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# Excess Capacity and Adjustment Potential in U.S. Agriculture

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Recursive aggregate demand and supply functions are used to simulate the ability of the farm sector to adjust during the 1970's to three policy alternatives. Different output demand elasticities and shifts in the supply and demand for farm output were assumed. Within reasonable bounds, agriculture could remain economically viable during the 1970's under policies diverting about 6 percent of potential output. An average of 6 percent was diverted from the market by Government production control, storage, and subsidized exports in 1962-69. Returning to a free market immediately or by 1980 would place severe financial strain on the farm sector.

Key words: Aggregate U.S. agriculture; excess capacity; Government programs; net farm income; simulation.

Ability of the farming industry to adjust to changing economic conditions depends on the magnitude of excess capacity, the characteristics of supply and demand, and the nature of public policies to deal with excess capacity. Excess capacity is defined in this paper as farm production in excess of market utilization at socially acceptable prices—current prices achieved by Government intervention. An operational definition of excess capacity is the value of production diverted from the market by Government production control, storage, and subsidized exports relative to potential farm output at current prices. One objective of this paper is to estimate excess capacity for recent years.

Excess capacity represents economic imbalance in resource use as well as output. The resource imbalance has been estimated elsewhere (*1*); measures of excess capacity in this paper focus on production.[1] The ability of the farm economy to cope with excess capacity, and the output, price, and income levels that would attend a more market-oriented farm industry, depend heavily on the characteristics of supply and demand. A second objective of this paper is to estimate output, prices, and net farm income from 1969 through 1980 under alternative assumptions about the elasticities of and shifts in demand and supply and under selected Government policies. These policies include continuing the programs of the 1960's, immediately eliminating Government programs, and gradually eliminating Government programs over the 1970's. The farm economy is simulated through 1980 to provide information on how it might adjust to different economic conditions and policies.

Footnotes are at end of article, p. 66.

## Excess Productive Capacity

Given the supply and demand parameters and other characteristics of agriculture and its environment, our farm plant has the capacity to produce an aggregate output generally greater than that demanded at prices with a socially (politically) acceptable level and stability. In a free market, the burden of excess capacity would fall on the farmer in terms of uncertain and generally low product prices which complicate investment decisions and yield low returns, and on the consumer via erratic supplies and prices although average consumer prices would be somewhat lower. In a free market, excess capacity as defined herein would not exist. But society has chosen to modify the market mechanism by diverting from regular markets quantities in excess of that level which clears the market at socially acceptable prices.[2]

Tyner and Tweeten (*6*) estimated that excess productive capacity in 1955-61 ranged from a low of 5.3 percent in fiscal year 1957 to a high of 11.2 percent in 1959.[3] Tyner and Tweeten's procedure for measuring excess capacity is followed in this study. Annual excess production during 1962-69 is defined as the value of potential farm output diverted by Government land withdrawal programs plus the value of production diverted from commercial markets by Government storage operations (Commodity Credit Corporation) and subsidized exports (P.L. 480, etc.). The sum of the value of these diversions (at current prices) for major farm commodities is defined as aggregate excess production. And the ratio of this sum to the value of potential agricultural production is the relative excess capacity in each particular year (*6*, p. 23).

Table 1.—Estimated value of net additions to CCC stocks, seven major commodities, fiscal years 1963-69[a]

(In millions of dollars)

| Year ending June 30 | Wheat | Rice | Feed grains[b] | Cotton | Peanuts | Tobacco | Dairy products[c] | Total |
|---|---|---|---|---|---|---|---|---|
| 1963..... | -26.2 | 8.3 | -225.6 | 430.6 | 77.7 | — | -10.7 | 254.1 |
| 1964..... | -347.5 | -1.0 | 279.3 | 46.1 | -77.7 | — | -15.2 | -116.0 |
| 1965..... | -246.4 | -1.4 | -361.9 | 328.6 | — | — | -1.4 | -282.5 |
| 1966..... | -498.8 | -3.6 | -409.4 | 278.7 | — | — | -2.1 | -635.2 |
| 1967..... | -301.3 | -2.2 | -380.9 | -326.3 | .7 | — | 15.8 | -994.2 |
| 1968..... | -26.4 | -.3 | -8.0 | -655.7 | -.7 | — | -5.6 | -696.7 |
| 1969.... | 74.9 | 29.0 | 188.6 | -54.4 | — | — | 4.1 | 242.2 |

[a]Net changes in CCC inventories times seasonal average price.
[b]Sum of rye, corn, grain sorghum, barley, and oats.
[c]Milk equivalent of net USDA acquisitions times manufacturing milk prices.

Source: Quantities from Annual Reports of Financial Condition and Operations (Commodity Credit Corporation) and Dairy Situation (DS 327, Sept. 1969, Economic Research Service) were weighted by season average prices from Agricultural Statistics, various issues, except that dairy products (milk equivalent) were weighted by manufacturing milk prices.

Excess capacity is measured for the fiscal year (ending June 30) to conform with available data. Commodity Credit Corporation (CCC) and export data are by fiscal year. Quantities are weighted by average prices received by farmers during the crop marketing year. Program diversions and value of total farm output for year $t$, e.g., 1967, are used in calculations for "year" $t$-($t$+1), e.g., 1967-68. To illustrate, the "analysis year" 1967-68 relates to net CCC stocks and subsidized exports for fiscal 1968, land diversions for 1967, marketing year prices for 1967-68, and value of total farm output for 1967.

