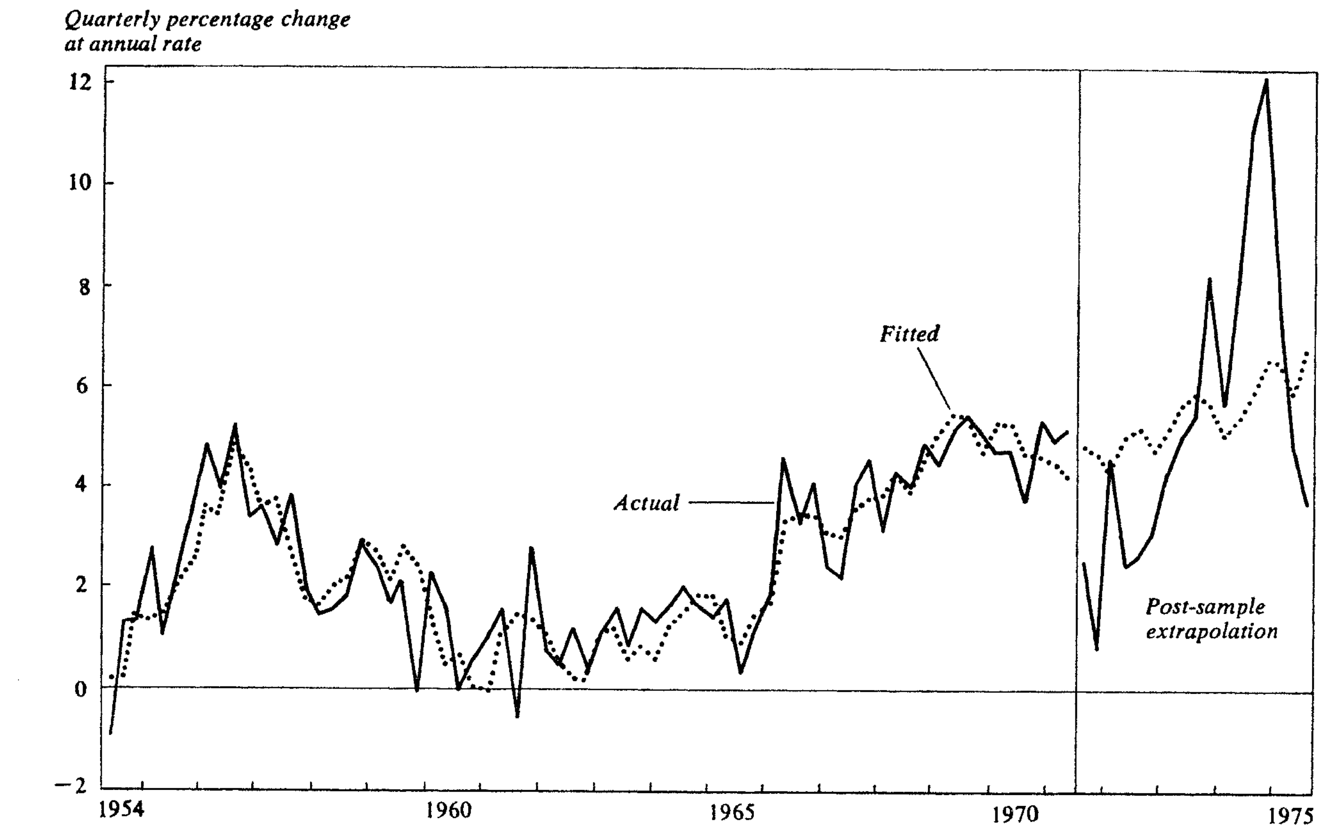
INTERPRETATIONS OF THE SAMPLE AND POST-SAMPLE PERIODS

The actual quarterly rate of change of the chain price index developed here (private nonfood final sales net of energy prices) is compared in figure 1 with the sample-period and post-sample predictions of the basic core equation 3.6. All major movements of the actual series are tracked well; moreover, so are several minor movements—for example, the temporary drop in the inflation rate in mid-1965 associated with the reduction in federal excise-tax rates. The major errors are a slight tendency to underpredict during 1955–56 and 1964 and to overpredict during 1959.

In this paper the 1971–75 period is evaluated by means of simulations of the post-sample period rather than by extension of the termination point of the estimated equations to 1975. A crucial feature of price behavior during 1971–75 was the imposition of price controls during 1971–73 followed by their complete removal in 1974. Estimation of price equations for the 1971–75 period that include a single dummy variable measuring the effect of the controls imposes the a priori constraint that the effect of controls operates solely via a shift in the constant term. As Oi has argued, the controls could equally well have shifted coefficients on variables other than the constant.[39] Although it is possible in principle to estimate a price equation for the 1971–75 period that includes *k* separate dummy variables, one for each of *k* independent variables, this procedure would more than exhaust the available degrees of freedom.

39. See Walter Y. Oi, "On Measuring the Impact of Controls," *Journal of Monetary Economics* (forthcoming, April 1976 supplement).

Figure 1. Actual and Fitted Values for the Aggregate Core Price Equation, 1954:2–1975:3



Source: Derived from table 3, equation 3.6, the core equation.

The implication of the extrapolation into the post-sample period is dramatic and surprising. The price explosion of 1974 can be explained almost entirely as a post-controls rebound. The actual rate of inflation was below the value predicted by the equation throughout the 1971:3–1973:3 period, and was above the predicted values in the 1973:4–1975:3 period by almost exactly the same amount. The values of the errors are listed in more detail in table 5, column 2. On average, the equation was almost perfectly on target during the last four years of the sample period (lines 1a and 1b in table 5). Then the actual rate of inflation fell well below the predicted rate (given, of course, the actual behavior of wages) by 2.0 percent at an annual rate during Phases I and II of price controls. The total shortfall of the *level* of the deflator below its predicted value reached a maximum of 3.48 percent in 1973:3 (line 2a).[40]

The excess of the actual over the predicted rate of change was 4.56 percent during the six quarters between 1973:4 and 1975:1, followed by a further 1.04 percent shortfall during the final two quarters, 1975:2 and 1975:3. A clue to the source of the overprediction during the final two quarters is provided by figure 2, which decomposes the predicted price series (as illustrated in figure 1) into the contributions of the five independent variables. The rate of growth of trend unit labor cost is the only explanatory variable that pushes the predicted price series upward in 1975:2 and 1975:3, as compared with its contribution in the previous year. The rate of growth of adjusted compensation per manhour minus the productivity trend more than doubled from a 4.02 percent rate in the four quarters ending in 1974:1 to an 8.24 percent rate in the four quarters ending in 1975:1, and this wage acceleration feeds slowly through the lag distribution displayed in table 4. If the estimated core equation overstates the lag in adjustment of prices to wage change, then the underprediction of price change in 1974 and the overprediction in 1975:2 and 1975:3 are correspondingly overstated. (In 1975:2 and 1975:3 the value of $(w - q^*)$ decelerated to a 7.04 percent annual rate.)

Columns 3 and 4 of table 5 display the over- and underpredictions for the post-sample period of two other equations with sample periods ending in 1971:2. The equation estimated for the period 1963:1–1971:2 underpredicts 1974 and overpredicts mid-1975 to an even greater extent than does

40. This is slightly larger than the maximum shortfall of 2.7 percent estimated by the same technique with a different specification of the price equation in my "Response of Wages and Prices," table 1, column 15, value for 1973:3.

