Some Relationships Between Agriculture and the General Economy

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Net farm income is affected by changes in final demand, in marketing charges, and in production costs. BAE publishes data relating to each of these three sets of factors. This article attempts a new combination of these data for a recent year, with agriculture divided into nine major commodity groups. Although the tentative and preliminary nature of the data must be emphasized, information of this kind is needed for several purposes, including estimation of the effect of changes in specific marketing and production cost items upon net income from different commodities. The success of newer approaches to the study of relationships between agriculture and the general economy also depends upon the development of accurate and detailed information of this kind.

STUDIES OF RELATIONSHIPS between agriculture and the rest of the economy must continually weigh the conveniences of aggregation against losses of relevant detail. At one extreme are simple models which treat all agriculture as one enterprise selling a single composite product.[2] But the diversity of conditions within agriculture generally forces us to frame price and production programs in terms of individual commodities. This diversity extends to the distribution of commodities among final uses and to the importance of specific marketing charges and production expenditures in determining net farm income from each commodity.

Each element of marketing charges and cash costs of production is a channel through which influences originating primarily in the nonfarm economy may be transmitted into the net income statements of farm operators. The size of each such element for a given commodity is a presumptive indicator of the vulnerability of its producers to changes in a particular segment of the nonfarm economy. Hence, estimates of these elements for different commodities, even for a single cross-section of time, have a considerable diagnostic value.

Modern techniques of analysis, such as the input-output or "interindustry relations" approach of Leontief[3] and the "linear programming" methods of Dantzig, Koopmans and others[4], are creating a demand for more accurate data of this type. These methods seem to hold much promise for the appraisal of governmental programs and for the general study of interrelationships between different sectors of the economy. Electronic computers can handle the formidable calculations required for such studies, but the accuracy of the final results must depend on that of the basic data.

The new data introduced in this article are preliminary and tentative in character. However, they will serve to illustrate the possibility of combining specialized sets of data into more general frameworks, and the desirability of developing certain data on a less aggregative basis than has been done in the past.

The Data

In connection with the Interindustry Relations Study being carried out by the Bureau of Labor Statistics, an attempt was made by specialists in BAE to allocate each item of production expenditures in the year 1947 among 18 groups of farm commodities. The authors later rearranged these

[1] The basic data for this article were developed under the direction of Harry C. Norcross. Karl A. Fox is responsible for the text.

[2] See, for example, Brownlee, O. H. and Johnson, D. Gale, "Reducing price variability confronting primary producers," *Journal of Farm Economics*, May 1950, pp. 176-193.

[3] LEONTIEF, WASSILY W., THE STRUCTURE OF THE AMERICAN ECONOMY, 1919-1939: AN EMPIRICAL APPLICATION OF EQUILIBRIUM ANALYSIS. (Second ed.) New York, 1951.

[4] ACTIVITY ANALYSIS OF PRODUCTION AND ALLOCATION, Cowles Commission Monograph No. 13, T. C. KOOPMANS, ed.; New York, 1951.

TABLE 1.—*Marketing charges, production expenditures, and sources of gross and net farm income, by commodity groups, United States, 1947*[1]

