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# Measuring the Size of the U.S. Food and Fiber System

Chinkook Lee, Gerald Schluter,  
William Edmondson, and Darryl Wills

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## **Abstract**

Civilian employment in the food and fiber system fell from over 21 percent of the workforce in 1975 to 18.5 percent in 1985. The system's share of gross national product (GNP) also fell from 20.4 percent in 1975 to 17.5 percent in 1985. The system generated \$700.8 billion in GNP and employed 21.4 million full-time workers in 1985. This report reviews procedures used to estimate income and employment in the food and fiber system and their usefulness in economic policy and decisionmaking.

**Keywords:** Food and fiber system, input-output, employment, value added, final demand, intersectoral analysis

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## Summary

Civilian employment in the food and fiber system fell from over 21 percent of the workforce in 1975 to 18.5 percent in 1985. The system's share of gross national product (GNP) also fell from 20.4 percent in 1975 to 17.5 percent in 1985. This report reviews procedures used to estimate income and employment in the food and fiber system and their usefulness in economic policy and decisionmaking. Specific findings:

- The food and fiber system generated \$700.8 billion in GNP and employed 21.4 million full-time equivalent workers in 1985.
- Farm employment in the food and fiber system stayed relatively stable during 1974-85, at around 2.5 to 3.0 million, while nonfarm employment fluctuated between 17.3 million in 1975 to 19.1 million in 1982.
- Transportation, trade, and retailing had the largest share of income in the food and fiber system, with \$220.4 billion, or nearly 6 percent of total GNP. This category also employed 6.6 million people, or 5.7 percent of the labor force.
- Income generated in the farm sector of the food and fiber system fluctuated substantially, from a high of \$75.1 billion in 1982 to a low of \$43.3 billion in 1975. Income of the system's nonfarm sectors rose steadily, but this relative share of GNP fell nonetheless.
- As personal income increased, people spent more of their income on nonfood items.

# Measuring the Size of the U.S. Food and Fiber System

Chinkook Lee, Gerald Schluter,  
William Edmondson, and Darryl Wills

## Introduction

The food and fiber system—from the farmer to the consumer—is one of the largest sectors in the U.S. economy, with \$700.8 billion of the gross national product (GNP) and 21.4 million full-time equivalent workers in 1985. The system includes all economic activities supporting farm production such as machinery repair and fertilizer production, food processing and manufacturing, transportation, wholesale, and retail distribution of food and apparel products, and eating establishments.

This report presents the economic logic of and procedures (in the appendix) behind the base year estimates and the off-year updated estimates of income and employment in the food and fiber system published by USDA (7).<sup>1</sup>

These estimates are important for several reasons. First, policies affect various sectors differently. Although we frequently speak of both government policy and macroeconomic policy as though they were one monolithic policy that affects everything equally, there are few, if any, sector-neutral policies. Similarly, changes in consumer preferences are seldom sector-neutral in their effect. Trade policies which affect grain exports or textile imports affect various economic sectors differently.

Second, sectors have different degrees of relative importance in the economy. Knowledge of these differences enables policymakers to institute policies to offset negative effects and promote programs to benefit from positive effects. In a highly developed, interrelated economy like that of the United States, determining the

relative importance of any one sector becomes complicated. For the farm sector, one could use the simplistic argument that farmers produce food, and food is essential to life, so the farm sector is most important. Yet if consumers could import their food, the lack of a domestic farm sector would not prevent operation of a nonfarm economy. Thus, what is needed is a means of determining what the farm and related sectors contribute to the economy.

One way to measure the total contribution of the farm sector to the economy is by using input/output (I/O) analysis. Davis and Goldberg first used this analysis in 1957 (3). They identified “agribusiness” as the contribution to total economic activity required to support the delivery of food, clothing and shoes, and tobacco to domestic consumers and to support agricultural exports.<sup>2</sup> They used the 1947 U.S. I/O transaction table in their estimation of income and employment. Time has eroded the usefulness of their estimates, however, since the authors estimated only 1947 and 1954 and did not update when subsequent I/O tables became available.<sup>3</sup>

## The Food and Fiber System in the U.S. Economy

Employment and income (including value added) in this report are the result of 17 economic activities involved in providing food and fiber to consumers (table 1). USDA has published similar estimates since 1980 in *Economic Indicators of the Farm Sector: Farm Sector Review* (7). Compared with the August 1984 estimates of *Farm Sector Review* for 1973-82, however, our

<sup>2</sup>Davis and Goldberg used the term “agribusiness” then instead of the food and fiber system. Since then, other more narrowly defined but still generic terms used were “food marketing system” in Greig (4) and “food manufacturing industries” in Connor and others (2).

<sup>3</sup>1954 figures were derived by extrapolation from 1947 figures.

<sup>1</sup>Italicized numbers in parentheses refer to items in the References.

estimates reflect at least two improvements (table 1). First, our data are based on the 1977 I/O structure of the U.S. economy rather than 1972. Second, previous estimates reflected the total output of the food and fiber system required to support domestic demand regardless of whether it was produced domestically or imported. Total imported food and fiber products are separated from domestic production to reflect more accurately domestic employment and income effects.

Compared with the estimates in (7) for 1975-84, our estimates reflect the U.S. Department of Commerce benchmark revisions in the National Income and Product Accounts (NIPA) and the associated shift in the base year for constant dollar NIPA estimates from 1972 to 1982. The more recent base year attributes more of the value of change in system output to real output changes and less to price changes.

The food and fiber system employed 18.5 percent of the civilian labor force and accounted for 17.5 percent of total GNP in 1985 (see final column, table 1). The food and fiber system accounted for about 41 percent of the total civilian labor force in 1947 (3, p. 11). Connor and others used the Davis and Goldberg study (3) to estimate that the food and fiber system generated about 40 percent of GNP in 1947 (2, p. 21). The drop in the food and fiber system's share of employment during 1947-85 reflects the marked increase in value of output per worker in the system and a faster economic growth rate in other parts of the economy.