Table 5. Actual Values and Prediction Errors for Rates of Change of Chain Index for Private Nonfood Final Sales Net of Energy, Three Equations, Various Periods, 1967–75

Percentage points

Type of change and period	Actual (1)	Errors (actual minus predicted): Equation 3.6 (1954:2–1971:2)[a] (2)	Equation 3.11 (1963:1–1971:2)[a] (3)	Equation 3.13 (1950:2–1971:2)[a] (4)
1. Average annual rate of change				
a. 1967:2–1969:2	4.33	0.01	−0.04	0.30
b. 1969:2–1971:2	5.52	0.06	0.07	−0.04
c. 1971:2–1975:3	5.46	0.01	−0.10	−0.08
2. Total change[b]				
a. 1971:2–1973:3	7.79	−3.48	−3.66	−5.12
b. 1973:3–1975:1	13.28	4.56	5.21	5.57
c. 1975:1–1975:3	2.12	−1.04	−1.93	−0.76
d. Total, 1971:2–1975:3	23.19	0.04	−0.38	−0.31

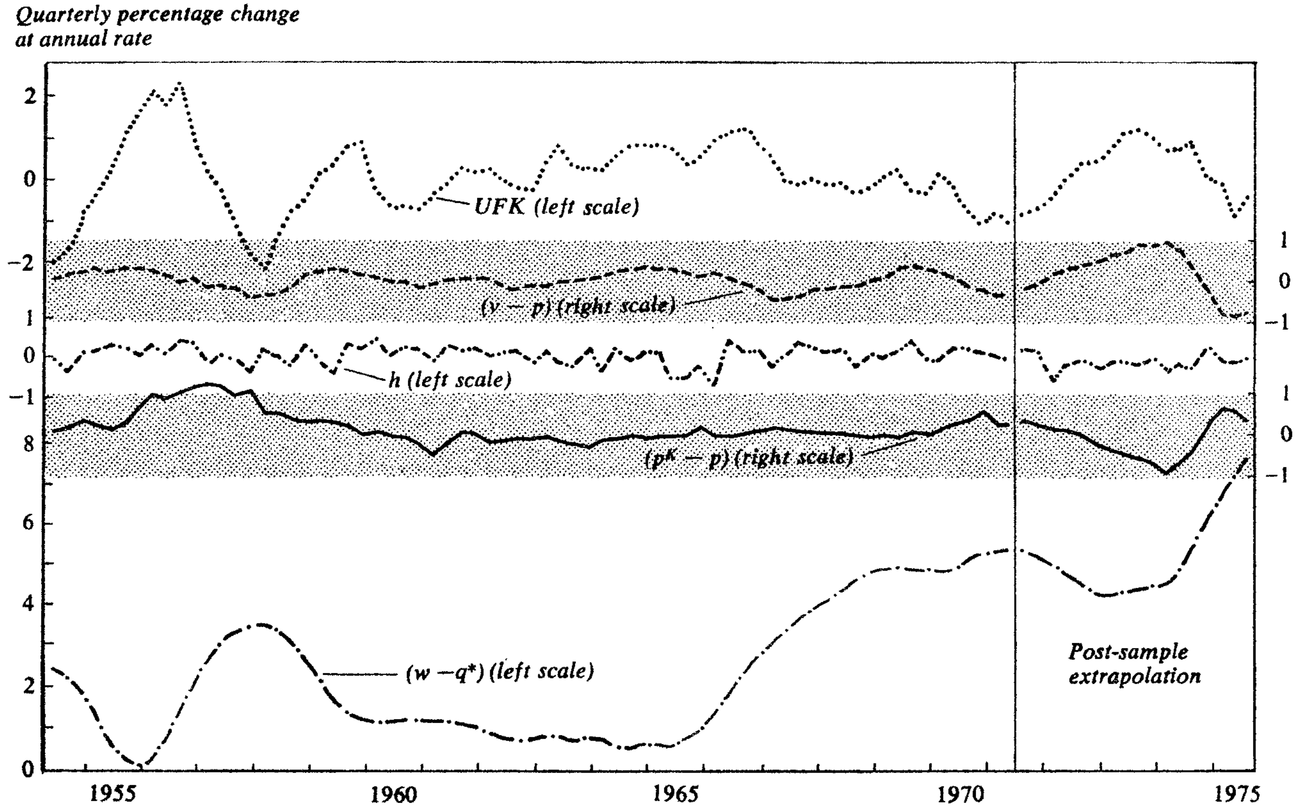
Source: Derived from table 3, equations 3.6, 3.11, 3.13.
a. Sample period.
b. Sum of quarterly rates of change.

the core equation, mainly because the lag of prices behind wage change is even longer (a mean lag of 5.21 quarters as compared with 4.14). The story is similar for the equation fitted to the long period 1950:2–1971:2 (a mean wage lag of 5.07 quarters), but in addition there is a greater overprediction during 1971:2–1973:3 and a smaller overprediction during 1975:1–1975:3, caused by the higher coefficient on the relative price of materials, the value of which was rising during 1973 and falling during 1975.

Overall, none of the estimated equations is able to capture the deceleration of price change in mid-1975. This failure does not necessarily discredit the equations as a description of normal relationships, but rather may offer an example of Lucas' point that structural parameters may be functions of the policy environment.[41] Because both firms and workers were aware in advance that controls were to be lifted at the end of April 1974, the lags from wages to prices and vice versa may have operated with unusual speed

41. Robert E. Lucas, Jr., "Econometric Policy Evaluation: A Critique," *Journal of Monetary Economics*, vol. 2 (January 1976 supplement).

Figure 2. Contribution of Independent Variables to Predicted Price Change in the Core Equation, 1954:2–1975:3



Source: Derived from table 3, equation 3.6, the core equation.

during the post-controls rebound. The equations estimated to earlier intervals may be more accurate when used for forecasting in future periods when controls are not relevant.

Another interesting feature of figure 2 is the estimated contribution of the aggregate-demand proxy to price change during the postwar period. The following table shows the differences in the inflation rate associated with movements of the demand variable between its minimum and maximum values in individual postwar half-cycles; the estimates are based on the coefficients from table 3, equation 3.6, as illustrated in figure 2.

Half-cycle	*Difference in annual rate of inflation*
Trough 1954:1 to peak 1956:3	4.33
Peak 1956:3 to trough 1958:1	−4.46
Trough 1958:1 to peak 1959:4	3.12
Peak 1959:4 to trough 1960:4	−1.68
Trough 1960:4 to peak 1966:3	1.99
Peak 1966:3 to trough 1970:4	−2.36
Trough 1970:4 to peak 1973:3	2.36
Peak 1973:3 to trough 1975:2	−2.16
Average absolute value, 1954:1–1975:2	2.81

These positive and negative demand effects roughly cancel out over a whole cycle. But demand plays a very significant role in the rate of inflation observed at peaks and troughs, over and above any effect of demand on wages. The demand effect estimated in this paper is considerably larger than any estimated in previous papers by myself or other authors, mainly because (1) here the demand variable is allowed to enter with a distributed lag and is not constrained to have its entire effect instantaneously, and (2) the wage variable is adjusted in this paper for the effects of overtime and interindustry shifts in output; that is, cyclical effects that in some previous papers were picked up by the unadjusted wage variable are here properly attributed to the demand variable.

THE PRICE OF CAPITAL SERVICES

According to the basic theoretical equation 13, the rate of change of prices should depend not only on the rates of change of standard unit labor cost and of the relative price of materials, but also on that of the relative price of capital services. Of the three components of the relative price of capital services—the relative price of investment goods, the cost of capital, and the tax term—only the first has been used in the equations estimated thus far in the paper. This is a consequence of the poor statistical performance of the other two components, as illustrated in table 6. In equation 6.2, the total relative price of capital services (n) enters with an insignificant coefficient, as does the cost of capital (r) by itself in equation 6.4. In equation 6.5 the tax term (j) enters very significantly, but with the wrong sign. Lower effective taxes on capital, reflected in the corporate-tax rate, the investment tax credit, and liberalization of depreciation provisions, did not reduce the aggregate price level relative to wages in 1954–55, 1962–64, or 1971, nor was the price level raised as a result of the temporary increase in the effective tax on capital in 1968–69.

If the cost-of-capital and tax terms are insignificant or of the wrong sign, how can one explain the strong effect of the relative price of capital goods? One hypothesis is that the relative-price term, like the relative price of raw materials, may be acting at least partly as a further proxy for demand, in this case the demand for investment goods. By this interpretation the markup of price over standard unit labor cost was widened during the 1955–57 period as a consequence of the unusually intense demand for investment goods.[42] The *UFK* variable may be only an imperfect proxy for the intensity of the 1955–57 boom in investment goods, requiring the "help" of relative investment prices for a full explanation of price behavior.