Item	(1) Meat animals	(2) Dairy products	(3) Poultry and eggs	(4) Fruits and vegetables	(5) Food grains	(6) Feed grains and hay	(7) Cotton and cottonseed	(8) Tobacco	(9) Miscellaneous	(10) All commodities
1. Food marketing charges:										
Retail value of farm food products	*Bil. dol.* 11.14	*Bil. dol.* 6.30	*Bil. dol.* 3.75	*Bil. dol.* 6.15	*Bil. dol.* [2]4.52	*Bil. dol.*	*Bil. dol.*	*Bil. dol.*	*Bil. dol.* [3,4]2.32	*Bil. dol.* [4]34.18
Less: Food marketing charges	4.02	2.59	1.19	3.63	3.04		*Nonfoods*: "Farmers' share" on retail cotton, wool and tobacco products averaged 12 to 17 percent. Margin concept inappropriate for industrial fabrics, etc.		1.46	15.93
Trade	2.28	1.73	.93	2.19	1.12				.59	8.84
Transportation (inter-city)	.40	.10	.10	.90	.20				.13	1.83
Processing	1.34	.76	.16	.54	1.72				.74	5.26
Equals: Equivalent farm value	7.12	3.70	2.56	2.52	[2]1.49				[3]84	18.23
2. Sources of cash farm income:[5]										
Sales for food use by domestic civilians[6]	7.18	3.80	2.64	2.56	1.00	0.22	0.19	—	0.64	18.23
Plus: Food use by armed forces	.24	.06	.05	.11	.04	—	—	—	—	.50
Nonfood products and byproducts for domestic use	.40	.01	.09	—	.39	.80	1.60	.68	[7]1.27	5.22
Exports and shipments	.13	.18	.14	.23	1.07	.34	.43	.24	.11	2.87
Inter-farm sales	1.20	—	—	—	.15	1.07	—	—	.24	2.66
Balancing item[7]	.19	—	.01	—.10	.12	—.10	.02	.11	—	.27
Equals: Cash receipts from farm marketings	9.34	4.05	2.93	2.80	2.77	2.33	2.24	1.03	2.26	29.75
3. Gross and net farm income and production expenditures:										
Cash receipts from farm marketings	9.34	4.05	2.93	2.80	2.77	2.33	2.24	1.03	2.26	29.75
Plus: Farm-home consumption	.72	.79	.48	.85	.01	.03	—	—	.22	3.10
Rental value of farm dwellings	.20	.24	.09	.11	.11	.10	.17	.08	.08	1.18
Equals: Gross farm income[8]	10.26	5.08	3.50	3.76	2.89	2.46	2.41	1.11	2.56	34.03
Less: Production expenditures[9]	4.19	3.05	2.48	1.91	1.23	.81	1.09	.39	2.08	17.23
Purchased livestock	1.20	—	.22	—	—	—	—	—	—	1.42
Purchased feed	.92	1.00	1.47	—	—	—	—	—	.30	3.69
Hired labor	.40	.49	.08	.85	.13	.14	.37	.09	.30	2.85
Operation of motor vehicles	.28	.24	.11	.16	.23	.15	.11	.02	.27	1.57
Misc. goods and services	.29	.35	.18	.54	.19	.15	.21	.07	.53	2.51
Taxes, interest, net rent	.68	.40	.24	.16	.34	.20	.21	.07	.28	2.58
Depreciation	.42	.57	.18	.20	.34	.17	.19	.14	.40	2.61
Equals: Realized net income of farm operators[8, 10]	6.07	2.03	1.02	1.85	1.66	1.63	1.32	.72	.48	16.80

[1] Data on marketing charges by function, on sources of farm income, and on production expenditures by commodity groups, are unofficial. [2] Bakery and cereal products. Farm value includes value of other bakery-product ingredients as well as value of flour, corn meal, etc. [3] Food only. Includes some cottonseed oil and corn products (wet process) in addition to products classified as "Miscellaneous" in Sections 2 and 3 of this table. [4] Includes 0.02 billion dollars of marketing taxes, mainly on oleomargarine and sugar. [5] Figures in section 2 of table are equivalent farm values of the respective commodity flows. [6] Same as row above, except that farm values of bakery and cereal products and miscellaneous foods have been redistributed according to farm-product categories of Section 2 and 3. [7] Includes changes in nonfarm stocks, statistical discrepancies, rounding errors, etc. [8] Excluding government payments. [9] Cash expenditures for current operations, plus allowance for depreciation. [10] Includes returns for the labor of farm operators and unpaid family workers, as well as for management and investment.

estimates in conformity with certain regularly published series of BAE. The new figures are not official estimates of the Bureau, but they reflect the informed judgments of competent analysts, and the impressions they give are believed to be reasonably accurate.

Table 1 combines the new estimates of production expenditures by commodity groups with estimates of cash receipts and gross farm income as reported in the *Farm Income Situation;* estimates of the national food marketing bill as published in the *Marketing and Transportation Situation;* and estimates of commodity supplies and distribution, upon which are based the consumption estimates carried in the *National Food Situation* and the various commodity situation reports.