The various sectors' shares of employment and value added also show how sectors in the food and fiber system are highly interrelated. Activities in one economic sector often support the other sectors to varying degrees. Sectors that directly and indirectly

**Table 1—The food and fiber system and the domestic economy**

Item	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
<i>Millions</i>											
Employment:											
Farm sector	2.8	2.8	3.0	3.0	2.8	2.6	2.5	2.3	2.6	2.7	2.5
Nonfarm sectors	17.3	17.5	17.7	18.0	18.7	19.0	18.9	19.1	18.6	18.6	18.9
Food processing	1.5	1.5	1.6	1.5	1.5	1.5	1.5	1.6	1.5	1.5	1.6
Manufacturing	3.2	3.1	3.2	3.2	3.3	3.3	3.3	3.3	3.2	3.0	3.0
Transportation, trade, and retailing	5.7	5.8	5.9	6.0	6.3	6.4	6.5	6.6	6.4	6.5	6.6
Eating	3.1	3.1	3.2	3.4	3.5	3.6	3.5	3.5	3.5	3.6	3.6
All other	3.7	3.8	3.8	3.9	4.1	4.1	4.1	4.2	4.0	4.0	4.1
Total food and fiber	20.1	20.3	20.7	20.9	21.5	21.6	21.4	21.4	21.1	21.3	21.4
Total domestic economy	93.8	96.2	99.0	102.3	105.0	106.9	108.7	110.2	111.6	113.5	115.5
<i>Percent</i>											
Farm sector	3.0	3.0	3.0	2.9	2.7	2.4	2.3	2.1	2.3	2.4	2.1
Nonfarm sectors	18.4	18.2	17.9	17.6	17.8	17.8	17.4	17.3	16.6	16.4	16.4
Total food and fiber	21.4	21.2	20.9	20.5	20.5	20.2	19.7	19.4	19.0	18.7	18.5
Total domestic economy	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
<i>\$ Billions</i>											
Value added by activity:											
Farm sector	43.3	43.4	44.7	49.0	59.4	55.1	67.3	75.1	49.8	65.9	71.6
Nonfarm sectors	282.4	311.2	340.3	366.0	406.0	444.8	495.0	536.7	553.3	594.3	629.1
Food processing	38.7	43.3	46.7	46.6	49.7	56.0	61.7	70.0	70.4	74.8	83.0
Manufacturing	57.0	60.9	66.2	70.6	77.1	83.0	93.1	97.7	98.2	101.7	103.3
Transportation, trade, and retailing	96.8	106.7	116.3	127.0	142.7	157.5	175.6	188.2	196.9	209.9	220.4
Eating	25.7	28.0	30.9	34.8	38.9	42.0	44.6	48.1	52.0	55.3	58.3
All other	64.2	72.2	80.1	86.9	97.6	106.3	120.0	132.7	135.8	152.6	164.2
Total food and fiber	325.7	354.6	385.1	415.0	465.4	499.9	562.3	611.8	603.1	660.2	700.8
Total domestic economy	1,598.4	1,782.8	1,990.5	2,249.7	2,508.2	2,732.0	3,052.6	3,166.0	3,405.7	3,765.0	3,998.1
<i>Percent</i>											
Farm sector	2.7	2.4	2.2	2.2	2.4	2.0	2.2	2.4	1.5	1.8	1.8
Nonfarm sectors	17.7	17.5	17.1	16.3	16.2	16.3	16.2	17.0	16.2	15.8	15.7
Total food and fiber	20.4	19.9	19.3	18.4	18.6	18.3	18.4	19.3	17.7	17.5	17.5
Total domestic economy	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

support the food and fiber system, for example, range from farming and food processing, to shipping and receiving activities in the grain elevator, to producing tin cans for food containers.

Compared with the rest of the economy, employment levels in the food and fiber system change less through the business cycle due to the relative stability of domestic food and clothing demands. During the 1975 recession (an investment-inventory recession), the food and fiber system contributed to the stability of the overall economy, accounting for a larger share of all GNP and employment. The food and fiber system's share again rose during the 1981-82 recession where a negative balance of trade accompanied the investment-inventory recession.

About 24.5 million people out of a total civilian labor force of 60.2 million were employed in the food and fiber system in 1947 (table 2). The 1954 figures show that food and fiber employment was nearly constant during 1947-54 while the national labor force grew. Thus, the food and fiber system's share of the total civilian labor force fell from 41 percent in 1947 to 37 percent in 1954. About 21.4 million workers were employed in the food and fiber system in 1985. This is only a 12.7-percent decrease in the food and fiber system labor force between 1947 and 1985. But the Nation's total civilian labor force rose from 60.2 million in 1947 to 115.5 million in 1985, a 92-percent increase.

### Farm Sector

The farm sector is a fairly small part of the whole food and fiber system, employing 2.5 million workers in 1985. This was only 11.7 percent of total food and fiber employment, or 2.1 percent of the total U.S. civilian labor force. Farm employment in the food and fiber system stayed relatively stable; slightly fewer than 3 million people were employed in the system each year

during 1975-85.<sup>4</sup> Growth in real final demand in the food and fiber system was matched by growth in farm labor productivity, so employment did not have to increase to provide the additional output.

In contrast to the relative stability of farm sector employment in the food and fiber system, this sector's value added fluctuated substantially, varying from a low of \$43.3 billion in 1975 to a high of \$75.1 billion in 1982. Value added (also called "GNP originating") is the residual after intermediate products consumed (purchases from other economic sectors) are subtracted from gross sector output. Thus, value-added estimates reflect changes in the volume of output, as well as relative price changes within the economy and a sector's ability or inability to adjust. Value added in 1983 was substantially smaller than in 1982, a \$25.3-billion decrease within a year. The main causes of such sharp drops were lower production associated with the payment-in-kind (PIK) program and drought. Conversely, jumps in nominal value added are often price related. The value added in 1979, for example, jumped to \$59.4 billion from \$49.0 billion in 1978. Price increases accounted for \$7 billion of this \$10-billion increase.

### Nonfarm Sector

Food and fiber system employment in nonfarm sectors increased 8.7 percent over the decade, from 17.3 million in 1975 to 18.9 million in 1985. Employment increased in transportation, trade, retailing, and eating places. Employment in the manufacturing sector of the food and fiber system decreased slightly during this period as labor productivity gains offset output increases.

Figure 1 shows the distribution of total employment within the food and fiber system in 1985. For example, the wholesale and retail trade sector's share was largest at 28.4 percent. Eating places employed 16.9 percent and farming accounted for 11.5 percent of total employment.

**Table 2—Distribution of food and fiber system employment in the national economy**

Item	1947	1954	1985
		<i>Millions</i>	
Food and fiber system	24.5	24.0	21.4
Civilian labor force	60.2	64.5	115.5
		<i>Percent</i>	
Food and fiber system as percentage of civilian labor force	41.0	37.0	18.5

Source: 1947 and 1954 estimates are from (3, pg. 11). 1985 estimates are from table 1.

<sup>4</sup>The 2.5-million-farmworker estimate reflects labor needs. With the farm labor market characterized by part-time workers, seasonal workers, unpaid family workers, and a mix of farm operator and hired labor, the 2.5-million-worker labor need likely is partially met by using a larger number of workers. This difficulty in measuring the actual involvement of labor in the farm sector is reflected in the range of estimates of farm employment. The Bureau of Labor Statistics estimated 1984 farm employment at 3.321 million (14). The U.S. Department of Agriculture's (USDA) Statistical Reporting Service (now the National Agricultural Statistics Service) estimates a total farm workforce of 3.75 million during July 1984 and 3.059 million in October of the same year. USDA's Economic Research Service estimates a hired farm workforce of 2.595 million in 1983.

The value added in all nonfarm sectors of the food and fiber system increased each year during 1975-85. These nominal increases parallel the steady increase of the price level in the general economy. Even though value added of nonfarm sectors in the food and fiber system increased, their share of value added in the general economy fluctuated. Reflecting the counter business cycle nature previously noted, the nonfarm sector's share of GNP fell from 17.7 percent in 1975 to 16.2 percent in 1979, rose to 17.0 percent in the recession year, 1982, and again fell to 15.8 and 15.7 percent in the expansion years, 1984 and 1985.

