Changing Agricultural Prices and their Impact on Food Prices Under Inflation

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I. Introduction

We know that mankind has lived with, suffered the consequences, or reaped the benefits of inflation since records have been kept. Despite the centuries of experience and hours of study and debate we still are far from understanding how to deal with persistant inflation and, in many cases, cannot agree among ourselves as to when or where its ifluences are beneficial or burdensome.

From our particular orientation and training, it is difficult for us to address the issues of inflation in anything but a microeconomic perspective. Yet at the microeconomic level, there is no inflation, just price change. So before we begin, let us look a little closer at inflation. There is far less agreement, we find, on a definition of inflation than there is on the consequences of price increases. We sketch out this process by way of introducing the empirical work we report later in this paper. This process reveals that microeconomic price increases in one sector, through their initial effect on consumer demand and their direct and indirect effects on costs of intermediate materials in other industries, can lead to

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inflation in the macroeconomic sense. Since this process is so fundamental to the way we measure the effects of inflation, it is worth looking at it in somewhat more detail.

To use a common economists' device, assume that oil prices rise worldwide, with domestic prices rising in lockstep. The immediate effect will be on consumption. With energy prices higher, substitution will occur -- less energy (gasoline, home heating oil, etc.) will be consumed relative to other commodities. Simultaneously, higher energy costs as factors of production or intermediate materials will permeate the industrial structure of the economy. With higher relative energy prices, firms will substitute capital and labor for energy until, at the margin, relative prices are equated to relative marginal products. This will raise costs to all users of energy in rough proportion to their energy use, with consequent increases in product prices. Increases in product prices will, likewise, stimulate increases in negotiated wages as workers attempt to retain their prior relative standard of living. Higher wages and higher product prices will cause other changes in consumption, etc. etc. Clearly this process, to the extent that it persists, is what we call inflation.1/

There are several aspects of this process that we can highlight: (1) one consequence of price changes is a change in consumption patterns; (2) changes in costs will alter production arrangements in other industries, not just that

industry immediately effected by price changes 2/; and (3) "second-round" effects will wash through the entire economy, including the industry initially effected. All of these are microeconomic effects of inflation. But the task of measuring them requires a macroeconomic perspective.

Even the concept of inflation is macroeconomic. Consider the definition of Prentice and Schertz (p. 1): "Inflation, a rise in the general price level, represents a decline in the real purchasing power of money." The terms "general price level" and "purchasing power of money" are macroeconomic, not microeconomic in nature. Johnson's (p. 104) definition, while very similar -- "a sustained rise in prices" -- has the added advantage of simplicity. But Johnson recognizes that . . . "one encounnters problems of some difficulty as soon as one tries to apply it in practice." The three major difficulties are: 1) some price increases are not inflationary; 2) the choice of which prices or indexes are to be used; and 3) most measures of price do not adequately reflect quality changes. Another definition attributable to Pigou (p. 14), defines inflation to exist when "money-income is expanding relative to the output of work by productive agents for which it is the payment." This attention to income flows or factor returns is the complement to price changes in commodity markets; it stresses the general equilibrium, or microeconomic aspects of inflation.

This paper will address some inflationary effecs -- we concentrate on measurement rather than attribution. Since we are dealing with microeconomic measurement -- by which we mean measurement of specific elements such as the number of beef cows on farms, etc. -- we will avoid much of the argument about cause. Instead, we focus on a price changes and the consequences of these changes.

This, then, is what interests us here: the adjustments that are made necessary by price increases and how these adjustments influence food and agriculture. We guage these adjustments by simulating the microeconomic activity in the agricultural sector with the Merrell-Lynch Agricultural Model. This simulation provides prices, quantities, and markups for the major outputs of the agricultural sector. These are then used to examine the macroeconomic consequences of changes in the agricultural sector using the Battelle FORSYS (Forcasting System) macroeconomic model. The results of these simulations are reported in the fourth section of this paper. Sections II and III provide descriptions of the agricultural and macroeconomic models respectively.

II. The Merrill Lynch Agricultural Model

The Merrill Lynch agricultural model is a quarterly microeconomic model of major agricultural commodities. The crop portion of the model is a disequilibrium submodel, allowing for partial price adjustment when current and desired stocks are not in equilibrium. The livestock submodel is an equilibrium model that uses the U. S. Department of Agriculture supply-utilization accounting framework.

The livestock submodel has markets for beef cattle, calves, hogs, broilers, turkeys, eggs and milk. Price determination occurs at the wholesale market, with marketing and processing costs added to obtain the retail price. Farm price is determined from the wholesale market price by taking into account transportation and other costs.