PRODUCTION EXPENDITURES.—Estimates of production expenditures by commodity groups are shown in the lower section of table 1. As used here, "production expenditures" include cash outlays for current operations plus depreciation charges which, on the average, must also be offset by cash outlays. "Net farm income" includes all returns for the operator's labor and investment, and for the labor of unpaid family workers. It is not to be confused with profits.

The form into which the commodity data are cast is dictated by the requirement that they add up to familiar published totals, such as "cash receipts from farm marketings." For example, the production expenditures allocated to feed grains and hay consist only of the expenses necessary to produce feeds *sold* by farmers. Production expenditures for feed fed on the farms where grown are allocated to the respective classes of livestock that consume those feeds. The result is that a considerable part of the cost of tractor and farm equipment use is allocated to the production of meat animals and dairy products. Similarly, the cost of hired labor used in producing corn on a hog-corn farm is mostly allocated to the meat animal group.

These concepts are appropriate to the BAE system of national farm income statistics. For production planning, the data might be organized quite differently. Total labor, fertilizer, and other items used in feed production would be recorded as inputs into the feed enterprise. The feed retained on farms would be treated as an input (at imputed prices) into livestock enterprises, along with the other cash and noncash inputs specifically associated with livestock production. This is the organization of data that might be called for by the Leontief input-output or Bureau of Labor Statistics interindustry approach. As a matter of fact, the production expense data underlying table 1 were originally prepared for an interindustry relations study according to specifications formulated by Philip M. Ritz of the Bureau of Labor Statistics. Considerable reworking was necessary to put the data in their present form.

Even in this framework of farm income statistics, table 1 does some violence to the dairy enterprise, as sales of dairy animals for slaughter are credited to "meat animals." Cash production expenditures allocable to dairy stock sold for slaughter are also transferred to the meat animal group. But the size of the dairy enterprise is understated by perhaps 1½ billion dollars, and the size of the meat animal enterprise correspondingly overstated, when we define the dairy "industry" in terms of cash receipts from milk and butterfat only. Also, since the ratio of net farm income to gross in 1947 was higher for meat animals than for dairy products, the relative profitability of the dairy enterprise is somewhat understated in table 1.

Table 2 shows the percentage distribution of each category of production expenditures among commodity groups. For example, the table indicates that about 25 percent of total expenditures for purchased feed were made in behalf of meat-animal production; 27 percent was for feed fed to dairy cattle; 40 percent of the purchased feeds by value went to poultry; and 8 percent went to other classes of livestock, chiefly horses and mules. In the case of hired labor, about 30 percent of the total farm-wage bill was paid by fruit and vegetable producers, 13 percent by cotton farmers, and 17 percent by dairy farmers. The shares of the total farm wage bill paid by cotton, fruit, and vegetable producers were two to three times their shares of total production expenditures. The differences in the distribution of other categories of expenditures in most cases were not so pronounced as in those of feed and labor.

At least one analytical application of the figures in table 2 suggests itself. If we wished to make an index of the demand for purchased feed, the figures in column 2 would provide appropriate weighting data for the respective classes of livestock products in such an indicator. Thus, poultry and eggs would have a considerably larger weight than either meat animals or dairy products, even though cash receipts

were considerably smaller from poultry and eggs than from dairy products and were only one-third as large as for meat animals. An index of the demand for hired farm labor might be based on weighting data from column 5. In this case, fruits and vegetables and cotton would get considerably larger weights than would be suggested by their shares of cash receipts or gross farm income.

Table 3 shows the break-down of total production expenditures for each commodity group. For example, nearly three-fifths of such expenditures for poultry and eggs in 1947 were for purchased feed, whereas this item accounted for only one-third of the production expenditures for dairy products and between one-fourth and one-fifth of those for meat animals. A 10-percent increase in prices of all purchased feeds would have had a much greater impact on net income from poultry and eggs than on income from milk or meat animals.

Also in 1947, wages accounted for about 45 percent of the cash costs of producing fruits and vegetables and 34 percent of the cash costs of producing cotton. The operation of motor vehicles was relatively a much larger expense item in connection with food grains and feeds than with other commodities. Depreciation was relatively high for tobacco, dairy products, and grains. Financial items (taxes, interest, and net rent to nonfarm landlords) were relatively higher for food and feed grains and cotton than for other commodity groups.

