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INFLATION AND U.S. AGRICULTURE: A GENERAL EQUILIBRIUM ANALYSIS OF THE EVENTS OF 1973*

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and

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ABSTRACT

Shei, Shun-Yi, and Robert L. Thompson -- Inflation and U.S. Agriculture: A General Equilibrium Analysis of the Events of 1973.

An open general equilibrium econometric model of the U.S. economy, including a monetary sector, is used to decompose observed 1973 sectoral and aggregate price increases. In decreasing order the major causes found were: U.S. monetary expansion, the Soviet grain deal, dollar devaluation and the world crop failure.

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INFLATION AND U. S. AGRICULTURE:

A GENERAL EQUILIBRIUM ANALYSIS OF THE EVENTS OF 1973

Shun-Yi Shei and Robert L. Thompson

In the early 1970's the most rapid increase in U.S. agricultural and food prices experienced since the Korean War occurred. Most explanations of these events have emphasized that adverse weather and associated crop failures in many parts of the world, the Soviet grain deal, and rapid growth in real per capita income and population in the rest of the world all contributed to an upward shift in foreign demand for U.S. agricultural exports. This, in turn, led to higher U.S. agricultural and food prices (e.g. Hathaway, p. 83). Schuh (1974) argued that U.S. dollar devaluation accounted for an important part of the observed increase in agricultural prices. Van Stolk has added to the debate by arguing that expansion in global liquidity can account for a significant part of the grain price increases in the U.S. as well as the rest of the world in the early 1970's.

These events have emphasized the interrelatedness of agriculture with the rest of the economy. This is manifested in a number of ways. Agricultural exports have been one of the strongest foreign exchange earners for the U.S. in the 1970's. General economic policy and trade policy which offset the exchange rate can shift export demand for our farm exports. In addition, agriculture provides most of the food supply of the nation. Food represents 17.7 percent of the Consumer Price Index (CPI) (12.2 percent for food at home and 5.5 percent for food away from home).[1/] Consumers are very sensitive to changes in food prices. Increases in food prices, from whatever source, cause increases in the CPI, which increases the wage bill of industry and transfer payments from the federal government through escalator clauses. U.S. agriculture also relies heavily on the industrial sector to

supply the modern inputs on which its high productivity is based. These illustrations emphasize the considerable linkages between agriculture and the rest of the American economy.

Nevertheless, most attempts at empirically accounting for the 1973 agricultural and food price inflation, particularly by agricultural economists, have taken a partial equilibrium approach. Partial equilibrium analysis does not provide an adequate theoretical foundation for analyzing the agricultural price increase in the early 1970's because many of the important and relevant variables are ignored or assumed away in partial equilibrium analysis. The fundamental inadequacies of partial equilibrium analysis in this context are that it ignores the linkages between agriculture and the rest of the economy and between the real and monetary sectors.

Although most analysts recognize that general equilibrium analysis is needed to more adequately account for the observed agricultural price changes, no previous attempt at empirical general equilibrium analysis of the 1973 food price inflation is known to the authors. This paper represents an attempt to empirically decompose the observed agricultural price increases of 1973 using an open general equilibrium econometric model of the U.S. economy, including a monetary sector. The theoretical bases for the analysis are first reviewed, and the model which is used in the analysis, is described. Finally, the relative effects of U.S. monetary expansion, dollar devaluation, the Soviet grain deal, and the drop in world grain production on both the general price level and on prices in the crops, livestock, industrial and services sectors are estimated.

The Model

To satisfy the objectives defined above, an open, general equilibrium model of the U.S. economy is constructed. The model treats both the real and monetary sectors with sufficient disaggregation that the important simultaneities between the agricultural sector and the rest of the economy can be reflected. It is specified to permit analysis of both demand pull inflation associated with monetary expansion and cost push inflation from the pass-through of input cost increases.

The output of the U.S. economy is dichotomized into tradable and non-tradable goods. In an open economy the effects of shocks such as an exchange rate change differ between internationally tradable and non-tradable goods in both degree and speed of adjustment. Traded goods are disaggregated into three subsectors: crops, livestock and industry. Non-tradable goods refer to the output of the service sector.

