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Factors Affecting Farm Income, Farm Prices, and Food Consumption

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Agricultural price analysis was one of the hard cores around which the agricultural economics of the 1920's and early 1930's were built. Since then, in all too many cases the working economists have been too busily engaged in current operations to set down their appraisals of price-making forces in any formal way. Many have drifted from recognized statistical methods to a shorter-run, almost wholly intuitive, "market feel" approach. Some of the theoretical or teaching economists, especially the mathematically trained group, have gone in the opposite direction, stressing models, structural equations, and the substitution of symbols for statistics. In one sense this article returns to an earlier tradition, once again substituting statistical values for symbols, and at the same time formally setting down both the methods and the results in such a way that they can be checked, in terms of both theory and experience.

But Fox has gone beyond the earlier tradition in a number of respects. Commodities accounting for a large proportion of farm income are treated in a consistent manner. The marketing system is recognized as a separate entity standing between consumer demand at retail prices and that of processors and dealers at the farm or local level. The statistical methods used are relatively simple, but they have been chosen after careful consideration of the theories and more complex equation forms advanced by the mathematical economists and econometricians. Suggestions are offered as to means of reconciling both family-budget and time-series information relating to the demand for food.

The more technical part of the article is preceded by a discussion of factors affecting the general level of farm income and the demand for farm products as a group.—O. V. Wells

Sources of Cash Farm Income

ONE APPROACH to the subject of demand for farm products is to consider the stream of goods marketed from farms and the ultimate destinations of the components of that stream. A stream of cash receipts flows back to farmers from each of the component flows of goods.

The volume of cash received from a particular source is only an approximate measure of its importance in the determination of farm income. The net effect of each flow of goods depends upon the elasticity of demand for farm products in other uses as well. For example, if there had been no price-support program on corn and cotton in 1948, cash income from commercial sales might have been considerably lower.

In table 1, cash receipts are separated into five components: (1) sales to other farmers, (2) sales to domestic consumers, (3) sales to the U. S. armed forces, (4) sales for export, and (5) net proceeds from price-support loans.

The first of these components, sales to other farmers, is frequently overlooked. In 1949, some

TABLE 1. — *Sources of cash farm income, United States, 1940, 1944, and 1949*

Source	Cash farm income[1]		
	1940	1944	1949
	Bil. dol.	*Bil. dol.*	*Bil. dol.*
1. Sales to other farmers[2]	*0.9*	*2.0*	*3.1*
a. Livestock	0.5*	0.7*	1.4*
b. Feed[3]	0.4	1.3	1.7
2. Sales to domestic consumers	*6.8*	*14.5*	*20.3*
a. Food	6.0*	11.7*	18.0*
b. Fibers[4]	0.5	1.1	1.3
c. Tobacco	0.2	0.6	0.7
d. Other[5]	(0.1)	(1.1)	(0.3)
3. Sales for the U. S. armed forces (food only)[6]	-----	*1.9*	*0.3*
4. Sales for export[7]	*0.4*	*1.8*	*2.8*
5. Net proceeds from price support loans[8]	*0.3*	*0.2*	*1.6*
Total, all sources	8.4*	20.4*	28.1*

[1] Each stream of goods valued at farm prices. Most of these figures are unofficial estimates. Asterisks denote official estimates (rounded).

[2] Used for further agricultural production.

[3] Fifty-five percent of total farm expenditures for purchased feed in 1944 and 1949; 45 percent in 1940.

[4] Cotton, wool, and mohair.

[5] Net result of (a) sales of miscellaneous nonfood crops, (b) equivalent farm value of hides and other nonfood livestock byproducts, (c) changes in commercial nonfarm stocks, (d) farm income from CCC price-support purchases minus CCC sales which appear in domestic consumption, purchased feed, and exports, and (e) errors of estimation and rounding.

[6] Excluding purchases for civilian feeding in occupied territories.

[7] Including military shipments for civilians in occupied territories.

[8] Net proceeds to farmers from CCC loans. Does not include returns from CCC purchase and disposal operations, as on potatoes.

1,363 million dollars' worth of livestock (mainly feeder and stocker cattle) were sold by one group of farmers, were shipped across State lines, and were bought by other farmers. This represents an internal flow of commodities and money within agriculture, and is not a net contribution from agriculture to other sectors of the economy. Farmers in 1949 also spent 3,080 million dollars for purchased feed. According to rough calculations, approximately 55 percent of this amount, or 1,700 million dollars, was reflected back into cash receipts for other farmers.

The movement of livestock and feed between farmers in 1949 accounted for 3.1 billion dollars, or about 11 percent of total cash receipts from farm marketings. The value of this internal flow is affected by changes in prices of livestock and feeds and by changes in the volume of movement between farms.

The second and by far the largest component of cash receipts is derived from sales to domestic civilian consumers. The total amount of this flow in 1949 was about 20.3 billion dollars. Between 8[illegible] and 90 percent of the total (18.0 billion dollars) was from sales of food. Sales of cotton, wool, and mohair, returned 1.3 billion dollars, and sales of tobacco for domestic use 0.7 billion dollars. The other item shown in table 1 under sales to domestic consumers is really a residual from the remaining calculations in the table, and is explained in its footnote 5.

The third component of cash farm income is from sales to the armed forces for the use of our own military personnel. During most of the postwar period, the military has also bought food for relief feeding in occupied territories. As these shipments are included in the value of exports (item 4 of table 1) and as their volume is not directly dependent on the size of the armed forces, they are not included here. Food used by the armed forces represented only about 1½ percent of our total food supplies in 1949. At the height of our war effort in 1944, however, the armed forces required nearly 15 percent of our food supply.

The fourth major component of farm income is from sales to foreign countries, and military shipments for civilian feeding in occupied areas. For several years the volume of exports has been unusually dependent upon programs of the U. S. Government. During 1949, more than 60 percent of the total value of agricultural exports was financed by ECA and military relief feeding programs.

The fifth component is net proceeds to farmers from CCC commodity loans. Under the terms of price-support legislation this is a residual source of income after all commercial demands at the prescribed price-support levels have been satisfied. During 1949, loans taken out by farmers on commodities exceeded farmers' redemptions of such loans by some 1.6 billion dollars. Although this item represented a substantial contribution to cash farm income in 1949, it could well be a negative item in other years. The rapid redemption of cotton of the 1949 crop during the summer of 1950 is an excellent illustration of this.

Table 1 shows that the great bulk of cash farm income is determined by domestic factors. More than 70 percent of total cash receipts come from sales to domestic consumers. The 10 or 11 percent of cash receipts representing sales to other farmers moves with the domestic demand for livestock

products. The volume of food required for our armed forces depends upon governmental decisions. Even sales for export are considerably influenced by domestic factors. This point is developed further in the following section.

Factors Affecting General Level of Farm Income

A number of basic factors must be considered in appraising the outlook for farm income at any given time.

DISPOSABLE INCOME OF CONSUMERS. — The disposable income of domestic consumers has proved to be the best over-all indicator of the demand for agricultural products consumed by them. Our livestock products, fresh fruits, and vegetables are consumed almost wholly in this country. Cash receipts from these products are closely associated with year-to-year changes in disposable income. Disposable income affects receipts from such export crops as wheat, cotton, and tobacco, but foreign demand conditions are also highly influential.

Obviously, a key problem in forecasting demand for farm products is to anticipate changes in disposable income. To see the factors that influence this variable, we must place it in a still broader context—that is, the total volume of economic activity of individuals, corporations and Government. Table 2 shows the major components of this total as estimated by the Department of Commerce.

In most years the strategic factors causing changes in disposable income are (1) gross private domestic investment and (2) expenditures of Federal, State, and local Governments. Government expenditures are a substantial factor in the peacetime economy, and the dominant element in time of mobilization or war. Gross private domestic investment includes new construction — residential, commercial, and industrial—expenditures for producers' durable equipment, and changes in business inventories.

The Securities and Exchange Commission has had considerable success in estimating changes in business expenditures for new plant and equipment on the basis of information submitted by businessmen. Actual construction of buildings or delivery of heavy equipment lags several months to a year behind the issuance of contracts or orders. Hence, knowledge of new contracts and orders gives us valuable insights into the level of employment and industrial activity to be expected several months ahead.

