Both the gross-output and net-output approaches are applied to measure the multifactor and labor productivity indexes of the food manufacturing sector and its associated nine industries. The gross-output approach relates the adjusted value of shipments as a function of capital, labor, energy, and all intermediate materials as shown in equation 7, while the net-output approach relates the net value added as a function of labor and capital as shown in equation 8. The detailed empirical results of yearly productivity indexes and related measures obtained from both approaches are reported in Appendix C. This section focuses mainly on the productivity results compiled in tables 5-10, in which average figures for each of 5 subperiods (four 5-year periods and one final 3-year period) are presented.

Gross-Output Productivity Measures

Table 5 presents the gross-output productivity results of the food manufacturing sector. As indicated in the table, the annual rate of change in multifactor productivity (4) is obtained by subtracting the combined inputs (2) from the gross output (1). The annual rate of change in labor productivity (5) is a summation of the capital and other input intensity per unit of labor (3) and multifactor productivity (4).

In table 5, the gross-output multifactor productivity index for food manufacturing grew 0.19 percent a year between 1975 and 1997. The productivity growth of food manufacturing shows a gain of 1.7 percent in 1975-79, then a loss of 1.38 percent in 1980-84, rebounding to 1.08 percent in 1985-89, before decreasing to a negative rate of -0.63 percent in 1995-97. The slow growth rate found in this study is consistent with the Bureau of Labor Statistics (BLS) estimate of 0.45 percent using different data. As shown in figure 5a, both the study's and BLS' productivity indexes show a trend of slow growth, moving up and down within 10 percent along a level slightly above the base year 1975.

Both the study's and BLS' estimates of productivity indexes are low when compared with the BLS estimate of 1.25 percent a year for the whole manufacturing sector over the same period of time. The reason for the lower productivity growth in food manufacturing is not fully understood, but low investment in research and development (R&D) could be one reason. This study found that real private sector R&D expenditures for food manufacturing in the period 1975-97 grew 2.22 percent a year on average (table 6). These R&D expenditures represent only 0.23 percent of sales. Over the same period, the R&D expenditures for food manufacturing even grew slower than similar expenditures

Table 5—Gross-output productivity and price of the food manufacturing sector, 1975-97

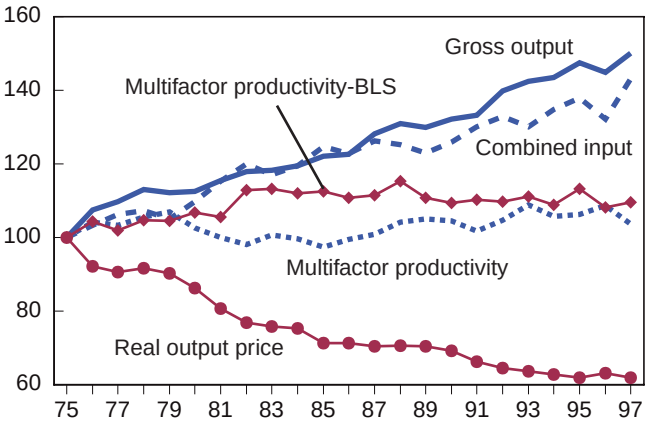
		1975-79	1980-84	1985-89	1990-94	1995-97	Average annual growth
		Calculated annual change rate (percent)					
Gross output	(1)	2.96	1.27	1.68	2.04	1.51	1.88
Inputs:							
Combined inputs	(2)	1.26	2.65	0.60	1.88	2.14	1.69
Nonlabor/labor intensity	(3)	0.00	4.58	-0.41	-0.13	1.62	1.14
Productivity:							
Multifactor productivity	(4)=(1)-(2)	1.70	-1.38	1.08	0.16	-0.63	0.19
Labor productivity	(5)=(3)+(4)	1.70	3.21	0.67	0.03	0.99	1.33
BLS multifactor productivity:							
Food and kindred products		1.12	1.43	-0.18	-0.35	0.29	0.45
Whole manufacturing		1.20	1.22	1.26	0.87	1.98	1.25
Real processed food price		-2.45	-3.58	-1.28	-2.27	-0.46	-2.13

Notes: Gross output = real adjusted value of shipments; Combined inputs = weighted average of all inputs;
Nonlabor/labor input = nonlabor intensity or combined nonlabor inputs per worker-hour;
Real processed food price is deflated by the consumer price index.
BLS Multifactor productivity is compiled from the BLS website (*http://stats.bls.gov/mfp/mprdload.html*).

