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Inflation

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# The Differential Effects of Inflation on Selected Food-Related Sectors of the U.S. Economy, 1967-1978

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by

Gerald Schluter*

and

Gene K. Lee*

*Agricultural Economists, National Economics Division, and International Economics Division, Economics, Statistics, and Cooperatives Service, USDA, Washington, D.C. Conclusions and viewpoints expressed are the author's and are not necessarily those of the United States Department of Agriculture.

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ABSTRACT

A consistent economic model for measuring the price-induced income effects of relative price changes is reported and used to analyse sectors within the food system. Since 1972 the farm sector has benefited from relative price changes but export-oriented crop sectors have done better than domestic-oriented crop sectors and livestock.

# THE DIFFERENTIAL EFFECTS OF INFLATION ON SELECTED FOOD-RELATED SECTORS OF THE U.S. ECONOMY, 1967-1978

Any informed discussion of the impacts of inflation inevitably is a discussion of relative price changes. Pure inflation, a substantial substained rise in the general price level with all prices staying the same relationship to each other (Reagan), likely exists only in theoretical formulations. In a dynamic economy all prices do not change at the same rate.[1/] Thus income redistribution is an inevitable consequence of inflation.[2/] During the 1970's agriculture has both benefited from those relative price changes which temporarily raised the farm share of the food dollar and has been a victim of relative price changes which raised production costs in years when the supply and demand situation for agricultural commodities did not allow an offsetting increase in gross revenue. While available information has supported this type of generalization about the influence of inflation on the farm sector, the ability to make more specific statements about the effect on parts of the food system has been lacking.

This paper presents a consistent economic model [3/] which allows the analysis of available price data to yield a measure of the income effects within various food system subsectors of changes in sector price indices. After a brief discussion the economic model and the situations under which the model results apply, we present the results for the 1967-78 period and an analysis of these results.

Studies of inflation and its impact essentially fall into two groups, those that attempt to explain the movement of prices (e.g. Ruttan; Eckstein and Hein, Penn) and those that attempt to explain the effect on participants in the economic system (e.g. Robinson). This study falls into the second group. We do not attempt to explain individual price movements but instead look at the historical price pattern and examine it for evidence of the identification of gainers and losers from the changing pattern of relative prices since 1967.

## Methodology

The economic model used for this analysis is presented in detail in Lee and Schluter. Basically the model is an input-output model adapted to measure the income effects of changes in relative prices. The complete Lee-Schluter model analyzes the effect on residual income 4/ of levels of relative prices domestically as well as import prices and the general wage level i.e.

$$(1) \quad r = [e\, D_p(I-A) - P_1 W - e\, D_{pm}\, M]\, D_o$$

where $r$ = a 1 x n vector of residual incomes, $r_j$'s

$e$ = a 1 x n vector of ones

$D_p$ = an n x n diagonal matrix of prices, $p_j$'s

$I$ = an n x n identity matrix

$A$ = an n x n matrix of I/O technical coefficients, $a_{ij}$'s

$P_1$ = a scalar, the general wage rate

$W$ = a 1 x n vector of physical labor requirement coefficients, $w_j$'s

$D_{pm}$ = an n x n diagonal matrix of import prices, $p_{mi}$'s

M = an n x n matrix of import coefficients, $m_{ij}$'s

$D_o$ = an n x n diagonal matrix of sector output, totals, $O_j$'s 5/ .

Equation (1) expresses the level of residual income as the product of a residual income coefficient (income per unit of output after deducting material and services costs and sector labor and import costs) and the level of output. Lee and Schluter estimated the effects of price changes by substituting a diagonal matrix $D_{\Delta p}$ for $D_p$ in equation (1). The diagonal matrix, $D_{\Delta p}$, is defined by a ratio of new prices over base year prices $p_i/p_o$.

