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SIMULATING THE IMPACT OF INPUT-PRICE INFLATION ON FARM INCOME

Leroy Quance and Luther Tweeten*

A 1964 survey of 500 wheat producers in Oklahoma and Kansas revealed that the cost-price squeeze is most commonly viewed by farmers as the major cause of chronically low farm income. The cost side of the squeeze is widely attributed to the wage-price spiral caused by cycles of wage and input price increases negotiated between labor unions and imperfectly competitive firms, and to rising taxes and interest rates.

That prices paid by farmers have increased is not in doubt. The parity index rose 30 percent in the 1960's, or 2.6 percent annually. Gains were moderate, only 1.4 percent per year, from 1960 to 1965. But annual gains averaged 4 percent from 1965 to 1970.

The principal issue is not whether input-price inflation (defined here as rising prices paid for inputs by farmers without an increase in quality, quantity or productivity of the input) has occurred, but rather what is the impact. Despite the major importance of inflation in most explanations of the farm problem, the subject has received little analytical treatment by economists. This study attempts to compensate for the neglect.

A premise of this paper is that inflation in the national economy has a real-price effect on the farming industry, that it reduces the parity ratio, *ceteris paribus*. General inflation in an economy characterized by excess demand may be associated with a slight increase in the demand for farm output. The increase is likely small due to the low income elasticity of demand for farm output. On the other hand,

higher marketing margins, engendered by higher wages and other costs in the marketing sector, reduce the demand for farm output at the farm level. These opposing forces suggest that the net impact of inflation in the national economy on prices received by farmers is small compared to the impact on prices paid. An examination of trends in prices paid and in prices received by farmers in the late 1970's (a period of marked national inflation as measured by the implicit inflator of the GNP) lends empirical support to the theoretical argument that national inflation does, in fact, have a real effect on the farming industry.

The impact of national inflation on prices received by farmers through a shift in the output demand curve is ignored in this study. Only the impact of general inflation through higher real input prices is considered—we simply call this input-price inflation. And the study traces the impact of input-price inflation on farm output, prices received by farmers, the parity ratio, gross receipts, costs, and net income. To our knowledge, such analysis is new. Of special interest is the role played by a positive supply elasticity in dampening the impact of higher input prices on farm costs and net income—a subject not treated before except in static analysis [5]. And while the study traces the impact of higher input prices on aggregate farm income, and not on asset values, past studies have consistently shown a close direct relationship between earnings or returns to durable assets and their value or price [1]. Hence, earnings as measured by net income may provide a more fundamental measure than asset values of the impact of input-price inflation on the farm economy.

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A STATIC ANALYSIS OF THE IMPACT OF RISING INPUT PRICES ON NET FARM INCOME

Higher input prices restrain input purchases. If demand for the input is price inelastic, higher input prices raise expenditures on the input. A decline in input use reduces farm output as expressed by the production function. If output demand is sufficiently inelastic, the gain in total receipts engendered by the cut in output may more than compensate for higher input expenditures. Thus, it is possible for input-price inflation to raise net farm income. The actual change can only be judged by applying relevant supply, demand, and production parameters.

Using available parameter estimates, Tweeten and Quance [5] traced the macro effects of an increment in prices paid by farmers for all purchased inputs through the farm economy. The supply elasticity was assumed .1 in the shortrun and .8 in the longrun [4], the demand elasticity $-.3$ in the shortrun and -1.0 in the longrun [2], and the production elasticity .62 [4].

Considering first, only the shortrun, a 10 percent gain in prices paid reduced the quantity taken of purchased inputs by 1 percent, which reduced output .62 percent.¹ Total revenue was estimated to rise 1.2 percent and expenditures for purchased inputs 9 percent. Properly weighting revenue and input cost, the authors estimated that net farm income was reduced by 2.3 percent.

With the same once for all gain of 10 percent in the price of purchased inputs, net returns were estimated to fall less in the longrun than in the shortrun. Input use fell 8 percent in the longrun, dropping output 5 percent. This reduction in output did not change gross receipts because of the assumed unitary longrun demand elasticity. However, the restraint in the use of inputs reduced the gain in expenditures on purchased inputs to only 2 percent. When this was properly weighted, the result was an estimated 1.2 percent drop in net farm income. In short, a rise in input prices by 10 percent reduced net income 2.3 percent in the shortrun (1-2 years) and 1.2 percent in the longrun of many years.