## CCC Storage Operations

The Commodity Credit Corporation acquires stocks through (a) acquisition of commodities pledged as collateral for price support loans, and (b) purchases of commodities from processors or handlers, or from producers by purchase agreements (*8*). CCC diversions shown in table 1 for seven major commodities are *net* additions to CCC stocks. These values were calculated as the quantities diverted times the seasonal average price received by farmers for the respective commodities.

A marked downward trend for CCC diversions in 1962-68 is apparent for all commodities except cotton. This trend reflects greater emphasis placed on supply control and heavy exports from CCC stocks under Government programs (P.L. 480, etc.) to relieve the pressure of large CCC stocks accumulated in earlier years and to aid food deficit areas of the world. In 1969, reduced exports resulted in a $242 million increase in CCC inventories.

## Exports Under Aid Programs

Conceptually, at least two approaches can be used to estimate excess capacity diverted from commercial markets through export programs. One approach is to estimate the amount of commercial exports to aid recipients in the absence of aid programs. Andersen (*1*) estimated that, on the average, each ton of wheat (the major component of aid exports) under U.S. aid programs replaced 0.41 ton of commercial wheat imports from 1964 to 1966. This implies that the residual, 0.59 ton, should be imputed to excess capacity. Since the U.S. had substantial reserves of food, the major share of commercial exports replacing aid would have come from U.S. supplies. It appears that at least half of U.S. food aid exports could be charged to excess capacity based on rates of commercial export substitution.

The second approach is to measure the cash equivalent value of food aid. With cash, aid recipients could have purchased fertilizer plants, irrigation equipment, technical assistance to develop improved crop varieties, or other items. In the 3-year period 1964-66, the cash equivalent value of food aid was 48.1 percent of the reported market value of food aid exports, excluding transportation costs (*1*). Thus approximately half of the value of food aid is imputed to real foreign aid (foreign economic development); the other half to support of domestic farm prices (excess capacity).

We assume that half of exports under Government programs are charged to excess capacity in table 2 for seven major commodity groups for the years 1962-68. These diversions fluctuated around $700 million from 1962 to 1968 with wheat accounting for over half of the diversions. In 1969, exports under aid programs

Table 2.—Estimated value of excess capacity exported under Government programs, seven major commodities, fiscal years 1963-69

(In millions of dollars)

| Year ending June 30 | Wheat | Rice | Feed grains[a] | Cotton | Peanuts | Tobacco | Dairy products | Total |
|---|---|---|---|---|---|---|---|---|
| 1963..... | 421.0 | 42.7 | 54.8 | 81.0 | — | 18.4 | 48.0 | 665.9 |
| 1964..... | 434.4 | 43.5 | 41.5 | 71.0 | — | 18.0 | 69.5 | 677.9 |
| 1965..... | 495.4 | 34.4 | 38.1 | 82.5 | — | 17.7 | 51.2 | 719.3 |
| 1966..... | 468.6 | 30.0 | 56.8 | 61.8 | — | 45.0 | 45.4 | 707.6 |
| 1967..... | 322.8 | 65.6 | 103.5 | 82.5 | — | 53.4 | 51.0 | 678.8 |
| 1968..... | 383.6 | 68.5 | 59.5 | 87.4 | — | 52.6 | 55.0 | 706.6 |
| 1969..... | 199.0 | 80.8 | 18.5 | 45.0 | — | 14.4 | 71.2 | 428.9 |

[a]Includes corn, grain sorghum, barley, oats, and rye.

Sources: Econ. Res. Serv., 12 Years of Achievement Under Public Law 480, ERS-Foreign 202, Nov. 1967, and Foreign Agricultural Trade of the United States, 1968, p. 22; and (*8*).

decreased $278 million, more than offsetting the $242 million net additions to CCC stocks.

## Land Withdrawal Programs

Net additions to CCC stocks and subsidized exports remove excess output already produced. Growing emphasis during the 1960's was placed on removing land from production to control output before it was produced. Estimates of land diverted from various crops are made from USDA data (*2*, *7*). A crucial question is "How productive is the diverted land?" Many persons agree that farmers divert marginal cropland and that, on the average, diverted land is less productive than land in production. Ruttan and Sanders estimated that productivity of diverted land may be as little as one-third that of land in production (*3*). But others (*12*) estimate that diverted acres may be 90 percent as productive as cropland in production. To estimate the potential farm output diverted by land withdrawal programs, we arbitrarily assume that yields on diverted acres would be 80 percent of average crop yields for each respective crop and year. Estimates of the potential production of three major crops were weighted by average prices received by farmers to obtain the value of potential farm output diverted by Government land withdrawal programs (table 3). The three crop categories in table 3 accounted for the normal use of 63 percent of the cropland in the Conservation Reserve in 1960 (*2*, p. 47), and the proportion these three crops comprise of total diversions by specific commodity programs would be even greater.

Feed grains account for about three-fourths of the potential production on diverted acres which, according to our estimates, was highest ($3.2 billion) in 1966 and lowest ($1.9 billion) in 1967, and was $2.7 billion in 1968. Diversions by land withdrawal programs generally increased except in 1963 when acres diverted from corn production decreased 3.3 million acres, in 1964 when the value of wheat acreage diversions declined by almost two-thirds, and in 1967 when concern over our dwindling surpluses and the world food deficit caused a reduction of production controls.