TABLE 2.—*Gross national product, disposable income, and consumer expenditures, United States, 1950*

Item	Amount
	Billions of dollars
A. Expenditure Account	
Gross national product	*279.8*
Government purchases of goods and services	*42.1*
Federal	22.7
State and local	19.4
Gross private domestic investment	*49.4*
Nonfarm residential construction	12.5
Other construction	9.3
Producers' durable equipment	23.4
Change in business inventories	4.1
Net foreign investment	*—2.5*
Personal consumption expenditures	*190.8*
Nondurable goods	*101.6*
Food	[1]52.2
Tobacco products	4.4
Clothing and shoes	18.7
Other (including alcoholic beverages)	[1]26.3
Services	*59.9*
Housing	18.3
Other	41.6
Durable goods	*29.2*
Automobiles and parts	12.1
Other	17.1
B. Income Account	
Gross national product	*279.8*
Minus: Business taxes, depreciation allowances, undistributed profits and other items[2]	75.6
Equals: Personal income from current production of goods and services	204.2
Plus: Government transfer payments	19.1
Equals: Total personal income	223.2
Minus: Personal taxes and related payments	20.5
Equals: Disposable personal income	*202.7*
Personal savings	11.9
Personal consumption expenditures	190.8

Source: U. S. Department of Commerce.

[1] Estimated.

[2] Includes capital consumption allowances, indirect business tax and nontax liabilities, subsidies minus current surplus of Government enterprises, corporate profits and inventory revaluation adjustment minus dividends, contributions for social insurance (included in Supplements to wages and salaries) and a statistical discrepancy.

Note: Details will not necessarily add to totals, because of rounding.

Changes in business inventories are an active element in the economy in some years. "Pipe-line" stocks of consumer durable goods were practically zero at the end of World War II, and the pressure to build up working stocks was a significant addition to the final consumer demand. At other times the change in business inventories is a surprise to businessmen themselves. It means that they have been producing or buying at a faster rate than was justified by the existing level of demand. An unplanned increase in business inventories may be followed by a sharp contraction in manufacturers' output, with a consequent reduction in employment

and payrolls in the industries that are overstocked. This, in turn, depresses the demand for consumers' goods, including food.

In 1950, Government purchases and gross private investment amounted to 33 percent of the Gross National Product. The other 67 percent consisted of personal-consumption expenditures. These expenditures are divided into three broad categories. In 1950, services, including rent and utilities, amounted to 59.9 billion dollars. Expenditures for nondurable goods amounted to 101.6 billion dollars, of which about 52 billion dollars went for food. The remaining 49 or 50 billion dollars went for clothing, household textiles, fuel, tobacco, alcoholic beverages, and a wide variety of items. Expenditures for such consumers' durable goods as automobiles and household appliances reached 29.2 billion dollars in 1950.

Under peacetime conditions consumer expenditures are generally regarded as a passive element in the economy, following rather than causing changes in employment and income. Expenditures for food, clothing, and other nondurable goods seem to adapt themselves rapidly to changes in disposable income. Outlays for such services as rent and utilities change more slowly.

Expenditures for consumer durable goods normally fluctuate 1.5 to 2.0 times as much from year to year as does disposable income. In years of low employment, consumers sharply reduce their outlays for new durables and get along on what they have. Toward the top of a business cycle deferred purchases are caught up, so that the rate of new purchases in a year like 1929 (or 1950) is higher than could be maintained indefinitely even under conditions of full employment.

Although expenditures for consumer durables generally move with consumer income, the fact that they *can* be either deferred or advanced makes them a potential hot-spot in the economy. The wave of consumer buying that immediately followed "Korea" is a dramatic illustration. Expenditures for durable goods had been unusually large from 1947 through 1949 and many economists had expected them to slacken in 1950. Actually, the 1950 expenditures for consumer durables were up 22 percent from 1949, with the bulk of the rise concentrated in the second half of the year.

In summary, we may say that year-to-year changes in disposable income depend on the decisions of businessmen (including farm operators), the decisions of consumers, and the decisions of Federal, State, and local Governments. Ordinarily the strategic decisions are made by business and Government. Although decisions of consumers usually follow changes in disposable income, they may become as influential as the decisions of businessmen in initiating changes at critical junctures. The "potential" of consumer initiative has been increased by the abnormally large holdings of liquid assets by individuals. Installment and mortgage credit give additional scope to consumer initiative in an inflationary period unless curbed by Government action.

CHANGES IN MARKETING MARGINS. — Disposable income is the chief determinant of consumer expenditures for food in retail stores and restaurants. But between consumer expenditures and cash farm income lies a vast, complex marketing system. During 1949, farmers received slightly less than 50 cents of the average dollar spent for food at retail stores. Still higher service charges were involved in food eaten at restaurants. For non-food products, as cotton, wool, and tobacco, farmers received about 15 percent of the consumer's dollar.

Marketing margins for food crops show great variation. Fresh fruits and vegetables grown locally during the summer and fall may move directly from farmers to consumers. In winter, fresh truck crops are transported long distances from such States as California, Texas, and Florida, and the freight bill takes a substantial share of the consumer's dollar.

Grain products undergo much processing between farms and consumers. A loaf of bread is a far different commodity than the pound or less of wheat which is its main ingredient. During the years between World War I and World War II farmers received for the wheat included in a loaf of bread anywhere from 7 to 19 percent of the selling price of the bread itself. Bread includes such other ingredients as sugar and fats and oils, which are also of farm origin, but 70 percent of the retail price of bread in 1949 represented baker's and retailer's charges over and above the cost of primary ingredients.

Meat-animal and poultry products have relatively high values per pound and most of them move through the marketing system in a short time. Farmers receive anywhere from 50 to 75 percent of the retail dollar spent for various food livestock products.

During the period between 1922 and 1941 a change of 1 dollar in retail food expenditures from year to year was usually associated with a change of 60 cents in farm cash receipts. But during World War II, marketing margins were limited by price-control and other measures, so that from 1940 through 1945 farm income from food products increased 78 cents for each dollar increase in their retail-store value. Following the removal of subsidies and special wartime controls in 1946, marketing margins for farm products rapidly "reflated." From 1946 to 1949 the national food marketing bill increased more than twice as much as did farm income from food products. Farmers got only 26 percent of the increase in retail food expenditures.

The mild recession of 1949 seemed to presage a return to the prewar relationship between changes in consumer food expenditures and farm cash receipts. If so, it has probably been disturbed again by the advent of mobilization and price control.

Cotton and wool are elaborately processed and may change hands several times before reaching the final consumer. The manufacturing and distributing sequence takes several months. Tobacco is stored for 1 to 3 years before manufacture. Excise taxes absorb close to 50 cents of the consumer's dollar spent for tobacco products. The marketing processes for these products are so expensive and time-consuming that short-run changes in their retail prices may show little relationship to concurrent price changes at the farm level.

Government Price Supports. — Domestic demand for such commodities as wheat, cotton, and tobacco is rather inelastic. Consumption varies little from year to year in response even to drastic changes in their farm prices. Therefore, Government loans have become extremely influential in maintaining farm income from these crops in years of large production.

Ordinarily Government price-support programs may be regarded as a passive factor in the demand for farm products, once the level of support has been prescribed by legislation or administrative decision. The loan program stands ready to absorb and hold any quantities that cannot be marketed in commercial channels, either domestic or export.[1] Government purchases under Section 32 of the Agricultural Adjustment Act have been of strategic importance in relieving temporary gluts of perishable commodities.

Export Demand.—At first glance it might appear that the demand for our agricultural exports is completely independent of decisions made in our own country. But foreign buyers must have means of payment, typically dollars or gold. United States imports of goods and services are usually by far the largest source of such means of payment. Our imports from other countries are closely geared to the disposable income of our consumers and to the level of industrial production. Prices of industrial and agricultural raw materials usually respond sharply to increases in demand. In consequence, the total value of our imports is closely correlated with our gross national product and disposable income. During the 1920's and 1930's nearly 75 percent of the year-to-year variation in the total value of our exports was associated with changes in disposable income in the United States.