The crop submodel has markets for food grains (three wheat commodities and rice), feed grains (corn, oats, barley, and sorghum grain), oil crops (soybeans, peanuts), and cotton. Production is determined from yields and acreages with utilization demands and desired stock positions determining the current market price at the wholesale level. Equilibrium price at the farm level and cost of production then determine acreage planted with crops competing for alternative uses of land.

Farm income is based on production and farm level prices for cash receipts and input costs and cost of production for expenses. The CPI for food and beverages is derived from produer level prices for agricultural commodities and markups that result from additional processing and retailing.

The major exogenous inputs to the agricultural model are disposable percapita income, interest rates, population, the CPI for all items less food and beverages, and major wholesale prices that constitute costs of agricultural production -- fertilizer, fuels and natural gas prices, and machinery costs. Wage rates and transportation costs are used to determine the marketing and processing costs that get added to determine retail prices. The major program variables that enter are loan rates, farm held reserves, target prices and other support program variables. Set asides and acreage diversions are also included in determination of acreage planted.

Some of these exogenous variables are determined in satellite models run prior to a solution for the agricultural model. The two major agricultural satellite models are the fertilizer model and the farm machinery model.

III. Battelle's FORSYS Macroeconomic Model

Battelle's FORSYS (Forecasting System) macroeconomic model is a 112-sector, annual, dynamic, input-output model of the United States economy. Final demand consists of consumption detail by 59 categories, investment detailed by 80 categories of producers durable equipment and 27 construction categories, government expenditures and net exports. Gross output is determined from these final demands and the input-output structure of the economy. Prices and wages are determined by sector within the model and are used to determine net incomes to business and consumers. Relative prices and incomes are determinants of consumption and investment decisions. Interest rates are determined endogenously in a monetary sector that relies on major monetary flows among agents of the economy to determine effective prices. We look briefly at each of these sectors, then describe how information from the agricultural sector model is introduced into the FORSYS model. We touch but lightly on all sectors except consumption, which plays a prominent role in our results.

The solution process for the FORSYS model begins with an initial estimate of prices and income used to compute consumer demand by product. Prices for the 59 categories of consumption

are obtained by conversion of the supply prices by input-output sector. For example, a dollar spent on personal consumption category titled "semi-durable household furnishing" may be distributed to a number of FORSYS manufacturing industries, as well as transportation and trade margins. Thus the price for semi-durable household furnishing is constructed as a fixed-weight aggregation of the market prices for these same sectors. With prices by consumer good and total expenditures, a simultaneous system of demand functions is employed to predict expenditures by 59 categories of consumption. These consumption estimates are derived from a two-step decision process, with consumers first allocating their budget among nine broad categories: food, fuel, clothing and footwear, household operations, household durables, private transportation, health services, and other services and nondurables. After expenditures on each of these aggregate groups is determined, the model then allocates expenditures among the subcategories within each group. This system of equations is based on the indirect transcendental logarithmic utility function which allows for both substitution and complementarity among consumption commodities, both within and between the broad categories.

FORSYS next determines the other elements of final demand and output: exports, imports, government expenditures, inventory change, fixed investment and gross output. With current estimates of output and capital stock (derived from

investment and past capital stock), a "desired" level of employment for the current year is obtained. This and previous employment determine current employment. Unit labor costs, based on wage rates and labor requirements, are then one of the major explanatory variables in the determination of prices.

Domestic prices in the FORSYS model follow the price "dual" formulation of input-output theory. Material costs are passed through on a dollar-for-dollar basis, while factor returns, making up value added, are treated separately. Supply price is then determined as a weighted average of prices of these domestically produced commodities and imported commodities.

The FORSYS model then ties this information together by estimating various income components of aggregate income, calculating the required National Income and Product accounts, estimating the domestic saving rate and hence determining consumer expenditures, which feed back into the demand system. We need further explain only how agricultural forecasts from the agricultural sector model feed into FORSYS.

FORSYS contanis seven consumption sectors and five input-output sectors that tie in directly to the agricultural sector model. The consumption categories, Meat and dairy products, Poultry and eggs, Fruit and vegetables, Fats and oils, Bread and cereal products, Purchased meals and beverages, and Tobacco products, tie in directly with the categories in

the agricultural sector model that relate to consumer prices. Quantity and price for the five input-output sectors can be built up from the commodity detail of the agricultural sector model. Of these five sectors -- Dairy and poultry products, Meat animals and livestock, Cotton, Food and feed grains, and Other agricultural products -- all but the last are determined endogenously. Two other input-output categoreis -- meat and dairy processing and other food processing -- are available to satisfy final demand for food consumption.