Table 3 also has at least one analytical application. The percentages for each category of production expenditures might be used as weights in indexes of prices of goods and services used in production. For poultry and eggs such an index would give a very heavy weight to prices of purchased feeds and relatively small weights to the operation of motor vehicles and to wages of hired farm labor. A similar index for fruits and vegetables would give predominant weight to farm wage rates and considerable weight to such items as containers and the materials for making them. An index of cash production costs for food and feed grains would give very heavy weight to operation of motor vehicles, depreciation, and various money payments in the form of taxes, interest, and rent.

The importance of the several items of cash production costs relative to *gross farm income* may differ from their share in production expenditures. Table 1 indicates that, in 1947, total production expenditures were equivalent to 33 percent of gross farm income from feed grains and hay, 41 percent in the case of meat animals and 71 percent in the case of poultry and eggs. These relationships would vary, of course, with changes in the relative prices of the different commodity groups. In 1947, poultry and eggs had one of the smallest percentage margins (differences between gross farm income and production expenditures) of any commodity group. Feed grains had perhaps the largest margin of any major group, as prices for feed during most of the year were at all-time record levels.

The figures discussed in this section suggest the possibility of obtaining rough estimates of the net farm-income positions of different commodity groups for a few years prior to and following 1947.

TABLE 2.—*Percentage distribution of major categories of production expenditures by commodity groups, United States, 1947*

Commodity group	Expenditures by farm operators for						
	(1) Total production expenditures	(2) Purchased feed	(3) Operation of motor vehicles	(4) Depreciation on vehicles, equipment and buildings	(5) Hired labor	(6) Taxes, interest and net rent to nonfarm landlords	(7) Miscellaneous (including purchased livestock)
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
All commodities	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Meat animals	24.3	24.9	17.8	16.1	14.0	26.4	[1]37.9
Dairy products	17.7	27.1	15.3	21.8	17.2	15.5	8.9
Poultry and eggs	14.4	39.8	7.0	6.9	2.8	9.3	[2]10.2
Fruits and vegetables	11.1	---	10.2	7.7	29.8	6.2	13.7
Food grains	7.1	---	14.6	13.0	4.6	13.2	4.8
Feed grains and hay	4.7	---	9.6	6.5	4.9	7.8	3.8
Cotton and cottonseed	6.3	---	7.0	7.3	13.0	8.1	5.3
Tobacco	2.3	---	1.3	5.4	3.2	2.7	1.8
Miscellaneous	12.1	8.2	17.2	15.3	10.5	10.8	13.6

[1]Includes 30.5 for purchased livestock.
[2]Includes 5.6 for purchased livestock.

Gross farm income could be adjusted by an index of prices received by farmers for the commodities in each group. Production expenditures could be adjusted by a similar index of prices of production goods and services weighted appropriately for each commodity group. But if the ratios of various purchased inputs to physical output of a commodity group were highly unstable, this price-index approach would break down. This might happen if unit costs varied substantially with yields and if yields themselves fluctuated violently because of weather.

It must be recognized that the nine commodity groups here considered still represent a high level of aggregation. The production process for hogs is greatly different from those for beef cattle and lambs within the meat animal group. Farm chickens and commercial broilers are produced under different conditions and the broilers are much more dependent on purchased feed.

The data are highly aggregative in a geographical sense as well. For example, in some parts of the Middle West dairy farmers buy little feed. At the other extreme are "dry lot" dairies in metropolitan areas; they have no pasture and buy all their feed, including hay. Intermediate are the conditions of milk production in the Northeast where dairy farmers grow most of their roughage but buy a substantial part of their feed concentrates. This suggests the desirability of developing data of the kind presented here, by broad regions and by major farming types within regions, in such a way that they can be aggregated into commodity and area totals. Data are already available for selected types of family-operated farms in certain regions, but this material has not been assimilated into the framework of national farm income estimates.

MARKET MARGINS.—The upper part of table 1 shows the distribution of food marketing margins by major commodity groups and by three main categories of marketing functions.