In the postwar period, loans and grants by the Government have been of tremendous importance in determining our agricultural exports. During 1949 some 60 percent of the total value of our agricultural exports was financed from appropriations for ECA and for civilian feeding in occupied countries.

There are many independent elements in the demand from abroad for our agricultural commodities. Unusually large crops in importing countries in a given year reduce their import requirements. An increase in production in other exporting countries also reduces the demand for our products. The effect of supplies in competing countries has been even more direct in the postwar years of dollar shortages than it was before World War II.

Factors Affecting Prices of Farm Products

During the last few months the author has developed statistical demand analyses for a considerable number of farm products. Practically all of these analyses are based on year-to-year changes in prices, production, disposable income, and other relevant factors, during the period between 1922 and 1941.

Price ceilings and other controls cut across these relationships during World War II and may well do so again during this mobilization period. But 1922-41 relationships are in most cases still the best bases we have for appraising short-run movements

[1] Subject to restrictions on eligibility for price support, such as compliance with marketing quotas or acreage allotments.

in, or pressures upon, the price structure. In practical forecasting, new elements which arise during the mobilization period must be given weight in addition to the variables included in our prewar analyses.

Method Used

Considerations of space make it necessary to assume that most readers are familiar with the statistical method by which the results of this section were derived. The method used was multiple regression (or correlation) analysis using the traditional least squares, single-equation approach. The recent development of a more elaborate method by the Cowles Commission of the University of Chicago necessitates a few words in explanation of the author's procedure.

In general, demand curves for farm products that are perishable and that have a single major use can be approximated by single-equation methods.[2] Most livestock products and fresh fruits and vegetables (and, pragmatically, feed grains and hay), fall in this category. Such products contribute more than half of total cash receipts from farm marketings. With other farm products—as wheat, cotton, tobacco, and fruits and vegetables for processing—two or more simultaneous relationships are involved in the determination of free-market prices. The multiple-equation approach of the Cowles Commission may be fruitful in dealing with such commodities. Even in the case of wheat or cotton, however, it is possible to approximate certain elements of the total demand structure by means of single equations.

The demand curves shown in this section have been fitted by single-equation methods after considering the conditions under which each commodity was produced and marketed. Commodities with complicated patterns of utilization have been treated partially or not at all.

The functions selected were straight lines fitted to first differences in logarithms of annual data. In most cases, retail price was taken as the dependent variable and per capita production and per capita disposable income undeflated as the major independent variables. To adapt the results to the requirements of a mobilization period in which consumption or retail price, or both, are controlled variables, per capita consumption was substituted for production in some analyses. Further adjustments were made in a few cases for the purpose of comparing net regressions of consumption upon (deflated) income with the results of family-budget studies.

The logarithmic form was chosen on the ground that price-quantity relationships in consumer demand functions were more likely to remain stable in percentage than in absolute terms when there were major changes in the general price level. First differences (year-to-year changes) were used to avoid spurious relationships due to trends and major cycles in the original variables, and for their relevance to the outlook work of the Bureau of Agricultural Economics which focuses on short-run changes.

Before World War II, commodity analysts frequently expressed the farm price of a commodity as a function of its production and some measure of consumer income. But consumers respond to retail prices. It will contribute to clear thinking if we derive one set of estimating equations relating retail prices and consumer income, and another set expressing the relationships between farm and retail prices. At certain periods, sharp readjustments may take place within the marketing system. For this reason, an equation that expressed farm price as a function of consumer income would have missed badly during 1946-49. We should not have known whether its failure was due to changes in consumer behavior or to changes in the marketing system, as both were telescoped into a single equation.

Results Obtained

Food Livestock Products. — Some consumer-demand curves for livestock products are summarized in table 3. A 1-percent increase in per capita consumption of food livestock products as a group was associated with a decrease of more than 1.6 percent in the average retail price. The relationships in table 3 are based on year-to-year changes for the 1922-41 period.

Two sets of relationships are shown in the case of meat. During the early and middle 1920's we exported as much as 800 million pounds of pork in a year. The export market tended to cushion the drop in prices of meat when there was an increase in hog slaughter. As total meat production was

[2] For a fuller treatment of this point and for a brief account of the history and present status of agricultural price analysis see the author's paper, RELATIONS BETWEEN PRICES, CONSUMPTION AND PRODUCTION, *American Statistical Association. Journal*, September 1951.

TABLE 3.—*Food livestock products: Factors affecting year-to-year changes in retail prices, United States, 1922-41*

Commodity or group	Coefficient of multiple determination[1]	Effects of one percent changes in: Production or consumption[2] Net effect	Production or consumption[2] Standard error	Disposable income[2] Net effect	Disposable income[2] Standard error	Supplies of competing commodities[2] Net effect	Supplies of competing commodities[2] Standard error
		Percent[3]		*Percent*[3]		*Percent*[3]	
All food livestock products[4]	.98	**—1.64**	(.13)	0.84	(.03)		
All meat (production)	.98	—1.07	(.07)	.86	(.07)		
Pork	.92	— .85	(.09)	.93	(.10)		
Beef	.96	— .83	(.09)	.83	(.05)	[5]—.38	(.05)
Lamb	.91	— .34*	(.15)	.78	(.07)	[5]—.40	(.11)
All meat (consumption)	.98	—1.50	(.08)	.87	(.03)		
Pork[4]	.97	—1.16	(.07)	.90	(.06)		
Beef[4]	.95	—1.06	(.12)	.88	(.06)	[6]—.52	(.09)
Lamb[4]	.94	— .50*	(.14)	.78	(.06)	[6]—.65	(.14)
Poultry and eggs:							
Chickens[4]	.86	— .75*	(.18)	.76	(.09)	[7]—.42	(.16)
Turkeys (farm price)	.90	—1.21	(.25)	1.06	(.20)	[8]—.97	(.48)
Eggs (adjusted)	.87	—2.34*	(.44)	1.34	(.13)		
Dairy products:							
Fluid milk	.87			.55	(.05)		
Evaporated milk	.84			.59	(.06)		
Cheese	.84			.77	(.08)		
Butter	.84			1.01	(.11)		

[1] Unadjusted. Represents the percentage of total year-to-year variation in retail price during 1922-41 which was "explained" by the combined effects of the other variables.
[2] Per capita basis.
[3] Coefficients based on first differences of logarithms. Can be used as percentages without serious bias for year-to-year changes of as much as 10 or 15 percent in each variable.
[4] Based on *consumption* per capita. Other analyses based on production per capita.
[5] Production per capita, all other meats.
[6] Consumption per capita, all other meats.
[7] Consumption per capita, all meat.
[8] Production per capita, chickens.
* Probably understates true effects of changes in production or consumption upon price.

fairly stable to begin with, small absolute changes in exports, imports, and cold-storage holdings, substantially reduced the percentage fluctuations in consumption of meat. During the 1922-41 period as a whole, meat consumption changed only about 70 percent as much from year to year as did meat production.

The first set of price-quantity coefficients for meat indicates that a 1-percent increase in meat production caused a decline of little more than 1 percent in the average retail price of meat. Increases of 1 percent in pork or beef production were associated with declines of less than 1 percent in their retail prices, and the net effect of lamb and mutton production upon the price of lamb was even smaller.

In a mobilization period the total civilian supply of meat is subject to control. The second set of meat analyses is more relevant to our current situation. A 1-percent decrease in per capita consumption of meat was associated with an increase of 1.5 percent in its average retail price.[3] A 1-percent change in the consumption of pork alone was associated with an opposite change of about 1.2 percent in its retail price. An increase in supplies of pork also had a significant depressing effect on the prices of beef and lamb.

A 1-percent increase in the consumption of beef was associated with slightly more than a 1-percent decrease in its retail price, if supplies of other meats remained constant. If the supply of other meats also increased 1 percent, the price of beef tended to decline another 0.5 percent. Supplies of beef and pork seem to have had fully as much in-

[3] In an inflationary period, commodity prices rise more rapidly than would be indicated by prewar relationships. This does not mean that the price elasticities of demand have changed. The disturbing factors are more likely to affect the relationship between price and consumer income.