We modify our macroeconomic forecasts by first altering the domestic agricultural price for commodities. This modification then influences the PCE deflators with consequent adjustment in consumption. Shifts in final demand then change the composition of output, and ultimately alter income and relative prices. The model is in equilibrium when the adjustments are complete.

IV. Simulations with the Models

Our empirical results consist of four impact analyses of the agricultural model with one impact analysis of the macroeconomic model. For our baseline we simulate both the agricultural and macroeconomic models beginning in 1977. Our results are then reported as deviations from this baseline. The three extreme agricultural simulations examine: 1) the effect of eliminating the farm held reserve; 2) the impact of a 10 percent increase in the CPI for all commodities less food and beverages; and 3) the effect of raising income for 1 percent for each of 5 years. A less extreme simulation increases both prices and income. The price changes that result from the second simulation of the agricultural model are then used to simulate the macroeconomic model, measuring the consequences of the agricultural sector changes on the macroeconomy.

A. Agricultural Model Simulations.

Our first simulation is designed to guage the impact of support programs on agricultural commodity prices. We proceed from the belief that inflation is transmitted to agriculture via dependence on inputs that originate off-farm. We then examine how these changes are re-transmitted to the general economy via changes in raw material prices and through taxes

drawn to support agricultural commodities.

The agricultural support mechanism is, in fact, one of the ways in which general inflation is institutionalized into the agricultural economy. It also serves to spread some of the risk inherent in agriculture across a wider base. Since the primary "damage" done by inflation at the micro-level is to increase risk, the support mechanism serves to reduce some of the detrimental impact of inflation. We cannot, however, argue that the net effect has contributed to the efficient use of resources: this will occur only if the support rates have been established from accurately anticipated changes in relative prices -- a most unlikely event. The cost of these supports are inefficiently organized resources if they do not reflect market relative prices.

Figure 1 shows the relationship between the production costs per bushel, prices received by farmers and the loan rate for corn. As the figures shows, the consistent increases in production cost have been translated into the loan rate and the loan rate has provided a lower limit to prices. The question, then, is what influence has this had on food and agriculture?

The first agricultural model simulation suggests that, so far as the American consumer is concerned, the absence of farm held reserves would have made very little difference in the near term. Food prices would have been only slightly lower for the first year. Prices received by farmers for crops would have

been lower, initially, but livestock prices would have increased. Table 1 shows the changes in cash receipts, prices received and the CPI for all food.

/////Table 1. Impact of Eliminating Farm Held Reserve////

The data in Table 1 show about a $1 billion net negative impact on cash receipts for the first two years, but a net increase of $20 billion for the second two years. These results, at least partially, reflect the short crops of 1980 and the transfer of supplies from the first two years to the latter two years, via the grain reserve. We do not propose that these results reflect the impact of more or less inflation; rather, they indicate that attempts to spread the risk (to achieve stable farm incomes or food supplies) must result in both costs and benefits. In the special case shown here, the maintenance of farm held reserves causes producers of crops to benefit through stable short-term income, but livestock producers to lose. Higher feed costs would discourage increased meat production and, although food prices decline initially, reduced meat production will mean higher prices later.

This simulation illustrates two important points. First, market intervention in the form of support programs has a differential impact on agricutural producers, with dynamic consequences that are difficult to anticipate. Second, support

programs institutionalize a higher cost structure.

It is through this higher cost structure that evidence is gained to support the proposition that inflation is good for (or at least not harmful to) agriculture. We would take issue with this argument unless it is made conditional on higher costs institutionalized by support programs. Gardner, for example, concluded that a 1 percent change in the CPI would result in a $950 million increase in real net farm income. Tweeten and Griffin report that prices paid by farmers will respond (long-term) one-to-one with general inflation, and found no significant relationship between general inflation and prices received.

Our second simulation provides some evidence regarding inflation and agriculture. We find that an increase in the overall CPI does have an influence, but primarily through reduced real consumer incomes. A 10 percent increase in the non-food component fo the CPI gives us an initial 5 percent reduction in crop prices, 10 percent reduction in livestock prices and about a 9 percent drop in total cash receipts (Table 2.). These results occur since, with nominal income held constant, the increase in the CPI reduces income enough to significantly disturb food consumption patterns. We emphasize that this simulations respresents an extreme case, but we use these extremes to bracket out results.