The ratio $p_i/p_o$ is an index number expressing a price for the ith commodity relative to the base period. Similar types of adjustments could be made for changes in wages, import prices or changes in output. We chose however, to hold these constant which, of course, assumes the base year labor and imports share of total output remain valid for all succeeding years. Further we chose to use the I/O concept of value added as our measure of income. Thus our income is residual income (r) plus wage income ($P_1W$). With these modifications equation (1) is changed to to read:

(2) $v = [\, e\, D_{\Delta p}\, (I-A) - m^*]\, D_o$

where v = 1 x n vector of value added, $v_i$'s

$D_{\Delta p}$ = an n x n diagonal matrix of price ratios relative to the base year, $p_i/p_o$

$m^*$ = a 1 x n vector of constant import coefficient

Thus the value added series for a particular industry is the 1967 value added adjusted for changes in that industry's output price and intermediate input prices. The weights for the prices are provided by the Leontief (I-A) matrix.

The analysis used a 42 sector aggregated version of the 1967 national I/O table (USDC, BEA, 1974) for the import and domestic input-output coefficients and thus for the base year income, final demand, and output estimates. The 42 so-defined sectors are presented in table 1 along with the price series selected to represent the price level of each sector. Published prices indices for service sectors are rare so indices from the annual data bank of Wharton Econometric Associates was used.

## Evaluation

The statistic we are measuring with our model is similar to a Laspeyres price index of value added i.e.

$$\frac{V^1}{V^0} = \frac{q^1Q^0 - m^1M^0}{q^0Q^0 - m^0M^0}$$

where V, q and m are prices of value added, output, and material inputs respectively and Q and M are output and material input levels, respectively and superscripts 0 denotes the base period and 1 the current period. This similarity provides both a check on the models' performance and an insight into the relative vulnerability of the studied sectors to the forces of the recent inflation.

A summary of the model's performance is presented in Table 2. Column 1 gives the model's estimate of the implicit price deflator for farm value added, column 2 gives the U.S. Department of Commerce implicit price deflator for gross farm product (GNP originating in farming), and column 3 gives the ratio of the two series. As column 3 shows, with the exception

Table 1 Sectoring Plan and Associated Price Series*

| ector: o. | Sector Description | Price Series | Variable |
|---|---|---|---|
| | Dairy Farm Products | FI Accts. Season av. | |
| | Poultry & Eggs | " | |
| | Meat Animals | " | |
| | Miscellaneous Livestock | " | |
| | Cotton | " | |
| | Food Grains | " | |
| | Feed Grains | " | |
| | Grass Seed | " | |
| | Tobacco | " | |
| | Fruits | Prices Received | All Fruit |
| | Tree Nuts | FI Accts. Season av. | |
| | Vegetables | Prices Received | Vegetables |
| | Sugar Crops | FI Accts. Season av. | |
| | Miscellaneous Crops | FI Accts. Season av. | |
| | Oil Bearing Crops | FI Accts. Season av. | |
| | Farm Forest and Nursery Products | Prices Received | All Crops |
| | Meat Products | Producers Price | 0221,0222 |
| | Dairy Plants | " | 023 |
| | Canning, Freezing & Dehydrating | | 024 |
| | Feed and Flour Milling | " | 0212-4,0291,3,4 |
| | Sugar | " | 02510102,3,4,5 |
| | Fats & Oils Mills | " | 027,0292 |
| | Confectioners and Bakeries | " | 02111,02140104;pt.0251 |
| | Beverages & Flavorings | " | 026 |
| | Fertilizers | " | 0651,0652 |
| | Petroleum Refining & Related Products | " | 057 |
| | Miscellaneous Food Processing | " | 028 |
| | Tobacco Manufacturing | " | 152 |
| | Textiles, Apparel & Fabrics | " | 03 |
| | Leather and Leather Products | " | 042,043,044 |
| | Crude Petroleum | " | 0561 |
| | Coal Mining | " | 051 |
| | Forestry, Fishing & Other Mining | " | 081 |
| | Other Manfacturing | " | Durable Manufacturing |
| | | | |
| | Transportation & Warehousing | WEFA | PXVGRGT |
| | Wholesale & Retail Trade | WEFA | PXVGWR |
| | Other - Non Commodities | WEFA | PXVGSU |
| | | | |
| | Electric Utilities | Producer Prices | 054 |
| | Gas | Producer Prices | 053 |
| | Real Estate | WEFA | PXVGFI65+6 |
| | Special Industries | assumed unity | |
| | Imports | WEFA | PTMB |