## Aggregate Excess Capacity

Estimates in tables 1 to 3 of net additions to CCC stocks, Government-aided exports, and potential production on diverted acres are summarized and added

Table 3.—Estimated value of diversions by land withdrawal programs, three major crops, crop years 1962-68

(In millions of dollars)

| Crop | 1962 | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 |
|---|---|---|---|---|---|---|---|
| Wheat . . . | 552.4 | 550.7 | 198.2 | 250.1 | 334.7 | 34.7 | 279.2 |
| Feed grains | 1,845.2 | 1,651.3 | 1,924.0 | 2,325.9 | 2,493.8 | 1,429.8 | 2,137.3 |
| Cotton . . | 60.2 | 64.8 | 104.4 | 151.8 | 389.4 | 468.7 | 290.3 |
| Total . . | 2,457.8 | 2,266.8 | 2,226.6 | 2,727.8 | 3,217.9 | 1,933.2 | 2,706.8 |

Sources: Acres removed by the conservation reserve and various commodity programs are from Agricultural Statistics, various issues. Estimates of normal use of land in the conservation reserve were taken from Economic Effects of Acreage Control Programs in the 1950's (*2*). Assumed production on diverted acres was weighted by the average prices received by farmers.

Table 4.—Government diversions, farm output, and excess capacity in agriculture, fiscal years 1963-69

| Year ending June 30 | Government diversions | | | | Farm output[a] | Excess capacity[b] |
|---|---|---|---|---|---|---|
| | CCC | Land withdrawals | Subsidized exports | Total | | |
| | *Mil. dol.* | *Mil. dol.* | *Mil. dol.* | *Mil. dol.* | *Mil. dol.* | *Percent* |
| 1963 | 254.1 | 2,457.8 | 665.9 | 3,377.8 | 38,806.6 | 8.19 |
| 1964 | -116.0 | 2,266.8 | 677.9 | 2,828.7 | 40,391.9 | 6.63 |
| 1965 | -282.5 | 2,226.6 | 719.3 | 2,663.4 | 41,111.9 | 6.15 |
| 1966 | -635.2 | 2,727.8 | 707.6 | 2,800.2 | 40,522.7 | 6.48 |
| 1967 | -994.2 | 3,217.9 | 678.8 | 2,902.5 | 37,096.4 | 7.20 |
| 1968 | -696.7 | 1,933.2 | 706.6 | 1,943.1 | 40,904.3 | 4.54 |
| 1969 | 242.2 | 2,706.8 | 428.9 | 3,377.9 | 40,308.0 | 7.85 |

[a]Net farm output in 1957-59 dollars adjusted to current values by the index of prices received by farmers (1957-59 = 100). Farm output estimates are from worksheets of the Farm Adjustment Branch, Farm Production Economics Division, ERS.

[b]Government diversions as a percentage of potential farm output where diversions of land withdrawal programs are added to actual farm output to more adequately reflect "total capacity" of agriculture.

to show aggregate excess production in table 4. Total diversions are then expressed as a percentage of potential farm output for fiscal 1963 to 1969 as a measure of excess capacity. These estimates are probably the lower bound on real excess capacity. There is some excess capacity in commodities not included in our estimates. If government programs were eliminated, farmers could bring more "new lands" into production as well as most of the diverted acres accounted for in this study.

Our estimates indicate that the adjustment gap in U.S. agriculture in the 1960's ranged from 6.2 to 8.2 percent, except for 1968, when our dwindling carryover and the world food gap led to a large decrease in diverted acres. In the 1960's, CCC stocks declined in every year except 1963 and 1969. Net declines in CCC stocks in recent years just about offset subsidized exports, and excess capacity is approximately equal to what could have been produced on land in Government land withdrawal programs. In simulating possible future adjustments in the farm economy, we use 6 percent of potential agricultural output as a measure of current excess capacity.

## Supply Parameters

*Supply elasticities* indicate the speed and magnitude of output adjustments in response to changes in product price. The price elasticity for aggregate farm output is especially important because it measures ability of the farming industry to adjust production to changing economic conditions continually confronting it in a dynamic economy.

Farmers have considerable latitude to substitute one commodity for another in production over a long period. Eventually, this should lead to adjustments among commodities until comparable resources are earning similar rates of return in production of each commodity. And because farm resources are adjusted much more easily among farm commodities than between farm and nonfarm commodities, it follows that the aggregate supply response, which tends to determine total resource earnings in agriculture, is less than the supply response for individual commodities (*5*, p. 342).

Point estimates of the aggregate supply elasticity were computed by the authors using three approaches: (a) Direct least squares, (b) separate yield and production unit components for crops and livestock, and (c) separate input contributions (*5*).[4] From these approaches we conclude that the supply elasticity is 0.10 in the short run and 0.80 in the long run for decreasing prices. But for increasing prices, the supply elasticity is considered 0.15 in the short run and 1.5 in the long run.

*Shift in supply due to nonprice variables.*—The best available indicator of the shift in the aggregate supply function for farm output is USDA's productivity index (*10*). 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 only 0.35 percent. The slowing of the increase is caused in part by the fact that the 1947-49 weights used in constructing the index were inappropriate for the 1960's. In our analysis, partly to compensate for a lack of confidence in past estimates of shift in aggregate supply over time and partly to simulate different levels of technological change in the future, we alternatively assume a 0.0, 1.0, and 1.5 percent increase per year in quantity supplied, due to technology and other supply shifters.

## Demand Parameters

Many forces influence the demand for farm output. Some forces are social and some are political, but many are economic factors that grow out of the market system as it reflects increased population and the changes in consumption in response to prices and income. We divide these economic forces into the price elasticity of demand and the annual shift in demand.