/////Table 2. Percent Change in Prices Received ////

So our third simulation looks at another extreme. When real income is elevated by 1 percent for 5 years, we obtain results much like those of Gardner. At the end of 5 years, cash receipts are $1.8 billion higher, with a mid-period average of slightly over $900 million. Since production expenses have been held constant, this also represents the change in net income. Our final simulation tries to find a set of assumptions intermediate between these extremes; we balance increases in both the non-food CPI and income increases with less dramatic results. Cash receipts are marginally lower and net income is also lower because of the production cost pass-through observed by Tweeton.

We conclude, then, that inflation is not harmful to agriculture only when it is validated by government support programs. Without this validation, our findings suggest that a one percent increase in inflation will reduce farm prices and income by approximately 2 percent.

B. Simulations wth the Macroeconomic Model.

To validate that the consequent effects of the initial price changes represented by the second agricultural simulation would have no devistating effects on the initial macroeconomic simulation, we re-simulated the macroeconomic model for a 10

percent reduction in livestock prices and a 7 percent reduction in crop prices. The simulation affirmed our major concern about the effects of agricultural price changes on real income -- that the effects were negligible. So the agricultural sector simulations are uneffected in any major way by processing these changes through the macroeconomic model.

Of more interest to this paper is the impact of these price changes to the consumption pattern of consumers and the supply prices of the non-agriculture sectors of the economy. We highlight these results in Table 3.

/////Table 3. Major Macroeconomic Changes.///

V. Conclusion

Persistent price changes outside of agriculture bring about changes in the cost of production. All other things being equal, farm income will decline. Thus if we measure the well being of the farm sector in terms of real farm income, abstract from the effects of inflation on land values and ignore the uncertainty effects of inflation on production, then we conclude that inflation has a substantial negative effect on the income position of agriculture. But all other things are rarely the same. The observation that inflation has little or no harmful effect on the farm economy we attribute to two compounding influences: First, government support programs

have institutionalized higher costs, thus mediating the effects of inflation. Second, coincident inflation and rising real income make it difficult to identify the separate effects of these two, allowing the erroneous conclusion that inflation does no harm to agriculture.