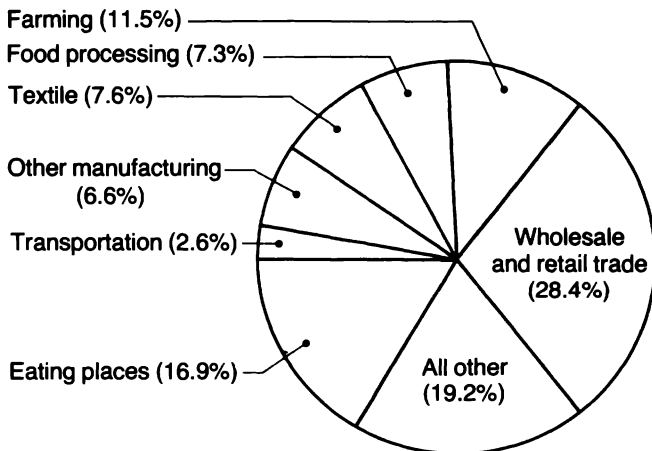
### Composition of Final Demand for Products of the System

The consumption pattern of food and fiber products changed significantly during 1947-85 (table 3). In 1947, for example, approximately 44 percent of total personal consumption expenditures (PCE) were for food and fiber products, with PCE for food alone accounting for 30.6 percent. As consumer income rose, the proportionate PCE on food and fiber products decreased slightly to 40 percent in 1954, and dropped to 25 percent in 1985.

We identified 17 individual components of demand in the food and fiber system and their values for 1975-85 (table 4). These demands are the impetus for generating income and employment in the food and fiber system. Eight of these 17 components are components of PCE. Exports are divided into farm (unprocessed) and food (processed) exports, and imports are divided into farm, food, and apparel imports. Changes in farm inventories are divided into livestock and crop inventories.

Figure 1

### Food and Fiber System Employment



1985 data. Total does not add due to rounding.

The size of individual components of final food and fiber demand largely determine estimates of employment and value added in the food and fiber system. The effects of changes in the composition of final demand on total demand for output of the food and fiber system, the livestock subsector, and the crop subsector, are shown in tables 5, 6, and 7, and figs. 2, 3, and 4, respectively. For example, in 1985, 48.3 percent of the total output of the food and fiber system was necessary to produce food for off-premise consumption (last column, first row table 5).

### International Trade

The food and fiber system is on net almost a wholly domestic sector. The net effect of apparel and agricultural imports on the food and fiber system was less than  $\pm 1$  percent during 1972-83 (see net exports total, table 5, and net export column, fig. 2). This may seem surprising since the direct balance of trade in agriculture (including apparel imports) was positive by several billion dollars each year during this period. The reason the net effect was so small is that the United States exports raw farm products (products with lower domestic output multipliers), and imports processed food products and apparel (added-value products with higher domestic output multipliers). In 1984 and 1985, however, the net effect was -3.3 and -4.8 percent, respectively, as the result of increased apparel imports and decreased exports of agricultural products and processed foods.

Table 3—Consumer purchases of food and fiber products

Product	1947	1954	1985
	<i>\$ Billions</i>		
Food	50.6	69.8	469.3
Tobacco	3.9	5.3	31.8
Shoes and footwear	3.0	3.5	22.9
Clothing	15.6	16.0	132.3
Total	73.1	94.6	656.3
Total personal consumption expenditures	165.4	236.5	2,600.5
	<i>Percent</i>		
Food and fiber consumption as percentage of total personal consumption expenditures	44.2	40.0	25.2

Source: Figures for 1947 and 1954 are from (3, pg. 8). Figures for 1985 are from (14) (see appendices).



## Domestic Demand

The relative importance of PCE for food as an impetus for output in the food and fiber system during 1972-85 declined from 75.5 to 69.1 percent of total system output while PCE for clothing rose from 16.6 to 22.7 percent. This largely reflects a 4.9-percent annual real growth in PCE for clothing, compared with a 2.1-percent annual rate in PCE for food. As income increased, people spent more of their income on nonfood items, although much of the growth in the demand for clothing was met by increased imports of apparel. Apparel imports grew more than 13 percent annually from \$4.9 billion in 1975 to \$19.5 billion in 1985 (table 4). The crop and livestock inventories and other final demands (largely driven by off-farm inventories and changes in Government stocks) added volatility to the annual share estimates rather than providing a stable

demand for output in the food and fiber system (see "other" column, fig. 2).

## Livestock

Two facts stand out in the analysis of the livestock sector (table 6). First is the fact that PCE food dominates as the primary source of demand for livestock (fig. 3). PCE food demands alone could account for all livestock output during most years; the rest of the categories offset each other. In 1984, for example, PCE for nonfood items (including shoes) accounted for 1.7 percent of real demands for livestock output but was offset by a -2.2 percent in net agricultural exports. Second, about three times more farm livestock production is necessary to meet processed food export demand than to meet raw farm product export demand.