Agricultural output is divided into separate crop and livestock sectors because there are significant net exports from the crop sector, while there are net imports of livestock products. Moreover, the crop sector is quite open and exposed to world market forces, while the U.S. livestock sector is highly protected by trade barriers, typically via import quotas.

A large-country assumption is maintained for the U.S. traded goods sectors. That is, it is assumed that U.S. actions can affect its export and import prices. Over the period 1970-74, U.S. agricultural exports and imports accounted for 14.7 and 8.2 percent, respectively, of the total value of world agricultural exports and imports. U.S. industrial exports represented 10.2 and 10.7 percent, respectively, of total world industrial exports and imports in the same period. It is assumed that the U.S. market shares are sufficiently large to give it some power over world market prices.

In each of the four sectors, one homogenous product aggregate is assumed. Explicit domestic supply and demand schedules are specified and estimated for each sector. Export demand schedules (net) for crops and industrial products are specified, and domestic prices in these two sectors are simultaneously determined with world market prices. Export prices are linked through the exchange rate to domestic prices in these two sectors. Since services are by definition non-tradable, no export demand schedule is specified. No import supply schedule is specified for the livestock sector because import quotas effectively insulate the domestic U.S. market from world market price signals. Therefore, the domestic price of livestock products is assumed to be determined by domestic supply and demand conditions, given the import quota for livestock products.

The model as described to this point is a real general equilibrium model in which all prices are determined simultaneously. However, it is not particularly useful to study the transmission of inflation. For this purpose the model must explicitly include the determination of aggregate expenditures and their effect through shifts in the respective domestic demand schedules. This requires the addition of a monetary sector to the model.

The monetary structure of the model is needed to permit monetary adjustments to be taken into account along with the real adjustments discussed above. The money supply (M2) is taken to equal the monetary base (high powered money) times the monetary multiplier. Any change in the monetary base, whether from the domestic component or international reserves, then affects the money supply through the monetary multiplier. An increase in the money supply causes actual real cash balances to exceed desired real balances, and an adjustment process is initiated through increasing expenditures. This shifts all demand schedules upwards through the marginal propensity to absorb, which equals the marginal

propensity to consume plus the marginal propensity to invest. This puts upward pressure on nominal prices in all sectors and thereby raises the general price level. Whether the price level in any given sector rises more or less than the general price level determines the net effect on quantity supplied, demanded, and traded in each sector.

The balance of payments on official reserve transactions equals the current plus capital account. Changes in official reserves[2/] are a component of the monetary base and therefore affect the money supply through the monetary multiplier, assuming less than complete sterilization.

The model is specified under the assumption of fixed exchange rates and is capable of simulating the effects of autonomous changes in the exchange rate on all endogenous variables in the system. The task of endogenizing the exchange rate is one of immense proportions and is beyond the scope of this study.

The monetary component of the model includes three behavioral relations which determine the interest rate, short run net capital inflows, and the level of real expenditures. There are also four identities which determine the level of the balance of payments, the stock of high powered money (the monetary base), the general price level and the level of real national income.

The parameters of the simultaneous equations model were estimated via two-stage least squares using annual data for 1950 to 1974. Further details on the model specification, data, estimates and validation may be found in Shei. Space limitations do not permit their inclusion here.

Simulation Results

To decompose the observed 1973 price inflation, the Newton method is used to simultaneously solve the 24-equation model.[3/] The model is first solved for the years 1972 and 1973 using the observed values of all predetermined and exogenous variables. This gives the total changes in all endogenous variables predicted by the model, given all the shocks which actually occurred in 1973, which include: U.S. monetary expansion by $8.7 billion (i.e., in domestic component of the stock of high-powered money), dollar devaluation (cumulative) of 8.2 percent, a fally in world cereals production of 37 million metric tons, and a Soviet (and Chinese) grain purchase of almost $1 billion. To estimate the effects of these shocks, the model is solved again for 1973 with these four "variables" set at their 1972 levels to obtain the solution values of all endogenous variables if none of the four events had occurred. Then, the shocks are reintroduced one at a time to estimate the separate effect of each event if none of the others had happened. Selected results are summarized in Table 1.

Of particular interest are the effects of these four shocks on the general price level and their differential effects on prices in the four sectors. Of these four sources of the 1973 price inflation (as reflected in the general price level), domestic monetary expansion had the greatest effect, followed by the Soviet grain deal, dollar devaluation, and the fall in world grain production.[4/] Note that agricultural price increases contributed more to the general price increase than did industrial and service prices.