The retail values, farm values, and total marketing charges for each of the six commodity groups have been published in the *Marketing and Transportation Situation*. The break-down of the marketing bill by major functions was based partly on relationships in 1939 between processing and distributing margins. Some possible uses of these data are brought out by means of special-purpose tables.

Table 4 expresses marketing charges by major functions for each commodity group as percentages of its total marketing bill. In general, the variations reflect differences in the services needed to move each group in the forms required between the farm and the consumer. Intercity transportation is over twice as important with fruits and vegetables as with any other commodity group. Many fruits and vegetables are shipped long distances, as from the Pacific Coast, Texas, and Florida, to the major consuming centers. More than half of the total retail expenditures for dairy products go for fluid milk which is produced within very short distances of the consumers. Consequently, intercity transportation makes up a smaller proportion of the total marketing bill for dairy products than for any other food group.

TABLE 3.—*Percentage distribution of production expenditures for major commodity groups, by expenditure categories, United States, 1947*

Commodity group	Expenditures by farm operators for						
	(1) Total production expenditures	(2) Purchased feed	(3) Operation of motor vehicles	(4) Depreciation on vehicles, equipment and buildings	(5) Hired labor	(6) Taxes, interest, and net rent to nonfarm landlords	(7) Miscellaneous (including purchased livestock)
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
All commodities	100.0	21.4	9.1	15.1	16.5	15.0	22.9
Meat animals	100.0	22.0	6.7	10.0	9.5	16.2	[1]35.6
Dairy products	100.0	32.8	7.9	18.7	16.1	13.1	11.4
Poultry and eggs	100.0	59.3	4.4	7.3	3.2	9.7	[2]16.1
Fruits and vegetables	100.0	—	8.4	10.5	44.5	8.4	28.2
Food grains	100.0	—	18.7	27.6	10.6	27.6	15.5
Feed grains and hay	100.0	—	18.5	21.0	17.3	24.7	18.5
Cotton and cottonseed	100.0	—	10.1	17.4	33.9	19.3	19.3
Tobacco	100.0	—	5.1	35.9	23.1	17.9	18.0
Miscellaneous	100.0	14.4	13.0	19.2	14.4	13.5	25.5

[1]Includes 28.6 for purchased livestock.
[2]Includes 8.9 for purchased livestock.

TABLE 4.—*Farm food products: Charges for major marketing functions as percentage of total marketing bill, by commodity groups, United States, 1947*

Commodity group	(1) Total marketing bill	(2) Trade[1]	(3) Intercity transportation[1]	(4) Processing[1]
	Percent	*Percent*	*Percent*	*Percent*
All food products	100	56	11	33
Meat products	100	57	10	33
Dairy products	100	67	4	29
Poultry and eggs	100	78	8	14
Fruits and vegetables	100	60	25	15
Bakery and cereal products	100	37	7	56
Miscellaneous	100	40	9	51

[1]Unofficial estimates, based partly on 1939 relationships.

As poultry and eggs require relatively little processing, charges for this work were something like 14 percent of the total marketing bill for the group. On the other hand, cereal products and miscellaneous foods (including sugar, vegetable oils, and wet-process corn products) require substantial processing to put the raw farm products into the forms in which they are customarily sold at retail. Processing charges for these two food groups reached a half or more of their total marketing bills. Processing charges seem to have been slightly more important for meats than for dairy products.

Table 5 looks at the same basic data from a different viewpoint. For example, fruits and vegetables accounted for some 50 percent of the total intercity transportation bill for farm food products, meat animals and meats for about 22 percent, and bakery and cereal products about 11 percent. Dairy products and poultry and eggs, combined, accounted for only 10 percent. These figures might be regarded as weights in a demand indicator for long-haul transportation services. Similarly, if we combine the costs of wholesale and retail distributive services and those of country assemblers, it appears that fruits and vegetables accounted for about 25 percent of the total gross income of such agencies; meat animals and meats about 25 percent, and dairy products about 20 percent.

The figures on marketing costs can be interpreted similarly to those on production expenditures. If retail prices remained constant, a uniform percentage increase in freight rates would hit fruits and vegetables much harder than any other group of farm commodities. On the same assumption, an increase in costs of construction, machinery, and types of materials and services used by processors would bear most heavily upon producers of grains, sugar crops, and oilseeds.

