PART III

Adjustments Related to Structure

Chapter 7

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The Structure of Agriculture*

SURPLUS production and associated income and resource difficulties which stem from a structural imbalance in agriculture currently constitute our major adjustment problem. The magnitude of the adjustment required depends upon the structural characteristics of agricultural demand and supply. The questions to be examined are: What are the magnitudes of the short-run elasticity coefficients for the supply and demand functions, quantities which are important in determining the intensity of the income and resource adjustment problem over short periods? Over longer periods of time will expanding production continue to outpace the growth of demand, causing a continued problem of imbalance; or, as some people suggest, will population growth offset output potential and restore more favorable incomes in agriculture? What quantities of products, resources, and farms are consistent with the volume of farm production likely to be demanded over the next decade?

The quantitative estimates of this chapter, contributed jointly from two different research undertakings, shed some light on these questions and on other relationships which are important for the adjustment problem. It is believed that the methods utilized in the two studies will be of signal interest to any future analysis of adjustment to the structural characteristics of agriculture. The first paper develops the present economic structure of agriculture and indicates how a knowledge of this structure might be used in the process of adjustment. The second paper builds a structure for agriculture in 1965 based upon certain assumptions and interrelated projections of demand factors, input requirements, and technology changes. On the basis of this structure, estimates of an equilibrium of production and consumption are made for various agricultural commodities. This second paper attempts to throw some light on the direction, size, and nature of the necessary adjustment to structural change to attain an equilibrium of production and consumption in 1965.

A SHORT RUN MODEL[1]

A knowledge of the forces which generate demands, supplies, and

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[1]This section is by William A. Cromarty. A more complete analysis is available in Cromarty, William A., "Economic structure in American agriculture," Michigan State University unpublished Ph.D. dissertation, 1957.

prices within agriculture is necessary if the effects of alternative adjustment policies are to be observed and understood. For example, what are the effects of substituting factors in production or products in consumption, of changing price support programs, of technological development, or of varying factors which are external to agriculture such as wages, income, or marketing costs? We do have some knowledge of the effects, much of it being qualitative and a lesser amount quantitative.

The object of this paper is to present some additional empirical results on the major macrorelationships existing within agriculture and between agriculture and the remainder of the economy. The relationships are termed macro since they are concerned with national data as compared with the individual farm, and are termed major since only the more important relationships are considered for the most important commodities. The procedure followed is to disaggregate agriculture into twelve product categories of which the first eleven have somewhat homogeneous demand and supply conditions while the last one is a miscellaneous category. Supply and demand functions are developed for each category with significant interactions between categories being permitted to exert their influence.

The categories are:

1. Feed grains (corn, oats, barley, sorghum)
2. Dairy products
3. Beef cattle
4. Hogs
5. Eggs
6. Poultry meats
7. Wheat
8. Soybeans
9. Cotton
10. Tobacco
11. Vegetables
12. Miscellaneous

Observations on these product categories are fitted for the 1929-53 period, using crop years for all crops and calendar years for all livestock products. The method of estimation varies between categories, but in general, limited information maximum likelihood estimates (LISE) are obtained for all relations except for the supply functions of crops for which single equation, least squares (LS) estimates are made. The total model, or system of equations, is formed from thirty-five structural equations plus several identities. The data are represented by time series on one hundred and ten variables.

In general, for each product category one supply relation is estimated. By contrast, several demand outlets may be considered covering commercial, government, and inventory demands. Quantities exported are treated independently of the model. In order to observe some of the major interactions between the demands and supplies of related commodities the first six product categories are fitted simultaneously as a subsystem. This represents the feed-livestock sector of agriculture. The remaining five product categories are fitted as independent subsystems.

The estimated prices and production for each product category may be aggregated to develop indexes of prices received by farmers and physical production. They may also be used to develop estimates of gross farm income for each category and for agriculture in total. Because production inputs are not available by product categories, production expenses and consequently net farm income cannot be estimated by product categories. However, aggregate production expenses may be estimated and subtracted from aggregate gross farm income to derive an estimate of net farm income.

Supply Relationships

In all cases the estimated supply relations represent behavioral rather than technological functions. For lack of space each particular relation is not expressed explicitly but the general procedure followed is presented. In the case of crops an attempt is made to include: (1) the effects of price expectations as measured by lagged product prices, (2) the prices of alternative crops, (3) costs of items used in production, (4) weather, by including critical climatic factors, or unharvested acreages if no single climatic factor can be distinguished, and (5) technological advances as measured by physical units of equipment or changing cultural practices. For the non-crop product categories the supply relations attempt to measure the effects of: (1) costs of items used in production, (2) the level of fixed assets, (3) price expectations as measured by lagged product prices, and (4) in some cases technological improvements. For the technology and weather variables the data used are inadequate but are better than complete omission or oversimplification which accompanies the use of a linear time trend.