A DYNAMIC ANALYSIS OF THE IMPACT OF INPUT PRICE INFLATION ON THE FARM ECONOMY

The above analysis is static—it does not consider shifts in supply, demand, and farm programs as these

might actually operate and interact in the 1970's. Accordingly, a dynamic economic model of the farming industry is used to simulate the impact of inflation from 1968 to 1980. Certain key assumptions of the model including initial excess production capacity and the magnitude of the supply and demand parameters are described below.

Aggregate Excess Capacity

Estimates by Quance [cf. 3] of net additions to CCC stocks, exports, and production diverted from commercial markets by government programs were summarized and added to show annual aggregate excess production capacity from 1962 to 1969. The annual aggregates, which could be called an adjustment gap, were then expressed as a percent of potential farm output in estimating excess capacity. Excess capacity in U. S. Agriculture averaged 6.8 percent in the 1962-69 period, ranging from 5.8 to 8.2 percent except for 1966-67 when our dwindling carry-over and the world food gap led to a large decrease in diverted acres. In simulating possible adjustments in the farm economy, we use 6.0 percent of potential agricultural output as a measure of excess capacity with continuation of the current type of commodity programs in the 1970's.

Supply Parameters

Point estimates of the aggregate supply elasticity computed by the authors using three approaches: (1) direct least squares, (2) separate yield and production unit components for crops and livestock, and (3) separate input contributions—all fell in the 0-2 range [4]. The "best" point estimate of the supply elasticity is 0.10 in the shortrun and 0.80 in the longrun for decreasing prices, but the supply elasticity is considered to be 0.15 in the shortrun and 1.5 in the longrun for increasing prices.

The best available indicator of the shift in the aggregate supply function for farm output is the USDA's productivity index [6]. With a rather stable input level from 1940 to 1960 and rising output, productivity per unit of input increased about 2 percent per year from 1940 to 1960. But the productivity index was only 2.9 percent higher in 1968 than in 1960—the annual 1960-68 increase was a low .35 percent. In subsequent analysis, we assume a 1.0 percent increase per year in quantity supplied due to technology and other supply shifters.

¹The supply elasticity can be taken as a measure of the aggregate input demand elasticity, if productivity is independent of the parity ratio. For a more detailed explanation of this static analysis see [5].

Demand Parameters

The demand for U. S. farm output is comprised of a domestic component and a foreign component. Because of the uncertain magnitude of the elasticity of foreign demand for U. S. food, feed and fiber, there is considerable difference of opinion as to the exact magnitude of the elasticity of total demand. Tweeten concluded that the elasticity of total demand is about $-.3$ in the shortrun and -1.0 in the long run [2]. But some economists believe these estimates are too high. In our analysis, we alternatively use demand elasticities of $-.3$ in the shortrun and -1.0 in the longrun; then halve these estimates to $-.15$ in the shortrun and $-.5$ in the longrun to more nearly conform to conventional wisdom. This also gives us a chance to view the reasonableness of the alternative estimates within the context of the simulated farm economy.

It is possible to predict shifts in the domestic demand for farm products with considerable accuracy. The annual increment in domestic demand is divided into a population effect and an income effect. In the decade preceding 1968, the domestic population grew at an annual compound rate of 1.24 percent. Personal consumption expenditures in constant dollars grew 2.6 percent per capita in the same period. If these trends continue, then based on a .15 income elasticity of demand at the farm level, the domestic demand for farm output will grow by $1.24 + 2.6(.15)$ or a total of 1.63 percent per year.

The export demand for farm output is much more difficult to predict. It depends on weather as well as on the political climate. Tweeten projected a 4 percent annual increase in demand for U. S. farm exports to 1980. Based on this estimate and assuming that 17 percent of farm output is exported, then total demand for farm output is projected to increase $.83(1.6) = 1.3$ percent from domestic sources and $.17(4) = .7$ percent from foreign sources, or a total of 2.0 percent per year.