*Price elasticity of demand.*—The demand for U.S. farm output consists of a domestic component (including inventory demand) 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's findings indicate the price elasticity of total demand is about −0.3 in the short run and −1.0 in the long run (4). But some economists believe these estimates are too high. In our analysis, we use demand elasticities of −0.3 in the short run and −0.5 in the long run to more nearly conform to conventional wisdom. Use of these elasticities also gives us a chance to view the reasonableness of the alternative estimates in the context of the simulated farm economy.

*Shift in demand due to nonprice variables.*—It is easier to predict shifts in the demand for farm products in the domestic market than in the foreign market. The annual increment in domestic demand is divided into a population effect and an income effect. In the decade preceding 1968, 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 0.15 income elasticity of demand at the farm level, the domestic demand for farm output will grow by 1.24 plus 2.6 (0.15) or a total of 1.63 percent per year.

On the export side, Tweeten projected a 4 percent annual increase in demand for U.S. farm exports to 1980. If 17 percent of farm output is exported, then total demand for farm output is projected to increase 0.83(1.5) = 1.3 percent from domestic sources and 0.17(4) = 0.7 percent from foreign sources, or a total of 2.0 percent per year.

This demand projection may be too optimistic in light of recent developments. If annual export demand grows 3 percent, per capita domestic income 2 percent, and population 1 percent, and if the domestic income elasticity of demand is 0.10, then demand for farm output will grow only 1.5 percent annually. In our analysis, we use shifts in demand of 1.0, 1.5, and 2.0 percent per year.

## Adjustment Potential in the 1970's

The adjustment potential of the farm economy is simulated from 1969 to 1980 under three different assumptions with regard to Government diversion programs. The first is that 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, although, in reality, the level of Government payments would likely be positively correlated to diversions. The second alternative assumes a gradual elimination of diversions and Government payments by 1980. The third alternative is to terminate all diversions and Government payments at the beginning of 1970—an immediate free market. To account for uncertain trends in the supply and demand for farm output and to determine the impact of different assumptions about the elasticity of demand, each policy alternative is simulated over six different combinations of supply and demand parameters. These six different combinations range from the most to the least favorable conditions likely to prevail for agriculture in the 1970's.

## The Model

The simulation model is built around a simple recursive formulation of the aggregate supply equation (1) and demand equation (2):

$$(1)\quad Q_t = \alpha_s \left(\frac{P}{P_d}\right)_{t-1}^{\beta_s} Q_{t-1}^{(1-\delta_s)}\, 2.718^{g_s(1-\delta_s+\delta_s T)}$$

$$(2)\quad P_t = \left[Q_t/(\alpha_d Q_{t-1}^{(1-\delta_d)}\, 2.718^{g_d(1-\delta_d+\delta_d T)})\right]^{1/\beta_d}$$

The quantity supplied in year $t$, $Q_t$ is dependent upon the real price in year $t$-1.[5] This supply equation is basically a free market supply function in that the quantity supplied includes diversions as well as the quantity moving into regular market channels.

The supply quantity, predetermined by past prices and adjusted as necessary for exogenously determined Government program diversions, is then fed into the demand equation to determine price in year $t$. Demand quantities are equal to supply quantities minus Government diversion. Gross farm receipts in year $t$ are equal to the market clearing demand quantity multiplied by the price in year $t$. Adding Government payments to gross farm receipts yields gross farm income. Real production expenses, assumed to equal 77.43 percent of the real quantity marketed in year $t$ (a percentage based

Table 5.—Estimates of prices received by farmers, parity ratio, quantity supplied, quantity demanded, and gross and net farm income under alternative Government policies, and with various combinations of demand and supply parameters, 1969 and 1980

| Policy alternative and specified variable[a] | Actual values in 1969 | Simulated 1980 values when elasticity of demand is— | | | | | |
|---|---|---|---|---|---|---|---|
| | | −0.3 (short run) and −1.0 (long run), with annual percent shift in demand/supply | | | −0.15 (short run) and −0.5 (long run), with annual percent shift in demand/supply | | |
| | | 2.0/1.0 | 1.5/1.0 | 1.5/1.5 | 2.0/1.0 | 1.5/1.0 | 1.5/1.5 |
| Continuation of present programs (6 percent diversion): | | | | | | | |
| Index of prices received by farmers | 275.0 | 325.6 | 313.8 | 305.9 | 352.8 | 335.1 | 322.6 |
| Parity ratio | 73.7 | 70.2 | 67.7 | 66.0 | 76.1 | 72.3 | 69.6 |
| Quantity supplied | 54,182 | 56,227 | 55,458 | 56,570 | 58,139 | 56,869 | 57,743 |
| Quantity demanded | 50,804 | 52,854 | 52,130 | 53,178 | 54,651 | 53,457 | 54,278 |
| Gross farm income | 54,598 | 66,376 | 63,282 | 62,949 | 73,899 | 68,937 | 67,458 |
| Net farm income | 16,534 | 17,130 | 14,719 | 13,412 | 22,988 | 19,138 | 16,894 |
| Gradual elimination of Government diversions and a free market by 1980: | | | | | | | |
| Index of prices received by farmers | 275.0 | 310.1 | 298.9 | 291.4 | 329.3 | 311.9 | 300.3 |
| Parity ratio | 73.7 | 66.9 | 64.4 | 62.8 | 71.1 | 67.3 | 64.7 |
| Quantity supplied | 54,182 | 55,076 | 54,322 | 55,392 | 56,160 | 55,139 | 55,966 |
| Quantity demanded | 50,804 | 55,076 | 54,322 | 55,392 | 56,160 | 55,139 | 55,966 |
| Gross farm income | 54,598 | 62,105 | 59,043 | 58,703 | 67,256 | 62,544 | 61,109 |
| Net farm income | 16,534 | 10,799 | 8,439 | 7,101 | 14,940 | 11,178 | 8,973 |
| Free market effective in 1970: | | | | | | | |
| Index of prices received by farmers | 275.0 | 314.6 | 303.3 | 295.4 | 335.9 | 322.5 | 313.5 |
| Parity ratio | 73.7 | 67.8 | 65.4 | 63.7 | 72.4 | 69.5 | 67.6 |
| Quantity supplied | 54,182 | 54,684 | 53,912 | 55,121 | 55,936 | 54,525 | 55,152 |
| Quantity demanded | 50,804 | 54,684 | 53,912 | 55,121 | 55,936 | 54,525 | 55,152 |
| Gross farm income | 54,598 | 62,562 | 59,464 | 59,200 | 68,332 | 63,942 | 62,870 |
| Net farm income | 16,534 | 11,619 | 9,241 | 7,851 | 16,223 | 13,148 | 11,492 |

