Effects of Relative Price Changes on U.S. Food Sectors, 1967-78

By Gerald Schluter and Gene K. Lee*

Abstract

For a half-century the parity ratio has served as the most commonly used measure of the effects of relative price changes on the farm economy The authors present a consistent economic model which measures the price-related income effects of relative price changes in selected sectors of the U.S economy during the 1967-78 period and use this model to analyse selected sectors within the food system Their model improves and expands upon the parity ratio It provides more detailed information within the farm sector, and it provides conceptually consistent measures of the effects of relative price changes in the nonfarm sectors of the food system

Keywords

Relative price changes, Parity ratio, Input-output analysis, Food system, Farm sector, Inflation

The first step, forming a clear idea of the ultimate use of the result, is most important, since it affords the clue to guide the compiler through the labyrinth of subsequent choices It is, however, the step most frequently omitted

Wesley Mitchell, 1915

Introduction

Mr Mitchell was referring to constructing a price index, but his advice is as true today as it was 65 years ago (*5*) [1] Equally true, we suggest, is a corollary for choosing a price series The first step, determining the purpose for which the price index is constructed, is most important, since it affords the clue to guide the user through the labyrinth of subsequent inappropriate uses A classic example of the failure to follow this corollary is the parity ratio

The parity ratio has survived 50 years of criticism, and it will likely continue to be used because it is timely (some price data are only about 2 weeks old when published), readily available, and easily understood In this article, we briefly review its suitability as an indicator of the effect of relative price changes on agriculture and compare it with two alternative price series Then we present a consistent economic model which measures the effects of relative price changes on selected farm, food-processing, and energy-related sectors of the U S. economy during the 1967-78 period, which, we propose, provides a better indicator of the effects of relative price changes in the food and agricultural sectors.

At the core of most attempts to support farm income has been the desire to maintain the purchasing power of farmers. Often this effort has taken the route of maintaining relative prices, since makers of agricultural policies have recognized that high or low prices for farm products are not in themselves of major importance Of far greater importance is the purchasing power of farm products in terms of the items farmers must buy for living and for their businesses In response to these needs, the U.S Department of Agriculture (USDA) developed, and first published in 1928, the parity index The parity index, or the Index of Prices Paid by Farmers for Commodities and Services, Interest, Taxes, and Wage Rates, is expressed on the 1910-14 = 100 base This parity index was used in conjunction with the Index of Prices Received by Farmers to yield a measure of farmers' purchasing power One obtains this measure, the parity ratio, by dividing the Index of Prices Received by the parity index The concept of a parity ratio has been critized almost from its start (*3*) Many criticisms have resulted from improper use by data users rather than from problems with the parity ratio series itself The parity ratio is a price comparison It is not a measure of cost of production, standard of living, or income parity (*9*) Nor is it more than one of many indicators of well-being in the farm sector Many of the criticisms of the parity ratio have resulted from attempts—contrary to Mitchell's advice—to make it serve roles for which it was never intended

Because the Prices Received Index reflects only farm commodities and the parity index includes farm-household consumption items as well as production expenditures, the

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[1] Italicized numbers in parentheses refer to items in the references at the end of this article

parity ratio most closely mirrors the situation of a farm-operator household in which the household's income comes entirely from farm production Relatively few farm households today depend solely, or even primarily, on income from farm sources. Moreover, using the ratio as a broader indicator to measure relative price changes for agriculture as an economic sector presents some conceptual problems The Prices Paid Index is more inclusive than the Prices Received Index. In addition to current production items, the parity index includes consumption items and capital expenditure items, as well as inflation premiums in interest rates and possibly in capital inputs Heady (*1*, p 142) points out the parity ratio is faulty in a formal supply sense because the parity index does not include the implicit cost of resources already committed and specialized to agriculture A sector measure of relative price changes would include only the prices of current output and current inputs Considering only current output and input prices has the additional advantage of avoiding the measurement problems which Heady enumerates and the problems of quality adjustment in capital goods prices and inflation premiums in interest rates.

A price series which meets this criterion, measuring only current economic activity in the farm sector, is the implicit price deflator for gross national product (GNP) originating in agriculture, or the gross farm product (GFP) The implicit GFP deflator includes on the output side not only prices of commodities sold but also changes in farm-related income, the value of inventory changes, and selected imputed items, and on the input side, purchased current goods and services and rents paid Comparing the implicit GFP deflator to the implicit GNP deflator provides a reference as to how price changes affect the farm sector relative to the general economy Applying this approach, we present a consistent economic model[2] in which the combined price effects on 16 farm commodity sectors nearly add to the implicit GFP deflator and in which the price effects on all the model's sectors nearly add to the implicit GNP deflator

Figure 1 presents three alternative measures of the effects of relative price changes on the farm sector The "parity ratio" line (PR/PI) presents the traditional—albeit inappropriate for our purpose—measure of the farm-sector relative price

