FOOD PRICES AND RISING ENERGY COSTS

R. McFALL LAMM, JR.

INTRODUCTION

Higher relative prices for energy and food are often referenced as important continuing problems in the United States. For example, the Council on Wage and Price Stability attributed 5.2 percent of the 18 percent increase in the Consumer Price Index (CPI) in early 1980 to higher crude oil prices and described energy prices as "uncontrollable." Similarly, the substantial upward movements in food prices during 1978 and 1979 were identified by policy-makers as a major source of inflation and stimulated Congressional hearings and an Administration investigation of the causes of rising food prices.

What is often overlooked in recent discussions of relative price change is that energy is a primary input into the food production and distribution process. Fuel utilization alone counts for more than five percent of total farm production expenses (see Torgenson and Cooper, Van Arsdall and Devlin, and Doering). But energy is also important in food manufacturing, wholesaling, and retailing--representing more than seven percent of the value added by the sector. Hence, rising energy prices are one of the fundamental determinants of higher food prices.

Given this cause and effect relationship, it is apparent that increasing energy prices have two distinct impacts on consumers. One is primary--higher crude energy prices are passed through the marketing system directly to consumers in terms of higher prices for finished energy products such as gasoline and natural gas. The other is secondary and indirect--rising prices for energy products push up the cost of producing and marketing food and other products, leading to higher consumer prices. This latter impact is the principal concern of this paper.

The basic question addressed is: What is the effect of rising energy costs on food prices? The major focus is on the short-run when input substitution is not possible, and on energy price impacts in the food manufacturing, wholesaling, and retailing sector. The results of the analysis have important implications for explaining food price changes. The second section of the paper reviews recent developments in the food and energy sectors, and considers general implications of rising energy costs for the food system. The model underlying the analysis is described in the third section of the paper, while selected estimation results are presented in the fourth. Concluding comments follow in the last section.

R. McFall Lamm, Jr. is Leader, Food Price Analysis Section, ESS, U.S.D.A., Washington, D.C.

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BACKGROUND

Microeconomic theory states that industry-wide increases in the prices of variable inputs cause upward shifts in the marginal and average cost functions of the firm. As a consequence, market supply declines, leading to higher product prices. Generally, the larger the change in input price, the greater will be the impact on product price. Also, the more important the input in the production process, the more significant will be the output price effect. For these reasons, because energy prices have risen substantially and since energy is a crucial input in the food manufacturing, wholesaling, and retailing production process, noticeable impacts on retail food prices would be expected.

It is crucial to distinguish short from long-run price effects. A gradual increase in the relative price of one input over time may have only a limited effect on product price, especially if other inputs are easily substitutable. For example, real wage rates for food industry workers rose from the 1950's through the 1970's. Because these increases were of limited magnitude, the effect on food product prices was virtually insignificant--capital was gradually substituted for labor as mechanization occurred and new plant facilities constructed. In contrast, real energy prices trended downward from the late 1950's through the early 1970's and energy utilization increased.

But beginning in late 1973, there was an explosive surge in energy prices, particularly for liquid fuels. Input mix adjustment could not occur immediately--plant technology and size were essentially fixed in the face of a short-run "shock." The result was a classical cost-push impact on food prices. A similar "shock" occurred in 1979. Hence, the fundamental problem with energy prices is not so much that they rise, but that increases have been so large and unpredictable (see Jorgenson).

Other factors are also important in explaining why food prices change. Certainly, the influence of weather on crop production dominates other considerations, although export demand and labor costs play major roles. For example, in the 1973-1974 period, and again in 1978-1979 the simultaneous impacts of bad weather, increasing export demand, and the explosion in raw energy prices led to the largest relative food price increases in the postwar era (see Table 1). Sensitivity to these stochastic influences is a major characteristic of the food manufacturing

Table 1. Annual Changes in Selected Consumer and Producer Prices, 1970-1980

Year	Consumer Price Index For: Food	Energy	Other Items Less Food and Energy	Producer Price Index For: Gas Fuels	Refined Petroleum Products	All Energy
			--Percent--			
1970	5.5	2.8	6.2	11.0	1.4	5.2
1971	3.0	3.8	4.7	4.7	6.1	8.5
1972	4.3	2.8	3.1	5.2	1.6	3.0
1973	14.5	8.0	3.5	7.5	18.2	13.2
1974	14.4	29.3	8.3	32.2	73.6	55.1
1975	8.5	10.6	9.2	33.6	15.3	17.7
1976	3.1	7.2	6.6	32.3	7.4	8.4
1977	6.3	9.5	6.2	35.2	11.4	13.8
1978	10.0	6.3	7.3	10.5	4.2	6.7
1979	10.9	25.2	9.7	26.9	38.6	26.5
1980	8.6	31.3	12.4	39.6	51.5	40.4
Mean	8.1	12.5	7.3	21.9	20.9	18.0
Standard Deviation	4.1	10.8	2.8	13.7	23.6	16.4