42. Assume that the aggregate rate of inflation (p) consists of inflation in investment goods (p^I) and noninvestment goods (p^N):

(a) $$p = gp^I + (1 - g)p^N.$$

Assume also that the rate of inflation in noninvestment goods is completely determined by the rate of change of wages (w), but that the rate of inflation in investment goods depends as well on the rate of change of demand (x), which is assumed to be unobservable:

(b) $$p^N = w,$$

(c) $$p^I = w + x.$$

Combining (a), (b), and (c) yields

(d) $$p = w + gx.$$

Estimating an aggregate price equation in which the relative price of investment goods is included as a separate variable,

(e) $$p = h(p^I - p) + w,$$

effectively introduces a proxy for the demand term, x, which is assumed to be unobservable. Substituting (c) and (d) into (e) yields

(f) $$p = h(1 - g)x + w.$$

Table 6. Effect of Alternative Components of the Price of Capital Services on Quarterly Percentage Changes in the Chain Index of Private Nonfood Final Sales Net of Energy, 1954:2–1971:2[a]

	Variable (quarterly rate of change)									Summary statistic	
Equation	Trend unit labor cost $(w - q^*)$[b] (1)	Productivity deviation $(q - q^*)$ (2)	Effective excise-tax rate h (3)	Relative spot-market-price index $(v - p)$[c] (4)	Ratio of unfilled orders to capacity UFK[d] (5)	Relative price of capital services n[e] (6)	Relative price of investment goods $(p^k - p)$[e] (7)	Cost of capital r[e] (8)	Tax component of price of capital services j[e] (9)	Standard error of estimate (10)	Durbin-Watson (11)
6.1	1.154	−0.036	0.391	0.019	0.075	...	...	...	...	0.00218	1.87
	(23.24)	(−1.13)	(1.93)	(1.07)	(6.07)						
6.2	1.184	−0.052	0.381	0.014	0.076	−0.011	...	...	...	0.00221	1.93
	(13.13)	(−1.47)	(1.82)	(0.72)	(4.96)	(−0.38)					
6.3	1.100	−0.024	0.386	0.023	0.072	...	0.397	...	...	0.00205	2.17
	(22.25)	(−0.78)	(2.03)	(1.39)	(5.37)		(3.41)				
6.4	1.146	−0.054	0.305	0.013	0.080	...	...	0.018	...	0.00215	2.01
	(20.73)	(−1.57)	(1.46)	(0.62)	(5.78)			(0.40)			
6.5	1.176	−0.058	0.463	0.028	0.069	...	...	...	−0.236	0.00214	2.11
	(23.82)	(−1.79)	(2.30)	(1.55)	(5.07)				(−2.60)		

Sources: See appendixes A and B.

a. The numbers in parentheses are t-ratios.

b. Each coefficient is the sum of twelve distributed-lag coefficients.

c. The four-quarter rate of change of materials prices minus the four-quarter rate of change of the private nonfood index.

d. Weights on the rate of change of UFK were constrained to be 10/30, 8/30, 6/30, 4/30, 2/30.

e. The coefficient is the sum of eight distributed-lag coefficients.

Table 7. Effect of Changes in the Money Supply on Quarterly Percentage Changes in the Chain Index of Private Nonfood Final Sales Net of Energy, Including and Excluding Core Variables, Selected Sample Periods, 1954–71[a]

		Nondemand variable (quarterly rate of change)					Demand variable (quarterly rate of change)		Summary statistic	
Period and equation	*Constant (1)*	*Trend unit labor cost* $(w - q^*)$[b] *(2)*	*Productivity deviation* $(q - q^*)$ *(3)*	*Relative price of investment goods* $(p^k - p)$[c] *(4)*	*Effective excise-tax rate* h *(5)*	*Relative spot-market-price index* $(v - p)$[d] *(6)*	*Ratio of unfilled orders to capacity UFK*[e] *(7)*	*Money supply* M_1[f] *(8)*	*Standard error of estimate (9)*	*Durbin-Watson (10)*
1954:2–1971:2										
7.1	−0.003	...	...	...	...	...	...	1.366	0.00218	1.89
	(−3.74)							(13.20)	...	...
7.2	−0.001	0.412	−0.035	0.074	0.364	0.019	0.042	0.824	0.00191	2.53
	(−1.42)	(1.79)	(−1.18)	(0.30)	(1.87)	(1.18)	(2.58)	(2.90)	...	...
1954:2–1962:4										
7.3	−0.003	...	...	...	...	...	...	1.341	0.00227	2.43
	(−1.74)							(4.20)	...	...
7.4	0.003	−0.443	0.010	0.587	0.091	0.075	−0.013	0.475	0.00238	2.79
	(0.64)	(−0.61)	(0.18)	(1.01)	(0.22)	(1.38)	(0.25)	(0.62)	...	...
1963:1–1971:2										
7.5	−0.002	...	...	...	...	...	...	1.202	0.00189	1.77
	(−1.89)							(9.77)	...	...
7.6	−0.000	0.452	−0.059	0.124	0.537	0.018	0.026	0.554	0.00148	2.35
	(−0.05)	(0.51)	(−1.34)	(0.13)	(2.47)	(0.41)	(0.64)	(0.40)	...	...

Sources: See appendixes A and B.
a. The core variables are from table 3. The numbers in parentheses are *t*-ratios.
b. Each coefficient is the sum of twelve distributed-lag coefficients.
c. Each coefficient is the sum of eight distributed-lag coefficients.
d. The four-quarter rate of change of materials prices minus the four-quarter rate of change of the private nonfood index.
e. Weights on the rate of change of *UFK* were constrained to be 10/30, 8/30, 6/30, 4/30, and 2/30.
f. Each coefficient is the sum of twenty-eight distributed-lag coefficients.

RATIONAL EXPECTATIONS AND THE EFFECT OF CHANGES IN THE MONEY SUPPLY

As a possible alternative to a specification such as the core model of price determination developed here, several authors have used the assumption of instantaneous response of price changes to changes in the money supply in their application of the theory of rational expectations to economic policy.[43] Although economists who have attempted to explain U.S. prices in large- or small-scale econometric models have been skeptical of any direct association between monetary changes and inflation, and in fact have rarely tested for such an association, there is no reason why the "Almon-lag trial run" technique cannot be used to search for a direct monetary effect.

After considerable experimentation, a very strong reduced-form relationship between money and prices has been uncovered; it is displayed in equation 7.1 of table 7 for the common sample period (1954:2–1971:2). The rate of change of money *by itself*, with no help from wage, productivity, or tax data, can explain changes in the nonfood deflator almost as well as the structural specification (equation 3.4) that uses the rate of change of the GNP gap. But there is a trick involved in finding a strong monetary effect. The lag distribution must be stretched and stretched again; the lag coefficients on monetary changes fade out to insignificance only after *twenty-eight* quarters. Furthermore, the estimated lag distribution is highly asymmetric and has a mean lag of seventeen quarters. Only 14 percent of the ultimate impact of changes in the growth rate of the money supply has been felt by the end of two years, and only 35 percent after four years. So the chain of influences from money to spending to unemployment to wages to prices is a lengthy one. Much of the inertia lies in the influence of unemployment on wages.[44]

If the effect of monetary changes on price changes is delayed so long, then the policy recommendations of the monetarists, usually based on the assumption of a much shorter lag, lose some of their appeal.[45] And it is also

43. See especially Thomas J. Sargent and Neil Wallace, *Rational Expectations and the Theory of Economic Policy*, Studies in Monetary Economics 2 (Federal Reserve Bank of Minneapolis, 1975), p. 5.

44. See my "Inflation in Recession and Recovery."

45. Friedman, for instance, has explicitly assumed a lag as short as six months: ". . . the Fed can and should start at once to slow down monetary growth. That is the only way to slow down inflation six months from now. . . .