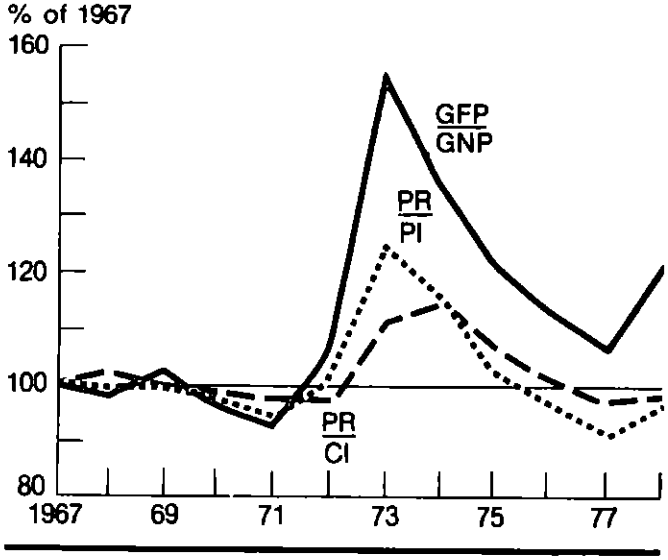
[2]In a consistent economic model the output of each industry is consistent with the demands, both final and from other industries, for its products A consistent economic model insures that estimates for individual sectors and industries will add up to a total estimate (for example, GNP)

Technically, the parity ratio is defined on a 1910-14 base, however, we use the same price series with a 1967 base The GFP/GNP line is the standard just discussed and also illustrates the type of standard used in applying the model. The PR/CI line presents an unpublished price series constructed to make the parity ratio approach a more appropriate concept for our purposes. As in the "parity ratio" line, the numerator of the ratio is the Prices Received Index (1967 = 100) The denominator, however, is the Index of Prices Paid by Farmers for Production Items after removing capital items (autos, trucks, tractors, machinery, and building and fencing materials) The remaining index and resulting ratio reflect current production activity.

The three measures follow similar patterns. All three measures agree that for 1970 and 1971 farm purchasing power decreased and that for 1973-75 farm purchasing power increased The average of the ratios for 1967-78 for all three measures exceeds 100, suggesting that even though the two "parity ratio" related measures ended the period below 100, farm purchasing power increased relative to the general economy over the entire period.

Figure 1

Alternative Price Series Measuring Relative Price Effects on Farming



Many of the criticisms of the parity ratio have resulted from attempts—contrary to Mitchell's advice—to make it serve roles for which it was never intended

Purchasing power as reflected here is purchasing power due to relative price changes but not to any change in the volume of economic activity Our measure of farm-sector purchasing power (implicit GFP deflator) is also conceptually consistent with the general measure of the dollar purchasing power in the general economy (the implicit GNP deflator) Here we present a consistent economic model which provides similar estimates of the effects of relative price changes during the 1967-78 period on selected farm, food-processing, and energy-related sectors of the U S economy We demonstrate that our individual farm sector estimates nearly add to the GFP implicit price deflator and together with nonfarm sectors nearly add to the implicit GNP deflator

Method

The economic model used for our analysis is adapted from Lee and Schluter (*4*). We used an input-output framework to measure the income effects of a change in relative prices on each sector of the model [3] Outputs in the model are held constant, so are the values for imports and the inter-industry flows. The constants function as weights for price changes in the same way that base-period quantities function as weights in a Laspeyres price index, such as the parity index. This similarity to a Laspeyres price index provides a check on the model's performance and shows the vulnerability of the food sector to the relative price changes which have accompanied recent inflation We used a simplified form of the Lee-Schluter model

$$r = [e\, D_p(I\text{-}A) - m]\, D_0$$

where

- r = $1 \times n$ vector of values added, v_i
- e = $1 \times n$ vector of 1's
- D_p = $n \times n$ diagonal matrix of price changes relative to a year; p_{it}/p_{i0}
- I = $n \times n$ identity matrix
- A = $n \times n$ technical coefficients matrix, a_{ij}
- m = $1 \times n$ vector of import coefficients, m_i
- D_0 = $n \times n$ diagonal matrix of base period sector output, O_i [4]

Thus, the value-added series for a particular industry is the 1967 value added to cover profits, rents, interest, taxes, and wages adjusted for changes in that industry's output price and its intermediate input prices Import prices are held constant at base-period levels

For our analysis, we used a 42-sector aggregated version of the 1967 national I/O table (*13*) for the import and the domestic input-output coefficients and, thus, for the base-year income, final demand, and output estimates. Table 1 presents these 42 sectors with the price series selected to represent the annual changes in price level of each sector

Evaluation

Table 2 summarizes the model's performance 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 GFP, and column 3 gives the ratio of the two series As column 3 shows, except for 1974, 1977, and 1978, all the model's estimation errors were 2 8 percent or less An analysis of the pattern of estimation errors suggests a subtle difference in weights between those implicit in the I/O matrix and those implicit in the price series used by Commerce The I/O model apparently assigns more weight to the crop sectors. Thus, when livestock prices increase relative to crop prices, our model underestimates the Commerce series As many crop prices were rising in 1974 while many livestock prices were falling, our model overestimated the implicit price deflator for that year

Columns 4 through 6 compare total GNP for the 1968-78 period [5] Our model estimated better for the whole economy than for an individual sector (farm, in this case), with an average error of 1.1 percent and with only one estimation error above 2 5 percent. The model consistently underestimated GNP during the period from 1967 to 1975.