Price elasticities of supply are presented in Table 7.1. The relevant prices are indicated in column (2). In the case of cotton, flue cured tobacco, and burley tobacco, the relevant price is assumed to be whichever is higher, the market price for the previous year or the announced

Table 7.1. Estimates of Price Elasticities of Supply

(1) Product category	(2) Relevant price	(3) Elasticity
Feed grains	ratio feed grains to wheat lagged one year	.364
Beef cattle	current price beef	.037
Dairy products	current price milk	.212
Hogs	current price hogs	.130
Eggs	price eggs for December of previous year	.298
Poultry meat	price broilers lagged one year	.678
Wheat	ratio wheat to feed grains, weighted average of previous three years	.129
Soybeans	price soybeans lagged one year	.171
Cotton	price cotton lagged one year	.361
Flue tobacco	price flue tobacco lagged one year	.516
Burley tobacco	price burley tobacco lagged one year	.381
Fresh vegetables	price fresh vegetables lagged one year	.316
Processed vegetables	price processed vegetables lagged one year	.416

support price for the current year. The price elasticity for soybeans is too low relative to other commodities, and this may be due to the rapidly changing structure of soybean production. It is also recognized that the responsiveness of beef production to prices of a previous time period has not been captured in the supply elasticity.

Demand Relationships

When appropriate, in each product category three distinct but interrelated demand outlets have been considered. These are termed commercial demand, inventory demand, and government demand. The technique of simultaneously estimating the demand relations permits observation of interactions between demands.

Commercial Demand. Commercial demand is defined as the quantities of commodities consumed by persons or industries in the private sector of the economy. In general, the demand relation associates the quantity taken with: (1) the current price of the product, (2) prices of close substitutes, (3) a measure of marketing charges, (4) per capita disposable income, (5) the general price level, and (6) in some cases, a time trend to remove some of the effects of changing tastes. The demand relations are unique in the sense that data on income and the price level are not observable but are built up by solving a more aggregative model[2] of the national economy. In this way a series of multipliers may be constructed to observe how the effects of changes in the nonagricultural sector (e.g., in wages, profits, tax structure) may be transmitted to the agricultural sector. As an alternative to presenting the complete system of commercial demand equations, elasticities of demand or price flexibilities are presented in Table 7.2.

Table 7.2. Elasticities and Flexibilities of Commercial Demand

Product category (1)	Price elasticity (2)	Income elasticity (3)	Price flexibility of demand (4)	Price flexibility of income (5)
Beef cattle			-1.329	.311
Dairy product			-1.484	.782
Hogs			- .422	.038
Eggs			- .965	1.409
Poultry meat			- .288	.395
Wheat	- .518	1.426		
Cotton	- .300	.953		
Flue tobacco	-5.759	2.678		
Burley tobacco	-1.325	.767		
Fresh vegetables			- .586	1.684
Processed vegetables			- .175	1.510

[2]Klein, L. R., and Goldberger, A. S., An Econometric Model of the United States, 1929-53, North Holland Publishing Co., Amsterdam, 1955.

Price and income elasticities are rather well known concepts. Price flexibility of demand is the ratio of the percentage change in price to the associated percentage change in consumption, and is estimated for those categories in which price rather than quantity is considered to be the "dependent" variable. (The reciprocal of this relationship does not equal the price elasticity of demand since, in assuming an equality between production and consumption for the livestock and vegetable categories, inventory changes are not considered). Price flexibility of income is the ratio of the percentage change in price to the associated percentage change in income and is estimated for those product categories in which price, rather than quantity, is considered as the "dependent" variable.

Inventory Demand. For the feed grains, wheat, and cotton product categories, estimates are made of the quantities carried over by the private sector at the end of the crop year. Naive relationships are established basing the carry-over on current prices, production, crop prospects for the wheat category, and foreign supply in the case of cotton. The price elasticities of demand for storage are presented in Table 7.3. In the case of feed grains and cotton they fall slightly below the commercial demand elasticities while for wheat they are slightly above.

Government Demand. Government demand is considered to be the amount of a commodity moving under loan or purchase agreement programs. Wheat, feed grains, cotton, flue cured and burley tobaccos represent the product categories covered. In each case the hypothesis used is to express government demand as a function of the difference between the support price and what the market price would be in the absence of government programs.[3] Since this latter price is an hypothetical one, being determined by demand and supply conditions where government operations do not exist, it cannot be measured directly; hence, it is estimated in terms of observable variables.

The validity of such estimates as those given above may be tested only by making forecasts and checking them against subsequently observable values. For the present, elasticities based upon such empirical results can be computed as a test of consistency with observed situations. For the above relationships, elasticities relating government demand to the supply of the crop and the price support level are computed in Table 7.4.

The validity of such elasticities is unknown since similar independent estimates are not available for comparison. However, in all cases the amount of a commodity moving under loan appears to be sensitive to changes in price support levels and production.

An Application of the Model

The fact that interactions between categories are permitted in the

[3]This method is discussed in the following two publications: Hathaway, D. E., "Effects of the price support program on the dry bean industry in Michigan," Mich. Agr. Exp. Sta. Tech. Bul. 250, 1955; Johnson, G. L., "Burley tobacco control programs," Ky. Agr. Exp. Sta. Bul. 580, 1952.

Table 7.3. Price Elasticities of Demand for Storage

Product category	Elasticity based upon current prices
Wheat	- .601
Feed grains	-1.776
Cotton	- .211

The estimated structural relations which measure some of the factors influencing the amount of a commodity moving under loan programs are given below for the feed grains, wheat, cotton, and burley tobacco product categories. The estimated standard errors appear in parentheses.