Detail greater than was required for the food system analysis, reflected in the sectoring lan is due to an attempt to include alternative sector analytical capabilities for the odel.

Table 2.-- Comparison of model estimate with actual implicit gross farm product and gross national product deflators, 1968-1978

| Year | Gross Farm Product | | | Gross National Product | | |
|---|---|---|---|---|---|---|
| | Estimate | Actual a/ | EST/ Act | Estimate | Actual a/ | EST/ Act. |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| 1968 | 103.4 | 102.8 | 1.006 | 103.9 | 104.5 | .994 |
| 1969 | 109.5 | 112.4 | .974 | 109.0 | 109.7 | .994 |
| 1970 | 109.3 | 111.4 | .981 | 113.4 | 115.6 | .981 |
| 1971 | 109.7 | 112.7 | .973 | 118.6 | 121.5 | .976 |
| 1972 | 131.1 | 133.7 | .981 | 122.5 | 126.6 | .968 |
| 1973 | 212.2 | 207.1 | 1.025 | 130.6 | 133.9 | .975 |
| 1974 | 218.9 | 199.5 | 1.097 | 145.9 | 146.8 | .994 |
| 1975 | 193.5 | 195.2 | .991 | 160.8 | 160.9 | .999 |
| 1976 | 192.4 | 191.6 | 1.004 | 169.5 | 169.2 | 1.002 |
| 1977 | 179.0 | 191.4 | .935 | 180.3 | 179.3 | 1.006 |
| 1978 | 221.1 | 232.6 | .951 | 193.8 | 192.4 | 1.007 |

a/ Survey of Current Business, National Income Issues, January 1976, July 1979.

only below the national trend line but also below the base year during the 1967-73 period, caught up with the national trend in 1974, was above in 1975-1976 and below in 1977-78.

Among the sectors processing crude farm crops, fat and oil mills have exceeded the national trend since 1970. Sugar refiners also achieved it that year and canning freezing and dehydrating achieved this status in 1974. On balance fat and oil mills and sugar refiners were gainers, grain mills were losers and canners about held their own.

Among more highly refined food processing sectors, confectioners and bakeries apparently benefited from inflation, as have beverages and flavoring in recent years. Miscellaneous food processing appears to have been at an consistent disadvantage

How credible are these estimates? They are not independent isolated estimates. They are derived from an economic model which uses estimates of the interrelatedness of the U.S. economy. The model is consistent. It can be and was validated by pooling individual sector estimates for comparison with published aggregates. In total this series of estimates provide the first systematic, internally consistent set of estimates of the relative vulnerability of parts of the food system to recent inflationary forces.