If domestic population and income increase as above but export demand grows only 2 percent annually and the domestic income elasticity of demand for farm output is only .10, then the total increase in demand for farm output will be only 1.5 percent annually. In our analysis, we alternatively use shifts in demand of 1.5 and 2.0 percent per year. The 1.5 estimate is considered the most likely rate for the 1970's.

Program Alternatives

The adjustment potential of the farm economy is simulated from 1969 to 1980 under two alternative government diversion programs. The first alternative

assumes that each year the government continues to divert 6 percent of potential agricultural output from conventional market channels. Government payments to farmers are assumed to continue at the 1969 level. The second alternative involves a gradual elimination of diversions and government payments by 1980. Government payments and production diversions are reduced by equal amounts annually until in 1980 there are no more government commodity programs.

The Model

The simulation model is built around a simple recursive formulation of aggregate demand and supply functions. The supply function is basically a free market supply function in that the quantity supplied includes diversions as well as the quantity moving into regular market channels. Input price inflation is introduced into the simulation model through the aggregate supply equation, which expresses the current quantity supplied as a function of the parity ratio of last year and of all previous years through a Koyck-Nerlove type of distributed lag. The parity ratio denominator, prices paid by farmers, is simply increased each year at alternative rates of 0, 2 and 4 percent. The effects over time work their way recursively through the entire model. The lower parity ratio decreases input use and the supply quantity. The demand quantity, which is the supply quantity less government diversions, determines prices received by farmers in the current year through the demand equation. The current index of prices received by farmers, when multiplied by the demand quantity, gives total farm receipts. Receipts plus government payments equal gross farm income. Gross farm income less production expenses equal net farm income.

Production expenses are computed as a constant proportion of the demand quantity, adjusted upward by the assumed input-price inflation rates. The demand quantity, rather than the supply quantity, is used as the base of calculations to exclude costs on diverted acres. Rising production expenses are associated with output expansion and rising input prices but with a constant ratio of real operating costs to output.

As mentioned earlier, three rates of input price inflation are included. The 2 percent rate conforms roughly to the average gain in prices paid by farmers in the early 1960's. The 4 percent rate conforms to the 1965-70 average gain and is the same as the July 1969-July 1970 rate. The latter rate may be expected for the immediate future. The zero rate provides a standard of comparison.

SIMULATION RESULTS

Estimates of the variables shown in Tables 1 and 2 were calculated for every year from 1968 to 1980 but, to save space, only data for the first and last years are presented.

Continuation of Current Commodity Programs

Input-price inflation results in higher prices received by farmers because it restrains output (Table 1). The gains are insufficient to offset the rise in prices paid, thus, the parity ratio falls .5 units (1910-14=100) for each 1 percent rise in prices paid by farmers under the $-.3$ and -1.0 demand elasticities. If these demand elasticities are halved, the drop

in the parity ratio is much less, and the parity ratio actually increases from 74 in 1969 to 76 in 1980 with a 2.0 percent shift demand and a 2.0 percent input-price inflation.

Even with an assumed unitary longrun demand elasticity, gross income is raised slightly by input-price inflation. The increase in gross farm income is insufficient to offset large increases in production expenses and the result is lower net farm income with inflation than without it. With the higher (absolute value) demand elasticities, net farm income is maintained near its 1969 level with 2 percent inflation but is cut severely with 4 percent inflation. Cutting the demand elasticities in half results in higher net farm income in 1980 than in 1969 in every case except for

TABLE 1. ESTIMATED ECONOMIC IMPLICATIONS OF INPUT-PRICE INFLATION WITH VARIOUS COMBINATIONS OF DEMAND PARAMETERS, WITH CONTINUATION OF PRESENT GOVERNMENT PROGRAMS, 1969 TO 1980