[3] 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

[4] Conventional I/O notation uses X to refer to the value of output We use P_iO to distinguish between the value of output (X_i or P_iO_i) and real output (O_i)

[5] A comparison of columns 2 and 5 shows another difficulty in determining the role of agriculture in general inflation The volatility of agricultural prices leads to volatile estimates of their role in general inflation The 1978 implicit GFP deflator of 232 6 represents an 8-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 11 years, almost all 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 increase in the farm sector was less than one-third that for general price levels

Table 1—Sectoring plan and associated price series[1]

Sector number	Sector description	Price series[2]
1	Dairy farm products	Farm income accounts, season average
2	Poultry and eggs	do
3	Meat animals	do
4	Miscellaneous livestock	do
5	Cotton	do
6	Food grains	do
7	Feed grains	do
8	Grass seed	do
9	Tobacco	do
10	Fruits	Prices received
11	Tree nuts	Farm income accounts, season average
12	Vegetables	Prices received
13	Sugar crops	Farm income accounts, season average
14	Miscellaneous crops	do
15	Oil-bearing crops	do
16	Farm-grown forest and nursery products	Prices received
17	Meat products	Producers Price Index
18	Dairy plants	do
19	Canning, freezing, and dehydrating	do
20	Feed and flour milling	do
21	Sugar	do
22	Fats and oils mills	do
23	Confectioners and bakeries	do
24	Beverages and flavorings	do
25	Fertilizers	do
26	Petroleum refining and related products	do
27	Miscellaneous food processing	do
28	Tobacco manufacturing	do
29	Textiles, apparel, and fabrics	do
30	Leather and leather products	do
31	Crude petroleum	do
32	Coal mining	do
33	Forestry, fishing, and other mining	do
34	Other manufacturing	do
35	Transportation and warehousing	WEFA
36	Wholesale and retail trade	do
37	Other noncommodities	do
38	Electric utilities	Producers Price Index
39	Gas	do
40	Real estate	WEFA
41	Special industries	Assumed unity
42	Imports	WEFA

[1] Detail greater than was required for the food-system analysis, reflected in the sectoring plan, is due to the inclusion of alternative-sector, analytical capabilities for the model

[2] Farm income accounts = season average price used in cash receipt estimates, Prices received = Index of Prices Received by Farmers, Producers Price Index = U S Bureau of Labor Statistics' Producers Price Index, WEFA = (*15*) The specific variables from these series for each sector are available from the senior author upon request

Columns 7 through 9 provide a third measure of the performance of our model Column 8 gives the actual ratio of the GFP deflator over the GNP deflator as graphed in figure 1 Column 7 gives the ratio of our estimates of these statistics, and column 9 gives the ratio of our estimates of the ratio to the actual ratio Our model predicted the actual ratio within 2 percent for 7 of the 11 years Although fairly sizable errors occur in 1973, 1974, 1977, and 1978, only in 1977 does the model incorrectly predict the movement of the GFP deflator relative to the GNP deflator

These implicit value-added price series are useful economic data not otherwise available They show the analysts how the sector has fared in the maze of interacting price relationships that characterize a dynamic economy

The relative movements provide useful information One must avoid giving too much weight to the levels as the level of output and input substitution have been fixed at base-year levels Thus, the income level estimated by the model may differ from the actual income level of the sectors A

These implicit value-added price series are useful economic data not otherwise available They show the analysts how the sector has fared in the maze of interacting private relationships that characterize a dynamic economy

Table 2—Comparison of model estimates with gross farm product (GFP) and gross national product (GNP) deflators, 1968-78

Year	GFP deflator			GNP deflator			GFP deflator/GNP deflator		
	Estimate	Actual[1]	Estimate/ actual	Estimate	Actual[1]	Estimate/ actual	Estimate	Actual	Estimate/ actual
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1968	103 4	102 8	1 006	103 9	104 5	0 994	0 9952	0 9837	1 0117
1969	109 5	112 4	974	109 0	109 7	994	1 0046	1 0246	9805
1970	109 3	111 4	981	113 4	115 6	981	9638	9637	1 0001
1971	109 7	112 7	973	118 6	121 5	976	9250	9276	9972
1972	131 1	133 7	981	122 5	126 6	968	1 0702	1 0561	1 0134
1973	212 2	207 1	1 025	130 6	133 9	975	1 6248	1 5467	1 0505
1974	218 9	199 5	1 097	145 9	146 8	994	1 5003	1 3590	1 1040
1975	193 5	195 2	991	160 8	160 9	999	1 2034	1 2132	9919
1976	192 4	191 6	1 004	169 5	169 2	1 002	1 1351	1 1324	1 0024
1977	179 0	191 4	935	180 3	179 3	1 006	9928	1 0675	9300
1978	221 1	232 6	951	193 8	192 4	1 007	1 1409	1 2089	9437

[1]Source (*14*)

final caveat it is difficult to establish a base year when all sectors of the economy were "normal," and determining the base year by the scheduling of an economic census may increase the likelihood of choosing a year when a number of sectors were atypical In our model, these atypical situations have become the norm by which other years are measured One must remember this difficulty when making intersectoral comparisons