Feed grains

$$(1.1)\quad Y_{24} = 1327 + \underset{(.483)}{1.686Z_{26}} - \underset{(.336)}{.0335Y_{32}} - \underset{(4.221)}{8.434Y_{42}} - \underset{(.464)}{.184Y_{52}} + \underset{(1.054)}{1.160Z_{25}} + \underset{(.955)}{.796Z_{21}}$$

Wheat

$$(1.2)\quad Y_{17} = -585 + \underset{(.180)}{.474Y_{11}^{*}} + \underset{(.151)}{.107Y_{21}} + \underset{(.211)}{.386Z_{49}} - \underset{(.304)}{.650Z_{41}} - \underset{(3.278)}{.603Z_{36}} + \underset{(1.252)}{2.799Z_{16}}$$

Cotton

$$(1.3)\quad Y_{97} = -7021 + \underset{(.149)}{.610Y_{91}^{*}} + \underset{(1.423)}{1.60Z_{95}^{*}} + \underset{(3.601)}{1.310Z_{99}} + \underset{(12.769)}{18.576Z_{98}} + \underset{(4.998)}{1.079Z_{41}} - \underset{(4.063)}{8.032Z_{36}}$$

Burley tobacco

$$(1.4)\quad Y_{11,4} = -314 + \underset{(.129)}{.791Y_{11,1}} - \underset{(.073)}{.199Z_{41}} + \underset{(.198)}{.610Z_{11,12}} + \underset{(.146)}{.183Z_{11,3}}$$

Definition of variables

Y_{24} = CCC loans and purchases of feed grains
Z_{26} = average support price for corn
Y_{32} = price of beef cattle
Y_{42} = price of milk
Y_{52} = price of hogs
Z_{25} = number of animal units fed beginning October 1 of previous year
Z_{21} = available supply of feed grains
Y_{17} = CCC loans and purchases of wheat
Y_{11}^{*} = available supply of wheat
Y_{21} = production of feed grains
Z_{49} = average hourly marketing charges for food products
Z_{41} = per capita disposable income
Z_{36} = general price level index for United States
Z_{16} = national average support price for wheat
Y_{97} = quantity of cotton placed under loan programs
Y_{91}^{*} = total supply of cotton
Z_{95}^{*} = supply of cotton outside U.S.A.
Z_{99} = production of synthetic fibers
Z_{98} = national average support price for cotton
$Y_{11,4}$ = quantity of burley tobacco pledged for loans
$Y_{11,1}$ = current burley production
$Z_{11,12}$ = burley manufacturers' ratio of stocks to disappearance
$Z_{11,3}$ = national average support price for burley tobacco

Table 7.4. Elasticities for Government Demand

Product category	Elasticity based upon supply	Elasticity based upon support price
Feed grains	4.535	5.934
Wheat	30.050	3.677
Cotton	4.005	1.252
Burley tobacco	11.809	1.553

estimating process increases the usefulness of the model in tracing the effects of internal or external shocks which the system might receive. An example of such a shock is traced using the elasticities computed in the previous sections.

Suppose that in year t the price of feed grains increases 10 percent. Based upon the estimated elasticity of supply production would, ceteris paribus, increase 3.62 percent in year t + 1. This increase in supply would be utilized in one of the three demand outlets — commercial, inventory, or government. In looking at the livestock sector a 3.62 percent increase in the supply of feed grains would cause a .49 percent increase in hog production and a .83 percent increase in beef cattle slaughterings. The meat production increases would, in turn, cause a .21 and 1.10 percent decline in the respective prices of hogs and beef. The decline in beef and hog prices would decrease the demand for feed grains an estimated .07 percent, which would cause the total supply of feed grains to increase 3.7, rather than 3.6 percent. The 3.7 percent increase in supply would now be allocated to inventory and government demands. Based upon the computed elasticities for these demand relations, inventory demand would increase 1.0 percent, while the remaining feed grains would increase government demand by 16.7 percent. A 10 percent increase in feed grain prices and its consequent production increase would cause little change in commercial or inventory while government demand would increase by approximately 17 percent.

A second example of the usefulness of the model is presented by tracing through the system the effects of a 10 percent increase in the announced support price of burley tobacco when the support price is the relevant price upon which producers act. Based upon a supply elasticity of .529, production would increase 5.29 percent. (Under an established acreage allotment program the elasticity may be high since the total production increase must come for increased yields per acre).

It is estimated that the market price for burley would decline .89 percent, and this would increase the commercial demand for burley by 1.19 percent. The net increase in supply would thus amount to approximately 4.10 percent, and this would be absorbed by increasing government demand. Based upon the demand elasticity given in Table 7.4, government demand would increase 48.4 percent.

The above examples illustrate the usefulness of the model for a relatively short period. If the model is to be applied to longer time periods, then the flow of resources between the agricultural and nonagricultural sectors of the economy must be given more emphasis. At this stage such flows are not assumed to be very effective in changing resource use for a one or two-year time period.

A LONG RUN MODEL: ECONOMIC ADJUSTMENT TO A DECADE OF STRUCTURAL CHANGE, 1955-1965[4]

The model constructed in this study estimates output and consumption for American agriculture in 1965. The estimates are based upon an effort to measure and project a limited number of structural changes of primary importance to the long-run future of agriculture. Such structural changes include the land-use pattern, livestock inventories, technology, population, and per capita consumption, as well as a number of structural changes in the general economy, which are also assumed or projected. The major emphasis of the study, however, is on the effort to estimate the impact of technological change upon the supply side of the model.