[a]The index of prices received by farmers for all farm commodities and the parity ratio are based on 1910-14 = 100. All quantity figures are in millions of 1969 dollars, and income figures are in millions of current dollars. A 2.0 percent rate of input price inflation is assumed.

[b]The elasticity of supply is 0.1 in the short run and 0.8 in the long run when the parity ratio is decreasing, but 0.15 in the short run and 1.5 in the long run when the parity ratio is increasing.

on 1969 data in the Farm Income Situation (*11*), are inflated 2 percent per year to reflect rising input prices and subtracted from gross farm income to yield net farm income in year $t$.[6] Both marketings and production expenses are net of interfarm sales.[7]

## Results

The shift in the supply function due to technological advance was near zero from 1963 to 1970. Assuming a 2.0 percent shift in demand and a stable supply function, farm prices by 1980 could be from 13.6 to 30.1 percent higher than in 1969, and net farm income could increase from $16.5 billion in 1969 to as high as $23.6 billion, depending on the assumed diversion policy and on the choice of demand elasticities. Such highly favorable conditions for agriculture are unlikely in the 1970's and results of these conditions are not tabulated. Alternative estimates, summarized in table 5, indicate that depending on the true magnitude of the elasticity of demand and the shifts in supply and demand, conditions less favorable than those above are likely to exist in 1980. Only beginning and ending year data are given in table 5.

*Equal shift in demand and supply.*—The farm sector can maintain its viability through 1980 according to estimates in table 5. But the importance of Government diversion programs is evident. Under unfavorable conditions for agriculture—an equal 1.5 percent annual shift in demand and supply, −0.30 and −1.0 elasticities of demand in the short run and long run respectively, and gradual elimination of Government diversion—the parity ratio would fall from 73.7 in 1969 to 62.8 in 1980 and net farm income would decrease approximately 57 percent, from $16.5 billion in 1969 to $7.1 billion in

1980. And our estimates indicate that an immediate reversion to free markets in 1970 would cause havoc in the first year—a decrease of 15 points in the parity ratio and a drastic decline in net farm income. Despite the relatively more favorable long-run outcome of a "one-shot" as opposed to a gradual return to a free market by 1980, the severe short-run impact of the one-shot return seems to rule it out as an acceptable policy alternative.

*Demand increasing twice as fast as supply.*—If the annual shift in demand for U.S. farm output is double that in supply, as illustrated by the 2.0 percent shift in demand and 1.0 percent shift in supply in table 5, the farm sector would gain by 1980 with continuation of Government programs similar to those of the 1960's. If the short-run demand elasticity is −0.15, prices received by farmers in 1980 would be 119.7 percent of 1969 prices under a policy of gradually eliminating Government diversions and payments. But 2 percent annual input-price inflation causes the parity ratio to decline from 73.7 to 71.1. Net farm income would decrease moderately to $14.9 billion. Under the "immediate free market" alternative, a 72.4 parity ratio and $16.2 billion net farm income result. But if present diversion and payment policies were continued, farm prices would reach 128.3 percent of the 1969 level and net farm income would be $23.0 billion—the highest of any alternative reported in table 5.

Using the higher (absolute value) demand elasticities results in less favorable but viable conditions for agriculture in 1980 if diversion policies are continued. With a continuation of programs to divert 6 percent of potential farm output from commercial markets, net farm income would increase $0.6 billion over the 1969 level.

*Demand increasing 50 percent faster than supply with high demand schedule.*—The set of outcomes in table 5 which most nearly fits our expectations for 1980 results from a 1.5 percent annual shift in demand, a 1.0 percent annual shift in supply, a −0.3 short-run demand elasticity, and a −1.0 long-run demand elasticity.[8] Depending on Government diversion and payment policies, the parity ratio would decrease 6 to 9 points. With one exception, the quantity of farm products demanded and supplied would increase. Net farm income would decrease moderately to $14.7 billion under continuation of diversion and Government payment policies of the 1960's, and it would decrease severely to $9.2 billion under a 1970 free market supply and to $8.4 billion under a policy that gradually reverts to a free market by 1980. Thus continued diversion and payment programs are needed to avoid a major drop in net farm income. Table 6 contains annual estimates for this set of outcomes.

Estimates in table 6 further illustrate the serious adjustment problems which would likely exist under a one-shot compared with a gradual policy to eliminate Government diversions and payments. Net farm income is higher by 1980 with the one-shot free market policy, but gradual elimination of diversions to achieve a free market by 1980 appears to offer major advantages during the difficult transition period.