Source: Bureau of Labor Satistics.

and distributing sector, and explains in part why food prices have fluctuated much more substantially than nonfood prices (except energy) over the last decade. Similarly, the fact that export demand and input prices have risen consistently through the 1970's indicates why food prices have increased relatively—the CPI for food rose more than eight percent per year over the last decade while the CPI for other items less food and energy moved up only a little more than seven percent per year.

It is no surprise that increasing food and energy prices are important issues to policy-makers. Consumers normally purchase food and gasoline frequently—usually at least once a week. Hence, when prices for these products increase rapidly, consumers are quickly aware. This cognizance is reinforced through media attention. The resulting public anxiety is communicated directly to Congress and the Executive branch through constituent appeals, often leading to policy actions designed to limit food and energy price increases, or at least to prevent sudden increases. Grain reserve programs, foodstuff export embargos, special diesel fuel allocations to agriculture in the spring of 1979, the continuation of price controls for natural gas used in food production, and other policies serve as recent examples.

METHODOLOGY

Econometric models and simulation have increasingly been used to analyze the effects higher energy prices have on the economies of large petroleum consuming states. The nature of the "energy crisis" is such that it is conducive to this approach--quantification in terms of prices and quantities is relatively simple, facilitating the evaluation and review of alternative policies. DeSouza recently has described the major energy models developed and utilized to analyze energy questions, while Heady and Dvoskin propose alternative approaches to modeling energy price effects. But to date, there has been only limited effort to explore the effects of higher energy costs on food prices through econometric models.

A small quarterly econometric model of the food sector developed by Lamm and Westcott (LW) serves as a basis for analysis in this paper. The LW model, currently used by the U.S. Department of Agriculture to forecast retail food prices, consists of 20 equations designed to explain the behavior of CPI's for major food groups. Three major classes of exogenous variables are included in the model: (1) prices received by farmers for basic food commodities and Producer Price Indexes (PPI's) for imported foodstuffs; (2) wage rates at food manufacturing plants, food stores, and eating and drinking establishments; and (3) prices for other material inputs such as glass bottles, paper, and energy (represented by the PPI for fuels, related products, and power). The model is linear, simultaneous, and estimated using three stage least squares with data from first quarter 1967 to fourth quarter 1977. The basic equations and a discussion of the model are given by Lamm and Westcott. An alternative version of the model, updated using data through 1979, is described by Lamm.

The theoretical rationale underlying the LW model is the markup pricing concept--price is set on the basis of unit cost plus a markup to generate profit, the size of the markup being functionally dependent on market power in the industry. In this context, rising input prices lead to higher unit costs, which are passed through directly to consumers. But this transmission process is not instantaneous--there are lags before prices can be marked up in response to higher unit costs and there are several stages of production in the vertical chain through which an initial increase must be passed.

For example, if the price of natural gas to a food manufacturer rises, it may be several weeks or months before it is fully reflected in the price of the firm's product--the administrative units assigned purchasing responsibilities and those allocated price-setting functions are usually separate entities and may even be located in different geographic areas. Hence, there is a coordination problem. In addition, marketing strategy considerations may delay an increase in product price as firms await their competitors' response.

The LW model incorporates these lags explicitly into its structure. Lagged endogenous as well as lagged exogenous variables enter many equations. Although the model does not derive specifically from a firm optimization problem, the inclusion of these lags represents a special structure which could be derived from several different firm optimization problem, (for an example of one see Heien). Other characteristics of the model include: (1) a restriction of simultaneity principally to high protein food classes (meats, fish and poultry); (2) an important role for expectations formation in many equations; and (3) a predominance of seasonal effects as determinants of retail prices for some foods.

A comprehensive testing procedure is utilized to validate the model following the typical approach in time series analysis. Deterministic simulations of the model are performed using exogenous data covering both the actual sample period and eight quarters of data beyond that used for estimation. The resulting validation statistics (mean absolute errors and Theil inequality coefficients) indicate that the model performs extremely well, both in an absolute sense and with respect to the performance of a food price forecasting model developed by Barr and Gale. Additionally, the model is tested as a "complete" forecasting tool--equations to forecast exogenous values are developed and utilized to make post sample predictions of changes in food prices.