The model-building procedure has three distinct stages: (1) In stage one tentative production and consumption projections are made independently of each other for 32 commodity categories. Only a few commodities involving major surplus problems are presented here. The basic structural changes in agriculture are determined in this stage and provide the basis of the output and consumption projections. (2) In stage two, the imbalances implied in the independent projection of production and consumption are analyzed, and an equilibrium estimate of production, price, and consumption is formed. Available research reports on individual commodity demand and supply response are used in resolving the imbalance between the tentative projections of production and consumption. The degree of pressure which various structural changes exert on an equilibrium are determined at this stage. (3) In the final stage of analysis, individual commodity equilibriums are aggregated to obtain estimates for "all farm products" and portions of "all farm products" such as "all food products," "livestock products," and "fats and oils." Structural interrelationships of commodities with high substitution possibilities and groupings of these commodities are analyzed for consistency in the aggregation process.

Stage One: Tentative Demand Projection

In analyzing the relationship between output and consumption in 1965, let us look first at the tentative projection of demand. We need to know: (1) the assumptions upon which the projection is based and (2) the

[4]This section is by James T. Bonnen. It is in the process of revision in order to allow the use of more recent and final data from the USDA. The revised and complete model, "A Balanced United States Agriculture in 1965," by James T. Bonnen and John D. Black will be published by the National Planning Association.

method of projecting structural changes in demand to 1965. The assumptions and the immediately related projections which are used for the subsequent analysis are as follows:

	1955[5]	1965
1. Population (millions)	165.3	190.3[7]
2. Total labor force (millions)	68.9	79.2[8]
3. Armed forces (millions)	3.0	3.0[9]
4. Work week (hours)	39.8[6]	38.0[10]
5. Growth in GNP man-hour over the decade (percent per annum) = 2.5		
6. Gross National Product (billions)	390.9	550.4
7. GNP per capita (dollars)	2364.8	2892.3

8. It is assumed that no major war will occur over the decade, but that present international tensions will continue.
9. A continued high level of economic activity is assumed. In short, we assume that fluctuations in the business cycle will not be great enough to cause unemployment of more than 4 percent of civilian labor force.
10. No change in the basic tax structure and no rationing or government allocation of materials is assumed.
11. The price and production base assumed is that of 1955. The economy on balance did not exhibit any appreciable inflation or deflation over this year, although prices of agricultural products continued the decline which began in early 1951.

The consumption projected for individual commodities is actually the product of two projections, population and per capita consumption. The Bureau of the Census population projection "A" of a population of 190 million for 1965 is accepted for this purpose.[11] For per capita consumption three hypothetical rates are projected within the framework of our assumptions as to per capita income and prices:

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[5]Except as noted, for historical data, see "The economic report of the President," Council of Economic Advisors, Washington, D. C., Jan. 23, 1957, pp. 126, 140.

[6]An average of the monthly data reported in Current Population Reports, Bureau of the Census, Series P-57, Nos. 151-62, but adjusted by the technique outlined by Gerhard Colm in "The American economy in 1960," Planning Pamphlet No. 81, National Planning Association, Washington, D. C., Dec., 1952, p. 119.

[7]Zitter, Meyer, "Revised projections of the population of the United States, by age and sex: 1960 to 1975," Current Population Reports, Bureau of the Census, Series P-25, No. 123, Oct., 1955.

[8]Bancroft, Gertrude, "Projections of the labor force in the United States, 1955 to 1957," Current Population Reports, Bureau of the Census, Series P-50, No. 69, Oct., 1956.

[9]Projected on the basis of assumed world conditions and manpower expectations.

[10]Assumes a continuation of the linear trend from the period 1945-55.

[11]Current Population Reports, Series P-25, No. 123, Oct., 1955.

1. The historical rate of change in per capita consumption (allowing for changes in real income and prices) is projected to 1965 from the period 1925-55.

2. In many instances clear changes occur in the time trend after 1925. The consumption pattern of many commodities shifted in the late 1930's and of others in the later 1940's. These shorter and more recent trends are projected to 1965.

3. A zero rate of change in per capita consumption is projected.

On the basis of the present study, historical data, and other available analyses of changes in consumption for particular farm products, subjective probabilities are attached to the consumption projections and to the intervening ranges between to form a distribution of probabilities. Thus, the result is a tentative, "most probable" projection of consumption.

Stage One: Tentative Supply Projection

The tentative projection of supply is based on the assumptions and related projections which follow:

1. Average weather conditions are assumed.

2. Existing "excess" stocks are assumed to be liquidated by 1965. Ultimate arbitrariness cannot be avoided in allowing for "excess" stocks in either definition of "excess," in the economic process of disposal, or in its timing; consequently, the assumption is selected for its simplicity. Adjustments for more complex assumptions can be applied to the final model, if desired.

3. The calendar year of 1955 is again used for the price and production base.

4. The agricultural labor force is projected from 6.7 million (census series) in 1955 to 5.2 million persons in 1965. This projection is made on the basis of trends in the relationship of the agricultural labor force to a total population, farm population, and to population and labor force composition. The assumptions of full employment and absence of major wars and certain data on technological change also condition this projection.

5. Some preliminary assumptions are made for land use and livestock numbers in the first stage of the analysis, while production is handled as the only major dependent variable. For this purpose the 1965 trend value of land use and livestock numbers is used where a fairly clear long-run pattern of change is exhibited. For commodities where no clear pattern of change is evident, an average of the post-World War II years is assumed during the first stage of the analysis for 1965. The land-use pattern and livestock inventory are freed from the first stage assumptions and are treated as dependent variables in the second stage of the analysis.