"If the Fed continues its present policy of modest growth in the money stock, we hard to accept the conclusion of the rational-expectation theorists that the monetary authority in principle has no power to control real output. Economic agents forming expectations rationally will conclude, on the basis of the long lags in equation 7.1, that monetary changes will have little effect on prices and that most of the impact will fall on real output in the short run. As a result, adoption of the idea of rational expectations has no revolutionary implications for the theory of economic policy, a conclusion strongly in conflict with the recent drift of theoretical writing in macroeconomics.

In equation 7.2 the money variable is supplemented by all of the variables in the basic structural equation (equation 3.5). Equation 7.2 serves mainly to demonstrate the collinearity of the wage and money variables; the money variable in 7.2 soaks up somewhat more than half of the effect on prices of trend unit labor cost in the basic equation that excludes money (compare with equation 3.5). The coefficients on both the relative price of investment goods and on the ratio of unfilled orders to capacity decline, but the latter retains significance. In equation 7.2, as in 7.1, the mean lag on the money-supply variable is seventeen quarters, supporting the interpretation that money may be acting more as a partial proxy for expected labor cost than as a true demand variable.

Although the results for the subsample periods are basically consistent with those for the complete period, the money-only reduced-form equation 7.3 has the startling feature that its standard error of estimate is considerably below that of the best structural equation for the same period (equation 3.9). The main reason is the extra degrees of freedom used in the structural equation; the sums of squared residuals are almost exactly the same in the money-only reduced form as in the no-money structural equation.[46]

The Disaggregated Equations

Price equations for the four sectoral components of the aggregate chain index developed here—durables, nonfood nondurables, services, and struc-

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should start seeing results in the near future. . . . The effect will first be on output. However, by fall at the latest, the pace of price rise should start coming down." Milton Friedman, "Money and Inflation," *Newsweek*, vol. 73 (May 26, 1969), p. 105.

46. The mean lags on the money variable in equations 7.3–7.6 are, respectively, 17.7, 24.1, 12.9, and 12.4 quarters.

tures, all net of energy—as well as for the food deflator, are presented in table 8. The sectoral equations do not use the wage rates, productivity-trend estimates, materials prices, or demand variables that appear in the aggregate equations; details on the variables chosen are presented in the notes to table 8 and in appendix B. The demand-proxy variables used are the rates of change of the ratio of unfilled orders to capacity (durables); nonfood nondurables utilization, approximated by the deviation of real output of nonfood nondurables from trend (nonfood nondurables); the gap (services and food); and the real output of the structures sector (structures).

Table 8 presents two equations for each of the five sectors, one without and one with a demand-proxy variable. Although the demand variables all have the correct sign, they are statistically insignificant in the services, structures, and food sectors. In the nonfood nondurables sector the demand variable is significant, but the equation including it (8.4) has exactly the same standard error as that excluding it (8.3), indicating that the demand variable in that sector simply substitutes for other, nondemand, variables. In the food sector the demand variable is not significant by itself, but results in a significantly reduced standard error of estimate indirectly, by changing coefficients on other variables, particularly trend unit labor cost.[47] Only the durables sector exhibits a strong demand effect that both is statistically significant and significantly reduces the standard error of estimate of the equation.

One would expect the disaggregated equations, taken together, to yield lower post-sample predictions of price change than does the aggregate equation, because the weighted average of the labor-cost coefficients in table 8 (using 1975 expenditure weights and excluding food) is 0.93, as compared with 1.09 in the aggregate core equation. The productivity-deviation coefficient is significant only for nonfood nondurables. The relative price of investment goods is not significant anywhere; its main effect in the aggregate equation works through durables prices, but in the equation for the durables sector the variable is defined as the price of investment goods relative to durable goods, eliminating its major movements. There is a faint cost-of-capital effect in the services and structures equations, and strong effects from materials prices in all sectors but durables.

47. Since no separate productivity estimates are available for services or structures, trend unit labor cost for these sectors is approximated by the rate of change of wages and a constant term.

Table 8. Price Equations for Sectoral Deflators Net of Energy, with and without Demand Variables, 1954:2–1971:2[a]

	Nondemand variable (quarterly rate of change)							Demand variable (quarterly rate of change)				Summary statistic	
Sector and equation	Constant (1)	Unit labor cost w^b (2)	Trend unit labor cost $(w-q^*)^b$ (3)	Trend productivity $(q-q^*)$ (4)	Cost of capital r^b (5)	Effective excise-tax rate h (6)	Relative spot-market-price index $(v-p)$ (7)	Ratio of unfilled orders to capacity UFK (8)	Real nonfood nondurables utilization XN (9)	Ratio of GNP gap to potential output GAP (10)	Real output of structures XS (11)	Standard error of estimate (12)	Durbin-Watson (13)
Durables													
8.1	...	...	0.809	...	...	1.346	...	...	...	...	...	0.00489	1.30
			(6.58)			(3.15)							
8.2	...	...	1.097	...	...	0.605	...	0.082[c]	...	...	...	0.00387	1.95
			(10.17)			(1.66)		(3.85)					
Nonfood nondurables													
8.3	...	...	1.032	−0.113	...	...	0.086[d]	...	...	...	...	0.00759	2.55
			(5.46)	(−1.59)			(1.76)						
8.4	...	...	1.149	−0.092	...	...	0.076[d]	...	0.484[e]	...	...	0.00759	2.69
			(5.80)	(−1.25)			(1.55)		(1.91)				
Services													
8.5	−0.003	0.882	...	...	0.057	0.300	0.032[d]	...	...	...	...	0.00232	1.85
	(−3.14)	(10.07)			(1.50)	(1.40)	(2.03)						
8.6	−0.004	0.926	...	...	0.053	0.312	0.040[d]	...	...	−0.101[e]	...	0.00232	1.94
	(−3.26)	(9.31)			(1.19)	(1.45)	(2.06)			(−1.26)			

Structures													
8.7	0.001	0.427	...	...	0.077	...	0.350[e]	...	...	...	...	0.00601	1.67
	(0.44)	(2.26)			(0.54)		(4.46)						
8.8	0.001	0.438	...	...	0.074	...	0.349[e]	...	...	...	0.014[c]	0.00608	1.64
	...	(2.12)			(0.46)		(4.12)				(0.11)		
Food													
8.9	0.003	...	0.206	...	...	...	0.259[f]	...	...	...	...	0.00648	1.43
	(2.05)		(0.79)				(3.72)						
8.10	0.002	...	0.432	...	...	...	0.211[f]	...	...	−0.110	...	0.00603	1.55
	(1.31)		(0.96)				(2.61)			(−0.33)			

Sources: See appendixes A and B.

a. The numbers in parentheses are t-ratios.

b. The coefficient is the sum of nine distributed-lag coefficients.

c. The coefficient is the sum of six distributed-lag coefficients.

d. The four-quarter rate of change of the spot-price index for raw industrials minus the four-quarter rate of change of the private nonfood index

e. The quarterly rate of change of the wholesale price index of materials and components for construction.

f. The coefficient is the sum of eight distributed-lag coefficients on the rate of change of the WPI for crude foodstuffs and feedstuffs.

Table 9. Prediction Errors Using Sectoral and Aggregate Price Equations, Various Post-Sample Intervals, 1971:2–1975:3

Sum of quarterly rates of change over each interval, in percentage points

Equation	*1971:2–1972:4*	*1972:4–1973:3*	*1973:3–1975:1*	*1975:1–1975:3*	*1971:2–1975:3*
Sectoral equations from table 8					
Durables	−3.94	0.27	4.29	−1.52	−0.90
Nonfood nondurables	−1.37	0.15	7.92	−1.14	5.56
Services	−2.40	−1.08	1.67	0.66	−1.15
Structures	2.73	0.51	−0.58	−2.45	0.21
Weighted average of sectoral equations	−1.83	−0.26	3.15	−0.64	0.42
Aggregate core equation from table 3, equation 3.6	−3.06	−0.41	4.56	−1.04	0.04
Addendum: Food equation	0.54	5.13	9.50	1.85	17.02

Source: Derived from equations in tables 3 and 8.