RESULTS

Linear econometric models with lagged endogenous variables possess what Goldberger has referred to as impact, interim, and total multipliers. The impact multipliers give the effects of changes in exogenous variables on endogenous variables in the current period. Interim multipliers give the effects of changes in exogenous variables on endogenous variables after one or more periods. And total multipliers are the sum of the impact and all interim multipliers--the total effect on endogenous variables of given changes in exogenous variables.

Table 2 presents impact, four quarters of interim, and total multipliers for energy and selected major food group prices as derived from the LW model. The entries in the first column show the effect of a one percent increase in energy prices on selected CPI's in the current quarter. For example, a one pecent increase in energy costs is found to cause a .26 percent increase in retail beef prices; a .07 percent increase in pork prices; a .08 percent increase in prices for other meats; a .01 percent increase in poultry prices; a .16 percent increase in fish prices; and a .36 percent rise in prices for processed fruits and vegetables. Weighting these components by their relative importance in the CPI indicates that prices for "all food" increase .05 percent concurrently in response to a one percent increase in energy prices.

After one quarter, the effects on retail prices for beef, pork, other meats, fish, and processed fruits and vegetables diminish significantly—most of the impact of rising energy costs comes in the same quarter in which it occurs for these foods. But for poultry, fats and oils, sugar and sweets, other prepared foods, and nonalcoholic beverages, the largest effect on retail price comes only after a one quarter delay. In this regard, a one percent increase in energy prices in the previous quarter is seen to cause a

Table 2. Effects of a One Percent Increase in Energy Prices

Consumer Price Index For	Impact in Quarter 0	1	2	3	4	Total
	--Percent--					
Beef	.26	-.05	.01	.00	.00	.22
Pork	.07	.02	.00	.00	.00	.09
Other Meats	.08	.02	.01	.00	.00	.11
Poultty	.01	.08	-.01	.00	.00	.08
Fish	.16	-.03	-.02	.01	-.01	.09
Fats and Oils	.00	.17	.06	.03	.01	.29
Sugar and Sweets	.00	.19	.00	.00	.00	.19
Other Prepared Foods	.00	.05	.00	.00	.00	.05
Nonalcoholic Beverages	.00	.20	.06	.02	.00	.28
Processed Fruits and Vegetables	.36	.09	.02	.01	.00	.48
All Food	.05	.03	.01	.00	.00	.10

.08 percent increase in poultry prices this quarter; a .17 percent increase in fats and oils prices; a .19 percent increase in sugar and sweets prices; a .20 percent increase in nonalcoholic beverage prices; and a .03 percent increase in the CPI for all food.

Increases in energy prices two, three, and four quarters ago are seen to have small effects on retail food prices this quarter for both individual food groups and the CPI for all food. However, the total cumulative effect on retail prices of increases in energy prices is found to be substantial. The largest effects of higher energy costs are on retail prices for beef, fats and oils, nonalcoholic beverages, and processed fruits and vegetables--all increase more than .20 percent in response to a one percent increase in energy prices. The total effect of a one percent increase in energy prices on the CPI for all food is .10 percent.

These findings are consistent with previous studies of the effects of higher energy prices on food costs. For example, Lasley found that a doubling of energy prices would lead to a two to six percent increase in food costs, while Whittlesey and Lee concluded that a doubling in energy prices would increase food costs five percent. The results presented in this paper focus on food prices, however--not on food costs. Even so, the results of the previous section suggest that if energy prices doubled, causing retail prices to rise 10 percent, a small offsetting decline in food consumption could easily put the change in the cost of food to consumers in the 5 percent range.

CONCLUDING COMMENTS

On the basis of the LW model, it is apparent that rising energy costs contribute substantially to increases in retail food prices. This contribution is more pronounced for some foods than for others, depending on the energy intensivity of the production process. About half of the effect from higher energy prices is passed through to retail immediately in the same quarter, about 30 percent after one quarter, and much of the remainder after 2 quarters. For this reason, it is clear that rising energy costs are quickly transmitted to consumers. This finding contrasts somewhat with that of other studies for nonfood items which generally indicate longer lags before increasing input prices show up at retail.

Combining the information on energy and food price changes from Table 1 with the total multipliers from Table 2 permits inferences concerning the impact of energy cost increases in specific years. In this respect, indications are that large increases in energy prices were responsible for more than one-third of the rise in food prices in 1974, about one-fourth in 1979, and more than forty percent of the 1980 increase. This illustrates importantly that changing energy prices have been a crucial factor in the recent food price inflation. This aspect is often overlooked in the public dialogue on the causes of higher food prices.

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