The production for individual commodities is the product of a number of projections. The production projections for crops are constructed from harvested acreage and yield projections. Output projections for livestock include some measure of the number of head in inventory, the efficiency of feed utilization, and the average live weight produced per head. (Some particular livestock items are, for obvious reasons, projected in different form. In hog production, for instance, changes in technology have been related in different ways to live weight produced per pig saved, the number of pigs saved per litter, the number of sows farrowing, and the efficiency of feed utilization. Consequently, all of these production variables are projected to 1965.)

One of the primary goals of this study is to measure and project the impact of technological change upon each commodity. No satisfactory single index of technological change exists for either livestock or crops, nor has a single index of technological change as such been constructed here; but rather a procedure was developed for measuring the impact of technological change on the major structural production characteristics which are being projected.

Estimates of the potential impact of technological change upon yield, inventory, and output were constructed for each crop and livestock product on the basis of data from the following sources:

1. Scientists at the Beltsville Agricultural Experimental Station. These scientists provided detailed evaluations of the impact of current research-in-progress and research completed in the last few years on crop yields, labor, capital, and land inputs for individual commodities; livestock output per animal, livestock efficiency of feed utilization, and labor, capital, and land inputs for individual livestock enterprises. The most complete and reliable evaluations concerned crop yields, livestock output per animal, and the efficiency of feed utilization. The scientists were asked to inventory anticipated innovations and to evaluate the impact of the individual innovations as well as their effect in sum. For crops they were asked to express in two forms their evaluation of a changing technology's impact on yields: (a) an estimate of capacity or highest yield possible under optimum physical conditions and (b) an estimate of what yield would probably be realized considering problems of adjustment. For livestock the evaluations centered around the efficiency of feed utilization and output per animal, and the estimates, as with crops, were framed in two forms: (a) an estimate of capacity or an optimal conditions estimate and (b) an estimate of the impact considering the problems of adjustment. This process of evaluation of the impact of technology was repeated in the USDA with agricultural economists who are commodity specialists. The process was repeated for confirmation of the reasonableness of the technological expectations and to insure the consistency of the estimates with the economic assumptions of the model.

2. Yields of experimental research collected from the experiment station publications of the various states. The yields were identified

in time sequence and used as timed optimum capacity statements. These were compared with an adjusted series of realized yields, and the implied historical rates of adaptation to potential capacity were applied to provide a check on the quantitative evaluations which the crop and livestock specialists provided. Where evidence conflicted, the more objective measure, yields of experimental research, was usually used.

3. The Land Grant College — USDA cooperative productivity committee projections of 1950 and 1955 production and yield possibilities. These projections provide implicit evaluations of change in technological capacity and the rates of adaptation to available technology. The estimates are published in detail by individual states. United States and regional aggregates are published by the USDA.[12]

4. Information from individual evaluations of the impact of current research-in-progress from the state agricultural experiment stations over the United States.

Since something not in existence cannot be evaluated, even as an idea, projections based on technological change are limited to "all known and almost known technology." By "almost known" technology is meant that research now in progress which is clearly coming to fruition.

Assumed land-use patterns and projected yields provide the tentative projections of crop production. For livestock, assumed inventories, projected efficiencies of feed utilization, and the average live weight produced per animal provide the tentative production projections.

Stage Two: Resolution of Projected Structural Imbalances

When consumption and production projections are made independently of each other, the quantitative results rarely balance. Stage two of the analysis compares these preliminary projections of production and consumption and resolves the resulting imbalances. At this point two previously posited assumptions are discarded. The assumption of constant relative prices for the different products is dropped, and the degree of pressure that the projected imbalance exerts on the price of the commodity is evaluated. The land-use pattern and livestock inventories assumed in stage one are also dropped. It is to be noted that the imbalances are resolved (the equilibrium is estimated) on the basis of an additional assumption: namely, that the controls and administrative action which are necessary to attain an equilibrium are undertaken, are in general accepted by farmers and farm organizations, and are effective. This is an heroic, if not totally unrealistic, assumption in the light of agricultural policy experience over the past three decades. However, the reason for analyzing 1965 agriculture in terms of an

[12] "Peacetime adjustments in farming: possibilities under prosperity conditions," Misc. Publ. No. 595, USDA, Washington, D. C., Dec., 1945; and for 1955 see "Agriculture's capacity to produce," Agr. Inf. Bul. No. 88, USDA, Washington, D. C., June, 1952.

equilibrium of production and consumption is that equilibrium is the publicly stated and continuing rational goal of national agricultural policy and is a goal of major importance in an era of chronic production surplus.

The available empirical material on the demand and supply response characteristics of specific commodities is used in the resolution of projected imbalances. This empirical material provides an additional basis for judging the probabilities of various solutions. With some commodities the imbalance can be evaluated in terms of price elasticities of demand and of supply. A base year "demand-supply response ratio" can be computed from available empirical estimates of elasticity.[13] The impact of major structural changes upon this "response ratio" is estimated to obtain the "demand-supply response ratio" for 1965. This study's final results are not the product of a completely rigorous model. Indeed, they cannot be, considering the nature of the problem faced.