In 1947, the total marketing bill was a smaller percentage of retail store value for some commodity groups than for others. For example, marketing charges were 32 percent of the retail store value for poultry and eggs, compared with 67 percent for bakery and cereal products. The corresponding percentages for other groups were meats, 36 percent; dairy products, 41 percent; fruits and vegetables, 59 percent; and miscellaneous foods, 64 percent. These percentages are complements of the more familiar figures on "farmers' shares" of the retail food dollar.

TABLE 5.—*Farm food products: Percentage distribution of major types of marketing charges among commodity groups, United States, 1947*

Commodity group	(1) Total marketing bill	(2) Trade[1]	(3) Intercity transportation[1]	(4) Processing[1]
	Percent	*Percent*	*Percent*	*Percent*
All food products	100	100	100	100
Meat products	25	25	22	26
Dairy products	16	20	5	14
Poultry and eggs	8	10	5	3
Fruits and vegetables	23	25	50	10
Bakery and cereal products	19	13	11	33
Miscellaneous	9	7	7	14

[1]Unofficial estimates, based partly on 1939 relationships.

SOURCES OF DEMAND FOR FARM PRODUCTS.—The previous section was concerned with decidedly the largest flow of farm products—sales for food use by domestic civilians. In addition there were large sales of nonfood products for domestic use, including cotton, tobacco, shorn wool, flaxseed, and others. To these may be added the value of byproducts such as hides, pulled wool, wheat millfeeds, and oilseed meals, which have not been included in the equivalent farm value of food products, and (for convenience) the value of feed grains processed by manufacturers of commercial feeds. In 1947, the farm value of nonfood items for domestic use totaled about 5 billion dollars (table 6).

The retail values of selected cotton, wool, and tobacco products, in 1947, averaged from six to ten times the equivalent farm values. Some cotton went into industrial uses for which a "farm-to-retail" calculation would be meaningless. Marketing

TABLE 6.—*Sources of cash farm income, United States, 1947*

Source	Cash farm income[1]	
	Amount	Percentage of total
	Bil. dol.	*Percent*
Total cash receipts from farm marketings	29.75	100.0
Sales for food use by domestic civilians	18.23	61.3
Food use by armed forces	0.50	1.7
Nonfood products and byproducts for domestic use	5.22	17.6
Inter-farm sales	2.66	8.9
Exports and shipments	2.87	9.6
Balancing item[2]	.27	0.9

[1]Equivalent farm values of commodity flows.
[2]Includes changes in nonfarm stocks, statistical discrepancies, rounding errors, etc.

charges on processed feeds bought by farmers were of about the same order of magnitude as their equivalent farm values.

In 1947, the equivalent farm value of food used by the U. S. armed forces was approximately 0.5 billion dollars, concentrated rather heavily in the meat and fruit and vegetable groups. The farm value of sales for export and shipment to territories was about 3 billion dollars. Food grains made the largest single contribution to the export total in that year. Exports of cotton were relatively small. Three crops—cotton, wheat, and tobacco—accounted for some 60 percent of the farm value of agricultural exports.

Cash receipts from farm marketings include receipts from sales to other farmers. The largest single flow of interfarm sales is the shipment of feeder and stocker cattle from range States to feeders in the Corn Belt and other areas. The other major interfarm flow consists of sales of feed grains and hay.

The proportion of total equivalent farm value of each commodity group obtained from sales to different outlets is an approximate indicator of the vulnerability of the farm prices of these products to changes in the different sources of demand. Exports are of great importance to producers of wheat, cotton, and tobacco. The prosperity of producers of livestock products, fruits, vegetables, and feed grains depends primarily on the prosperity of domestic consumers. Prices paid for feeder cattle and for both raw and processed feeds are influenced by prices received for slaughter cattle and other livestock products, which in turn depend on consumer income.

Implications for Further Analysis

Table 1 suggests some of the major connections between agriculture and the rest of the economy. If we have information as to coming changes in certain segments of the nonfarm economy, this table can help us to estimate their direct effects upon agriculture. Statistical demand analyses in some cases enable us to predict with reasonable accuracy the effects of changes in production and changes in consumer income upon retail food prices. Average relationships between retail and farm prices may enable us to estimate the corresponding effects at the farm level. However, information about prospective changes in freight rates, wage rates of food marketing employees, costs of containers and other specific items, should help us to estimate these effects more accurately.