If the program of the 1960's is continued, our estimates indicate that prices received by farmers will increase about 1.2 percent per year and will reach 114.1 percent of 1969 prices by 1980. But continued input-price inflation at the assumed rate of 2 percent per year would deflate this nominal price gain to a loss of 6 points in the parity ratio. Quantity supplied would increase $1.3 billion, to reach $55.5 billion by 1980, compared with a quantity demanded of $52.1 billion. Government diversions would decrease $50.3 million, reaching $3.33 billion in 1980. Gross farm receipts would increase 17 percent to $59.5 billion by 1980. According to our assumption, real production expenses rise in proportion to the quantity marketed (no production costs on diverted production), and are then inflated at the annual rate of 2 percent. These expenses would reach $48.6 billion by 1980. With production expenses rising faster than gross farm income, net farm income decreases 1.0 percent per year to $14.7 billion by 1980.

Estimates in table 6 also illustrate some weakness in the model. The deterministic simulation model used to generate the estimates is free of the random and often severe fluctuations which occur in agricultural production and export demand due to weather and other uncontrollable factors. Recent increases in prices paid by farmers exceed the annual 2.0 percent rate assumed in this paper. This aspect of adjustments in the farm economy needs additional research, and some recent estimates by the authors indicate that adjustments in the farm economy may be significantly affected by a higher rate of input-price inflation. Also, the kinds of aggregate adjustment patterns derived above need to be related to classes and types of farms by region. For example, it would be useful to know the impact of a 50 percent drop in net farm income on the viability of the commercial farm unit in 1980 in the different commodity sectors. Attention to these issues will increase the effectiveness of our model in analyzing public policies for dealing with excess capacity in agriculture and the ability of agriculture to adjust.

## Summary

Excess capacity in U.S. agriculture in recent years has averaged about 6 percent of potential output. In the

Table 6.–Estimated adjustment patterns of selected variables in the agricultural sector, 1969-80[a]