Relative estimates of the effect of price changes are derived from an economic model which describes the interrelatedness of the U S economy The model is consistent The model can be validated, and we did validate it, by aggregating individual sector estimates for comparison with published aggregates However, this is not the chief value of our method More important, this series is the first systematic, internally consistent set of estimates of the relative vulnerability of parts of the food system to recent relative price changes. These estimates for individual sectors include the price-related income effects on all participants, farm operators, workers, interest recipients, and others who commit factors (labor, capital, land, and others) to the individual sectors

Model Limitations

The model uses the level and mix of real output in 1967 Thus, the model does not incorporate any changes in income earned by a sector due to changes in level of output or the mix of final demand It only accounts for changes in income due to changes in relative prices

Similarly, the weight given each price in calculating this income effect is its weight in the 1967 industry cost function (direct requirements column) Thus, input substitutions due to price changes are ignored, as are input coefficient changes due to changes in production technique. Although these assumptions could lead to potentially serious biases, this problem is common to the use of fixed-weight indexes Although we do not overlook this potential bias in our model, we accept it as an occupational hazard. Due to the fixed weights, the results can be interpreted as the change in the value added, with all input (primary and intermediate) and output quantities held fixed because of price changes occurring during the 1967-78 period

Another potential source of error in the model occurs when the series chosen to represent the price effects of a specific sector fails to fulfill this function. The price series chosen may not properly reflect the price changes in that sector, or the collection of price data may differ from commodity marketing patterns

Finally, these income estimates should not be confused with sector or industry profits, although profits are a component of the income estimates. Rather, our income estimates include wages, interest, depreciation allowances, rents, and indirect business taxes as well as profit-type income Thus, one dollar of increase in income represents one more dollar of income available for distribution to these factor suppliers

Results

We discuss our results by groups of sectors The crop sectors are divided into those more directly influenced by world markets and those more reliant on domestic markets The food processing sectors are divided into those processing farm livestock products, those processing farm crop products, and those further processing food products Groups also discussed are farm livestock and energy-related sectors

Figures 2 through 6 depict graphically our results as percentage variations from the income level in 1967 Thus, a value of zero represents no change, a value of one represents a doubling of base-year income, and a negative number represents an income loss The implicit GNP deflator is included in each figure to provide a comparison with the overall rate of inflation

World Market Crop Sectors

Figure 2 presents the estimated income levels of the export-oriented crop sectors relative to the 1967 levels During the 1968-70 period, relative prices moved to the economic detriment of all these sectors, and their incomes fell below 1967 levels The oil crops sector first crossed the baseline in 1971 and was 33 percent above it by 1972 Then, with the export boom, the domestic terms of trade shifted dramatically in favor of all four of these crop sectors The most dramatic shift occurred in the food-grain sector All four sectors peaked in 1974, income levels fell in 1975 and continued to fall in 1976, except for cotton (for which price and income recovered to above 1974 levels) and for oil crops (which rose slightly from its 1975 income level) In 1977, the oil crops sector continued to rise, but the others dropped Cotton and food grains rose in 1978, but oil crops stabilized, and feed crops continued to fall

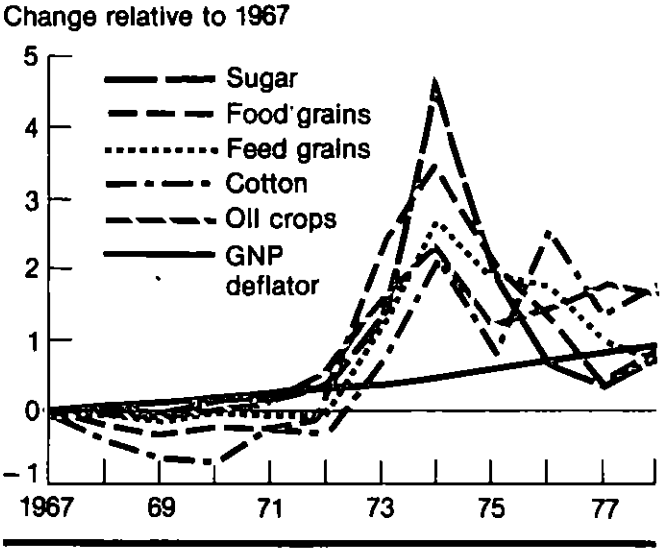
Because we import a significant share of our domestic sugar, the sugar crop sector is subject to different forces than are other crops With the expiration of the Sugar Act and a strong world demand for sugar, the income of the sector soared in 1974, dropped (but remained strong) in 1975, and fell again to near 1967-73 trend-line levels in 1976, 1977, and 1978 (fig 2)

Domestic Crops

In contrast to the world-market crop sectors, the income of the domestic crop sectors (vegetables, fruits, and tree nuts) did not shift dramatically due to relative price movements