The benefit of disaggregation for predicting aggregate price behavior is debatable. When the actual and predicted values in the four component sectors are combined, weighted by their shares of current-dollar expenditures on nonfood products net of energy, the resulting average can be compared with the core aggregate equation, both for goodness of fit within the sample period and for the characteristics of the post-sample extrapolations. The variance left unexplained by both predicted series within the sample period is almost identical, with R^2 equal to 0.789 for the aggregate equation and 0.781 for the disaggregated average. The root mean-square errors are, respectively, 0.00191 and 0.00193. These differences are not statistically significant.

Table 9 displays the difference between the actual and predicted values for various subperiods of the period after 1971:2 for the individual sectoral equations, the weighted average of the sectoral equations, and the aggregate core equation. The weighted average yields a smaller estimate of the effect of controls than the aggregate (maximum effect of −2.09 versus −3.47 percent through 1973:3) and a smaller post-controls rebound, and makes an overall underprediction of the entire post-sample period slightly smaller than that of the aggregate (0.42 percentage point versus 0.04).

The weighted average, which tracks the total rate of change of prices after 1971:2 quite well, disguises large errors in some of the equations for individual sectors. While the equation for structures does relatively well, those for durables and services are off by about 1 percentage point, while the equation for nonfood nondurables underpredicts total price change by 5.56 percentage points. Price change is estimated to have been held down in all sectors except structures during Phases I and II (mid-1971 to late 1972); then in 1973 the control effect ended in nonfood manufacturing but continued in services. The underprediction of inflation in structures in 1971–72, and the overprediction during mid-1975, may represent evidence that the equation for the structures sector understates the demand effect, since housing demand was high in 1972 but weak in 1975.

The food equation fitted to the pre-1971 period confirms the impression given by table 2 that the margins of the farm-to-market processing industry have widened in the last four years in comparison with historical behavior. Part of the problem may be the low sum of coefficients on labor and materials cost in the food equation; estimated coefficients from a sample period in which raw farm prices were relatively stable may not predict accurately when farm prices are changing by very large amounts.

The underprediction of the sectoral equations for nonfood nondurables during the post-1971 period leaves open a role for the "purchasing power parity" hypothesis which unties prices from domestic costs for the subset of goods that are traded. Between 1971:2 and 1973:4, the dollar price of exports from countries of the Organisation for Economic Co-operation and Development other than the United States, mainly industrial products, increased by 42 percent, as compared with increases of only 11.6 percent for all U.S. goods (including food and energy) and of only 12.4 percent for U.S. nonfood nondurable goods.[48] On this interpretation, the behavior of prices of nondurable goods reported in table 9 is not at all surprising, but a puzzle remains: since durables can be traded, why are their prices overpredicted rather than underpredicted for the post-1971 period?

Conclusions

The first conclusion to be drawn from the analysis in this paper is that any discussion of price behavior during the past four years must begin by disentangling the effects of inflation in food and energy from the factors

48. The price index for non-U.S. exports was calculated from data for individual countries published in *International Financial Statistics*. I am grateful to my colleague John Bilson for supplying the raw data needed for the calculation.

that determine the prices of other outputs. The total increase in prices from 1971:4 to 1975:3 for private U.S. final sales has been 27.3 percent, but the total increase in nonfood nonenergy prices has been 22.4 percent, almost one-fifth less. Between mid-1973 and mid-1974, fully 28 percent of the increase in prices was contributed by energy and food.

Second, proxy variables for the influence of aggregate demand on prices (given wages) enter significantly into the equations for aggregate final sales of nonfood products net of energy and into the sectoral equations for durable and nonfood nondurable goods. On average during postwar business cycles, the demand effect in the aggregate equation has raised the rate of inflation during the peak quarter about 2.8 percentage points above the rate in the trough quarter, holding wage change constant.

Third, this aggregate-demand effect has shown no sign of weakening during the postwar period. Tests of structural shift indicate that the effect was stronger during the 1963-71 period than during the 1954-62 period. This conclusion is qualified to the extent that the relative price of investment goods is acting as a proxy for demand in the earlier period.

Fourth, the relative price of investment goods is the only component of the relative price of capital services that has a correctly signed and significant effect on price markups. Even here, one suspects that the variable may be acting as another demand proxy, rather than as a component of the relative price of capital services. There is a faint hint of a positive coefficient on the cost of capital in the sectoral equations for services and structures.

Fifth, a reduced-form relationship between the rate of change of prices and money performs surprisingly well in competition with the structural price-markup equation but only by allowing lags in the effect of money on prices that are much longer than those usually assumed in journalistic discussions of public policy; the lag effect estimated here stretches out over seven years, with a mean of over four years. Neither policymakers nor their advisers should be intimidated by those who claim that an attempt to stimulate temporarily rapid growth in real output by a temporary acceleration in the money supply would simply raise prices. Economic agents may be perfectly well aware of what the Federal Reserve is doing, but they do not translate their knowledge into instantaneous changes in prices, either downward in the wake of Fed restriction, such as in 1969–70 or 1974–75, or upward. The reduced-form regression of inflation on the rate of change in the money supply confirms the predominant influence of inertia on price-setting behavior evident in previous structural wage-price models.

Sixth, the aggregate equation for nonfood products net of energy, when extrapolated after the end of its sample period in mid-1971, confirms my earlier conclusion that the U.S. price controls held down the price level by a maximum of 3.5 to 5.1 percent, depending on the initial date chosen for the sample period. All of the control effect was reversed during 1974–75, and the price level is now within one-half percentage point of the level predicted in the absence of controls.

Seventh, the disaggregated sectoral equations indicate that the price controls held down prices in all sectors but structures and food during 1971–72; but in 1973 the effect was reversed everywhere but in services.

Eighth, it is impossible to test formally for the influence of foreign prices in U.S. data, because the data are contaminated by the imposition and unwinding of controls. Since the United States devalued during the control period, adherents of the purchasing-power-parity hypothesis would expect to find positive unexplained residuals in the post-control period for traded goods but not for nontraded goods. No such pattern emerges in the extrapolations of the disaggregated sectoral equations, with positive residuals for nonfood nondurables but negative residuals for durable goods.

Finally, perhaps the most surprising conclusion is that, overall, outside of food and energy, aggregate price behavior since mid-1971 contains no puzzle that cannot be explained by equations estimated for a sample period ending in mid-1971.

APPENDIX A

Energy and Food Adjustments: Methodology and Data

THIS APPENDIX lists the methodology and data used in making the adjustments for energy and food prices.

Energy

DIRECT PURCHASES OF ENERGY BY CONSUMERS, CURRENT AND CONSTANT DOLLARS

Nondurables—gasoline and motor oil: 1952:1–1975:3, quarterly, obtained from an unpublished computer printout (and telephone updates for 1975) supplied by the U.S. Bureau of Economic Analysis; 1947:1–1951:4, annual data from the national income accounts, tables 2.5 and 2.6, converted to quarterly data by interpolation. Data for national income accounts are published in U.S. Department of Commerce, *The National Income and Product Accounts of the United States, 1929–1965: Statistical Tables* (1966) and *Survey of Current Business.*

Nondurables—heating oil and other fuel: 1958:1–1975:3, same as gasoline and motor oil for 1952:1–1975:3; 1947:1–1957:4, same as gasoline and motor oil for 1947:1–1951:4.

Services—electricity and natural gas: 1974:1–1975:3, same as gasoline and motor oil for 1952:1–1975:3; 1947:1–1973:4, same as gasoline and motor oil for 1947:1–1951:4.