| Year | Index of prices received | Index of prices paid | Parity ratio | Quantity supplied | Quantity demanded | Government diversions | Gross farm receipts | Gross farm income | Production expenses | Net farm income |
|---|---|---|---|---|---|---|---|---|---|---|
| | *1910-14 = 100* | | | *Million 1969 dollars* | | | *Million current dollars* | | | |
| Continuation of present program (6 percen diversion): | | | | | | | | | | |
| 1969 | 275.00 | 373.00 | 73.73 | 54,181.72 | 50,803.92 | 3,377.80 | 50,803.92 | 54,597.92 | 38,063.82 | 16,534.10 |
| 1970 | 276.04 | 380.46 | 72.55 | 54,229.38 | 50,975.61 | 3,253.76 | 51,167.20 | 54,961.20 | 38,956.25 | 16,004.95 |
| 1971 | 282.03 | 388.07 | 72.68 | 54,251.86 | 50,996.75 | 3,255.11 | 52,300.15 | 56,094.15 | 39,751.85 | 16,342.30 |
| 1972 | 286.42 | 395.83 | 72.36 | 54,260.51 | 51,004.88 | 3,255.63 | 53,122.07 | 56,916.07 | 40,553.32 | 16,362.74 |
| 1973 | 288.37 | 403.75 | 71.42 | 54,400.35 | 51,136.32 | 3,264.02 | 53,622.00 | 57,416.00 | 41,470.99 | 15,945.00 |
| 1974 | 292.34 | 411.82 | 70.99 | 54,520.25 | 51,249.03 | 3,271.21 | 54,479.56 | 58,273.56 | 42,393.60 | 15,879.96 |
| 1975 | 295.75 | 420.06 | 70.41 | 54,660.13 | 51,380.52 | 3,279.61 | 55,256.34 | 59,050.34 | 43,352.41 | 15,697.93 |
| 1976 | 299.34 | 428.46 | 69.86 | 54,806.36 | 51,517.97 | 3,288.38 | 56,077.02 | 59,871.02 | 44,337.74 | 15,533.28 |
| 1977 | 302.91 | 437.03 | 69.31 | 54,960.79 | 51,663.14 | 3,297.65 | 56,905.64 | 60,699.64 | 45,351.91 | 15,347.73 |
| 1978 | 306.52 | 445.77 | 68.76 | 55,121.36 | 51,814.07 | 3,307.28 | 57,751.53 | 61,545.53 | 46,394.04 | 15,151.49 |
| 1979 | 310.15 | 454.68 | 68.21 | 55,287.30 | 51,970.07 | 3,317.24 | 58,612.09 | 62,406.09 | 47,464.40 | 14,941.69 |
| 1980 | 313.82 | 463.78 | 67.67 | 55,457.80 | 52,130.33 | 3,327.47 | 59,487.60 | 63,281.60 | 48,562.95 | 14,718.66 |
| Gradual elimination of diversions, free market by 1980: | | | | | | | | | | |
| 1969 | 275.00 | 373.00 | 73.73 | 54,181.72 | 50,803.92 | 3,377.80 | 50,803.92 | 54,597.92 | 38,063.82 | 16,534.10 |
| 1970 | 270.76 | 380.46 | 71.17 | 54,229.38 | 51,271.41 | 2,957.97 | 50,481.04 | 53,930.13 | 39,182.30 | 14,747.83 |
| 1971 | 276.85 | 388.07 | 71.34 | 54,147.34 | 51,489.19 | 2,658.14 | 51,835.62 | 54,939.80 | 40,135.71 | 14,804.09 |
| 1972 | 280.73 | 395.83 | 70.92 | 54,016.05 | 51,658.98 | 2,357.06 | 52,735.19 | 55,494.46 | 41,073.39 | 14,421.07 |
| 1973 | 280.72 | 403.75 | 69.53 | 54,077.29 | 52,012.52 | 2,064.77 | 53,093.27 | 55,507.63 | 42,181.57 | 13,326.06 |
| 1974 | 283.88 | 411.82 | 68.93 | 54,091.18 | 52,320.92 | 1,770.26 | 54,009.93 | 56,079.39 | 43,280.27 | 12,799.11 |
| 1975 | 286.16 | 420.06 | 68.12 | 54,124.43 | 52,648.30 | 1,476.12 | 54,784.41 | 56,508.95 | 44,422.10 | 12,086.85 |
| 1976 | 288.72 | 428.46 | 67.39 | 54,157.30 | 52,975.68 | 1,181.61 | 55,617.45 | 56,997.09 | 45,592.29 | 11,404.80 |
| 1977 | 291.22 | 437.03 | 66.64 | 54,194.66 | 53,307.84 | 886.82 | 56,451.12 | 57,485.84 | 46,795.68 | 10,690.16 |
| 1978 | 293.76 | 445.77 | 65.90 | 54,234.56 | 53,642.91 | 591.65 | 57,301.97 | 57,991.79 | 48,031.57 | 9,960.21 |
| 1979 | 296.32 | 454.68 | 65.17 | 54,277.03 | 53,980.97 | 296.06 | 58,165.70 | 58,510.61 | 49,300.96 | 9,209.64 |
| 1980 | 298.91 | 463.78 | 64.45 | 54,321.72 | 54,321.72 | 0.00 | 59,043.35 | 59,043.35 | 50,604.38 | 8,438.97 |
| Free market effective in 1970: | | | | | | | | | | |
| 1969 | 275.00 | 373.00 | 73.73 | 54,181.72 | 50,803.92 | 3,377.80 | 50,803.92 | 54,597.92 | 38,063.82 | 16,534.10 |
| 1970 | 224.59 | 380.46 | 59.03 | 54,229.38 | 54,229.38 | 0.00 | 44,288.39 | 44,288.39 | 41,442.82 | 2,845.57 |
| 1971 | 283.98 | 388.07 | 73.18 | 53,144.38 | 53,144.38 | 0.00 | 54,878.63 | 54,878.63 | 41,425.92 | 13,452.70 |
| 1972 | 272.02 | 395.83 | 68.72 | 53,317.55 | 53,317.55 | 0.00 | 52,739.98 | 52,739.98 | 42,392.11 | 10,347.88 |
| 1973 | 278.60 | 403.75 | 69.00 | 53,296.70 | 53,296.70 | 0.00 | 53,994.26 | 53,994.26 | 43,223.03 | 10,771.23 |
| 1974 | 286.19 | 411.82 | 69.49 | 53,092.41 | 53,092.41 | 0.00 | 55,253.02 | 55,253.02 | 43,918.46 | 11,334.56 |
| 1975 | 289.27 | 420.06 | 68.86 | 53,018.47 | 53,018.47 | 0.00 | 55,768.70 | 55,768.70 | 44,734.43 | 11,034.27 |
| 1976 | 288.55 | 428.46 | 67.35 | 53,245.26 | 53,245.26 | 0.00 | 55,868.54 | 55,868.54 | 45,824.29 | 10,044.24 |
| 1977 | 293.14 | 437.03 | 67.08 | 53,392.19 | 53,392.19 | 0.00 | 56,913.37 | 56,913.37 | 46,869.73 | 10,043.64 |
| 1978 | 296.25 | 445.77 | 66.46 | 53,566.43 | 53,566.43 | 0.00 | 57,705.58 | 57,705.58 | 47,963.09 | 9,742.49 |
| 1979 | 299.83 | 454.68 | 65.94 | 53,736.87 | 53,736.87 | 0.00 | 58,588.77 | 58,588.77 | 49,078.02 | 9,510.75 |
| 1980 | 303.32 | 463.78 | 65.40 | 53,911.88 | 53,911.88 | 0.00 | 59,463.75 | 59,463.75 | 50,222.58 | 9,241.17 |

[a]These estimates resulted from a −0.3 short-run and −0.1 long-run demand elasticity; a 0.1 short-run and 0.3 long-run supply elasticity for a decreasing parity ratio and a 0.15 short-run and 1.5 long-run elasticity for an increasing parity ratio; a 1.5 percent annual increase in demand and 1.0 annual increase in supply; and 2 percent annual input price inflation.

1960's, CCC stocks declined in every year except fiscal 1963 and 1969, and that part of exports attributed to excess capacity remained at approximately $700 million until decreasing to $429 million in 1969. Net declines in CCC stocks in recent years just about offset subsidized exports. Thus excess production, $3,378 million in 1969, is approximately equal to what would have been produced on land in Government land withdrawal programs.

We conclude, based on previous studies and on results of the simulation model used in this study, that the best available estimates of supply and demand parameters are: Supply elasticities, 0.10 in the short run and 0.80 in the long run for decreasing prices, and 0.15 in the short run and 1.5 in the long run for increasing prices; demand elasticities, of −0.3 in the short run and −1.0 in the long run; and annual average shifts in the supply and demand functions due to nonprice variables, 1.0 and 1.5 percent, respectively.