TABLE 4.—*Food livestock products: Relationships between year-to-year changes in farm price and retail price, United States, 1922-41*

Commodity or group	Coefficient of determination	Effects of 1-percent changes in:			
		Retail price		Other factors	
		Effect	Standard error	Net effect	Standard error
		Percent[1]		*Percent*[1]	
All food livestock products	.97	1.47	(.07)		
Meat animals—all	.91	1.57	(.12)		
Hogs (1)	.86	1.75	(.17)		
Hogs (2)	.87	1.35	(.44)	[2]0.28	(.29)
Beef cattle	.91	1.74	(.14)		
Lambs	.85	1.06	(.18)	[3] .26	(.05)
Poultry and eggs:					
Chickens	.93	1.35	(.09)		
Eggs	.97	1.08	(.05)		
Dairy products:					
Milk for fluid use	.93	1.64	(.11)		
Condensery milk	.79	2.13	(.27)		
Milk for cheese	.79	1.76	(.22)		
Butterfat	.95	[4]1.35	(.06)		
Creamery milk	.95	[4]1.19	(.08)	[5] .13	(.04)

[1] Coefficients based on first differences of logarithms.

[2] Wholesale price of *lard* at Chicago. Coefficient not significant owing to high intercorrelation ($r^2 = .85$) between retail price of pork and wholesale price of lard.

[3] U. S. average farm price of *wool*.

[4] Coefficient derived by algebraic linkage of two regressions: (1) Farm price upon wholesale price of butter and (2) wholesale price upon retail price. Coefficients of determination have been reduced and the standard error increased to allow for residual errors in both equations.

[5] Wholesale price of dry nonfat milk solids (average of prices for both human and animal use).

fluence on the price of lamb as did the supply of lamb itself.

Increases of 1 percent in supplies of chicken and turkey have depressed their retail prices by about the same amount. The price of chicken was significantly affected by supplies of meat, and the price of turkey was significantly affected by supplies of chicken. It is evident from these two relationships that supplies of meat were also a factor in the determination of prices for turkey. In a special analysis not shown in table 3, supplies of pork during October-December appeared to have a significant effect upon the farm price of turkeys.

The retail price of eggs responded more sharply to changes in production than did prices of any of the livestock products previously mentioned. The change of —2.3 percent (table 3) probably understates the true effect of a 1-percent change in per capita egg production. For reasons discussed later, no price-production relationships are shown for dairy products.

If we turn briefly to the price-income relationships in table 3 we find that many of the coefficients run between 0.8 and 1.0. If we had an adequate retail-price series for turkeys, the regression of retail price upon disposable income would probably be somewhat less than 1.0. Prices of eggs appeared to respond more sharply to changes in consumer income than did those of other livestock products.

There are many difficulties in price and consumption analysis for dairy products. All of these products stem from the same basic flow of milk. The fluid milksheds are only partially insulated from the effects of supplies and prices of milk in other areas. Surpluses from these milksheds are converted into manufactured products, thereby affecting prices of manufacturing milk and butterfat.

In the major manufacturing milk areas there are at least three alternative outlets for milk. Competition between condenseries, cheese factories, and creameries (including "butter-powder" plants), keeps prices of raw milk in the different uses approximately equal. The retail price of each product reflects the common price of manufacturing milk plus processing margins and mark-ups. Dairy products which have wide dollars-and-cents margins show a small percentage relationship between retail price and consumer income. Butter has a small processing and distributive cost relative to its value and shows a sharper "response" of retail price to disposable income.

Table 4 shows some relationships between year-to-year changes in retail prices and associated

changes at the farm level. The coefficients are all in percentage (logarithmic) terms.

It has long been recognized that farm prices fluctuate more violently than retail prices because of the presence of fixed costs or charges in the marketing system. The coefficients in table 4 bear out this observation. Prices of livestock products as a group, during 1922-41, were approximately 1.5 times as variable (in percentages) at the farm level as at retail. The relationships for hogs, beef cattle, and for meat animals as a group ranged from 1.5 to 1.75 percent. The relationship for chickens was about 1.35 percent. The percentage change in the farm price of eggs was only slightly larger than the percentage change at retail.

Farm prices of milk and butterfat fluctuate considerably more than do retail prices of the finished products. Butter has the smallest marketing margin and the smallest percentage relationship between farm and retail price changes. The farm price of fluid milk changed about 1.6 times as sharply as the retail price and the price of milk used for cheese fluctuated about 1.8 times as much as the retail price of cheese. The price paid for milk by condenseries fluctuated more than twice as sharply as the retail price of evaporated milk, owing to the importance of fixed costs and charges in the marketing system.

At least three of the commodities listed in table 4 have important byproducts. Thus, the price of wool is a highly significant factor affecting prices received by farmers for lambs. The price of lard is a recognized factor in market prices for hogs, including price discounts for heavier animals. However, since the wholesale price of lard during 1922-41 was highly correlated with the retail price of pork, the coefficient that relates hog prices to the price of lard is not statistically significant. The price of whole milk delivered to creameries is significantly related to the price of dry nonfat milk solids, as well as to the price of butter.

Other commodities shown in the table have byproducts of some value, including hides and skins. The value of these byproducts is undoubtedly reflected in market prices to some extent and enters into the calculations of processors. But it is not always possible to measure these relationships from time series.

Table 5 summarizes relationships between farm prices, production and disposable income. In most cases the effect of a 1-percent change in production or consumption per capita is associated with more than a 1-percent change in the farm price. There is some indication that the price of hogs during April-September is less sharply affected by changes in pork production than during the heavy marketing season, October-March. Prices of eggs respond more sharply to changes in production than do prices of other livestock products. The price-quantity coefficients for individual dairy products have little significance. The regressions of consumption upon price shown in table 6 are more meaningful and are considered later.

For most livestock products the response of farm price to disposable income is more than 1 to 1. Coefficients seem to center around 1.3. Exceptions to this are prices received by farmers for all dairy products and for wholesale milk, where the coefficients are approximately 1.0.

As in table 3, supplies of competing commodities influence the farm prices of beef cattle, calves, lambs, chickens, and turkeys. The price of dry nonfat solids is again included as a factor affecting the farm price of creamery milk.

Food Crops and Miscellaneous Foods.—Table 5 also shows factors affecting farm prices of several fruits and vegetables. Prices of some of the deciduous fruits responded less than proportionately to year-to-year changes in production. The response for apples averaged —.8 percent, and for peaches (excluding California) approximately —.7. Peaches in other States are produced mainly for fresh market, whereas half or more of the California peaches are clingstone, produced for canning. In California, freestone peaches also are used extensively for canning and drying. Because of the complex utilization pattern, no single estimating equation for California peaches is likely to yield meaningful results.

Before 1936, about 90 percent of all cranberries were marketed in fresh form. Marketings were confined to the fall. A bumper crop in 1937 caused a sharp expansion in processing, and this utilization continued to increase. There is some evidence in the data for later years that the demand for cranberries has become somewhat more elastic as a result. That is, the farm price has been somewhat less responsive to changes in production than it was during the 1922-36 period. On the debit side, farm prices have been depressed in some recent years by excessive carry-overs of processed cranberries.