Figure 1

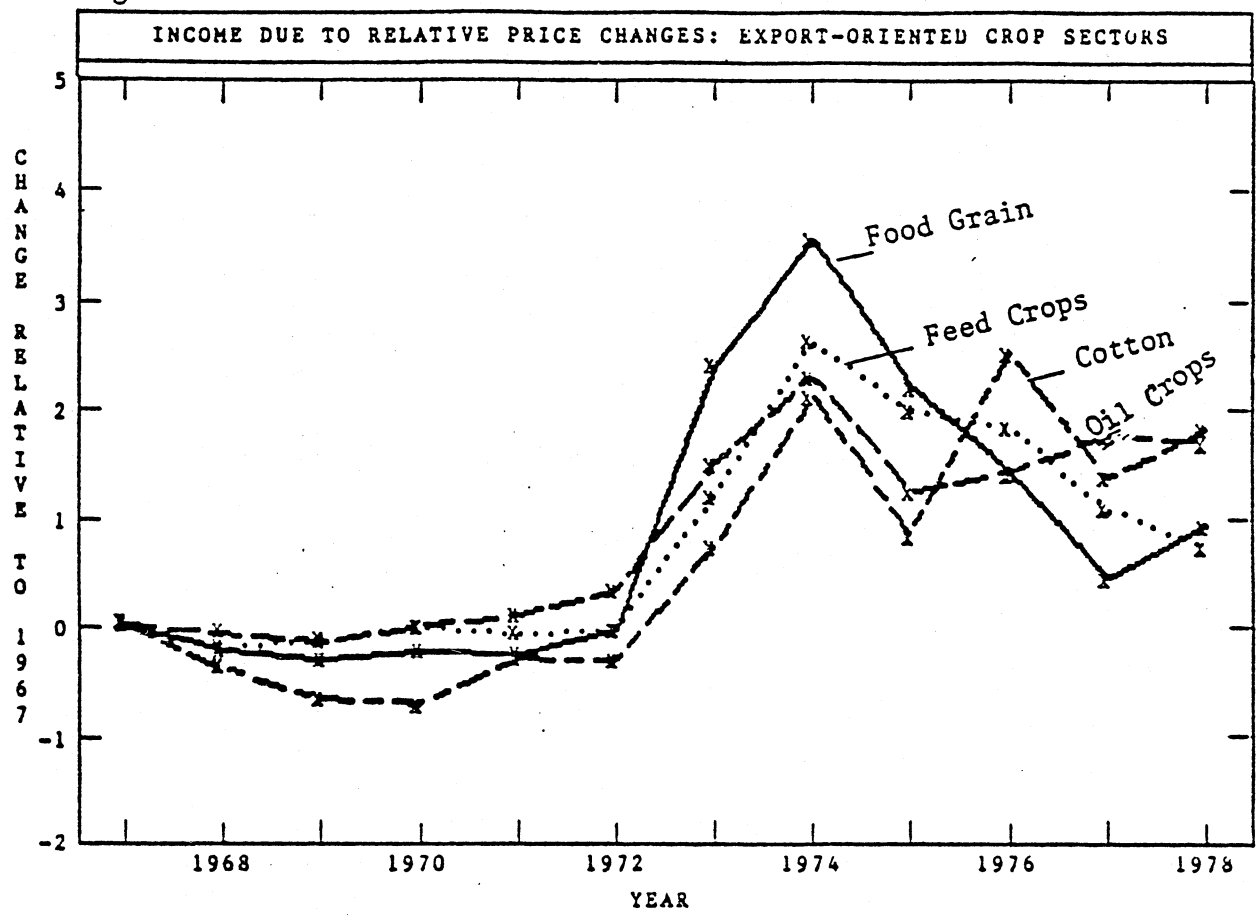


Figure 2

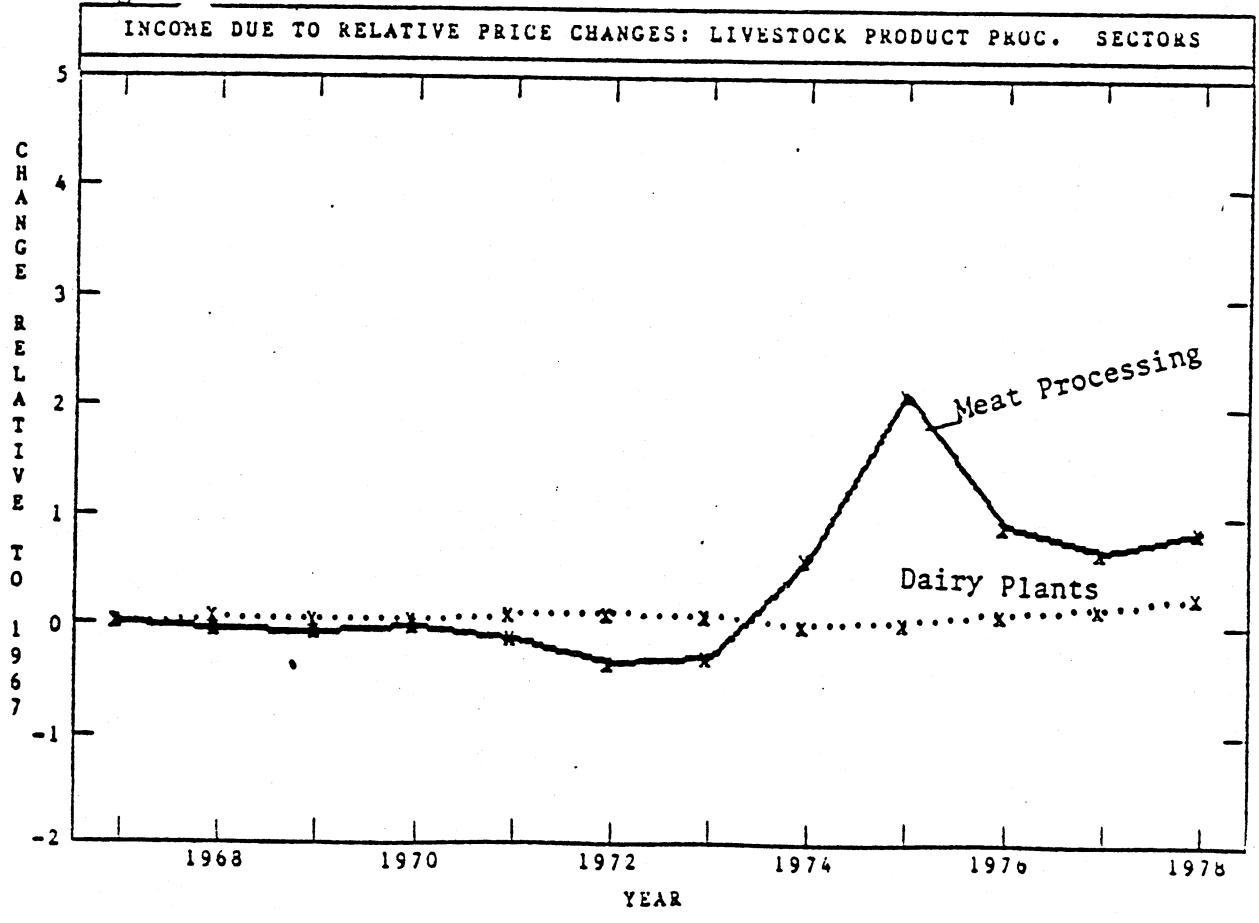

Figure 1 presents the estimated income levels relative to 1967 of four export oriented crop sectors. During the 1968-70 period relative price changes moved to the detriment of all these sectors and their incomes fell below 1967 levels. In 1971 the oil crops sector moved above the base line and by 1972 oil crops had moved to a level 33 percent over base. Then with the export boom the domestic terms of trade dramatically shifted in the favor of these four crop sectors. The most dramatic shift occurred in the food grain sector which went from a level equal to the 1967 base in 1972 to a high of 353 percent above base in 1974. All four sectors, food grains, feed crops, cotton, and oil crops, peaked in 1974 and income levels fell in 1975 and continued to do so in 1976 with the exception of cotton for which price and income recovered to above 1974 levels and oil crops which rose slightly from its 1975 income level. In 1977, the oil crops sector continued its rise but the rest dropped. Cotton and food grains again rose in 1978, but oil crops stabilized and feed crops continued to fall.