Stage Three: Aggregation

Aggregates of production and consumption are constructed from the individual product equilibriums. Indices are constructed with production value weights obtained by applying 1955 prices to the sum of 1954 and 1955 production. Production for both 1954 and 1955 is used to average out single year departures from normal production. The individual commodity balance from stage two is not necessarily the final one; commodities with high substitution possibilities (e.g., edible oils) are aggregated, a balance of production and consumption is determined, and commodity interrelationships are checked for consistency and reasonability. The final balance or equilibrium includes many of the feedbacks and

Table 7.5. Wheat Situation

	1955	1965	Percent change
Acreage harvested (thousands)	47,285	44,100	- 6.7
Yield (bu./acre)	19.8	20	+ 1.01
Production (thousand bu.)	934,731	882,000	- 5.6
Average price ($/bu.)	2.02	1.60 to 1.70	-18.3
Annual surplus (thousand bu.)	61,731	None	
Total consumption (thousand bu.)	873,000	882,000	+ 1.03
Domestic civilian	471,000	467,000	- 0.58
Military	9,000	10,000	+11.1
Non-food and seed	116,000	130,000	+12.1
Export	277,000	275,000	- 0.7
Lbs. per capita domestic consumption	172	150	-12.8

[13]Demand-supply response ratio = $\frac{\text{price elasticity of supply}}{\text{price elasticity of demand}}$

direct interrelationships which condition the actual process of demand-supply equilibration. This procedure provides a check on products with high substitution possibilities, and it frequently results in revision of individual product equilibriums. This model does not simply cut off the production projection at the point where it equals the projected level of consumption, as do most projections for future time horizons.

Table 7.6. Feed Grains Situation
(Corn, Oats, Barley, Sorghum)

	1955	1965	Percent change
Acreage harvested (million acres)	146	128	-12.3
Yield (tons/acre)	.89	1.05	+17.9
Production (million tons)	130.2	134	+ 2.9
Produced for grain (million tons)	120.7	123.4	+ 2.2
Average price ($/ton)	44.67	42.7 to 46.7	0.0
Annual surplus (million tons)	8.5	None	
Total consumption (million tons)	112.2	123.4	+10.0
Food use	4.6	4.9	+ 6.5
Nonfood use	102.6	113.5	+10.6
Exports	5.0	5.0	0.0

Empirical Results of the Model

Final equilibrium estimates of production, consumption, prices, and acreage harvested are presented for a number of commodities with serious surplus difficulties (Tables 7.5-7.8).

Table 7.7. Cotton Situation

	1955	1965	Percent change
Acres harvested (thousands)	16,928	11,584	-31.6
Yield (lb. lint/acre)	417	480	+15.1
Production (thousand bales)	14,721	11,584	-21.3
Average price ($/lb.)	.3217	.26 to .29	-14.5
Annual surplus (thousand bales)	3,290	None	
Total consumption (thousand bales)	11,431	11,704	+ 2.4
Mill consumption	9,202	8,704	- 5.4
Net exports	2,229	3,000	+34.6
Net imports	140	120	-14.3
Lbs. per capita consumption	26.5	22	-17.0

Table 7.8. Tobacco Situation

	1955	1965	Percent change
Acres harvested (thousands)	1,494	1,115	-25.4
Yield (lbs./acre)	1,467	1,650	+12.5
Production (million lbs.)	2,193	1,839	-16.1
Average price ($/lb.)	.51	.44 to .46	-11.8
Annual surplus (million lbs.)	258	None	
Total consumption (million lbs.)	2,055	1,969	- 4.2
Domestic	1,408	1,469	+ 4.3
Exports	647	500	-22.7
Imports	120	130	+ 8.3
Lbs. per capita consumption (for persons 15 yrs. and over)	11.9	11	- 7.6

The input resource flows for land and labor have been quantified and are presented in Tables 7.9-7.11. Note the flow of resources between farm and nonfarm economies.

Table 7.9. United States Land by Uses (Millions of Acres)

Land use	1950[a]	1955[b]	1965	Percent change between 1955 and 1965
Land in farms				
Cropland	409	399	366	- 8.3
Cropland used for pasture	70	66	80	+21.2
Open pasture and graze	415	460	497	+ 8.0
Woodland pastured	135	121	145	+19.8
Woodlands not pastured	85	76	90	+18.4
Other uses	45	36	30	-16.7
Total	1,159	1,158	1,208	+ 4.3
Land not in farms				
Grassland pasture and graze	215	173	165	- 4.6
Woodland pastured	185	180	160	-11.1
Woodlands not pastured	201	238	210	-11.8
Other uses	144	155	161	+ 3.9
Total	745	746	696	- 6.7
Total land area of U. S.	1,904	1,904	1,904	0.0

[a] "Agricultural statistics, 1953," USDA, Washington, D. C., 1953, p. 550, and Supplement to "Major uses of land in the United States," USDA, Washington, D. C., Sept., 1953, pp. 61-62.

[b] "Major uses of land in the United States, summary for 1954," Agr. Inf. Bul. No. 168, USDA, Washington, D.C., Jan., 1957, p. 5.

The net farm-nonfarm transfer of land results in a slight increase in the total land area in farms. The farm land increase occurs in woodlands and pasture, while the amount of cropland declines. As might be expected, changing composition of labor force involves a continued increase in nonfarm labor force and a decline in agricultural labor force. Farm labor force declines from 10.2 percent of total civilian labor force in 1955 to 6.8 percent by 1965.

Table 7.10. Harvested Crop Acreage Adjustment for a 1965 Equilibrium
(thousands of acres)

Crops	1950[a]	1955	1965	Acre change 1955 to 1965[b]
Wheat	61,610	47,285	44,100	- 3,185
Feed grains	144,038	146,203	128,000	-18,203
Cotton	17,843	16,928	11,584	- 5,344
Tobacco	1,599	1,494	1,115	- 379
Total	225,090	211,910	184,799	-27,111
Other crops	115,756	124,490	124,201	- 289
Total harvested acreage	340,846	336,400	309,000	-27,400

[a]The 1950 data are from Agricultural Statistics, 1954, USDA, Washington, D.C., 1954, p. 443. The 1955 data are from "Crop Production, 1956 Annual Summary," USDA, Washington, D.C., Dec. 1956, pp. 3-4.
[b]Average quality land.