Prices of citrus fruits responded more than pro-

TABLE 5.—*Factors affecting year-to-year changes in farm prices, United States, 1922-41*

Commodity or group	Coefficient of multiple determination	Effect of 1-percent changes in: Production or consumption — Net effect	Production or consumption — Standard error	Disposable income — Net effect	Disposable income — Standard error	Supplies of competing commodities — Net effect	Supplies of competing commodities — Standard error
		Percent[1]		*Percent*[1]		*Percent*[1]	
				Food Livestock Products (per capita basis)			
All food livestock products[2]	.95	—2.45	(.31)	1.23	(.07)		
All meat animals (production)	.88	—1.60	(.26)	1.43	(.15)		
Hogs—cal. yr.	.82	—1.54	(.26)	1.63	(.28)		
Hogs—Oct.-Mar.	.81	—1.52	(.26)	2.08	(.28)		
Hogs—Apr.-Sept.	.69	— .99*	(.25)	1.50	(.37)		
Beef cattle	.90	—1.19	(.23)	1.27	(.13)	[3]— .40	(.15)
Veal calves	.93	— .82	(.16)	1.30	(.10)	[3]— .75	(.16)
Lambs	.87	—1.50	(.31)	1.09	(.15)	[3]— .70	(.24)
Poultry and eggs:							
Chickens	.86	— .62*	(.28)	1.06	(.12)	[4]—1.01	(.30)
Turkeys	.90	—1.21	(.25)	1.06	(.20)	[5]— .97	(.48)
Eggs (adjusted)	.82	—2.91*	(.55)	1.43	(.17)		
Dairy products:							
All	.87			.98	(.09)		
Milk, wholesale	.88			1.05	(.10)		
Milk, fluid use[6]	.91	—1.49	(.42)	.79	(.07)		
Condensery milk[6]	.76	[7]— .41	(.47)	1.34	(.19)		
Milk for cheese[6]	.71	[7]—1.01	(.59)	1.47	(.23)		
Butterfat[6]	.85	[7]—1.13	(.55)	1.28	(.15)		
Creamery milk	.79			[8]1.21	(.14)	[9] .13	(.04)
				Fruits and Vegetables (per capita basis unless otherwise noted)			
All fruits (total)	.82	— .94	(.12)	1.06	(.21)		
All deciduous fruits (total)	.82	— .68	(.09)	1.08	(.18)		
Apples (total)	.96	— .79	(.04)	1.04	(.12)		
Peaches (total)[10]	.80	— .67	(.09)	.96	(.30)		
Cranberries (1932-36)[11]	.86	—1.49	(.19)	.78	(.31)		
All citrus fruits (total)	.92	—1.32	(.10)	.98	(.20)		
Oranges	.93	—1.61	(.11)	1.34	(.25)		
Grapefruit	.72	—1.77	(.28)	1.29	(.55)		
Lemons, all	.61	—1.69	(.34)	[12] .78	(.59)		
Lemons shipped fresh:						Temperature	
Summer[13]	.79	—2.48	(.40)	1.07	(.30)	[14] .98	(.17)
Winter[13]	.88	—1.39	(.16)			[15]—1.69	(.37)
Potatoes	.93	—3.51	(.26)	1.20	(.33)		
Sweetpotatoes	.75	— .77	(.16)	.89	(.24)		
Onions:							
All[16]	.89	—2.27	(.20)	1.00	(.29)		
Late summer[16]	.85	—2.90	(.32)	[17] .72	(.60)		
Truck crops for fresh market[18]							
Calendar year (total)	.85	—1.03*	(.26)	.81	(.12)		
Winter (total)	.67	—1.13*	(.35)	.92	(.31)		
Spring (total)	.49	[17]— .95*	(.48)	.63	(.22)		
Summer (total)	.87	—1.72	(.34)	1.23	(.19)		
Fall (total)	.84	—1.67	(.35)	.85	(.20)		

[1] Coefficients based on first differences of logarithms. [2] Consumption per capita (index). [3] Production per capita, other meats. [4] Consumption per capita, all meat. [5] Production per capita, chickens.

[6] Equations include per capita consumption of end product.

[7] These coefficients do not have "structural" significance, and two of them are statistically nonsignificant also.

[8] Coefficient obtained by algebraic linkage of three equations. Coefficient of determination reduced and standard error increased to allow (approximately) for residual errors in all three equations.

[9] Wholesale price of dry nonfat milk solids (average of prices for both human and animal use).

[10] United States, excluding California.

[11] Processing outlet expanded rapidly after 1937. There is evidence that demand is now more elastic.

[12] Nonsignificant.

[13] Adapted from analyses originally developed by George M. Kuznets and Lawrence R. Klein in "A Statistical Analysis of the Domestic Demand for Lemons, 1921-1941," Giannini Foundation of Agricultural Economics, Mimeographed Report No. 84, June 1943. Prices are measured at the f.o.b. level. The adaptations consist in (1) converting all variables into logarithmic first differences (year-to-year changes), and (2) substituting disposable personal income for nonagricultural income. The latter adjustment had little effect on the results.

[14] Index of summer temperatures in major U. S. cities (Kuznets and Klein).

[15] Index of winter temperatures in major U. S. cities (Kuznets and Klein).

[16] Analysis developed by Herbert W. Mumford, Jr. [17] Nonsignificant at 5 percent level. [18] Equations fitted to 1928-41 data only. * Probably understates true effect of production on price.

portionately to changes in production. The regression coefficients for oranges, grapefruit, and lemons, individually ranged from —1.6 to —1.8 percent. Adaptations of analyses originally developed by Kuznets and Klein suggest that prices of lemons respond much more sharply to year-to-year changes in fresh-market shipments during the summer than during the winter.

The regressions of farm prices upon disposable income center around 1.0. As in most of the analyses the price-income coefficient is not so accurately established as the price-production coefficient, little significance can be attached to deviations above or below 1.0 in the former.

Kuznets and Klein introduced an interesting feature into their analyses—an index of temperatures in major consuming centers. Temperature appears to be a highly significant factor in both summer and winter. Hot weather in the summer increases the demand for lemons in thirst-quenching drinks. On the other hand, unusually cold weather in the winter appears to increase the demand for lemons; the reputation of lemon juice as a preventive of colds may be influential.

Prices of potatoes and onions respond rather sharply to changes in production. In the prewar period, when there were no price-support programs of consequence for potatoes, a 1-percent change in potato production per capita was associated with a 3.5-percent opposite change in the U. S. farm price. Prices of the late summer crop of onions, from which most of our storage supplies come, showed a price-production response of approximately —2.9. The 12-month average price of onions indicates a less violent response to changes in production, or about —2.3.

The analyses for fresh-market truck crops are based on indices of prices and production recently developed by Herbert W. Mumford, Jr. These indices have not yet been thoroughly tested. The correlations between price and production in the summer and fall look reasonable. They indicate a price response to production of about —1.7 percent. The analyses for the winter and spring are not so accurately established. It seems probable that the true response of price to production in these seasons and for the calendar year as a whole is somewhat greater than is implied by table 5.

The regressions of farm prices of vegetables upon disposable income in table 5 center around 1.0. The standard errors of these coefficients are, in general, sufficiently large that the deviations from 1.0 are not significant.

Responses of Consumption to Price.—Table 6 summarizes responses of the consumption of various food livestock products to changes in retail price and disposable income. These coefficients are estimates of the elasticity of consumer demand. For food livestock products as a group, elasticity of demand during 1922-41 seems to have been slightly more than —.5.[4] The elasticity of demand for all meat appears to have been slightly more than —.6. Demand elasticities for individual meats, assuming that supplies of other meats remained constant, ranged from —.8 for pork and beef to at least —.9 for lamb. It is possible that the true elasticity of demand for lamb (with supplies of other meats held constant) was somewhat more than —1.0.

For certain technical reasons the elasticities of demand for chicken and turkey at retail are probably higher than the least-squares coefficients in table 6. The coefficient for turkey is based on farm prices and the response of consumption to a 1-percent change in retail price would certainly be somewhat larger. It seems probable that the elasticities of consumer demand for both chicken and turkey were not far from —1.0 during the 1922-41 period.

The elasticity of demand for eggs is estimated at —.26. It is the least elastic of the livestock products included in table 6 with the possible exception of fluid milk and butter.

The demand elasticities for individual dairy products are not so accurately established as are those for meat and poultry products. There is some evidence that the elasticity of demand for fluid milk (based on year-to-year changes) is about —.3. The elasticity of demand for evaporated milk may be as high as —1.0 although the standard error of this coefficient is fairly large. The only statistically significant coefficient obtained for butter consumption indicated a demand elasticity of about —.25 during 1922-41. Even if this result is correct it seems probable that the consumption of butter under present conditions would respond more sharply than this to changes in price. The increasing use of oleomargarine as a bread-spread is the main reason for this belief.