Figure 2

Change in Income Due to Price Changes, World Market Crop Sectors



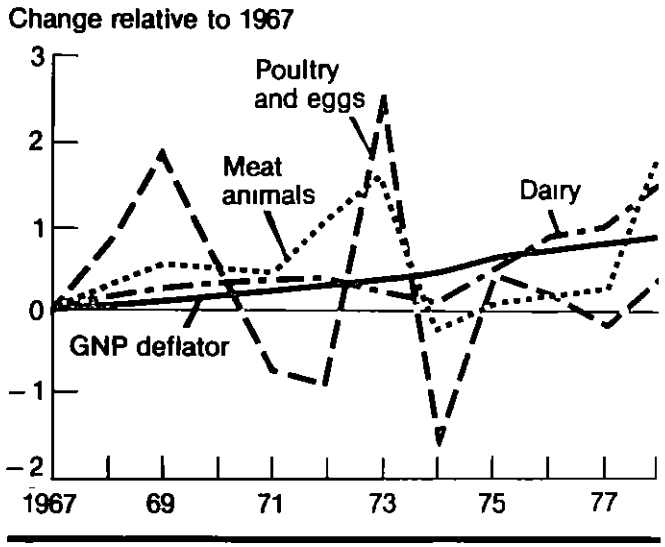
In fact, except for 1968 and 1973, the value-added indexes of these sectors were consistently below the overall standard (the GNP deflator) until 1978, when fruits and tree nuts finished the 1967-78 period above the standard

Livestock Sectors

The livestock sectors, especially poultry and eggs, were more vulnerable to price changes (fig 3) Some of the variability in poultry and egg income was due to a relatively low income level in the base year, which accentuated the degree of income fluctuations as relative prices changed Furthermore, the output price for this sector tends to vary more than the input prices, which introduces income variability Thus, in 1968 and 1969, poultry and egg prices were 7 and 21 percent, respectively, above 1967 levels, leading to income 80 and 180 percent, respectively, above the base period Conversely, in 1971 and 1972, when price levels were only 3 and 5 percent, respectively, above 1967, income levels were 73 and 89, percent, respectively, below 1967. A subsequent price rise in 1973, to 79 percent above 1967 levels, sent incomes soaring, to 250 percent above base level When the

Figure 3

Change in Income Due to Price Changes, Livestock Sectors



poultry and egg price index dropped 17 index points in 1974, while the feed crop price index increased 72 index points and the grain mills (manufactured feeds) PPI increased 22 index points, the poultry and egg sector income plunged to negative levels Subsequent strength in poultry and egg prices, together with weaker feed prices, allowed 1975 and 1976 estimated income levels to recover to levels 38 and 15 percent, respectively, above base period before falling again below base level in 1977 and recovering to 28 percent above base level in 1978

The meat animal sector was less volatile than the poultry and egg sector because of a larger base-year income and more stable output prices. The sharp drop in the meat animal index in 1974 does not appear in other economic indicators, such as the Index of Prices Received by Farmers for Meat Animals Figure 4 dramatically illustrates the superiority of the proposed index of relative income over ordinary price indexes The relative income index allows explicitly for higher feed costs, whereas the Index of Prices Received by Farmers for Meat Animals does not The meat animal sector experienced 2 strong years (1972-73) before price weaknesses and higher feed costs took their toll From 1974 to 1977, the Index of Prices Received by Farmers for Meat Animals was fairly constant (165, 169, 170, and 168), thus, any increase in strength of sector income resulted from slightly lower input prices Price strength in 1978 improved the income position of this sector to 175 percent above base level Relying solely on the Index of Prices Received by Farmers for Meat Animals would have been misleading because of changes in input prices

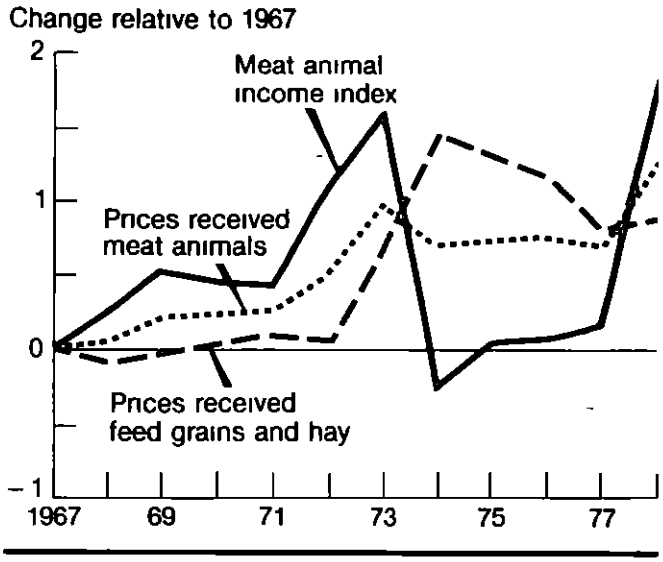
The income pattern in the dairy sector (fig 3) was rather stable for most of this period, with exceptional strength since 1976 From 1975 to 1978, the dairy-product price index rose 20 percent above 1975 levels, whereas the feed-crop price index fell 20 percent As a result, sector income rose from 39 percent above base level in 1975 to 143 percent above base level in 1978

Livestock Processing

The stable price and income pattern that we observed for the farm dairy sector is even more pronounced for the manufactured dairy products sector (fig 5) From 1967 through 1975, the estimated income levels stayed within 10 percent

Figure 4

A Relative Income Index Contrasted With Comparable Price Indexes



of base year levels, not until 1976 did they exceed 10 percent Nonetheless, the sector was losing ground relative to the implicit GNP price deflator Apparently, this sector is able to pass on increases in the farm price of milk, but the demand for milk prevents larger increases.