Within reasonable bounds of the above parameters, agriculture has the ability to remain economically viable during the 1970's under policies to divert from commercial markets about 6 percent of potential farm output coupled with direct payments of up to $4 billion annually. With prices paid increasing more rapidly than prices received, the quantity supplied tends to be restricted and thus net farm income decreases less through 1980 if the price elasticity of demand for farm products is under −0.3 in the short run and −1.0 in the long run. Returning to a free market immediately or gradually by 1980 would place severe financial strain and adjustment pressure on the farm sector. A one-shot return to a free market, if it had occurred in 1970, would find a less depressed agriculture by 1980 than would a gradual return to a free market. But the severe short-run impact of the one-shot return seems to rule it out as an acceptable policy alternative.

Given the supply and demand parameters specified above and a continued policy to divert about 6 percent of potential production, the parity ratio would fall 6 points by 1980 and net farm income would decrease to $14.7 billion, compared with $16.5 billion in 1969. A gradual return to a free market would result in a 4.8 percent reduction in the parity ratio relative to 1969 and net farm income would decrease about 50 percent to $8.4 billion in 1980. Net farm income would be $6.3 billion less by 1980 under a gradual return to a free market than under a continuation of the present program.

It is beyond the scope of this paper to analyze adjustments by commodity groups and regions. The aggregate analysis reported herein provides useful insights only into the economic viability of the farming industry. While analysis of commodity sectors and regions would be desirable, opportunities for substitution permit at least short-run disparities in the economic health of one sector or another without any real insight into the economic health of the aggregate as reported in this paper.

Knowledge of the overall economic health of the farm industry is vital for policy planning. Two general approaches may be used to gain needed information. One is the aggregative approach used in this paper. A second is a disaggregate approach, building aggregate estimates up from studies of component crop and livestock sectors. Inability to quantify substantial opportunities for substitution among commodities in production and consumption preclude realistic aggregate results from micro studies. On the other hand, it may be feasible to anchor microeconomic projections in the aggregative projections of this study. An analysis of adjustments over time by commodity group, region, and farm class would clearly be desirable and a logical extension of the aggregate estimates contained in this study.

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## Footnotes

[1]Italic numbers in parentheses indicate items in the References.

[2]Socially acceptable prices here refer to prices farmers receive for farm-produced commodities. They are generally market or Government support prices but also could be defined to include Government direct payments to farmers.

[3]This definition of, and technique for measuring, excess capacity does have some shortcomings. First, data on some diversions of the kind included in this definition are unavailable or insufficient to include in our estimates. Second, farmers' inability to organize production at the optimal level and least-cost combination of production inputs is another kind of excess capacity. Tyner and Tweeten (7) estimate that this latter type of excess capacity is approximately equal in dollar value to excess output. But excess capacity due to less than optimal resource combination is internal to agriculture and would be present, perhaps even to a greater extent, in the absence of Government programs. Thus excess capacity, as estimated in this study, is an adequate and operational measure of the farm sector's ability to adjust to changing economic conditions with and without Government programs.

[4]The aggregate supply elasticity reflects adjustments of livestock and crops to changes in prices received by farmers. The slow adjustment for livestock largely explains the greater magnitude of the elasticity in the long run than the short run. An alternative approach to that used in this study would be to estimate crop and livestock excess capacity separately and apply respective elasticities. To determine aggregate effects, cross elasticities could be used to bring the sectors together. We rejected this approach because cross elasticities have never been estimated with acceptable reliability, and we have more confidence in estimates of the aggregate elasticities than in individual crop and livestock components.

[5]The supply and demand functions are linear in logarithms. For the supply function, (1), $Q_t$ is the quantity supplied in year $t$. $a_s$ is the supply constant. $(P/P_d)_{t-1}$ is the price $P$ received by farmers, deflated by the price $P_d$ paid by famers for production inputs in year $t$-1. $\beta_s$ is the short-run supply elasticity. The coefficient $(1-\delta_s)$ of the quantity supplied in year $t$-1 specifies an adjustment rate $\delta_s$, where the long-run supply elasticity is equal to $\beta_s/\delta_s$. The exponent $g_s(1-\delta_s+\delta_s T)$ for the base of the natural logarithm (2.718) is required to maintain a constant shift in supply over the short- and long-run adjustments to time, $T$. Coefficient $g_s$ is the annual percentage increase in the quantity supplied due to nonprice variables.

The demand function, transposed in (2) to make $P$ the dependent variable, is specified similarly to the supply function with corresponding parameters subscripted with a $d$ to denote demand.

[6]Using data from the Farm Income Situation, marketings net of interfarm sales are deflated by the index of prices received by farmers and production expenses net of interfarm sales are deflated by the index of prices by farmers. The resulting ratio of real production expenses to real marketings actually decreased from 0.67 in 1951 to 0.57 in 1969. Thus, the historical increase in production expenses was due to output expansion and input-price inflation, and not to increases in real purchased inputs relative to real marketings.

[7]Interfarm sales are assumed to equal 25 percent of purchased seed plus 50 percent of purchased feed plus 75 percent of purchased livestock. In 1969, interfarm sales amounted to $6,621 million, realized gross farm income excluding Government payments totaled $50,804 million, Government payments were $3,794 million, and production expenses were $38,064 million. Net farm income, equal to gross farm income including Government payments minus production expenses, was $16,534 million (*11*, p. 44).

[8]The results apply more generally to a situation in which the shift to the right in demand exceeds that of supply by 0.5 percentage point annually. The demand and supply parameters specified above were the most reasonable choices, based on results from previous studies in which a wide range of estimates were considered. Also, these parameters provide the most reasonable set of outcomes in results of the simulation model reported herein.