Table 7 summarizes coefficients for fruits and vegetables which, in general, may be taken as ap-

[4] The words "more" or "less" applied to demand elasticities in this article refer to absolute values. In this case, the estimated elasticity is between —.5 and —.6.

TABLE 6.—*Food livestock products: Factors affecting year-to-year changes in per capita consumption, United States, 1922-41*

Commodity or group	Coefficient of determination	Effects of 1-percent changes in: Retail price		Price of all other commodities		Disposable income[1]		Supply of competing commodities[1]	
		Net effect	Standard error	Net effect	Standard error	Net effect	Standard error	Net effect	Standard error
		Per-cent[2]		*Per-cent*[2]		*Per-cent*[2]		*Per-cent*[2]	
All food livestock products:	*Multiple*								
Actual income	.91	—.56	(.04)			0.47	(.04)		
Deflated income	.95	—.52	(.03)	[3].70	(.10)	[4] .40	(.03)		
All meat:									
Actual income	.96	—.64	(.03)			.56	(.04)		
Deflated income	.96	—.62	(.04)	[5].69	(.15)	[4] .51	(.05)		
Pork	.94	—.81	(.05)			.72	(.07)		
Beef	.86	—.79	(.09)			.73	(.08)	[6] —.41	(.09)
Lamb	.59	—.91*	(.26)			.65	(.23)	[6] —.83	(.20)
Poultry and eggs:	*Partial*								
Chicken	.54	—.72*	(.17)						
Turkey (farm price)	.74	[7] —.61*	(.13)						
Eggs	.48	[7] —.26	(.07)						
Dairy products:									
Milk for fluid use (farm price)	.44	—.30	(.08)						
Evaporated milk	.28	—.84	(.32)						
Butter	.21	[8] —.25	(.12)						

[1] Per capita basis.
[2] Coefficients based on first differences of logarithms.
[3] Special index, retail prices other than food livestock products.
[4] Disposable income deflated by retail price index.
[5] Special index, retail prices other than meat.
[6] Consumption per capita, other meats.
[7] Production per capita.
[8] Based on algebraic linkage of three equations. Elasticity of demand for butter has probably increased in recent years.
* Probably understates true effect of price upon consumption.

proximations to the elasticity of dealer demand. This is strictly true only if production and sales are exactly equal. These coefficients can also be used as a basis for estimating elasticities of demand at retail if (1) supplies actually reaching consumers are nearly equal to production and (2) if we have appropriate equations relating percentage changes in prices at retail and farm levels. If there are any fixed elements in the marketing margin, the elasticity of demand at the consumer level will be greater than at the farm price or dealer level.

The demand for apples and peaches at the farm-price level was moderately elastic, averaging about —1.2. The demand for cranberries before 1936 was moderately inelastic (about —.6). The elasticity of —1.1 for deciduous fruits as a group was a weighted average for an extremely heterogeneous group of commodities, including fruits used for processing. Apples carried a heavier weight than any other deciduous fruit and contributed largely both to the regression coefficient and to the coefficient of partial determination for the deciduous group as a whole.

Demand elasticities for individual citrus fruits at the packinghouse door appear to have ranged from —.6 down to —.3. Demands for oranges and winter lemons were the most elastic, grapefruit was of intermediate elasticity, and summer lemons had the least elasticity. Processing outlets for citrus fruits have expanded greatly over the last 15 years. Processing has extended the marketing season and increased the variety of product for each of the citrus fruits. On logical grounds, at least, this should have increased the elasticity of demand for them at the farm level. Consequently, the elasticities in table 7 should not be applied to the current situation without careful statistical and qualitative

TABLE 7.—*Fruits and vegetables: Net regressions of production upon current farm price, United States, 1922-41* [1]

Commodity or group	Coefficient of partial determination	Net regression of production upon farm price [2]	
		Coefficient	Standard error
		Percent [3]	
All fruits (total)	.77	— .82	(.11)
Deciduous fruits (total)	.76	—1.11	(.15)
Apples (total)	.96	—1.21	(.06)
Peaches [4] (total)	.79	—1.18	(.15)
Cranberries (1922-36) [5]	.85	— .57	(.07)
All citrus fruits	.91	— .69	(.05)
Oranges	.92	— .58	(.04)
Grapefruit	.70	— .40	(.06)
Lemons, all	.59	— .35	(.07)
Lemons shipped fresh:			
Summer [6]	.72	— .29	(.05)
Winter [6]	.85	— .61	(.07)
Potatoes — production	.92	— .26	(.02)
Potatoes — consumption [7]	.81	— .22	(.03)
Sweetpotatoes	.57	— .74	(.16)
Onions — all [8]	.88	—. 39	(.03)
Onions — late summer [8]	.83	— .28	(.03)
Truck crops for fresh market [9]			
Calendar year (total)	.61	— .59	(.15)
Winter (total)	.51	— .45	(.14)
Spring (total)	.28	[10] — .30	(.15)
Summer (total)	.72	— .42	(.08)
Fall (total)	.69	— .41	(.09)

[1] If consumption is nearly equal to production, these coefficients may be taken as approximations to the elasticity of *dealer* demand. Demand at the consumer level will typically be more elastic than at the farm or f.o.b. level.

[2] Production per capita unless otherwise noted.

[3] Based on first differences of logarithms.

[4] United States, excluding California.

[5] Processing expanded rapidly after 1936. There is some evidence that demand is now more elastic.

[6] Adapted from data and analyses originally developed by George M. Kuznets and Lawrence R. Klein, Giannini Foundation, 1943. (See table 5, footnote 4).

[7] Response of per capita consumption to retail price.

[8] Analysis developed by Herbert W. Mumford, Jr.

[9] Equations fitted to 1928-41 only.

[10] Unrounded coefficient not significant at 5-percent level.

study of recent experience. In particular, the phenomenal expansion of frozen concentrated orange juice since 1948 may have had a substantial effect on the elasticity of demand for oranges.

During 1922-41, the elasticity of demand for potatoes at retail seems to have been little more than —.2. The extremely inelastic demand contributes to price-support difficulties for this crop, for relatively small surpluses have a considerable depressing effect on both retail and farm prices. The elasticity of demand for onions at the farm-price level appears to have been —.3 or less for the late summer crop, and about —.4 for the year as a whole.

The elasticity of demand for sweetpotatoes is less meaningful than those for potatoes and onions. Some 50 or 60 percent of all sweetpotatoes produced are used on the farms where grown. The elasticity of market demand may be decidedly different from the production-price coefficient in table 7.

Elasticities of demand for fresh-market truck crops seem to center around —.4 at the farm-price level. These coefficients are based on indexes which include a heterogeneous group of commodities. For example, the indexes include onions for which the demand elasticity in late summer and fall was —.3 or less. Implicitly, it appears that demand elasticities for some individual truck crops may be considerably higher than —.4 if supplies of competing truck crops are held constant. The analyses for fresh-market truck crops are little more than exploratory. More detailed analyses for individual commodities will be made as time permits.

TABLE 8.—*Feed grains and hay: Factors affecting year-to-year changes in farm prices, United States, 1922-41*

Commodity	Coefficient of multiple or simple determination	Effect of changes of 1-percent in: Supply factors: Net effect	Supply factors: Standard error	Demand factors: Net effect	Demand factors: Standard error
	Multiple	*Percent* [1]		*Percent* [1]	
Hay	.89	−1.39	(.15)	[2] 0.83	(.16)
Corn	.85	[3] −1.93	(.21)	[4] .89 [5] 2.26	(.20) (.71)
Corn	.82	[6] −1.26 [7] − .89	(.28) (.40)	[8] 1.06	(.25)
Corn	.85	[6] −1.22 [9] − .82 [10] +1.72	(.27) (.29) (1.19)	[8] .89	(.25)
		Average percent change in price associated with one percent change in price of corn			
	Simple	Percent change [1]		Standard error	
All feed grains: Prices received by farmers	.99	.91		(.02)	
Hominy feed (Chicago)	.97	.86		(.03)	
Prices paid by farmers for purchased feed	.91	.55		(.04)	
Grain sorghums	.88	.97		(.09)	
Oats	.82	.73		(.08)	
Barley	.77	.68		(.09)	
Soybean meal (Chicago)	.67	.59		(.13)	
Hay	.51	.40		(.09)	
Tankage (Chicago)	.35	.41		(.13)	

[1] Coefficients based on first differences of logarithms.
[2] Cash receipts from beef cattle and dairy products, weighted approximately in proportion to total hay consumption by each type of cattle.
[3] Total U. S. supply of corn, oats, barley and grain sorghums.
[4] Index of prices received by farmers for grain-consuming livestock (weighted according to grain requirements).
[5] Number of grain-consuming animal units on farms, January 1.
[6] U. S. supply of corn (adjusted for net changes in CCC stocks).
[7] U. S. supply of other feed grains and byproduct feeds.
[8] Product of numbers and prices of grain-consuming livestock.
[9] U. S. supply of oats, barley and grain sorghums, plus wheat and rye fed.
[10] U. S. supply of byproduct feeds. Regression coefficient is statistically nonsignificant.