The model provides no direct basis for estimating aggregative capital flows, either within agriculture or between agriculture and the rest of the economy. However, the commodity-by-commodity analysis of technological change gives many indications of the direction and nature of these changing capital flows.

Table 7.11. Labor Force
(in millions)[a]

	Total labor force	Armed forces	Total civilian labor force	Employed			Un-employed
				Total	Agri-culture	Nonagri-culture	
1955	68.9	3.0	65.9	63.2	6.7	56.5	2.65
1965	79.2[b]	3.0	76.2	73.2	5.2	68.0	3.00

[a]Individual figures do not add to totals due to rounding. 1955 data are from "The economic report of the President," Council of Economic Advisors, Washington, D.C., Jan. 23, 1957, p. 140.
[b]Bancroft, Gertrude, "Projections of the labor force in the United States, 1955 to 1975," Current Population Reports, Bureau of the Census, Series P-50, No. 69, Oct. 1956.

Aggregative Conclusions of the Equilibrium Model

Different types of models and projections can be derived from the research reported here: technological capacity projections, economic capacity projections, and various types of equilibrium models positing different economic paths and policies for adjustment of projected disequilibria. One such equilibrium model is presented in this chapter.

The aggregative indices computed for the equilibrium model provide the following estimates of total production and consumption for the United States:

	1965 consumption index	1965 production index
All agricultural products	117	112.5
All food products	119.8	116.3

The surplus of production over consumption in 1955 is estimated at 4 percent for all agricultural products and 3 percent for all food products.[14] The model aggregates imply a per capita food consumption increase of 4 percent over the decade. Also implied in the model is a decline in the income elasticity of demand for food from 0.23 in 1955 to 0.20 in 1965.

We may draw a number of conclusions from the model and its related analysis. The annual surplus of production is a structurally chronic condition destined for a decade of continuous growth unless far more effective production control measures are taken than at present. The combined indices of crop yields and the efficiency of feed utilization indicate an expected increase of 23 percent over the decade. Most awesome, however, is the estimated potential increase in yields and efficiency of feed utilization, aggregating better than 60 percent by 1965. This contrasts with the 12 to 13 percent increase in agricultural output that can reasonably be absorbed by the economy in 1965. In practically every commodity group, yields will increase more than production needs by 1965. We are not going to "eat our way out" through increases in per capita consumption and population; the total effect of both of these factors will raise food consumption no more than 20 percent. On the basis of computations from the model it is estimated that, with no production controls and 1955 prices, a 30 percent increase in food production by 1965 would be well within the bounds of possibility.

[14] All surplus figures in the model understate the annual surplus rather significantly. No provision is made in the estimates for the effect of the subsidy and donation programs which account for a significant volume in some agricultural markets. Specifically, there is no allowance for the P.L. 480 and Section 32 funds, the school lunch program, I.C.A. activities, and the other export subsidy, promotion, and barter activities of the federal government. Not only are meaningful data unavailable, but important conceptual difficulties arise in defining surpluses under these conditions. The actual surplus is probably somewhere on the order of twice the size of the model figures.

The adjustments implied are fairly obvious. Technological change in agriculture will have the usual effect of raising the minimum size of an optimum production unit. While the labor force declines from 6.7 to 5.2 million persons, the average size of the American farm still must increase about 20 percent if income is to be adjusted effectively to expected changes in technology and productive capacity. This implies a decline in the number of farms from around 5 million in 1955 to a little more than 4.25 million by 1965. The model indicates a decline in farm prices of around 5 to 10 percent to attain the projected equilibrium of production and consumption. The 1965 equilibrium appears to involve a parity ratio of between 75 to 80, although this is at best a very rough estimate.

Any attempt to alleviate the structural imbalance by moving large amounts of one resource, such as land, out of agricultural production is doomed to failure. Other resources (fertilizer, pesticides, irrigation water, equipment, and even labor) are simply substituted for land; and with higher yields production remains at high levels or increases still further. The soil bank technique by itself is no solution; in fact, as presently set up, the soil bank is undoubtedly production increasing. It is estimated from the model that a minimum of between 50 to 60 million acres would have to be taken out of production permanently before such efforts could achieve anything close to an equilibrium of production and consumption in 1965. And, even then, the effectiveness of such techniques can reasonably be doubted when employed by themselves. Much the same may be said of proposals for a solution by moving only labor out of agriculture. Labor has been moving off the farm at a fantastic pace over the past decade, yet production has increased even more rapidly. The substitution of capital for labor and land has been a characteristic feature of agriculture's technological and organizational revolution. Any effective effort to reduce production must involve the simultaneous transfer of some combination of labor, land, and capital resources to nonagricultural pursuits.

It makes economic sense in the face of chronic production surpluses to move resources toward the production enterprises which require the greatest investment of resources per pound of output. Thus, shifting production toward livestock products tends to reduce the annual surplus. The suggestion sometimes made that the entire "surplus problem" could be absorbed by the livestock economy has been tested using the model of this paper.[15] The model indicates that only about a quarter of the annual production surplus could be absorbed without serious consequences to the livestock industry. Certainly no other sector of American agriculture has even this potential capacity of expansion and resource absorption. A relatively large animal product enterprise also provides a reservoir from which resources can be drawn in times of war and other catastrophes.