INDIRECT PURCHASES OF ENERGY BY PRODUCERS

In constant 1967 dollars. The basic source was the 1967 U.S. input-output table published in *Survey of Current Business*, vol. 54 (February 1974), pp. 38–43. All input from columns 7 (coal mining), 31 (petroleum refining), and 68 (electric, gas, water, and sanitary services utilities) into industries 1–6, 9–30, and 32–77 were counted on the first round. Then the energy component of purchases of these industries from each other was calculated. The first and subsequent rounds yielded the total dollar value in 1967 of the energy component of sales by all nonenergy industries to the final-output sector, both in the form of direct energy purchases from industries 7, 31, and 68, and of energy purchases of all nonenergy-supplying industries (industries 1–6, 9–30, and 32–77). These industries were allocated to the five sectors as follows:[49]

Sector	*Industries*	*1967 energy share*
Durables	20–23, 36–63, 69	0.0335
Food	1–4, 14–15, 69	0.0434
Nonfood nondurables	16–19, 27–30, 32–34, 69	0.0439
Services	24–26, 65–67, 71–77	0.0363
Structures	11–12	0.0446

In constant 1958 dollars. The energy shares listed in the previous section were multiplied by 1958 constant-dollar sectoral final sales, from the national income accounts, table 1.5 (the split between food and nonfood is explained below).

In current dollars. The 1958 constant-dollar sectoral totals were multiplied by the wholesale price index of the U.S. Bureau of Labor Statistics for "fuels and related products, and power," rebased to 1958.

OIL IMPORTS

In current dollars. 1973:2–1974:3, from George L. Perry, "The United States," in Edward R. Fried and Charles L. Schultze, eds., *Higher Oil Prices and the World Economy: The Adjustment Problem* (Brookings Institution, 1975), table 2-4, p. 82; 1974:4–1975:3, *Survey of Current Business,* vol. 55 (October 1975), p. S-23.

In constant dollars. 1973:2–1973:4, Perry's series on barrels of oil imported, "The United States" (table 2-1, p. 75, column C), multiplied by the

49. Retail and wholesale trade (69) was allocated among sectors as follows: durable and nondurable goods were assumed to have equal markups—that is, the durables-nondurables split in total trade value added was assumed to be proportional to the purchases made by the final-output sector from the two manufacturing sectors. The food-nonfood split within nondurables was based on the assumption that nonfood markups were double those in the food sector.

average 1974 ratio of real oil imports to Perry's series on barrels of oil imported; 1974:1–1975:3, current-dollar value divided by price index (see below).

Price index. 1973:2–1973:4, the price index equals current-dollar value divided by constant-dollar value; 1974:1–1975:3, unit-value index, all petroleum imports (not available quarterly before 1974:1), obtained by telephone from the U.S. Bureau of the Census, Foreign Trade Division, converted to 1958 dollars by dividing the census index (base year 1972), by the implicit price deflator (1958 = 1.0) in 1972 for gasoline and motor oil, from the national income accounts, tables 2.5 and 2.6.

FINAL SALES NET OF ENERGY IN CURRENT AND CONSTANT DOLLARS

From final sales in each sector (national income accounts, tables 1.3 and 1.5, with nondurables split into food and nonfood as described below) was subtracted the sum of direct energy purchases (nonfood nondurables and services only) and indirect energy purchases (all sectors). To this difference was added oil imports in the nonfood nondurables sector only. The current-dollar and constant-dollar series for each sector, and aggregates including and excluding food, are displayed in table A-1.

Food

Quarterly consumer expenditures on food and beverages in current and constant dollars for the period 1952:1–1975:3 were obtained from an unpublished computer printout supplied by the U.S. Bureau of Economic Analysis (and telephone updates for 1975). Quarterly figures for 1947–52 were obtained by interpolating between annual figures from the national income accounts, tables 2.5 and 2.6. This series was converted into a final-sales series by the addition of food exports and subtraction of food imports.

Current-dollar values and unit-value indexes of U.S. exports and imports of crude and manufactured food and beverages were obtained from U.S. Bureau of the Census, Foreign Trade Division, *Indexes of U.S. Exports and Imports by Economic Class: 1919 to 1971* (1972). Before 1958 the series are available annually in this publication and were converted into quarterly series by interpolation. Quarterly series for 1958:1–1971:4 were copied

Table A-1. Final Sales Net of Energy in Current and Constant Dollars, by Sector and Aggregate, 1973:1–1975:3

Year and quarter	Sector					Aggregate	
		Nondurables					
	Durables	*Food*	*Nonfood*	*Services*	*Structures*	*Including food*	*Excluding food*
			Current dollars (billions)				
1973:1	229.0	151.2	153.3	340.9	133.6	1,008.1	856.9
2	231.9	157.1	159.4	349.7	135.4	1,033.5	876.4
3	234.3	166.5	164.4	358.1	136.5	1,060.0	893.4
4	230.6	170.4	171.9	366.3	135.2	1,074.6	904.1
1974:1	230.2	175.8	177.2	375.0	131.2	1,089.7	913.8
2	234.3	178.6	180.8	378.5	133.0	1,105.4	926.8
3	244.2	185.0	180.1	391.3	129.7	1,130.5	945.5
4	232.0	193.0	177.1	401.8	127.1	1,131.1	938.0
1975:1	238.4	199.1	184.3	403.7	122.3	1,148.0	948.8
2	246.7	201.5	190.8	411.6	118.7	1,169.5	967.9
3	252.7	206.2	196.9	417.5	122.6	1,196.1	989.8
			Constant 1958 dollars (billions)				
1973:1	192.8	104.0	109.4	214.8	73.2	694.4	590.4
2	193.7	103.5	111.9	217.7	72.8	699.9	596.3
3	192.3	104.1	113.8	220.6	72.6	703.5	599.3
4	188.3	102.6	115.0	221.0	69.8	696.9	594.3
1974:1	187.7	101.1	113.8	223.3	67.5	693.6	592.4
2	190.0	101.2	112.5	220.5	66.6	691.0	589.7
3	190.0	103.4	109.8	222.4	63.4	689.2	585.7
4	170.7	103.1	104.9	224.7	60.3	664.0	560.8
1975:1	170.2	104.9	107.7	223.3	56.8	663.0	558.1
2	171.8	105.7	111.9	224.6	54.9	669.0	563.3
3	176.7	105.6	113.2	224.8	56.4	676.9	571.2

Sources: See text of appendix A. Figures are rounded.

from the publication, and quarterly series for 1972:1–1975:3 were obtained by telephone from the Foreign Trade Division.

Nonfood nondurables final sales were obtained by the subtraction of consumer food expenditures plus exports minus imports from nondurables final sales (national income accounts, tables 1.3 and 1.5).

APPENDIX B

Definitions of Variables and Sources of Data

Definitions of Variables

ALL VARIABLES are expressed as quarterly rates of change. See next section for definitions of abbreviations.

Symbol for rate of change of variable	*Definition of level of variable*	*Source (NBER Code)*
GAP	Ratio of GNP gap to potential output	NBER (GNPGAP/GNPPOT)
h	Ratio of indirect tax liability to personal consumption	NBER (GTXL/GAE)
j	Tax component of the price of capital services	Hickman-Coen
M_1	Currency plus demand deposits	NBER (FMS)
n	Real price of capital services	$= r + j + (p^k - p)$
p	Net-of-energy price indexes	See appendix A
$p^k - p$	Ratio of the implicit deflator for nonresidential investment to the implicit deflator for private product	NBER (GDIN/GDP)
q	Aggregate: nonfarm private output per manhour	NBER (LOUTU)

Symbol for rate of change of variable	*Definition of level of variable*	*Source (NBER Code)*
	Manufacturing: manufacturing output per manhour	NBER (LOUTM)
q^*	Trend rate of growth of output per manhour	Estimated coefficients in regression equations, see note 32 above
r	Cost of capital: prime commercial paper rate plus Hickman-Coen depreciation rate	NBER (FYCP)
UFK	Ratio of unfilled orders to capacity in durable goods, computed as the product of the ratio of unfilled orders to shipments and the rate of capacity utilization	BCD, series 850 times 852
v	Aggregate, durables, nonfood nondurables, services: index of spot-market prices for thirteen raw materials	NBER (PSMAT)
	Food: wholesale price index for crude foodstuffs and feedstuffs	BLS
w	Aggregate: nonfarm private compensation per manhour,	NBER (LCPU)
	times adjusted hourly earnings,	RJG
	divided by unadjusted hourly earnings	NBER (LEH)
	Manufacturing: manufacturing private compensation per manhour,	NBER (LCPM)
	times manufacturing adjusted hourly earnings,	NBER (LEMXS)
	divided by manufacturing unadjusted hourly earnings	NBER (LEHM)
	Services: 1964–75—hourly earnings in services; linked to	NBER (LEHS)