In the case of export crops, we may be able to derive export demand curves on the basis of past relationships, supplemented with judgments as to peculiarities of the current situation. We may conceive of the farm price of wheat as being determined by separate demand curves for domestic food use, for export, for feed, and for reserve stocks. For most purposes, the slopes and shapes of these demand curves can be approximated with usable accuracy. These demand curves constitute the major part of an economic model of factors affecting the price and utilization of wheat.

One goal of applied economics should be to develop similar models for as many as possible of our major farm products. These models should reflect competitive relationships between commodities in such groups as meats and poultry, oilseeds, and feed grains. They should also "explain" the demand for feeds (and for feeder cattle) in terms of prices, numbers, and other factors relating to each major class of livestock and livestock product. Supply responses, as of pig crops to corn supplies or hog-corn ratios, should also appear in these models.

If we are tracing the impacts of changed conditions upon one farm commodity at a time, we may generally regard changes in domestic and foreign demand as determined outside of the agricultural economy. But if we add up these direct impacts for all farm products we begin to recognize the incompleteness of the individual commodity models. For example, during 1922-41 a year-to-year change of 10 billion dollars in U. S. disposable income was associated with an average change of more than a

billion dollars in cash receipts from farm marketings. But production expenditures also tended to increase with cash receipts. For each billion-dollar change in cash receipts from one year to the next, farm purchases of livestock and feed tended to change by more than 100 million dollars. The farm-wage bill changed an average of 80 million dollars per billion-dollar change in cash receipts. Farm wages were influenced by the prevailing level of nonfarm wage rates and the ease with which nonfarm employment could be obtained.

There are other production items the prices of which are largely determined outside of the agricultural economy. Prices of motor vehicles, gasoline, and oil, are examples, for only moderate proportions of the total outputs of these items are used in farm production. Most types of farm machinery are not usable for other purposes. Nevertheless, prices of steel, rubber, and other materials used in farm equipment, as well as factory wage rates, are determined in a very broad competitive area; and prices of the farm machinery itself may not be very responsive to changes in farm income. During 1922-41 cash outlays for production requisites excluding feed, livestock, and hired labor and including net investment in farm buildings and equipment changed about 300 million dollars in association with year-to-year changes of a billion dollars in cash receipts. This association may be regarded in large part as a "back-effect" of farm income upon the nonfarm economy.

As an average during 1922-41, the realized net income of farm operators rose nearly 700 million dollars in response to a year-to-year increase of 1 billion in cash receipts from marketings.[5] Of this, over 100 million dollars represented net new investment in farm buildings and equipment, an item mentioned in the preceding paragraph. The remainder also had its back-effects on the nonfarm economy through increased expenditures on goods and services for family living.

[5]The sum of net income and production expenditures (including depreciation allowances) is equal to gross farm income. Gross income is larger than cash receipts by the imputed rental value of farm dwellings and the value of home-grown products consumed by the farm family. The latter value changes directly with cash receipts, as the price components of the two series are quite similar. As a result, gross farm income during 1922-41 changed about 1.1 billion dollars per billion-dollar change in cash receipts. Production expenditures (including depreciation allowances) accounted for a little more than 400 million and net income for a little less than 700 million dollars.

Hence, if we try to trace the ultimate effects of an initial increase in consumer income (due perhaps to an increase in the rate of defense expenditures) we are led through a series of approximations. The "first round" increase in farm cash receipts leads to a secondary increase in nonfarm income (perhaps no more than 10 percent of the initial one). This leads to a secondary increase in farm income, which produces a third-order effect on nonfarm income (perhaps no more than 1 percent of the initial increase).