Item and inflation rate, in percent	1980				
	1969	Demand elast. $-.3$ (SR) and -1 (LR)		Demand elast. $-.15$ (SR) and $-.50$ (LR)	
		Percent shift in demand ¹		Percent shift in demand ¹	
		2.0	1.5	2.0	1.5
Prices received (1910-14 = 100)					
0	275	299	290	296	290
2	275	326	314	353	335
4	275	349	337	394	373
Parity ratio (1910-14 = 100)					
0	74	80	78	79	78
2	74	70	68	76	72
4	74	61	59	69	65
Quantity supplied (Billion 1969 dollars)					
0	54.2	59.9	58.8	61.3	59.7
2	54.2	56.2	55.4	58.1	56.9
4	54.2	53.3	52.6	55.8	54.6
Quantity demanded (Billion 1969 dollars)					
0	50.8	56.3	55.2	57.7	56.1
2	50.8	52.8	52.1	54.6	53.4
4	50.8	50.1	49.4	52.4	51.3
Gross farm income (Billion current dollars)					
0	54.6	65.1	62.2	65.8	62.9
2	54.6	66.4	63.3	73.9	68.9
4	54.6	67.5	64.3	78.9	73.4
Production expenses (Billion current dollars)					
0	38.1	42.2	41.4	43.2	42.0
2	38.1	49.2	48.6	50.9	49.8
4	38.1	57.8	57.0	60.5	59.2
Net farm income (Billion current dollars)					
0	16.5	22.9	20.8	22.6	20.8
2	16.5	17.3	14.7	23.0	19.1
4	16.5	9.6	7.3	18.4	14.2

¹Supply shifts 1 percent annually; the supply elasticity is .1 in shortrun and .8 in the longrun for a decreasing parity ratio and .15 in the shortrun and 1.5 in the longrun for an increasing parity ratio.

TABLE 2. ESTIMATED ECONOMIC IMPLICATIONS OF INPUT-PRICE INFLATION WITH VARIOUS COMBINATIONS OF DEMAND PARAMETERS, WITH TRANSITION TO A FREE MARKET COMPLETED BY 1980

Item and inflation rate in percent	1969	1980			
		Demand elast. $-.3$ (SR) and -1 (LR)		Demand elast. $-.15$ (SR) and $-.50$ (LR)	
		Percent shift in demand ¹		Percent shift in demand ¹	
		2.0	1.5	2.0	1.5
Prices received (1910-14 = 100)					
0	275	288	279	289	281
2	275	310	299	329	312
4	275	333	321	367	347
Parity ratio (1910-14 = 100)					
0	74	77	75	77	75
2	74	67	64	71	67
4	74	58	56	64	60
Quantity supplied (Billion 1969 dollars)					
0	54.2	58.2	57.2	59.0	57.4
2	54.2	55.1	54.3	56.2	55.1
4	54.2	52.2	51.5	54.0	52.9
Quantity demanded (Billion 1969 dollars)					
0	50.8	58.2	57.2	59.0	57.4
2	50.8	55.1	54.3	56.2	55.1
4	50.8	52.2	51.5	54.0	52.9
Gross farm income (Billion current dollars)					
0	54.6	61.0	58.0	61.9	58.6
2	54.6	66.4	59.0	67.2	62.5
4	54.6	63.2	60.1	72.1	66.8
Production expenses (Billion current dollars)					
0	38.1	43.6	42.8	44.2	43.0
2	38.1	49.2	50.6	52.3	51.4
4	38.1	60.2	59.4	62.3	61.0
Net farm income (Billion current dollars)					
0	16.5	17.3	15.2	17.7	15.6
2	16.5	17.1	8.4	14.9	11.2
4	16.5	2.9	.6	9.8	5.9

¹Supply shifts 1 percent annually; the supply elasticity is .1 in shortrun and .8 in the longrun for a decreasing parity ratio and .15 in the shortrun and 1.5 in the longrun for an increasing parity ratio.

the moderate decrease to \$14.2 billion with 4.0 percent input price inflation and a 1.5 percent shift in demand.

With the lower (absolute value) demand elasticities, gross farm income rises from \$54.6 billion (excluding interfarm sales) in 1969 to \$73.9 billion in 1980 with 2 percent inflation and with a 2 percent rise in demand. The gain in income is sufficient to overcome a 34 percent rise in production expenses leaving net income \$.4 billion greater than with no inflation. Of course, the net income is in current dollars and could represent an absolute drop in buying power if prices of items purchased with net income have gone up. But the gain in net income is relatively favorable to farmers in the sense that, if

prices of items purchased with net income have gone up, it is better to have more dollars to spend.