Table 4—Real final demands of the U.S. food and fiber system

Components of demand	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
<i>\$ 1982 Billion</i>											
Personal consumption expenditures, food:											
Off-premises consumption	244.0	257.2	266.8	263.1	266.5	272.4	272.4	278.4	288.1	293.1	300.5
Purchased meals and beverages	94.9	98.7	103.1	109.3	113.6	115.1	112.5	112.9	118.2	123.2	124.9
Furnished to employees	5.6	5.9	5.8	6.0	6.2	6.4	6.5	6.6	6.6	6.8	7.1
Consumed in farm households	1.8	1.8	1.5	1.3	1.2	1.1	1.0	1.0	1.0	1.0	.9
Total	346.4	363.6	377.1	379.6	387.5	394.9	392.5	398.8	414.0	424.2	433.4
Personal consumption expenditures, other:											
Tobacco	23.8	25.5	24.6	24.3	25.0	24.9	25.3	24.7	23.7	23.5	23.6
Clothing	73.3	77.1	81.4	89.5	93.9	96.5	102.9	105.5	112.5	121.3	123.8
Shoes	14.7	15.2	16.0	17.5	18.2	18.3	19.3	18.9	20.1	21.4	22.2
Flowers	4.3	4.5	4.2	4.8	4.9	4.7	4.6	4.5	4.7	5.1	5.2
Total	116.2	122.2	126.2	136.1	141.9	144.4	152.1	153.6	161.0	171.3	174.8
Net exports:											
Agricultural exports	21.6	21.8	21.4	23.4	24.6	29.9	30.0	26.0	25.6	23.0	18.4
Processed food exports	8.3	9.8	10.8	12.3	12.7	13.5	14.0	11.7	11.2	11.2	10.4
Agricultural imports	-1.0	-1.2	-1.6	-1.4	-1.2	-1.4	-1.2	-2.2	-2.6	-3.2	-3.0
Processed food imports	-7.5	-7.5	-7.5	-8.3	-9.3	-9.7	-9.2	-7.9	-8.1	-8.5	-9.7
Apparel imports	-4.9	-6.6	-7.0	-9.5	-9.7	-9.8	-10.8	-11.6	-13.4	-18.0	-19.5
Total	16.5	16.3	16.1	16.5	17.1	22.5	22.8	16.0	12.7	4.5	-3.4
Others:											
Livestock inventory change	-2.9	-2.6	-3.7	-2.9	.8	1.6	.3	-.7	-.8	-2.5	-2.8
Crop inventory change	4.3	-1.0	1.8	3.5	3.8	-6.3	4.6	-.7	-5.5	7.4	.8
Other final demand	.9	3.6	3.7	-.1	-.1	.3	1.2	7.3	-.1	1.5	7.7
Farm capital expenditures	24.9	25.3	24.8	27.2	26.9	21.8	18.3	13.7	12.4	11.4	9.3
Total	27.2	25.3	26.6	27.7	31.4	17.4	24.4	19.6	6.0	17.8	15.0
Total	506.3	527.5	545.9	559.9	578.0	579.2	591.8	587.9	593.7	617.7	619.8
<i>Percent</i>											
Components as percentage of demand:											
Personal consumption expenditures, food	68.4	68.9	69.1	67.8	67.1	68.2	66.3	67.8	69.7	68.7	69.9
Personal consumption expenditures, other	22.9	23.2	23.1	24.3	24.6	24.9	25.7	26.1	27.1	27.7	28.2
Net exports	3.3	3.1	2.9	2.9	3.0	3.9	3.9	2.7	2.1	.7	-.6
Others	5.4	4.8	4.9	4.9	5.4	3.0	4.1	3.3	1.0	2.9	2.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Totals may not add due to rounding.

Note: For detailed sources of these values, see appendices 1 and 2.

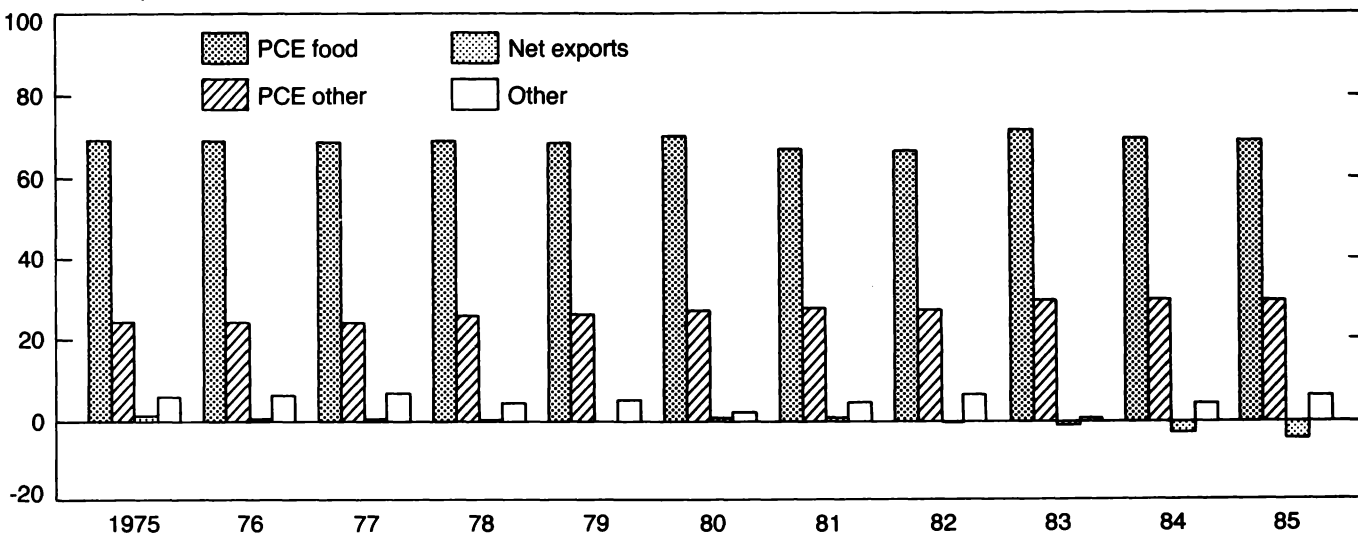
**Table 5—Contribution of individual real demands to food and fiber output**

Components of demand	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	<i>Percent</i>													
<b>Personal consumption expenditures, food:</b>														
Off-premises consumption	55.1	51.5	51.6	49.1	49.3	49.1	48.4	47.6	48.9	47.0	46.9	50.2	48.3	48.3
Purchased meals and beverages	18.8	18.9	19.1	18.4	18.2	18.3	19.3	19.5	19.9	18.7	18.3	19.8	19.5	19.3
Furnished to employees	1.1	1.1	1.2	1.2	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Consumed in farm households	.4	.4	.5	.4	.4	.3	.3	.3	.2	.2	.2	.2	.2	.2
<b>Total</b>	<b>75.5</b>	<b>71.8</b>	<b>72.4</b>	<b>69.1</b>	<b>69.1</b>	<b>68.9</b>	<b>69.1</b>	<b>68.5</b>	<b>70.2</b>	<b>67.0</b>	<b>66.6</b>	<b>71.5</b>	<b>69.3</b>	<b>69.1</b>
<b>Personal consumption expenditures, other:</b>														
Tobacco	3.9	4.0	4.1	3.8	3.9	3.6	3.6	3.6	3.6	3.5	3.3	3.3	3.1	3.0
Clothing	16.6	17.0	17.3	16.8	16.8	17.1	18.7	19.1	19.7	20.2	20.2	22.3	22.8	22.7
Shoes	3.1	3.1	3.0	2.8	2.8	2.8	3.0	3.1	3.1	3.1	3.0	3.3	3.3	3.4
Flowers	.7	.7	.7	.7	.7	.6	.7	.7	.6	.6	.6	.6	.6	.6
<b>Total</b>	<b>24.2</b>	<b>24.8</b>	<b>25.2</b>	<b>24.1</b>	<b>24.1</b>	<b>24.1</b>	<b>26.0</b>	<b>26.4</b>	<b>27.0</b>	<b>27.4</b>	<b>27.2</b>	<b>29.6</b>	<b>29.8</b>	<b>29.7</b>
<b>Net exports:</b>														
Agricultural exports	2.3	3.4	4.0	3.9	3.7	3.5	3.9	3.9	4.8	4.6	3.9	4.0	3.4	2.7
Processed food exports	2.1	2.3	2.6	2.1	2.4	2.5	2.9	2.9	3.1	3.1	2.5	2.5	2.3	2.1
Agricultural imports	-.4	-.3	-.3	-.3	-.3	-.4	-.3	-.3	-.3	-.3	-.5	-.6	-.7	-.6
Processed food imports	-3.2	-3.4	-3.9	-2.9	-2.8	-2.7	-3.0	-3.2	-3.4	-3.1	-2.6	-2.8	-2.7	-3.0
Apparel imports	-1.7	-1.8	-1.9	-1.8	-2.4	-2.4	-3.3	-3.3	-3.3	-3.5	-3.7	-4.4	-5.6	-5.9
<b>Total</b>	<b>-1.0</b>	<b>.2</b>	<b>.6</b>	<b>1.0</b>	<b>.7</b>	<b>.6</b>	<b>.1</b>	<b>0</b>	<b>.9</b>	<b>.8</b>	<b>-.3</b>	<b>-1.2</b>	<b>-3.3</b>	<b>-4.8</b>
<b>Others:</b>														
Livestock inventory change	.3	.5	.3	-.4	-.3	-.4	-.3	.1	.2	0	-.1	-.1	-.3	-.3
Crop inventory change	.2	.6	-.6	1.3	-.3	.5	1.0	1.0	-1.7	1.2	-.2	-1.4	1.8	.2
Other final demand	-3.5	-3.1	-2.8	.7	2.7	2.7	-.1	-.1	.2	.8	4.8	-.1	1.0	4.9
Farm capital expenditures	4.2	5.1	5.0	4.2	4.0	3.8	4.2	4.0	3.3	2.6	1.9	1.8	1.6	1.3
<b>Total</b>	<b>1.2</b>	<b>3.2</b>	<b>1.9</b>	<b>5.8</b>	<b>6.2</b>	<b>6.5</b>	<b>4.7</b>	<b>5.1</b>	<b>2.0</b>	<b>4.7</b>	<b>6.5</b>	<b>.2</b>	<b>4.1</b>	<b>6.0</b>
<b>Total</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>