But we must also consider another stream of influences. The bulk of the initial increase in consumer income will be spent for nonfarm goods and services. This expenditure leads to an increase in nonfarm employment and income, which reinforces the original one and leads to a further (but smaller) expansion in expenditures. If, for example, a defense program increased the rate of wage, salary, and other income payments *directly* by 10 billion dollars while the rate of private investment remained constant, the total increase in income (in the absence of controls) might be around 20 billions.[6] If so, farm cash receipts would tend to increase by twice the amount suggested by the initial impact, rather than by 1.11 times that amount as suggested by considering back-effects through farm income only.

In the last few paragraphs we have fallen back, for simplicity, on a highly aggregative type of analysis. This analysis may be sufficient for some purposes. But if we are interested in anticipating changes in the farm economy at the level of commodity detail that is important for farmers themselves, or for national policy, we must work toward an economic model which places individual farm commodities in the context not only of agriculture as a whole but of the entire national economy, recognizing its interconnections (through trade) with other parts of the world.

Some concept of what is involved can be obtained if we visualize the data in table 1 as being rearranged in a larger table of (say) 50 rows and 50 columns, representing a classification of the entire economy into 50 industries. The first 9 rows would record the distribution of farm products to different industries (including "households" and "for-

[6]Magnitude based on Smithies, A. R., "The Multiplier," *American Economic Review*, Proceedings Number, May 1948, pp. 299-305.

eign countries'') in which they were transformed or consumed; the first 9 columns would record inputs used in farm production according to the industries from which they originated. (Production expenditures would be more finely subdivided than in table 1, so that motor vehicles, petroleum products, fertilizer, farm machinery, and other major inputs would be represented by separate industries.) Thus, the *direct* relationships of agriculture with its major suppliers and purchasers would be represented by a Γ-shaped array of figures occupying 9 rows and 9 columns. The other 41 rows and columns would record the relationships between nonagricultural industries, including those that supplied inputs to agriculture as well as those that had no direct contact with it.

In a complete system of this kind the ramifications of a change in one industry can be traced throughout the economy and the final effects upon each industry measured, granted certain assumptions. An increase in the output of a given industry would require increased inputs from its suppliers. But this would mean corresponding increases in the total outputs of these industries. Each such increase would constitute a further requirement for inputs (hence outputs) from the appropriate supplying industries. The size of the second, third, and higher order effects would diminish progressively as the system approached a new equilibrium. The steps in this process are analogous to those of the ''income multiplier'' analysis on the preceding page. The ratio of the final to the initial change in output from a given industry may be regarded as an ''interindustry multiplier'' implicit in the system of input-output relationships in the economy.

The assumptions underlying both types of multiplier analysis are still highly restrictive. But in the absence of a self-consistent model of some kind, discussions of interaction between agriculture and the general economy tend to suffer from oversimplification and from unverified assumptions about quantitative relationships.

For this reason, agricultural economists should take an active interest in the interpretation, application, and further development, of the interindustry relations approach most recently exemplified by the Bureau of Labor Statistics study of the U. S. economy in 1947.[7] The interindustry approach is highly instructive in itself if we are concerned with physical relationships between outputs and inputs, as in many aspects of mobilization planning. But, in general, a change in money demand for the products of a given industry sets up reverberations not only through the input-output structure of the economy, but also through the whole system of demand and supply relationships which together determine changes in prices and incomes as well as in production and consumption.

As time goes on, we need to supplement the input-output approach with one that permits us to use, among other things, our knowledge of demand and supply curves for agricultural commodities. Conceptually, this leads us into a very large system of simultaneous equations—a sort of ''econometric map'' of the agricultural economy in the framework of total economic activity.[8] Our single-equation demand analyses, and sub-models of moderate complexity, would be as useful as ever. But the over-all model would force upon us a keener awareness of the nature of the approximations we were making, and of the variables or sets of economic relationships that we were assuming constant.

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[7] A 42-industry table based on this study appears in an informative article by Wassily M. Leontief: ''Input-Output Economics,'' *Scientific American*, October 1951, pp. 15-21. In this table ''agriculture and fisheries'' are treated as a single industry. It is expected that larger, more detailed tables from the 1947 study will be available soon.

[8] For further insight into the usefulness of such an undertaking, see Haavelmo, Trygve, ''Quantitative Research in Agricultural Economics: The Interdependence Between Agriculture and the National Economy''; *Journal of Farm Economics*, November 1947, pp. 910-924.