Symbol for rate of change of variable	*Definition of level of variable*	*Source (NBER Code)*
	1947–63—hourly earnings in wholesale trade	NBER (LE6HTW)
	Structures: Hourly earnings in construction	NBER (LE6HCC)
XN	Real net-of-energy output in nonfood nondurables (deviation from trend)	Appendix A
XS	Real net-of-energy output in structures	Appendix A

Sources of Data

Abbreviation	*Definition*
BLS	Unpublished tabulation of historical data obtained from U.S. Bureau of Labor Statistics
BCD	*Business Conditions Digest*
Hickman-Coen	B. G. Hickman and R. M. Coen, *An Annual Growth Model of the U.S. Economy* (Amsterdam: North-Holland, 1976), and unpublished data printout obtained from R. M. Coen
NBER	NBER data tape, as maintained at Northwestern University computer center
RJG	Robert J. Gordon, "Inflation in Recession and Recovery," *BPEA, 1:1971*, appendix C, updated by NBER series LEPXS

Comments and Discussion

William D. Nordhaus: Robert Gordon's latest paper on price behavior updates his earlier work and presents some interesting new material. His major conclusions, which appear justified by his econometric equations, are three: First, it appears that demand has a significant effect on prices through the impact not only on materials prices and labor costs, as others have found, but also on the markup of prices over standard costs. The latest version (table 3, equation 3.4) shows that the total effect operating through the markup is about one-third of the quantity response, so that of a cyclical rise in nominal income, about three-fourths ends up in higher output and one-fourth in higher prices.

Although Gordon's basic conclusion seems buttressed by his equations, I admit that I am only partially convinced. In his disaggregated results, a slightly fishy smell emerges since the only significant demand effects turn up in durable goods. In durables and nondurables, I compared Gordon's results with those of Eckstein and Wyss (tables 2 and 5), and had some trouble reconciling them. Finally, I must say that I am experiencing vertigo from the list of demand variables used to explain the cyclical sensitivity of prices. When I reviewed eight studies in 1970, I noted that eleven different demand variables were used with virtually no overlap. Chateau Gordon vintage 1970 used the new orders-to-sales ratio and the "employment rate," but Chateau Gordon 1971 used a different grape—the ratio of unfilled orders to capacity. Chateau Gordon 1975 contains two different demand indexes (the ratio of unfilled orders to capacity and the GNP gap) and these are run in both levels and differences.[1]

1. These are references to Gordon's papers in *BPEA*, *1:1970*, pp. 8–41; *1:1971*, pp. 105–58; and this paper.

This rapid turnover of demand variables makes me suspicious that what is operating are good Darwinian principles rather than good econometric principles; the demand variables that have survived to 1975 clearly illustrate selection of the fittest. Gordon was candid in 1971 when he stated that "the measure [the ratio of unfilled orders to capacity] is used here in preference to the ratio of new orders to shipments . . . because the latter . . . has little correlation with price behavior after 1951" (p. 128). What is the interpretation of a specification that is chosen to maximize the *t*-statistic on the demand variable? Instead, the results should be tested with a Darwinian *t*-statistic. It takes into account the large number of regressions that are extinct for every one that survives. For example, if the surviving species represent 50 percent of the extinct, under independence assumptions a significant *t*-statistic should be four rather than two. By the standard of the Darwinian *t*-statistic, Gordon's demand variables are insignificant.

Coming back to the main theme, Gordon correctly identifies the short-run flexibility of prices as one of the major elements in the new theory of why macroeconomic policy is bound to fail. Whether the exact fraction of the increase in nominal income that ends up in prices is only 1 percent or as much as 30 percent, it is certainly way below the 100 percent that this theory seems to require. Gordon makes much of this critique of the Lucas-Sargent-Wallace theory of the effectiveness of policy. In addition, I would emphasize the asymmetry in knowledge between the Federal Reserve and my grandmother-in-law—without committing myself about whose judgment is better.

The second major result of the Gordon paper concerns the effects of the price controls since August 1971. Using the prediction from the 1975-vintage equation, Gordon predicts the movement in prices over the period. He concludes that by the end of the period (third quarter of 1975) the *level* of prices was on track. This seems consistent with the fact that profit margins in nonenergy products, cyclically corrected, have not taken a dive over the five-year period. His preferred equation shows a horrendous set of post-sample errors, and the conclusion is either that Gordon's equation falls apart, or—and this is Gordon's hypothesis—that price controls were responsible for depressing margins in the period from 1971:2 to 1973:3, and that removing them led to recovery of margins from 1973:3 to 1975:3.

I tend to accept Gordon's verdict that price controls were responsible for the wild fluctuations in the markup, but I admit to some nervousness. I am not a professional historian of this period, but my recollections about the timing of controls does not coincide with the Gordon residuals. For example, he finds continual depression of margins during the Phase III period, when many economic pundits, including some in this room, were arguing that Phase III was actually leading to a profit surge and to virtually complete decontrol. Most of Gordon's decontrol effect comes in the last half of 1974, well after legal decontrol had taken place.

More generally, the methodology that Gordon and others use to test for incomes policies is inadequate. Can't economists be more creative than to use dummy variables? Why can't we *model* price controls and test that model explicitly?

The third major result is, in fact, also a major surprise, at least to me. This is the finding that changes in the money supply predict inflation almost as well as Gordon's best 1975-vintage price equation. The bit of cork in the wine is that Gordon has had to stretch the Almon lag so far that it touches its tail—seven full years.

That *some* such equation should work is no surprise. In a reduced-form price equation, money enters along with exports, defense expenditures, and so on. The puzzle is that omission of other exogenous variables and of overidentifying restrictions doesn't make the reduced-form equation worthless. I don't know the solution to the puzzle. A glance at the data suggests that the answer may be that the inflation rate has only one long and one short cycle, and these are essentially all the money-supply variable is picking up. Since Gordon's money variable really has five separate coefficients (four polynomial terms plus the lag), its ability to track the inflation rate pretty well may be less surprising. In addition, given the thousands of regressions of prices on money supply that probably have been run over the last decade, the proper Darwinian *t*-statistic would deflate the significance of the results. A final possibility is that Gordon has misspecified the structural equation, and that the money supply is a proxy for some of the omitted variables.

All in all, Gordon's paper provides a good deal of insight into the inflationary process. I welcome his attempt to disaggregate and give the poor exhausted nonfarm deflator a little time on the bench. The major uncertainties left hanging by Gordon's study will probably require much more of this work.

Charles L. Schultze: Gordon's aggregate price index, before he subtracts food and energy, matches very closely the movements of the official private product deflator (see the first and third rows of table 2). Two of the BEA sectoral indexes that Gordon uses are, however, very curious constructions for analytic purposes. In constructing the deflator for final sales of durables and nondurables, durable and nondurable imports are subtracted from both current- and constant-dollar sales. Although nondurable imports are used by both durable and nondurable domestic industries, their entire value is subtracted from the nondurables sector. Durable imports are treated similarly. Hence, the resulting deflators are a strange hybrid and not a "true" value-added deflator.

Gordon calculates that the relative rise in the gross margin between farm prices and food prices accounts for an additional 1.93 points of the price rise between 1973:1 and 1975:2. Gordon argues that the large rise in food-marketing margins is special, and should be subtracted from an aggregate index before fitting macro price-determination equations. I have two problems with this. First, a substantial part of the farm-to-market spread and the value of inputs to farming arises in the transportation, packaging, and a wide range of other industries, whose contributions to inflation should not be subtracted out. Second, by comparing his deflator for food and beverage prices to the deflator for gross farm product, he arrives at the estimate, cited above, of a 1.93 point contribution of food-marketing margins to the rise in the nonfarm deflator. But the composition and derivation of the gross farm product deflator is not comparable to those of the food deflator. Using a set of indexes explicitly constructed by the Department of Agriculture to measure the gross food-marketing margin,[1] I estimate that the relative increase in gross food margins contributed 1.1, not 1.9, points to the deflator over the relevant period. In short, I question whether Gordon's nonfood nonenergy index captures the rate of price increase that has to be explained.