The meat- and poultry-processing sector faces a different demand situation (fig 5) As the farm price of meat animals and poultry rose in 1971-73, the meat- and poultry-processing sector apparently did not pass on higher raw product costs, and income levels fell almost 40 percent below base level After 1973, the PPI for processed meats showed more resilience than farm prices, and the income position of this sector rose during the 1974-75 period, it later dropped to more modest levels

Farm Crop Processing

Figure 6 shows the variety of income responses of food manufacturing sectors to explicit changes in prices of their respective farm raw materials The feed and flour-milling sector exhibits tendencies similar to those in the meat-processing sector Millers apparently did not pass on all costs of higher priced grain inputs during 1974 and 1975, and incomes dropped to near 1967 levels But their 1976 and 1977 output prices rose 4 and 2 index points, respectively, over 1975 levels, while the food-grains price index fell 37 and 80 index points, respectively, from 1975 levels, resulting in income jumps of 43 and 54 percent, respectively, above base levels

Figure 5

Changes in Income Due to Price Changes, Livestock Product Processing

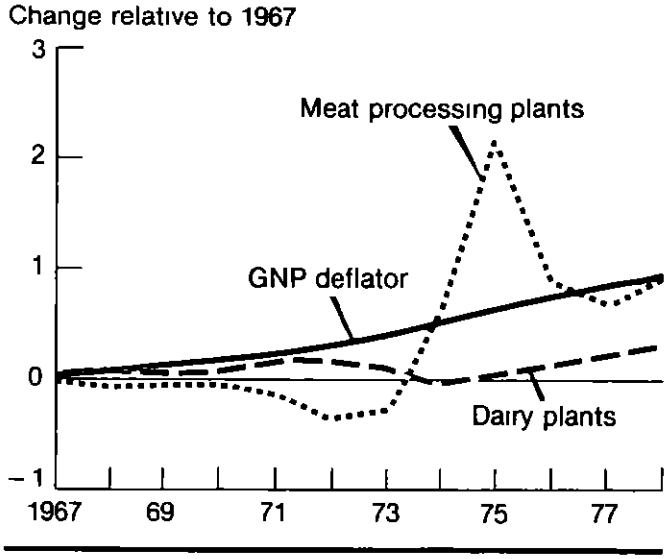
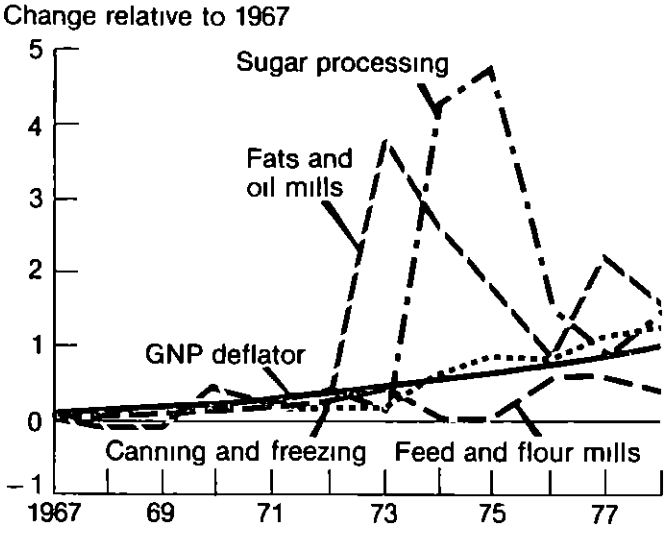


Figure 6

Changes in Income Due to Price Changes, Crude Crop Processing Sectors



The fats and oils refining sector exhibited a different pattern Its income pattern roughly parallels that of the oil crop sector, which suggests that the sector is able to pass through increased raw material costs and a proportional margin to its customers, but the nature of the sector's supply and demand conditions does not allow it to maintain its output price when associated farm prices decline An exception to this parallel pattern occurred in 1976 when the refining sector's income fell, while oil crops income rose slightly

The sugar refining sector benefitted from large increases in world sugar prices in 1974, and it increased its income position slightly in 1975 when the sugar crop sector declined By

1978, however, incomes in this sector had returned to a level about 145 percent above base level.

After a fairly stable, but increasing, income level during the 1967-73 period, the canning, freezing, and dehydrating sector income grew considerably during 1974 and 1975, weakened somewhat in 1976, and ended the period 111 percent above base level.