[15]Bonnen, James T., and Witt, Lawrence W., "What is American agriculture geared to produce?" Proc. of Sixth Ann. Nat. Inst. of Anim. Agr., Purdue University, Lafayette, Ind., Apr., 1956, pp. 49-63.

Additional hypotheses as to the effects of different resource mixes may be tested in this model. The hypotheses so far tested show that the structural imbalance implied by the model is a serious long-run problem which will have to be faced honestly and thoughtfully by American agriculture if a generally satisfactory adjustment is to be attained.

Contrast of Models

By comparison both models recognize economic structure in agriculture, the first as a formal system of equations from which empirical coefficients are derived and the second as a structural system in the sense that it quantifies long-run changes in interrelationships and evaluates their effects in a systematic manner, but within a partially, not totally, rigorous system. The objectives of both are primarily the same, aside from length of run — to determine the structure which generates demands and supplies of agricultural commodities and to obtain empirical estimates of the structure. The empirical estimates form a basis for determining the effects of various changes which occur in the system.

The first model evaluates the structure in terms of annual changes, while the second involves a period of ten years. Because of this the second model gives more emphasis to some of the resource flows which are likely to occur between the agricultural and nonagricultural sectors of the economy. These resource flows do not affect the structure of the first model to as great a degree. For instance, the size of farm and nonfarm labor forces and their composition do not change much over a period of only a year, but over a decade significant changes occur.

These are provided for in the long-run model. Similarly, land-use patterns are altered significantly over the long run, with shifts of land resources between farm and nonfarm uses. Major capital flows change in size and composition over long-time periods. Explicit long-run changes in management efficiency were estimated. Additional structural changes due to technology are included for the long-run model. Over the long run the substitution of leisure for income is included by projecting the trend for the average length of the work week. Population change is allowed for in both models. Tastes also change. A time trend is used to account for change of tastes in the short-run model. For the long-run model a number of the more obvious long-run time trends were projected and additional information used in selecting the final, most probable trend estimate.

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Discussion

CHAPTERS 4 and 5 on demand and supply have laid the groundwork for this discussion of the adjustment in agriculture to the economic growth in the years ahead.

Bonnen and Cromarty recognize the same limitations that have been discussed previously, namely that we are still lacking in basic statistical data and in an adequate conceptual framework to solve all agricultural problems precisely.

The first part of the paper by Dr. Cromarty presents an analysis of the economic structure with an indication of the usefulness of this procedure in short-run adjustments. The grouping of agricultural products into 12 categories seems logical. It might be advantageous to group livestock products in one category (similar to the grouping of feed grains) since there is considerable substitution among the livestock products. However, Cromarty has recognized the interaction between these products.

I would question the significance of determining demand elasticities for each of the three outlets — commercial, inventory or storage, and government. Government purchases hardly represent a demand in the usual meaning of the term. These purchases merely represent the fulfillment of the government promises to purchase the total production of those producers who meet the requirements (stay within acreage allotments) at a predetermined price. The three outlets for farm products do not seem to be independent components of demand.

Cromarty's estimates of the elasticity of supply and demand are similar to those arrived at by others. If the basic data can be provided that will give such analysis a fairly high degree of reliability, the process can become very useful. The effect of agricultural price policy could then be tested in advance and a policy could be adopted that would at least point in the right direction.

Dr. Bonnen's part in the paper represents the long-run approach to adjustments in agriculture. His projections for the U. S. economy to 1965 are similar to those determined by others (Table 4.2 in the Collins-Mehren paper). Bonnen projects demand and supply to 1965 for the same 12 categories of farm products used by Cromarty, then in the third stage of his analysis aggregates the projected production and consumption of agricultural products. In spite of an increase in population of 15 percent by 1965 we would have to reduce cropland approximately 30 million acres, shift 14 million acres to woodlands not pastured, and reduce by 50 million acres the land not in farms but used for agricultural uses. Other shifts within the agricultural uses would be necessary. The agricultural labor force can be reduced 1.5 million workers or 22 percent. Recognizing the lack of adequate data and the effect of this on his analysis, Bonnen concludes that we will not "eat our way out," at least not by 1965.

Bonnen's qualifying assumptions are clearly stated. One limitation in the analysis is the impact of technological changes. Bonnen has of necessity limited himself to the "known and almost known" technology. However, the impact of the unknown technological innovations may be a major disturbance.

Some questions can be raised regarding the general approach. Most of my questions would focus on the inadequacy of our basic data and conceptual framework of analysis. Does our analysis of supply and demand adequately measure the response to price of both consumers and producers? We know that farmers in one region will respond differently from those in another area. The wheat farmer with few alternatives will respond differently to a change in price of an alternative product when marketing quotas are in effect on wheat than he will in a period of free wheat production. Do we have adequate measures of the response of consumers to changes in price under various conditions? The relatively low elasticity of demand for farm products tends to reduce the importance of such changes but does not remove their significance entirely.

The authors have not assumed to have solved all adjustment problems. They set out merely "to shed a little light." This they have done. If we can develop more refined procedures and compile more adequate data and further test the reliability of this procedure we may find a very useful tool. We need to explore many new avenues if we want to solve the surplus problem. The authors are to be commended for their work.