Transition Program

The estimates in Table 1 were based on continuation of current government programs to 1980, with 6 percent annual diversion of production capacity. The Food and Fiber Commission as well as a major farm organization have called for a greater market orientation and less government involvement in farming, and the Agricultural Act of 1970 is a move toward freer farm markets. To reduce the trauma that would attend an immediate move to a free market, the transition is assumed to be made by equal annual reductions in direct payments and production diver-

sion until in 1980 there are no production diversions or government payments. The results are shown in Table 2.

Net income tends to decrease less by 1980 with the higher than with the lower demand elasticities. A slow growth in demand and a high rate of increase in input prices, when combined, create unusually severe problems of low income for farmers. A 4 percent annual input-price inflation signaled something of a net income crises by 1980 under current programs (Table 1), but a disaster under a gradual transition to a free market (Table 2). On the other hand, the farming industry appears able to adjust with far less trauma to a free market by 1980 if demand increases by 2 percent annually and inflation is held to no more than 2.0 percent per year.

Net farm income by 1980, under the unitary demand elasticity with transition to a free market, is \$.2 billion below that with continuation of present programs with a 2.0 percent shift in demand, and \$6.3 billion lower with a 1.5 percent shift in demand. Net income computed for each year (not shown but available from the authors) trends gradually and uniformly downward from 1968 to 1980 with the unitary longrun demand elasticity but fluctuates in a cobweb pattern with the $-.5$ longrun demand elasticity. The gap between the free market and current program net income also gradually widens over the period, but would narrow after 1980 because the transition to no government program is completed by 1980. In fact, given time for land prices to adjust, there would be little difference between the net income to pay family and operator labor with and without government programs if the input price inflation were held to 2.0 percent.

A stochastic element to reflect the effect of unpredictable weather, foreign demand and other variables was not introduced. If this were done, it could be shown that government programs could reduce the variability of net farm income in the longrun, even if they do not increase the level of returns to farm operators for their labor and equity.

SUMMARY AND CONCLUSIONS

Based on what we consider the most realistic assumptions (demand shifting to the right at 1.5 percent per year with an elasticity of $-.3$ in the shortrun and -1.0 in the longrun), the parity ratio rises from 74 (1910-14=100) in 1969 to 78 by 1980 with a continuation of present government programs

and no inflation, but falls to 59 in 1980 with 4 percent annual inflation. If demand increases 2 percent annually, the parity ratio falls to 70 by 1980 with a continuation of present programs and 2 percent inflation. Under the same conditions but with a gradual return to a free market by 1980, the parity ratio declines to 67 in 1980. Under all circumstances, the impact of inflation is to reduce the supply quantity relative to what it would be in 1980 without inflation.

Input-price inflation has a comparatively small impact on net farm income if held to not more than 2 percent per year. The impact is not large because higher input prices restrain use of inputs and hence restrain output. With an inelastic demand, less output means more revenue. But input price gains, reaching 4.0 percent annually, inflate costs to the point where they considerably exceed additional receipts. Thus, net farm income declines sharply. Aggregate demand elasticities of $-.3$ and -1.0 indicate that each percentage point of annual input-price inflation reduces net farm income \$3 to \$4 billion under current type government programs. In the case of aggregate demand elasticities for farm output of $-.15$ in the shortrun and $-.50$ in the longrun, net farm income appears lowered less by inflation.

The rate at which demand shifts to the right does not seem to significantly affect the impact of inflation. A 4 percent inflation rate reduces potential net income \$13.3 billion with a 2 percent annual gain in demand and \$13.5 billion with a 1.5 percent annual gain in demand, other things equal (Table 1).

The reduction appears affected little by a greater market orientation in government programs for farmers. Four percent annual inflation reduces net farm income \$14.4 billion with a gradual transition to a free market and \$13.3 billion with continuation of present programs—based on the 2 percent demand shift.

The results of this paper indicate that if demand shifts to the right .5 percentage points greater than the annual shift in supply in the 1970's, then the farming industry can about hold its own in net income and even adjust to a free market with 2 percent annual inflation in input prices. But with higher rates of inflation, the farming industry appears destined for hard times. Major adjustments in government or farmer-run programs will be needed to avoid severe financial troubles for farmers if inflation continues at its 1970 rate.

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