An analysis of the demand for all food represents too high a degree of aggregation for most purposes. Livestock products account for more than 60 percent of the retail value of food products sold to domestic consumers and originating on farms in the United States. Consumer purchases of livestock products respond significantly to changes in price. Demand elasticities for several of these products range from −0.5 to −1.0.

The foods mainly of plant origin include some fruits and vegetables for which demand is even more elastic than the demand for meat. They also include potatoes, dry beans, cereals, sugar, and fats and oils, for which both price and income elasticities of consumption are extremely small.

Aggregative analyses of the demand for all food yield regression coefficients which are weighted averages of these diverse elasticities for individual foods. If the price of every food at retail dropped 10 percent (income remaining constant in real terms) total food consumption might increase by something like 3 to 4 percent. However, the consumption response is not independent of the distribution of price changes for individual foods if we relax the assumption of parallel price movement. A drastic decline in prices of potatoes, flour, sugar, and lard would have a negligible effect on total food consumption if prices of meats, poultry, fruits and vegetables, remained constant. On the other hand, a 10-percent drop in an index of food prices caused by a 30-percent drop in the price of meat might well lead to a 6-percent increase in an index of total food consumption.

FEED CROPS.—Table 8 summarizes some price-estimating equations for hay and corn. The U. S. average farm price of hay generally dropped about 1.4 percent in response to 1-percent increase in total supply of hay. The demand factor used in the hay analysis is an index of cash receipts from sales of dairy products and beef cattle, weighted in pro-

portion to total hay consumption by dairy and beef cattle respectively. The price of hay changed somewhat less than proportionately to this demand index.

The first analysis shown for corn expresses corn prices as a function of total supplies of corn, oats, barley, and grain sorghums. These grains are closely substitutable for corn in most feeding uses. A 1-percent increase in total supplies of the four grains generally reduced the price of corn almost 2 percent.

Two demand factors are used in this analysis. The first is an index of prices received by farmers for livestock products, with each product weighted approximately by its grain requirements. The regression coefficient indicates that a 1-percent increase in the average price of grain-consuming livestock is associated with very nearly a 1-percent increase in the price of corn. This is consistent with the function of livestock-feed price ratios as equilibrating mechanisms for the feed-livestock economy. The second demand factor in this equation is the number of grain-consuming animal units on farms as of January 1. This coefficient is significant but is not so accurately established as the other coefficients in the equation. It implies that a 1-percent increase in grain-consuming animal units from one year to the next tends to increase corn prices perhaps 2 percent.

The other two analyses for corn illustrate points that are sometimes overlooked in price analysis. As other feed grains are substitutable for corn the net effect of a 1-percent increase in corn supplies upon corn prices (supplies of other feeds remaining constant) is less than the effect obtained if supplies of all feed grains increase by 1 percent. The last analysis subdivides the total supply of feed concentrates into three parts. During 1922-41 the net response of corn price to corn supply was not much more than —1.2. The response of corn prices to changes in supplies of other feed grains was approximately —.8. The regression of corn prices upon supplies of byproduct feeds was positive but statistically nonsignificant. The positive sign is not wholly implausible since these feeds are used to a large extent as supplements rather than substitutes for corn.

Table 8 also summarizes some simple regression relationships between year-to-year changes in prices of other feeds and the price of corn. The level of correlation obtained is a rough indicator of the closeness of competition between the other feeds and corn on a short-run (year-to-year) basis.

Export Crops.—All of the analyses referred to in tables 3 through 8 are based on the traditional single-equation approach. This approach is not conceptually adequate to derive the complete demand structures for export crops such as wheat, cotton, and tobacco. In the absence of price supports, at least two (relatively) independent demand curves are involved in determining their prices—domestic and foreign.

It is possible, however, to get approximate estimates of the response of domestic consumption of wheat and cotton (and possibly tobacco) to changes in their farm prices. An exploratory analysis by the author yielded a demand elasticity (with respect to farm price) of —.07 ($\pm$ .027) for the domestic food use of wheat. Other investigators have obtained elasticities of about —.2 (with respect to spot market prices) for the domestic mill consumption of cotton. The domestic consumption of tobacco products also appears to respond very little to changes in the farm price of tobacco.

Comparison of Time-Series Results with Family-Budget Studies

The problem of reconciling time-series and family-budget data on demand has interested economists for many years. Among other difficulties, few analysts have found sufficiently good data of both types to work with. These pages are exploratory, but they may stimulate some fruitful discussion and criticism. Space does not permit a full exposition of the methods used in this section, but a brief indication is given in table 9, footnote 1.

Table 6 contains two time-series analyses that were designed to simulate as nearly as possible the conditions prevailing in family-budget studies. One coefficient in each equation measures the relationship between consumption and real disposable income with prices of all commodities held constant by statistical means. These coefficients are compared in table 9 with corresponding family-budget regressions based on data collected by the Bureau of Human Nutrition and Home Economics in the spring of 1948. (See also table 10.)

Consumption in the time-series equation for food livestock products is measured by means of an index number. A pound of steak is weighted more heavily than a pound of hamburger and, of course, much more heavily than a pound of fluid milk. The

TABLE 9.—*Relationships between consumption and income as measured from time series and from family budget data, United States, 1922-41 and 1948*

Item	Net effect of 1-percent change in per capita income upon:		
	Consumption per capita (time series data, 1922-41)	Expenditure per capita [1] (family budget data, spring 1948)	Quantity purchased per capita [1] (family budget data, spring 1948)
	Percent	*Percent*	*Percent*
All food livestock products	0.40 [2] (.03)	0.33	0.23
All meat	.51 [2] (.05)	[3] .36	.23

[1] See table 10, footnote 2. A fuller statement of the methods used to obtain these coefficients will be supplied on request.

[2] Standard error of time series coefficient. Comparable measures for the family budget coefficients are not available, as the coefficients were calculated from grouped data.

[3] Meat, poultry, and fish. Coefficient for meat alone would be slightly higher.

weights are average retail prices in 1935-39. Hence the time-series regression implies that if all prices are held constant, *expenditures* will increase with income in the proportions indicated.

Conversely, the expenditures shown in family-budget data are analogous to price-weighted indexes. As the price of each type, cut, and grade of product is the same to consumers of all income groups during the week of the survey, expenditures for livestock products at two family-income levels are equal to the different quantities bought, multiplied by the same fixed prices.

Consumption in the time-series analysis for meat is measured in pounds (carcass-weight equivalent) but each "pound" is a composite of all species, grades, and cuts. Expenditures at constant prices will change almost exactly in proportion to these "statistical pounds." But the actual pounds shown in family-budget data reflect more expensive cuts and grades at high- than at low-income levels. In the 1948 study, average prices per pound paid by the highest income group exceeded those paid by the lowest in the following ratios: All beef, 34 percent; all pork, 28 percent; all meat, 35 percent; meat, poultry, and fish combined, 32 percent. On the average, a pound of meat (retail weight) bought by a high-income family represented a greater demand upon agricultural resources than a pound of meat bought by a low-income family.