Figure 2

**Sources of Demand for Food and Fiber Output**

% of total output



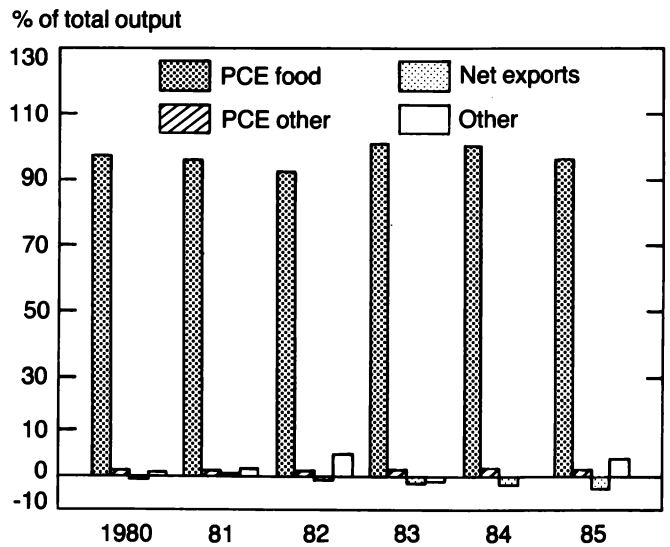
## Crops

Compared with livestock, the base of demand for crops is broader and changing (table 7, fig. 4). Domestic food consumption as a source of crop output demand has declined from over 85 percent in 1972 to about 60 percent in recent years.<sup>5</sup> Raw farm exports as a source of demand for crop output have risen from 18 percent in 1972 to nearly 36 percent in 1980. Many major crops are storable and the Government uses its own storage as a tool in price support programs. Thus, changes in private and Government stocks are often a significant component of aggregate crop demand. But such stocks are also volatile. When export and other domestic demands are met by liquidating stock, swings can be wide enough to influence the year-to-year magnitude of all share coefficients of demand components for crop output, as during 1982-84.

<sup>5</sup>The share coefficients in 1983 are distorted because both the PIK program and the drought led to reduced production; as a result, a historically disproportionate share of 1983 domestic demands were met by drawing down stocks. This is reflected in the -13.7 percent for crop inventories and the -14.1 percent for the "others" category. Domestic food demand as a share of current year production is also a disproportionately high 77.1 percent.

Figure 3

## Sources of Demand for Livestock Output



PCE is personal consumption expenditures.

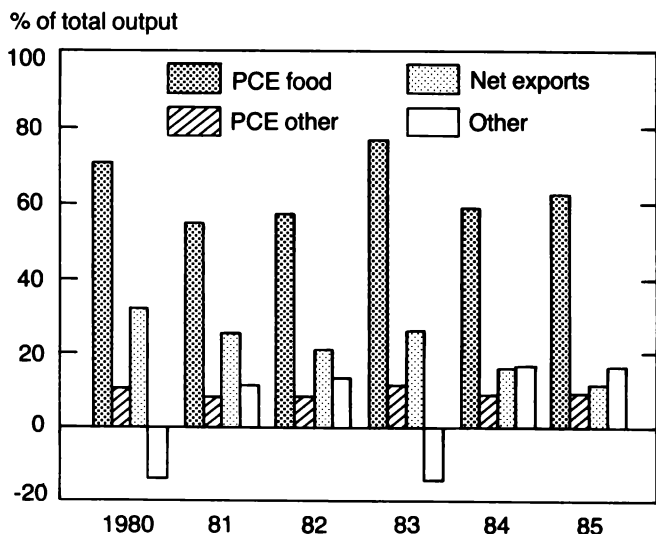
Table 6—Contribution of individual real demands to livestock output