Domestic monetary expansion accounts for 34 percent of the increase in crops prices, 60 percent of the livestock price rise , and almost half of the increases in industrial and services prices and in the general price level. These differences reflect the differences in the marginal propensities to

Table 1. The Price Effects of Four Shocks

to the U.S. Economy, 1973.

Shock	Crops Prices	Livestock Prices	Industrial Prices	Services Prices	General Price Level
	(Change in price index from 1972 to 1973)[1/]				
Cumulative devaluation of 8.2 percentage points	2.387 (7.54)	1.017 (5.91)	0.382 (3.70)	0.305 (3.61)	0.407 (3.95)
Domestic monetary expansion of $8.7 billion	10.736 (33.91)	10.279 (59.69)	5.137 (49.76)	4.099 (48.52)	4.944 (48.03)
World cereal production decrease of 37 million M.T.	1.286 (4.06)	0.245 (1.42)	0.071 (0.69)	0.057 (0.67)	0.098 (0.95)
Soviet grain purchase of $ 963 million[2/]	18.081 (57.11)	3.445 (20.00)	0.998 (9.67)	0.801 (9.48)	1.378 (13.39)
Total Explained	32.490 (102.63)	14.986 (87.02)	6.558 (63.82)	5.262 (62.29)	6.827 (66.33)
Unexplained	-0.832 (-2.63)	2.236 (12.98)	3.735 (36.18)	3.185 (37.71)	3.465 (33.67)
Change[3/]	31.658 (100.00)	17.221 (100.00)	10.323 (100.00)	8.447 (100.00)	10.292 (100.00)

1/ In parentheses the values below each entry are the percents of the observed total change.

2/ The Soviet grain purchase in 1972/1973, together with Chinese purchases, accounted for about a third of the increase in the volume of U.S. grain exports in fiscal 1973 (Economic Report of the President 1974, p. 132). The observed increase in fiscal 1973 was $2.89 billion (price deflated). One-third of the observed increase is therefore, equal to $ 963 million.

3/ The "observed total" equals the difference between the base solution values for 1973 and 1972.

absorb the four product aggregates as expenditures increase. However, the effects of these shifts are modified by the general equilibrium interactions among the four sectors as increases in prices in each sector in turn shift the supply schedules of other sectors, and so on until all the (short run) general equilibrium effects work themselves out.

Of the four shocks, the Soviet grain deal had the most significant effect on domestic crops prices. It alone accounts for 57 percent of the observed increase in crops prices, and in turn for 20 percent of the increase in livestock prices. These shocks then work their way through the economy, raising the general price level, then the industrial and services wage rate and in turn prices in those sectors. This finally exerts some additional upward pressure on crop and livestock prices. The net effect, as observed, accounts for over 13 percent of the increase in the general price level.[5/]

Dollar devaluation was the third largest source of increase in the general price level, accounting for only four percent of the observed increase. Similar to the other two shocks, its effect was relatively greater on the prices of crops and livestock. It is interesting to note that while all prices increase as a result of dollar devaluation, the effect is greatest on crops prices, intermediate on livestock prices, and relatively smallest on industrial and services prices. These results suggest that the inflationary effects of dollar devaluation were transmitted most strongly through the crops sector, and secondarily through the livestock sector. Two effects are working here. First, the increase in the price of crops raises the livestock production cost structure, shifting its supply schedule upwards. At the same time, the expenditure elasticity of demand for livestock products is higher than for crops. In the general equilibrium analysis of the devaluation, the associated increase in real expenditures causes a larger proportional upward shift in the demand for

livestock schedule than in the demand for crops schedule. Both shifts put upward pressure on livestock prices.

The final simulation experiment concerned the effect of the observed 37-million metric ton decline in world cereals production in 1972. This accounted for less than one percent of the increase in the U.S. general price level, and only four percent of the increase in crops prices. This is partly explained by the fact that the U.S. is not the only grain exporter, and that the effect of the shock is distributed over all countries which permit the world market price signals to be reflected into their domestic markets.[6/] Moreover, the effect of the Soviet grain purchase was already treated separately above. The important point to note, however, is that the effects of the shift in crop export demand associated with crop failure in the rest of the world were small relative to the effects of the U.S. monetary expansion, the Soviet grain deal and dollar devaluation.