Highly Processed Foods

The three highly processed food sectors were relatively stable, exhibiting no abrupt annual fluctuations For example, the confectioners and bakeries sector retained its 1967 income level throughout 1968, its income increased to 30 percent over base in 1969, then reached a 40-50 percent plateau where it stayed through 1973 After 1973, the sector income rose steadily for 2 years to a new plateau of 85-90 percent above base level in spite of high sugar prices By 1978, its price-related income position was 103 percent above base level

The income level of the flavoring and beverages sector was nearly constant from 1969 through 1973, rose sharply from 1974 to 1977, then dipped in 1978

The miscellaneous food processing sector did not show strong income growth during the 1968-78 period

Energy-Related Sectors

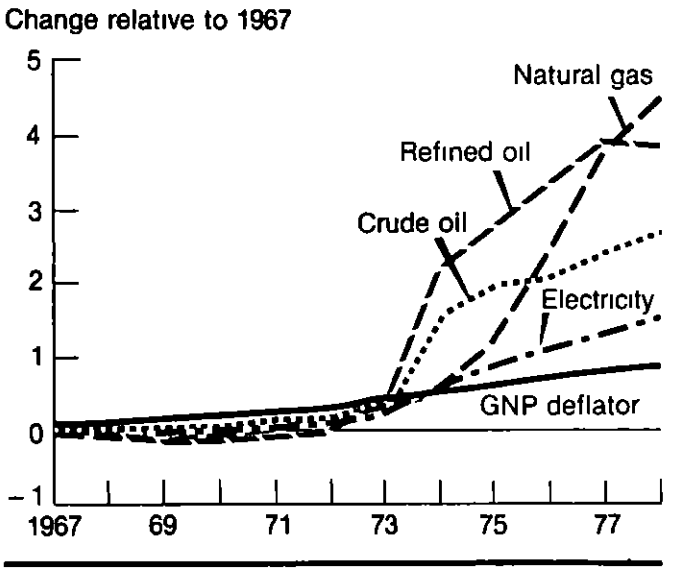
The plot of income due to relative price changes for energy-related sectors illustrates a pattern characteristic of the U S energy price situation From 1967 to 1973, the real price of energy declined annually, after 1973, it rose to allocate tight supplies of oil and gas. The plot for the energy-related sectors (fig 7) contrasts with plots for the farm sectors Whereas the farm sectors did not retain any income peaks resulting from relative price shifts in their favor brought about by supply or demand shocks, the energy-related sectors have been able to retain income levels resulting from relative price changes

Conclusion

Our model is useful because it shows which sectors of the food system have gained from the relative price changes accompanying the recent inflation and which sectors have lost

Figure 7

Changes in Income Due to Price Changes, Energy Sectors



We have proposed, as a rough measure of the relative position of a sector with respect to inflation, its sector value-added price deflator relative to the GNP implicit price deflator. This comparison is available from the sector's value-added deflator lines and the GNP implicit price deflator in each figure.

Since 1973, except for feed crops in 1978 and food grains in 1977 and 1978, all export-oriented crops have exceeded the national norm (the implicit GNP deflator) and have benefitted from the relative price changes accompanying inflation by an amount likely to offset their less favorable position from 1967 to 1973

Sugar has benefitted from the recent relative price changes accompanying inflation Domestic-oriented crops have been relative losers On balance, fruits, tree nuts, 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 From 1967 to 1973, the meat animal sector was a relative gainer, as were dairy in 1967-72 and poultry and eggs in 1967-70 The livestock sectors gained in the years when the general farm price

levels were rising slowly, but lost during the big farm price surge 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 but also below the base year during the 1967-73 period, it caught up with the national trend in 1974, was above it in 1975-1976, and below it in 1977-78

Among the sectors processing crude farm crops, fats and oils mills have exceeded the national trend since 1970 Sugar refiners reached trend levels in 1970, and canning, freezing, and dehydrating reached trend levels in 1974 On balance, fats and oils mills and sugar refiners were gainers, grain mills were losers, and canners were unchanged

Among the more highly refined food-processing sectors, confectioners and bakeries benefitted from relative price changes accompanying inflation, as have beverages and flavorings in recent years The miscellaneous food processing sector has not benefitted

Implications

Our results, which illustrate sector vulnerabilities to the relative price changes characterizing an economy adjusting to inflation, are not without lessons

We have seen that if one uses the standard of the GFP implicit price deflator relative to the GNP price deflator, the farm sector has benefitted from relative price changes since 1972 (fig 1) Previous studies of the effects of relative price changes on agriculture during the inflationary periods have not gone beyond the farm sector Tweeten and Quance (*11*) found that farmers were disadvantaged by input price inflation They concluded that a 10-percent increase in the Prices Paid by Farmers Index reduces nominal net farm income by 4 percent in the short run and by 2 percent in the long run Tweeten and Griffin (*10*), updating this model, estimated that a 10-percent increase in farm input prices would reduce nominal net farm income 9 percent in short run, but would raise net farm income as much as 17 percent in the long run