Components of demand	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
<i>Percent</i>														
<b>Personal consumption expenditures, food:</b>														
Off-premises consumption	87.2	83.3	84.6	82.8	80.0	80.7	82.3	79.4	79.1	78.2	75.4	82.3	81.6	78.5
Purchased meals and beverages	14.1	14.5	14.8	14.7	14.0	14.2	15.6	15.4	15.2	14.7	13.9	15.4	15.7	14.9
Furnished to employees	2.2	2.2	2.5	2.5	2.5	2.4	2.5	2.5	2.5	2.5	2.4	2.6	2.6	2.5
Consumed in farm households	1.2	1.1	1.4	1.3	1.2	.9	.8	.7	.7	.6	.6	.6	.6	.5
<b>Total</b>	<b>104.7</b>	<b>101.2</b>	<b>103.3</b>	<b>101.3</b>	<b>97.7</b>	<b>98.3</b>	<b>101.3</b>	<b>98.1</b>	<b>97.5</b>	<b>96.1</b>	<b>92.3</b>	<b>100.9</b>	<b>100.5</b>	<b>96.4</b>
<b>Personal consumption expenditures, other:</b>														
Tobacco	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
Clothing	.7	.7	.7	.7	.7	.7	.8	.8	.8	.9	.8	.9	1.0	.9
Shoes	.3	.4	.4	.3	.3	.3	.4	.4	.4	.4	.3	.4	.4	.4
Flowers	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
<b>Total</b>	<b>1.4</b>	<b>1.4</b>	<b>1.5</b>	<b>1.4</b>	<b>1.4</b>	<b>1.4</b>	<b>1.5</b>	<b>1.5</b>	<b>1.5</b>	<b>1.5</b>	<b>1.5</b>	<b>1.6</b>	<b>1.7</b>	<b>1.6</b>
<b>Net exports:</b>														
Agricultural exports	.9	1.4	1.6	1.6	1.5	1.4	1.6	1.6	1.9	1.9	1.6	1.6	1.4	1.1
Processed food exports	4.0	4.4	5.2	4.3	4.6	5.0	5.9	5.8	6.0	6.1	4.8	4.9	4.7	4.1
Agricultural imports	-1.1	-.8	-.8	-.7	-.8	-1.1	-1.0	-.8	-.9	-.8	-1.3	-1.6	-2.0	-1.7
Processed food imports	-6.6	-7.0	-8.2	-6.4	-5.8	-5.7	-6.5	-6.9	-7.0	-6.6	-5.4	-5.8	-5.9	-6.3
Apparel imports	-.1	-.2	-.2	-.2	-.2	-.2	-.3	-.3	-.3	-.3	-.3	-.4	-.5	-.5
<b>Total</b>	<b>-2.9</b>	<b>-2.1</b>	<b>-2.3</b>	<b>-1.4</b>	<b>-.7</b>	<b>-.5</b>	<b>-.3</b>	<b>-.6</b>	<b>-.3</b>	<b>-.4</b>	<b>-.6</b>	<b>-1.3</b>	<b>-2.2</b>	<b>-3.3</b>
<b>Others:</b>														
Livestock inventory change	1.9	3.9	2.0	-3.0	-2.5	-3.5	-2.8	.7	1.4	.3	-.6	-.7	-2.2	-2.3
Crop inventory change	.1	.2	-.2	.4	-.1	.2	.3	.3	-.5	.4	-.1	-.4	.6	.1
Other final demand	-5.3	-4.7	-4.3	1.2	4.2	4.2	-1	-1	.3	1.3	7.4	-.1	1.6	7.5
Farm capital expenditures	.1	.1	.1	.1	.1	.1	.1	.1	0	0	0	0	0	0
<b>Total</b>	<b>-3.2</b>	<b>-.5</b>	<b>-2.5</b>	<b>-1.4</b>	<b>1.7</b>	<b>.9</b>	<b>-2.5</b>	<b>1.0</b>	<b>1.3</b>	<b>2.0</b>	<b>6.8</b>	<b>-1.2</b>	<b>0</b>	<b>5.3</b>
<b>Total</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>

**Table 7—Contribution of individual real demands to crop output**

Components of demand	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	<i>Percent</i>													
<b>Personal consumption expenditures, food:</b>														
Off-premises consumption	72.1	60.8	64.1	48.7	52.3	50.5	50.8	49.5	58.6	45.4	47.4	63.7	48.6	51.7
Purchased meals and beverages	10.8	9.7	10.4	8.0	8.4	8.2	8.9	8.9	10.4	7.9	8.1	11.0	8.6	9.0
Furnished to employees	1.7	1.4	1.7	1.3	1.5	1.3	1.4	1.4	1.7	1.3	1.4	1.8	1.4	1.5
Consumed in farm households	1.1	1.0	1.2	.9	.9	.7	.6	.5	.6	.4	.4	.5	.4	.4
<b>Total</b>	<b>85.7</b>	<b>72.9</b>	<b>77.5</b>	<b>58.9</b>	<b>63.1</b>	<b>60.7</b>	<b>61.7</b>	<b>60.3</b>	<b>71.2</b>	<b>55.0</b>	<b>57.3</b>	<b>77.1</b>	<b>59.0</b>	<b>62.5</b>
<b>Personal consumption expenditures, other:</b>														
Tobacco	5.1	4.6	5.1	3.7	4.1	3.7	3.7	3.6	4.2	3.3	3.3	4.1	3.1	3.2
Clothing	2.6	2.4	2.6	2.0	2.1	2.1	2.4	2.4	2.8	2.3	2.4	3.4	2.7	2.9
Shoes	.3	.3	.3	.2	.2	.2	.3	.3	.3	.2	.2	.3	.3	.3
Flowers	3.7	3.3	3.7	2.7	2.8	2.5	2.9	2.8	3.1	2.4	2.4	3.2	2.6	2.8
<b>Total</b>	<b>11.6</b>	<b>10.6</b>	<b>11.6</b>	<b>8.6</b>	<b>9.2</b>	<b>8.4</b>	<b>9.2</b>	<b>9.1</b>	<b>10.4</b>	<b>8.3</b>	<b>8.4</b>	<b>11.1</b>	<b>8.7</b>	<b>9.1</b>
<b>Net exports:</b>														
Agricultural exports	18.5	24.7	30.5	24.0	24.6	22.5	25.1	25.4	35.7	27.8	24.6	31.5	21.2	17.6
Processed food exports	2.7	2.6	3.2	2.1	2.5	2.5	3.0	2.9	3.6	2.9	2.5	3.1	2.3	2.2
Agricultural imports	-2.8	-1.7	-1.9	-1.4	-1.7	-2.1	-1.9	-1.6	-2.1	-1.4	-2.6	-4.0	-3.7	-3.6
Processed food imports	-4.4	-4.2	-5.1	-3.1	-3.1	-2.9	-3.3	-3.5	-4.3	-3.1	-2.7	-3.7	-2.9	-3.4
Apparel imports	-.4	-.4	-.4	-.3	-.4	-.4	-.6	-.6	-.6	-.6	-.6	-.9	-.9	-1.0
<b>Total</b>	<b>13.6</b>	<b>21.1</b>	<b>26.4</b>	<b>21.3</b>	<b>21.9</b>	<b>19.6</b>	<b>22.3</b>	<b>22.7</b>	<b>32.3</b>	<b>25.6</b>	<b>21.1</b>	<b>26.0</b>	<b>16.0</b>	<b>11.8</b>
<b>Others:</b>														
Livestock inventory change	.6	1.1	.6	-.7	-.6	-.8	-.7	.2	.4	.1	-.1	-.2	-.5	-.6
Crop inventory change	2.3	5.1	-5.8	9.6	-2.3	3.8	7.6	7.9	-15.2	8.6	-1.3	-13.7	13.8	1.5
Other final demand	-13.9	-10.8	-10.4	2.2	8.7	8.2	-2	-2	.8	2.4	14.7	-.2	3.0	15.6
Farm capital expenditures	.1	.1	.1	.1	.1	.1	.1	.1	.1	0	0	0	0	0
<b>Total</b>	<b>-10.9</b>	<b>-4.6</b>	<b>-15.5</b>	<b>11.2</b>	<b>5.8</b>	<b>11.3</b>	<b>6.8</b>	<b>8.0</b>	<b>-14.0</b>	<b>11.1</b>	<b>13.3</b>	<b>-14.1</b>	<b>16.3</b>	<b>16.6</b>
<b>Total</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>

Figure 4  
Sources of Demand for Crop Output



PCE is personal consumption expenditures.