I also have some problems with his excess-demand variable. He explains what margin is left to be explained by his excess-demand variables—unfilled orders relative to sales in the durable-goods industry multiplied by the ratio of manufacturing output to capacity, detrended. Now, unfilled orders in durable goods are heavily dominated by three industries: nonelectrical machinery, electrical machinery, and transportation equipment except motor vehicles account for some two-thirds of the unfilled orders, but produce less than 10 percent of the private nonfarm value added. So Gordon is wagging a large dog by an awfully small tail.

1. U. S. Department of Agriculture, Economic Research Service, *Marketing and Transportation Situation*, various issues.

The fundamental element on which Gordon's conclusions hinge is his selection of this excess-demand variable, ΔUFK, which, after being run through his equations, exhibits the following properties (see figure 2): (1) the contribution of excess demand to price-wage margins was substantially *less* in 1968–69 than it was in 1963–66; (2) the contribution of excess demand as late in the recession as the third quarter of 1974 was much larger than it was in 1968–69, and was exceeded in only two other quarters between 1956 and 1972; and (3) the trough of the demand variable's contribution to prices was higher in the 1974–75 recession than in any other recession of the postwar period, save 1960–61. If one believes that the ratio of unfilled orders to capacity in three major durable-goods industries is a good proxy for economy-wide excess demand, and if one accepts the lag structure that emerges from Gordon's equations, the conclusion is inevitable: during 1974, as the economy was sliding into the worst recession of thirty years, excess demand was continuing to put upward pressure on prices.

R. J. Gordon: Responding to Nordhaus' comments, I do not see that there is any inconsistency between my results and those of Eckstein and Wyss. While the two papers are not directly comparable, because Eckstein and Wyss did not use the ratio of unfilled orders to capacity and either did not allow demand variables to enter with a lag or constrained the lag to be the same as on other independent variables, nevertheless they found strong demand effects, particularly for durables (see the results for the utilization rate in their table 6). Nordhaus' attempt with the "Darwinian statistic" concept to deflate the significance of the demand coefficients in the present paper is incorrect since the basic demand variable in this paper (ΔUFK) is exactly the same as that used in the 1971 paper. Other alternative demand variables have been included in table 3 simply to show that the demand effect is robust to the choice of demand proxies, and none of the four alternative proxies in table 3 is rendered "extinct"—that is, statistically insignificant. Finally, Nordhaus' criticism of the price-controls methodology implies that dummy variables have been used; in fact, all sample periods ended in 1971:2 precisely to avoid the use of dummy variables to estimate the effect of controls.

In response to Schultze, the difference of 1.93 percentage points between our two price indexes is contributed by the "food minus farm" sector —that is, total gross food product minus gross farm product. This difference consists not only of the gross margin between farm prices and food prices—for example, labor, transportation, and packaging costs—but also of the inputs purchased by farmers. If Schultze has calculated that 1.1 percentage points of the 1.93 can be attributed to food-marketing margins, then the remainder must have been contributed by the costs of farm inputs. As to Schultze's reservations about the excess-demand proxy variable, ΔUFK, the dominance of three industries in the data on unfilled orders does not necessarily raise problems if the unobservable excess demand for the products of other industries is positively correlated with unfilled orders in these three industries. Finally, for those who are still unwilling to accept ΔUFK, let me call attention to table 3, equation 3.4, in which the rate of change of the GNP gap appears as a significant demand proxy, with a t-statistic of -4.37.

General Discussion

Robert Hall was pleased to see that the effect of demand upon aggregate prices had finally been empirically verified, and he thought further work would uncover an even greater demand elasticity than Gordon estimated. In his view, a surge in demand should meet a fairly inelastic supply in the short run due to the fixity of capital, thus running prices up and giving a short-run price elasticity in the neighborhood of 0.4. In the long run, supply should flatten out, cutting the price elasticity. But Lawrence Krause questioned Hall's scenario for an open economy, since short-run capital constraints on domestic output can be relieved by imports from abroad, giving a flatter marginal cost curve and a lower price elasticity. And George Perry noted that the presence of cyclically underutilized capital would also alter such a calculation. Hall agreed, but thought the extreme position of an infinitely elastic short-run supply curve—that some researchers found and that Nordhaus' skepticism of Gordon's modest price effects implied—could not be achieved through imports.

Paul Samuelson found that the price equation lacked theoretical underpinning. Steady-state prices in a time-phased Leontief-Sraffa system, with labor and perhaps some raw materials taken as primary inputs, can be defined for each given steady-state profit rate. They can be computed as the "dual, price" function of the steady-state primary factor and final output relations, in which every depreciation coefficient is amplified by addition of the profit rate. It was not clear that Gordon's empirical specification would be implied by such a model or that it was adequate for the real, multisector world that was being examined.

Christopher Sims remarked that Gordon's attempt to explain inflation by the past money supply did not test or reject the rational-expectations model with which Gordon associated it. A rational-expectations model with a one-period information delay always implies that monetary policy has no systematic impact on real quantities, yet such a model is consistent with an arbitrarily long mean lag in regressions of prices on money. Indeed, natural assumptions on the serial-correlation properties of the money supply make such a long mean lag likely in these models. Thus, the simplest and most extreme rational-expectations models are consistent with Gordon's findings. Gordon agreed with Sims that, in principle, there were two possible interpretations of the long lag between monetary growth and price change. Either (1) real output reacts only to monetary surprises, and prices lag behind money as long as the actual and expected rates of monetary growth diverge; or (2) a sluggish price-adjustment structure allows even fully comprehended monetary changes to constrain behavior and affect real output. Gordon supported the second interpretation, both because it was more consistent with the 1974–75 recession, and because recent tests of the first interpretation had yielded such short money-to-price lags. Samuelson pointed out that a reduced form of the kind of model that most economists think of would look a lot like Gordon's estimated equation between money and prices. In the longest run, the standard model is homogeneous of degree zero in terms of real output and homogeneous of degree one in terms of every price. Over a very long time, this model explains the price level on the basis of the money supply, and the only possibly surprising thing about Gordon's result is that he finds, over so long a lag period, no exogenous shifts in velocity that require special explanation. But such a model has no useful predictive or prescriptive properties for the short run when real output is not fixed.

Sims pointed to Gordon's finding that demand influences prices as evidence that simultaneous-equations bias exists in simple price or wage regressions. With both prices and wages influenced by demand, Gordon's use of single-equation methods is inappropriate for estimating the price equation. Gordon noted, however, that identification of a structural price equation was still possible if the demand effect in the wage equation was relatively weak and operated with a long lag, as seemed to be the case.

Perry shared the doubts Charles Schultze had about the food adjustment Gordon made. He found the difference between Gordon's findings and Schultze's in *BPEA, 2:1975* too large to associate simply with food processing, distribution, and farm inputs. Since the energy adjustment has already been made in a separate calculation, the 0.8 percentage point residual (Gordon's 1.9 points less the 1.1 points attributable to the farm-to-market spread), which must come from farm inputs, seems surprisingly high, amounting to about $8 billion. What is more, all of the 1.9 percentage point spread that is attributable to wages is already in the aggregate wage-cost variable. If these wage costs rose exceptionally fast, they incorrectly help "predict" an extraordinary rise in the nonfood price deflator.

Arthur Okun voiced some doubts about the treatment of raw-materials prices. Statistically, entering them as the difference from the left-hand variable seemed likely to bias the estimated coefficient toward zero. In addition, some raw materials are imported and some are domestically produced and are thus a part of the left-hand variable being explained. The estimated coefficient on this hybrid variable was thus serving to measure different structural relations. Okun would have preferred a clearer variable or set of variables measuring raw-materials prices, with their effects estimated directly rather than as differences from the dependent variable in the equation. He also noted that the estimated lags on wage cost were larger than he would have expected; if the true lags were much shorter, this might explain why Gordon estimates such a strong demand effect in his equations.