To provide an indication of the overall performance of the model in accounting for the observed changes in price levels, the simulated effects of the four individual shocks are also summed up in Table 1 to obtain the overall effect. The proportion of the total change accounted for by the four individual shocks provides an indication of the explanatory power of the model. As indicated, 103 percent of the crop price increase and 87 percent of the livestock price increase are accounted for by the model. On the other hand only 62-64 percent of the increase in service and industrial prices are explained. Some of the unaccounted for increase might be explained by omitted variables, including increases in petroleum prices which resulted from the OPEC oil embargo in the fall of 1973, the shifting character of U.S. domestic price controls, an upsurge in both domestic and foreign demand for industrial output, and unexpected capacity constraints in the U.S. industrial sector.

Limitations

The predicting ability of this general equilibrium model depends on the specification and econometric estimates of the structural equations. While the model is very aggregative and incorporates some strong simplifying assumptions, the empirical results are encouraging and suggest that such general equilibrium modeling of the simultaneous interactions between agriculture and the rest of the monetary sector is feasible.

It should be emphasized that, while the model has firm theoretical foundations, the empirical results have not been extensively analyzed, and its properties have not been compared with the relatively small number of other existing general equilibrium econometric models. Hence, these results should be treated with some caution by users wanting to make policy inferences. This study should probably be best regarded as an empirical exercise based on a well-founded theoretical model, an approach which seems to be potentially interesting and fruitful for U.S. agricultural sector analysis.

Implications

The simulation results suggest that the largest single factor accounting for the rapid 1973 agricultural and general price inflation in the U.S. was the 10 percent expansion in the domestic component of the monetary base in that year. This suggests that monetary policy, which tends to be ignored in most aggregate agricultural price analysis has been an important omitted variable. An adequate understanding of the behavior of nominal agricultural prices cannot be had without a more adequate consideration of the effects of monetary policy.

The results also provided evidence that dollar devaluation accounted for a significant part of the increase in U.S. prices, particularly in agriculture.

Nevertheless, the general equilibrium analysis reported here suggested a somewhat smaller effect than that estimated by Schuh (1974) on the basis of partial equilibrium analysis.[7/] This suggests that too many relevant simultaneous variables are ignored or assumed exogenous in the partial analysis and that a general equilibrium approach is needed to analyze the effects of exchange rate change on agriculture or any other individual sector. As Schuh (1977) has also pointed out, there is a great need for analyzing agricultural sector problems in a broader context, including the simultaneities between agriculture and the rest of the economy, including the monetary sector. Moreover, as suggested here, the effects of general economic policy on the agricultural sector may be even greater than the effects of the specifically "agricultural" policy. If we as agricultural economists take a parochial view and ignore the effects of general economic policies on the agricultural sector, we are likely to find ourselves passed by in favor of general economists who have too little understanding of the unique aspects of agricultural production and agricultural markets.

Footnotes

1/ These food components of the CPI are inclusive of all processing costs, marketing services, etc. which are incurred between the farm and the consumer.

2/ Changes may arise from either the current or capital account. Relative prices are taken as the dominant explanatory factor on the current account, and relative interest rates, on the capital account.

3/ The model contains a number of nonlinearities in the form of price ratios in demand and supply equations and multiplication and division of endogenous variables to determine the general price level. These nonlinearities preclude the use of matrix inversion to solve the system.

4/ It is interesting to note that Eckstein and Heien, using only a set of econometric models of the U.S. livestock and grains sectors reached a similar ranking of the major causes of the 1973 food price inflation: domestic monetary policy, government acreage restrictions, the Soviet grain deal, world economic growth, dollar devaluation, and the price freeze.

5/ This includes the effects of the additional monetary expansion associated with the increase in foreign exchange revenue.

6/ It could also be argued that it is asking too much to expect one aggregate export demand schedule for the crops sector to adequately capture the effect on the U.S. of all the adjustments which occurred in the world agricultural markets following the crop shortfalls.

7/ The smaller effect of dollar devaluation on U.S. agricultural prices found here is due not only to our consideration of general equilibrium. Our crop export demand schedule is unit elastic, while Schuh (1974) assumed a range of -6.4 to -15.9.

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