## Conclusions

Because the food and fiber system involves all economic activities from the production of farm commodities to final goods purchased by consumers, I/O analysis is an appropriate economic model to trace empirically the direct and indirect linkages between economic activities.

This analysis does not address specific reasons for change in income and employment in each sector, but shows the aggregate movement to income and employment in the food and fiber system. There are, however, several lessons to learn from this analysis for economic policy and decisionmaking.

First, because food, like clothing and shelter, is essential to life, the demand for food is relatively unresponsive to price or household income changes. We have shown that meeting these needs still generates significant income and employment in the system.

Second, the composition of final demand changes over time. Domestic clothing and shoe demand have grown relative to domestic food demand, while raw agricul-

tural exports, processed food imports, and apparel imports have grown relative to other food and fiber system final demands. Thus, analysis of international trade is important to accurately measure and monitor the size of income generation and employment in the food and fiber system.

Third, even though demands for the food and fiber system's output are stable, with relatively lower income

elasticities for food and fiber system demands, the system's relative share of GNP is likely to decline over time. This is not because of any decline in food consumption. Rather, as per capita GNP grows, domestic consumers will likely spend an increasing share of additional income on nonfood and fiber system products. The production of these new and more income-elastic products will probably account for a larger share of GNP.

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## Appendix I—Data Sources

Data sources for the seventeen components of final demand, table 4:

- Row 1: PCE food purchased for off-premise consumption (*14*, table 2.5, line 21).
- Row 2: PCE purchased meals and beverages (*14*, table 2.5, line 22).
- Row 3: PCE food furnished to employees (*14*, table 2.5, line 23; split by current dollar value, table 2.4, lines 5-6).
- Row 4: PCE food produced and consumed on farms (*14*, table 2.5, line 23; split by current dollar value, table 2.4, lines 5-6).
- Row 5: PCE tobacco (*14*, table 2.5, line 34).
- Row 6: PCE clothing (*14*, table 2.5, line 27 minus line 28).
- Row 7: PCE shoes (*14*, table 2.5, line 28).
- Row 8: PCE flowers, seeds, potted plants (*14*, table 2.5, line 42; split by current dollar value, table 2.4, lines 84 and 89).
- Row 9: Agricultural exports (*10*). Data categorized by I/O sectors, port value converted to producer value, transportation value and wholesale trade value using proportion from 1977 I/O table worksheet, sectoral detail deflated by sector prices.
- Row 10: Agricultural exports, processed (*10*).
- Row 11: Agricultural imports (*10*).
- Row 12: Agricultural imports, processed (*10*).
- Row 13: Apparel imports (*12*, table 1491). General imports by selected commodity groups numbers deflated by the implicit price deflator for clothing and shoes, respectively (*14*, table 7.12 shoes; tables 2.4 and 2.5, clothing).
- Row 14: Livestock inventory change (*14*, table 1.19, line 9).
- Row 15: Crop inventory change (*14*, table 1.19 line 10).

Row 16: Other final demands made up of three components: Change in farm inventories held off farm. Federal purchase of farm products, and State and local purchases of farm products. All are taken directly or indirectly from the 1977 I/O table (detailed procedure explained in appendix II).

Row 17: Farm capital expenditures, Economic Indicators Branch, National Economics Division, Economic Research Service, U.S. Department of Agriculture, deflated by index of prices paid by farmers for tractors and other self-propelled machines taken from (*11*).

## Appendix II—Calculation of Other Final Demand

“Other Final Demand” is made up of three components: 1) Changes in farm commodity inventories held off farms, 2) Federal Government purchases of farm products, and 3) State and local government purchases of farm products (app. table 1). The 1977 values of these components, as well as Federal, State, and local purchases of farm products are derived from (*13*, table 1). The change in off-farm commodity inventories is found by subtracting the change in commodity inventories held on farms from the total change in farm commodity inventories in table 1 (*13*).

These detailed measures of the three components, derived from 1977 I/O tables, are available only for 1977. To estimate these measures for subsequent years, a set of movers is constructed as follows. Changes in farm commodity inventories held off farms is estimated assuming that they change at the same rate as all other inventories held off farms. Similarly, the farm portion of State and local government purchases is assumed to change at the same rate as total purchases. Federal purchases of farm products are assumed to change at the same rate as the value of CCC stocks held by the Federal Government.

The equation, then, for Other Final Demand in year *i* is:

$$1977 \text{ FIOF} \times \frac{\text{NFIN } i}{\text{NFIN } 1977} + 1977 \text{ Fed. Pur.} \\ (\$234 \text{ million}) \quad (\$3.502 \text{ billion})$$

$$\times \frac{\text{Value CCC stocks } i}{\text{Value CCC stocks } 1977}$$

+ 1977 SLPFP  
(\$145 million)

× State and Local Government Purchases i  
State and Local Government Purchases 1977  
= Other Final Demand

where:

FIOF is farm inventories held off farms  
(\$234 million).

NFIN is nonfarm inventories.

SLPFP is State and local government purchases of farm products.

**Appendix Table 1—Values of components and other final demand**

Year	Change in nonfarm inventory	Change in value of CCC stocks	State & local government purchases	Other final demand
				\$ 1982 Million
		\$ 1982 Billion		\$ 1982 Million
1972	19.3	-7.0	324.7	-4,057.2
1973	34.5	-6.2	335.2	-3,656.6
1974	33.4	-5.6	346.8	-3,274.7
1975	-14.1	.7	354.6	924.1
1976	25.7	5.5	356.0	3,606.9
1977	31.0	5.7	357.2	3,683.0
1978	36.2	-4	370.4	-91.5
1979	10.4	-7	373.0	-95.1
1980	-2.3	-2	373.6	300.1
1981	19.0	1.5	370.1	1,234.4
1982	-23.1	10.9	369.0	7,306.5
1983	-1	-8	373.9	-84.9
1984	54.3	2.5	383.5	1,543.1
1985	10.9	11.9	397.6	7,666.8

### Appendix III—Estimating Procedures

While our estimates were made using the 79-sector U.S. I/O table, these 79 sectors were combined into 8 main categories for ease of presentation. Appendix table 2 shows these eight food and fiber system categories, including one category of direct production of raw farm products (farming), two categories of processing industries of farm products, one category of direct distribution of processed products to consumer (eating places), one category for supporting manufactured inputs (other manufacturing), and two categories of trade and transportation. Because I/O-based measures are economywide, the eighth sector (rest of the economy) includes all of the original 79 sectors that are not previously listed in the table. These include mining, fisheries and forestry, and all service industries other than trade, transportation, and eating places.

**Appendix Table 2—Output originating categories**

	Original 79 I/O sectors
Food and fiber system	
Farming	1,2
Food processing	14
Textile manufacturing	16-19
Other manufacturing	13, 15, 20-64
Trade	69
Transportation	65
Eating places	74
Rest of the economy	3-12, 66-68, 70-73, 75-79

Because we defined the food and fiber system as involving all economic activities from the farm to the consumer, I/O analysis is an appropriate economic procedure to trace these direct and indirect links of economic activities. In this procedure, the various sectors' shares of the U.S. I/O transaction table published by the U.S. Department of Commerce determine the degree of disaggregation at which these economic activities can be identified (13).