FIGURE 1. PRICE RECIEVED, LOAN RATE, AND PRODUCTION COST FOR CORN

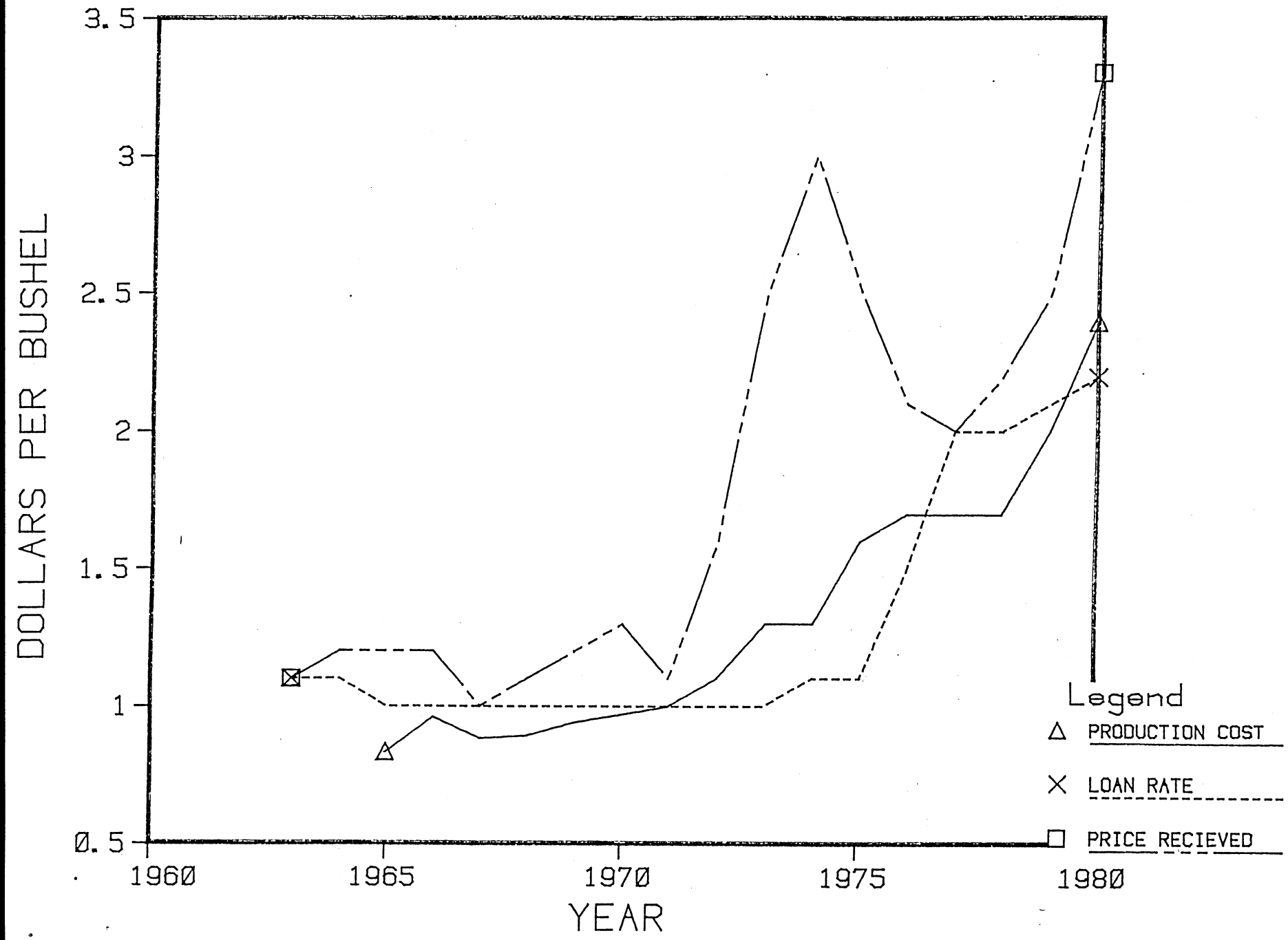

TABLE 2. Percent Change in Prices Received and Cash Receipts Resulting from a 10 Percent Increase in Non-food Components of the CPI

	Years				
	1	2	3	4	5
Price Received					
Crops	- 5.3	- 8.8	- 8.9	- 7.0	- 4.9
Livestock	-10.0	- 8.0	- 4.0	- 1.0	- 1.0
Cash Receipts					
Crops	- 7.5	-11.0	-12.0	-10.0	- 7.5
Livestock	-11.0	-10.0	- 6.0	- 2.0	- 2.0

TABLE 1. Impact of Eliminating Farm Held Reserve - Cash Receipts and Prices 1978 to 1981

	Year			
	2	3	4	5
	- - - - Change - - - -			
Prices Received[1] (%)				
Crops	-3.3	-1.1	4.2	4.5
Livestock	.8	6.3	8.2	6.1
Cash Receipts ($ Bil.)				
Crops	-1.1	3.4	2.3	5.9
Livestock	.3	3.3	6.4	6.0
CPI - All Food[1] (%)	0	.4	1.2	1.1
Beef Cattle on farms[1] (Mil.)	.1	.2	1.0	1.9
Breeding Sows[1] (Mil)	.1	.5	1.0	1.2

[1] Fourth quarter

TABLE 3. Macroeconomic Changes from Agricultural Price Reductions* First Year Effects

	Level	% Change
GNP (Bil. $ 1972)	+ .7	0.05
PCE (Mil. $ 1972)	+ 452	0.05
National Income (Bil. $)	- 5.6	- 0.46
Disposable Income (Bil. $)	- 7.0	- 0.55
Food Consumption ($ Mil.)		
Meat and Dairy	733	1.4
Poultry and Eggs	300	3.4
Fruits and Vegetables	215	0.8
Fats and Oils	266	5.9
Bread and Cereal	33	0.2
Purchased Meals	- 364	- 0.6
Agricultural Investment (Mil. $ 1972)	$ 79.6	0.6
Gross Agricultural Output (Mil. $ 1972)	$ 983.4	0.8
Implicit Deflators (1972 = 100)		
Gross National Product	- 0.7	- 0.5
Personal Consumption Exp.	- 0.8	- 0.6
- Livestock Products	- 6.9	- 4.7
- Fruits and Vegetables	- 4.0	- 2.6
- Fats and Oils	- 3.9	- 2.6
- Bread and Cereals	- 2.9	- 2.0
- Purchased Meals	- 1.9	- 1.3

* Livestock and Product Prices Reduced 10%. Other Food Products Reduced 7%.

NOTES

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1. We choose this particular commodity to illustrate that inflation may well be a consequence of normal economic activity, in contrast to the undertone in much of what is written that suggests that inflation is somehow imposed on the system. Continuous depletion of a non-renewable resource can certainly lead to persistent price increases, and to increases in the general price level if the resource has limited substitutes. This analysis is further predicated on the reasonable empirical assumption that the Federal Reserve System, whether using interest rates or monetary aggregates as intermediate targets, cannot effectively prevent such price changes from effecting the general price level.

2. The effects of uncertainty on the decision making of the firm is another consequence of inflation, quite apart from the adjustments required by changing relative prices.

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