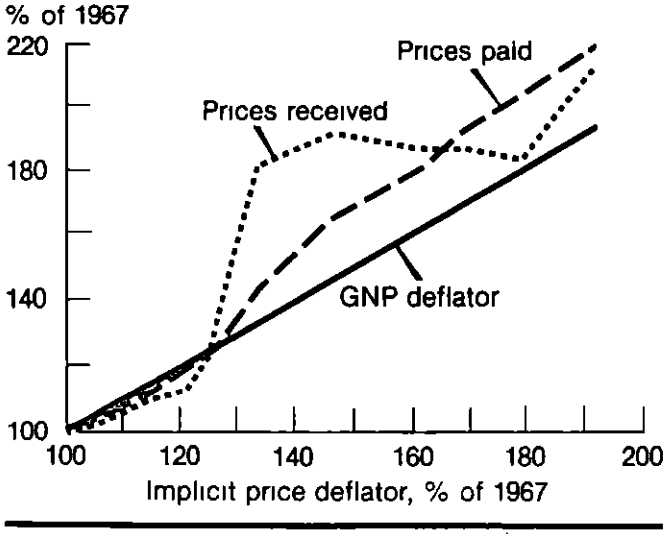
Other attempts to measure the effects of price changes on the farm sector during general price inflation have suggested that agriculture is always adversely affected In a study which Ruttan characterizes as "the only rigorous empirical investigation of the effects of inflation on prices received and paid by farmers," Tweeten and Griffin (*10*) regressed the Farm Prices Received Index and Prices Paid by Farmers Index on the implicit GNP deflator and the lag of each variable for 1920-69. They observed a positive and significant relationship between the Prices Paid by Farmers Index and the implicit GNP deflator, but no significant relationship for the Prices Received Index On this basis they concluded, "national inflation exerts a real price effect on the farming industry, reducing the parity ratio" (*10*, p 10)

Because the Tweeten-Griffin results are based on price data similar to ours, yet arrive at the opposite conclusion, a further comparison of these two findings is in order Some of the difference is explained by the different time periods Tweeten and Griffin studied the 1920-69 period, whereas our study used the 1967-78 period We suggest as an unproven hypothesis that the 1972-73 period, with its rapid expansion of agricultural exports and changes in the pricing policies of oil exporting countries, may have caused such fundamental shifts in relative price relationships as to invalidate many economic judgments for the post-1973 period, based on studies of time periods prior to 1972

A second explanation is suggested by figure 8—that is, the Prices Received and Prices Paid by Farmers Indexes plotted

Figure 8

Farmers' Prices Received and Prices Paid Index Compared to the Implicit GNP Deflator



against the implicit GNP deflator The prices paid line increases throughout the period and often nearly parallels the GNP deflator (45°) line One would expect the Tweeten-Griffin result of a significant relationship between the Prices Paid by Farmers Index and the implicit GNP deflator However, the Prices Received Index line both rises sharply and falls during the 1967-78 period and is hardly parallel Again, one would expect the Tweeten-Griffin result of no significant relationship between the Prices Received Index and the implicit GNP deflator But one would be misled by drawing a conclusion like Tweeten and Griffin's from these results that is, general inflation reduces the parity ratio, because during this period, although the Prices Received Index varied too much to be signficiantly related to the GNP deflator, most of the variance was at a level above the GNP deflator

Thus, during the 1967 period, while the general price level as measured by the GNP deflator rose each year and the rise totaled 92 percent, the parity ratio (1967 = 100) did not fall in 4 of the 11 years and fell only 4 percent over the 11-year period The Tweeten-Griffin equations would have predicted an 8-percent drop, if one uses their insignificant coefficient in the Prices Received equation, and would have predicted a somewhat larger drop, assuming no relationship between the Prices Received Index and the GNP deflator In 3 of the 4 years, the parity ratio did not fall, it rose 5 percent or more The Tweeten-Griffin analysis does not consider the fact that, in recent times, supply and demand shocks on farm output prices have enhanced rather than depressed prices

The first implication of our study, therefore, is to question the conventional wisdom about general price inflation having a negative real price effect on agriculture

The proposed relative income index adds an analytical tool which measures the effect of relative price changes in greater detail than can the parity ratio Our model allows the analyst to consider relative price effects on nonfarm sectors of the economy by keeping the individual sector measures consistent with national aggregate measures

Ordinary price indexes are likely to mislead because they reflect only prices received or paid, but not both The relative income index reflects net income after adjusting for prices received and paid by an individual sector

Our model also demonstrates the effects of relative price changes on different sectors of the food system Considering inflationary effects on either the food system or the farm sector masks the diversity in relative prices at the commodity and industry level

Because inflation distorts investment decisions, capital values, and other time-related economic variables, the relative price effects presented here provide the policymaker with unique economic data These effects are derived only from current flows from current production, thus, the relative measures of effects of relative price changes are not distorted by investment, cash flow, tax effects, and other time-related distortions

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In Earlier Issues

Statistical demand analysis is a synthesis of several disciplines—economic theory, probability theory, and mathematical statistics—applied to concrete data. Each application requires special knowledge of the commodities involved and the adequacy of the statistical series which purport to measure their prices and quantities

No one of these specialties prepares [one] to give well-rounded advice to commodity experts concerning the statistical measurement of economic relationships The verbal economist is too verbal, the mathematical economist too mathematical, and the statistician too disdainful of non-experimental data In ignorance or desperation the commodity economist turns to empiricism, and it is too empirical

Karl A Fox
Vol 5, No 3, July 1953, p 63