#### Base Year Estimation

The estimation procedure for income and employment in the food and fiber system for a year when an I/O transaction table is available follows.

#### Income Generation

Since income (or GNP) measures, in an aggregated form, the sum of value added in various I/O sectors, then

$$\text{Income} = \sum_{j=1}^n V_j \quad (1)$$

where  $V_j$  is value added in sector  $j$ . Under an I/O structure, value added is a fixed proportion of output, so that income can be written in a matrix form as:

$$Y = vX = v(I-A)^{-1}F \quad (2)$$

where,  $Y$  = an  $n \times 1$  vector of GNP originating from each sector of the economy

$v$  = an  $n \times n$  diagonal matrix of value added per dollar of sector output coefficients<sup>6</sup>

<sup>6</sup>The matrix  $v$  in equation (2) will have zeroes on the off-diagonal elements. Diagonal elements are one minus the column sum of the direct requirements.

Thus, a typical element of  $v$  on the main diagonal is then

$$v_{jj} = 1 - \sum_{i=1}^n a_{ij}$$

$X$  = an  $n \times 1$  vector of sector outputs

$(I-A)^{-1}$  = an  $n \times n$  I/O total requirements matrix

$F$  = an  $n \times 1$  vector of total final demand.

The vector  $F$  in equation (2) can also be rewritten as a product of the distributional matrix  $B$  post multiplied by the matrix of total (real final) demand  $D$  so that:

$$F = BD \quad (3)$$

where,  $B$  = an  $n \times m$  matrix of percentage sectoral distribution within each final demand category,<sup>7</sup>

$D$  = an  $m \times 1$  matrix of GNP expenditure components (or the sum of the column elements in final demand sectoral matrix,  $d$ ).

Replacing  $F$  in the equation (2) with  $B D$  yields (4)

$$Y = v(I-A)^{-1}BD \quad (4)$$

$$\text{or } Y = MD \quad (5)$$

where,  $M = v(I-A)^{-1}B$

The matrix  $M$ , like matrix  $B$ , has  $n \times m$  elements, but elements  $m_{ij}$  of the matrix  $M$  are interpreted as the GNP generated in producing sector  $i$  per dollar of expenditure in final demand component  $j$ . Through this procedure, we derive the sectoral measurement of the income originating in the food and fiber system.

### Employment Generation

Using the above notations, employment in each sector of I/O industries is derived as:

$$E = L(I-A)^{-1}BD \quad (6)$$

where,  $(I-A)^{-1}B$  and  $D$  are as previously defined

$L$  = an  $n \times n$  diagonal matrix of civilian employment coefficients per dollar of sector output.

<sup>7</sup>The percentage distribution matrix  $B$  is known as "bridge-matrix" because it bridges the GNP components and I/O industries (17). This matrix also translates demand components of GNP into a "bill of goods." A typical element of the  $B$  matrix is

$$b_{ij} = \frac{d_{ij}}{D_j}$$

where  $d_{ij}$  = the level of final demand category  $j$  produced by sector  $i$ .

$E$  = an  $n \times 1$  vector of sector employment needs for meeting the total output of food and fiber system.

### Nonbase Year Estimation

To estimate income and employment in the food and fiber system for years beyond the published I/O tables, one must work with less information, since no current  $(I-A)^{-1}$ ;  $F$ ,  $V$ , and  $L$  are available. Yet there are observable changes which can be incorporated into the analysis. Changes may have occurred since the base year as the result of factors such as changes in labor productivity and in the sectoral composition of final demand. Changes in the composition of final demand may also require changes in industry output requirements which in turn change interindustry demand. Likewise, increases in labor productivity imply that the same output can be produced with a smaller workforce or that more output can be produced with the same size workforce.

Changes in the components of final demand are available from the national income and product accounts (NIPA) published in various issues of *Survey of Current Business* (14). Using this information, the procedure uses real (constant dollar) measures of final demands as movers to update base year derived demands for output-supporting demands for food and fiber products.

Nonbase year income is estimated through a modification of equation (5).

$$Y = uqGT \quad (7)$$

where,

$$T = v(I-A)^{-1}BD$$

$G$  = an 8 by  $n$  aggregation matrix which combines  $n$  sectors into 8 mutually exclusive categories

$q$  = an 8 by 8 diagonal matrix of output originating price deflators

$u$  = an 8 by 8 diagonal matrix of adjustment coefficients

Thus, vector  $Y$  is "forecasted" using the base year "A" matrix but using a future year's final demand.<sup>8</sup>

If there have been changes in any of the fixed coefficients from the base year to the current year, then equations (5) or (7) will not correctly estimate employ-

<sup>8</sup>This is known as the "constant dollar" method which requires deflating final demand to the base year prices. For further details, see (6).



ment or income originating.<sup>9</sup> Assuming that any over- or under-estimation bias for the whole economy is also true for the food and fiber system, we make gross adjustments in the GNP-originating estimates for both farm and nonfarm estimates and employment requirements for nonfarm sectors. To quantify the adjustment, we use equation (5) with matrices D and M which include all components of the U.S. NIPA, and compute the adjustment coefficient. These adjustments are not made to farm employment estimates, however, because farm employment is rather stable and not especially sensitive to small output changes. An equation (8)-type estimate of farm employment would likely introduce fictitious variability to a fairly stable empirical series.

The estimate of GNP originating from farming from the full economy (equation 5) is summed and compared with published real gross farm product (GFP) to compute an adjustment coefficient. Likewise, the resulting nonfarm elements of GNP are summed and compared with real GNP less GFP to compute the adjustment coefficients for nonfarm sectors. These coefficients are

<sup>9</sup>See (5) for a discussion of sources of these estimation errors and an alternative adjustment procedure.

placed on the diagonal of matrix u. For employment, the farm adjustment coefficient is replaced with a one.

Labor productivity changes in farming and in nonfarm sectors are also available from the U.S. Department of Agriculture and the U.S. Department of Labor, respectively (15, 16). Therefore, equation (6) is modified to incorporate the effect of productivity change in the generation of employment. Changes in the composition of final demand for different years are incorporated through relative changes in elements in the D matrix.

$$E = upGW \quad (8)$$

where, p = an 8 × 8 diagonal matrix showing ratio of base year labor productivity to current year productivity,<sup>10</sup>

$$W = L(I-A)^{-1}BD.$$

<sup>10</sup>Thus, without adjusting for productivity, any element  $e_j$  of the vector E of equation (8) measures total employment in  $j^{\text{th}}$  sector assuming, say, 1977 employment condition (meaning 1977 L relationship). If labor productivity increases by 2 percent in 1978 over 1977, the same output could be produced with a 2-percent smaller workforce. Therefore, without p adjustment in equation (8), 1978 employment would be overestimated by 2 percent.