In contrast to the volatile price and income pattern observed for export oriented crops in figure 1 a stable price and income pattern occurred for the manufactured dairy products sector (figure 2). From 1967 through 1975 the estimated income levels stayed within ten percent of the base year levels. Not until 1976 did it break the 10 percent barrier. Apparently this sector is able to pass on increases in the farm price of milk but the demand situation for its product is such that this is about all it is able to do. The meat and poultry processing sector apparently faces a different demand situation for its output. As the farm price of meat animals and poultry rose in the 1971-73 period, the meat and poultry processing sector was unable to pass on this higher raw material cost and income levels fell almost 40 percent below base. After this however the

wholesale price index for processed meats showed more resilience than the farm prices and the income position of this sector got exceptionally stronger during the 1974-1975 period after which its income position dropped to more modest levels.

## CONCLUSION

All caveats and other considerations aside, the model, in order to be useful, must have something to say about which sectors of the food system have gained from the recent inflation and which have lost. And it does. A rough measure of the relative position of a sector with respect to inflation is its sector value-added price deflator relative to the GNP implicit price deflator.

Since 1973 with the exception of feed crops in 1978 and food grains in 1977 and 1978 all the export oriented crops have exceeded the national norm (the implicit GNP deflator) and benefited relatively from price inflation by an amount likely to offset its relatively less favorable position from 1967 to 1973.

Among the domestic oriented crops only sugar has been able to benefit from inflation. On balance fruits and vegetables have been relative losers. Since 1973 all the livestock sectors except dairy in 1976 and 1977 and dairy and meat animals in 1978 have been below the national norm and losers to inflationary forces. From 1967 to 1973 the meat animal sector was a relative gainer against inflation as was dairy in 1967-72 and poultry and eggs in 1967-70. They were gaining in the years when the general farm price level was rising slowly but lost when the big farm price surge came. Among livestock product processing firms the dairy food manufacturing sector has consistently been below the national trend. Meat and poultry processing was not

only below the national trend line but also below the base year during the 1967-73 period, caught up with the national trend in 1974, was above in 1975-1976 and below in 1977-78.

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## Footnotes

1/ Relative prices change for many supply and demand related reasons not all necessarily related to inflation. Yet it is not possible to isolate inflation related price changes from those price changes which are normal market adjustments to changes in supply and demand conditions. Thus, all our usual measures of inflation; the implicit price deflator for gross national product (GNP), the consumer price index, and the producer price index are weighted price indices of observed price changes without regard for why they change. As a working definition, inflation for this paper refers to movements in this measured level of the general price level as represented in the implicit GNP deflator.

2/ Of course with pure inflation there are no relative price changes so the inflationary effects are felt not on current transactions but rather on the values of assets and debts. With inflation as actually measured unequal relative price changes inevitable leads to income redistribution as a result of current transactions as well as revaluation of assets and debts.

3/ In a consistent economic model the output of each industry is consistent with the demands, both final and from other industries, for its products. A consistent economic model insures that estimates for individual sectors and industries will add up to a total estimate (e.g. of Gross National Product)

4/ The definition of income in input-output is synonymous with the value created. Thus, residual income includes proprietors' income, rental income, corporate profits, net interest, business transfer payments, indirect business taxes, and capital consumption allowances.

5/ Conventional I/O notion uses X to refer to the value of output. We use $p_i O_i$ to facilitate reference to the value of output ($X_i$ or $_i O_i$) and real output ($O_i$).

6/ A comparison of columns 2 and 5 show another difficulty of discussing the role of agriculture in general inflation. The volatility of ag prices lead to volatile estimates of their role in general inflation. The 1978 implicit gross farm product deflator of 232.6 represents an eight percent annual rate of increase, well above the 6.1 percent rate in the GNP deflator. Yet the GFP deflator decreased in 5 of the eleven years. Almost all of the increase came in 1969, 1972, 1973, and 1978. Thus while the GNP deflator increased each year, in only 4 of the 11 years did the change in the GFP deflator rate exceed the change in the GNP deflator rate. Over the 11 year period the farm sector price deflator grew faster than the national deflator rate. Yet in 6 of those 11 years the rate of price increase in the farm sector was less than one-third that of the general price level.