There are strong arguments for comparing the expenditure - income regressions from family-budget data with the consumption-income regressions from time series. The coefficients are not unduly far apart, considering the possible factors that make for differences. Among other things, 1948 was a year of full employment. As the income elasticity of food consumption decreases at higher family-income levels, and as the family-budget observations have been weighted according to the high-income pattern of 1948, the regression coefficients in table 10 are probably lower than would have been obtained on the average during 1922-41.

Some internal features of the family-budget data for 1948 deserve comment. In the case of livestock products the expenditure coefficients more nearly reflect demands upon agriculture (hence, real income to agriculture) than do the quantity coefficients. The differences between the two sets of coefficients are largely due to differences in type and quality of products consumed, with the significant aspects of quality being reflected back to farmers in the form of higher farm values per retail pound.

The situation with respect to two of the fruit and vegetable categories seems to be similar to that of livestock products (table 10). The difference between expenditure and quantity coefficients probably reflects increasing use of the more expensive types and qualities within each commodity group. The higher income families may be paying more for marketing services, but they are also paying more per pound to the farmer.

This is only partly true in the "other foods" group. *Grains* at the farm level are fairly homogenous. The difference between expenditure and quantity regressions for grain products must largely reflect differences in marketing services (baked goods versus flour, and so forth). *Sugars* and *sweets* include candy, soft drinks, and preserves, and sugars and sirups. To the extent that candy includes domestically produced nuts, or that preserves include domestic fruits and berries, the positive expenditure coefficient indicates some benefits to farmers. But most of the difference between expenditure and quantity regressions for sweets goes to bottlers, confectioners, and distributors.

The positive expenditure coefficient for *fats* and *oils* is mainly due to the greater use of butter by the higher income groups. Because of this fact, the expenditure coefficient more nearly represents the demand for agricultural resources in the produc-

TABLE 10.—*Food expenditures and quantities purchased: Average percentage relationship to family income, urban families, United States, spring 1948*

Item	Relative importance[1] (1)	Effect of one-percent change in income upon: Expenditure (2)	Quantity purchased (3)	Col. (2) minus Col. (3) (4)
		Percent[2]	*Percent*[2]	*Percent*[2]
A. Per family:				
All food expenditures		*0.51*		
At home		.40		
Away from home		1.12		
B. Per family member:[3]				
All food expenditures		*.42*		
At home		.29		
Away from home		1.14		
C. Per 21 meals at home:[3]				
All food (excluding accessories)	*100.0*	*.28*	[4]*0.14*	*0.14*
All livestock products	*50.8*	*.33*	[4] *.23*	*.10*
Meat, poultry and fish	29.2	.36	.23	.13
Dairy products (excluding butter)	16.9	.32	.23	.09
Eggs	4.7	.22	.20	.02
Fruits and vegetables	*19.0*	*.42*	[4] *.33*	*.09*
Leafy, green and yellow vegetables	4.9	.37	.21	.16
Citrus fruit and tomatoes	5.2	.41	.42	— .01
Other vegetables and fruits	8.9	.45	.35	.10
Other foods	*30.2*	*.08*	[4]— *.12*	*.20*
Grain products	11.4	.02	— .21	.23
Fats and oils	9.8	.13	— .04	.17
Sugars and sweets	5.2	.20	— .07	.27
Dry beans, peas and nuts	1.5	— .07	— .33	.26
Potatoes and sweetpotatoes	2.3	.05	— .05	.10

[1] Percent of total expenditures for food used at home, excluding condiments, coffee, and alcoholic beverages.

[2] Regression coefficients based upon logarithms of food expenditures or quantities purchased per 21 meals at home and logarithms of estimated Spring 1948 disposable incomes per family member, weighted by proportion of total families falling in each family income group. The object was to obtain coefficients reasonably comparable with those derived from time series.

[3] Per capita regression coefficients are lower than per family coefficients in this study whenever the latter are less than 1.0. This happens because average family size was positively correlated with family income among the survey group. A technical demonstration of this point will be supplied on request.

[4] Weighted averages of quantity-income coefficients for subgroups.

Basic data from UNITED STATES BUREAU OF HUMAN NUTRITION AND HOME ECONOMICS. 1948 FOOD CONSUMPTION SURVEYS. PRELIMINARY REPT. No. 5, May 30, 1949; tables 1 and 3.

tion of fats and oils. In the group comprising dry beans, peas, and nuts, the first two decline rapidly and the third increases rapidly as family income rises, so the expenditure regression is more relevant to farm income than is the quantity coefficient.

For all foods (excluding condiments, alcoholic beverages, and coffee) the 1948 survey of BHNHE indicates a tendency for expenditures per 21 meals at home to rise about 28 percent as much as family income per member. The weighted average of the quantity-income regressions is about 14 percent. One-fourth, or one-third, of the difference probably goes to marketing services. On balance, it appears that, in 1948, a 10-percent difference in income per family member meant a difference of roughly 2.5 percent in the per capita demand for agricultural resources used in food production.

This effect was a weighted average of 3.3 percent for livestock products, 4.2 percent for fruits and vegetables other than potatoes, and *slightly less than zero* for other foods as a group. These coefficients indicate the direction in which consumers tend to adjust their food patterns as their incomes increase. At present, per capita consumption of grain products and potatoes is 15 percent lower than in 1935-39. The demand for spreads for bread has also been caught in this downtrend, so that the per capita consumption of butter and oleomargarine combined in 1950 was 3 pounds, or 15 percent, below the prewar average. Consumption of sugar and total food fats and oils per person

was about the same in 1950 as in 1935-39. On the other hand, per capita consumption of livestock products (excluding butter and lard) was up more than 23 percent and consumption of fruits and vegetables (aside from potatoes and sweetpotatoes) was up 9 percent.

Two other points might be noted in closing: (1) The regression of *calories* upon income per family member is somewhat less than the average quantity gradient of 14 percent would suggest, as costs per calorie are considerably lower for sugar, fats and oils, and grain products, than for livestock products and fruits and vegetables; (2) the demand for *restaurant meals* seems to increase slightly more than 10 percent in response to a 10-percent increase in income per family member. This implies, of course, a similar increase in demand for restaurant services.

Economic Research in Farm Electrification

By Joe F. Davis

Farm electrification has become a major economic development in American agriculture. Studies of the uses that farmers are making of electric power have been completed or are in progress in nine areas from Georgia to Washington State. Preliminary comparisons of the findings in different areas are here reported and interpreted. (The research on which this article is based was financed in part with funds provided by the Research and Marketing Act of 1946.)

FIFTEEN YEARS AGO about 800,000 farms in the United States had electric service from central-station sources. By June 30 last year more than 5,000,000 or about 86 percent of all farms had this service.

Widespread use of electric power in rural areas has created a multitude of problems that are still with us. They are of concern both to farmers and to those in the service fields. Farmers need guidance on ways to use the power profitably, on the kinds of equipment to install, and on problems of farmstead wiring. Suppliers of electricity want a firm basis for estimating the probable future use of electricity on farms as a guide for the installation of adequate service facilities and for the establishment of rate schedules. The public too is concerned with various aspects — lending activities, utility regulations, research, teaching.

Economic research in this field was begun by the Bureau of Agricultural Economics in 1948 with the cooperation of State agricultural experiment stations. The Rural Electrification Administration and other governmental agencies have given valuable assistance in certain aspects of the work. At the outset two principal objectives were envisioned. First, to establish criteria that would be useful in estimating the probable future use of electricity on farms. Second, to study the place of electricity in the whole scheme of farm mechanization — to appraise its usefulness in reducing costs and in increasing labor efficiency on farms.

How the Studies Were Made

STUDY AREAS.—The work was begun by initiating a series of surveys in the principal type-of-farming areas of the country. Field work for nine surveys has been completed. Reports for three of these have been published—for a dairy and poultry area of northwestern Washington (USDA, FM 77), a general livestock area of eastern Iowa (USDA Circular 852) and an old cotton area in the Upper Piedmont of Georgia (Georgia Experiment Station Bulletin 263). Analyses of the data from the other 6 surveys are in various stages of progress. These surveys were made in the winter-wheat belt of southwestern Kansas, the general-farming area of the East Tennessee Valley of Tennessee, the wheat-producing area of eastern Washington, the Clay