Source: USDA/Economic Research Service.

Figure 5a

The food sector: Gross-output multifactor productivity and real output price



Source: USDA/Economic Research Service.

for agricultural input industries such as agricultural chemicals and plant breeding. Also, the National Science Foundation estimated that the real private R&D expenditures of all industries grew at much faster rates of 5.78 percent yearly in the same period.

Although productivity has been relatively low, food manufacturing output has grown significantly over the last two decades. According to this study, it was the expansion of combined factor inputs that provided the major impetus to the sector's output. Gross output measured at 1982 prices grew 1.88 percent a year during 1975-97. During this period the combined capital, labor, energy, and material inputs grew at an average annual rate of 1.69 percent. Material inputs grew the fastest at 2.25 percent a year. Food manufacturing is materials-intensive with material costs constituting about 60 percent or more of the value of gross output. A 3.06-percent annual decline in real producer prices of crude food and feedstuffs in the period 1975-97 fueled the expansion of input utilization.

This expansion of food manufacturing output benefited U.S. and global consumers. The real producer price of processed foods declined on average 2.13 percent a year between 1975 and 1997 (table 5 and fig. 5a). Researchers have hypothesized that advances in food manufacturing productivity would explain the decline in real prices of processed foods. To explain the cause of decline, this study estimates a log-linear regression by expressing the real producer price of processed foods (P_t) at time t as a function of the multifactor productivity index (A_t) and the real price index of crude food and feedstuffs (F_t) represented for material cost. The empirical results of the fitted price equation covering 1975-97 for the food manufacturing sector are shown below:

$$ln\ P_t = 2.5593 - 0.1381\ ln\ A_t + 0.5854\ ln\ F_t \qquad R^2 = 0.99$$
$$\qquad\qquad\quad (0.1280) \qquad\quad (0.0173) \qquad\qquad\qquad (9)$$

The figures in parentheses are the standard errors. The estimated coefficient implies that a 1-percent decrease in the price index of crude food and feedstuffs (F_t) would reduce the real price of processed foods by 0.59 percent, and is statistically significant. The effect of a 1-percent increase in multifactor productivity (A_t), however, would reduce the real price of processed food by only 0.14 percent, but would not be statistically significant. The results found in this study indicate that a decrease in the prices of crude food and feed-

Table 6—Private research and development (R&D) expenditures, 1975-97

	1975-79	1980-84	1985-89	1990-94	1995-97	Average annual growth
			Million $ at 1982 prices			
Total agricultural inputs	865	1,091	1,163	1,396	1,548	4.04
Plant breeding	89	123	173	237	288	6.31
Agricultural chemicals	346	522	606	754	804	5.60
Farm machinery	304	312	234	231	271	1.95
Veterinary pharmaceuticals	125	134	151	174	185	2.56
Food manufacturing products	497	604	687	609	644	2.22
Total agricultural R&D	1,362	1,695	1,850	2,005	2,192	3.34
All U.S. industries	28,721	40,692	54,000	66,419	80,499	5.78

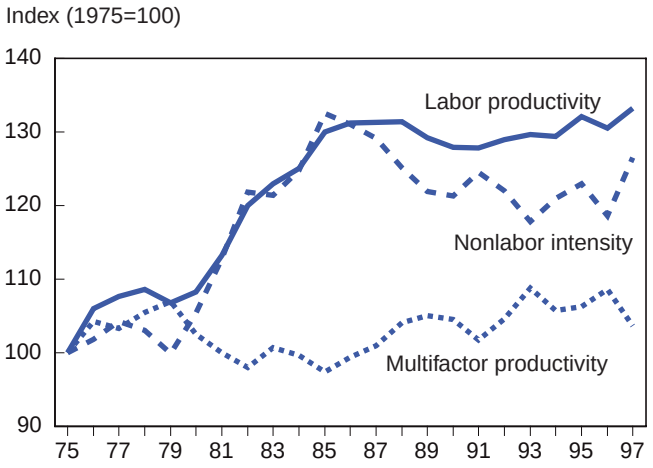
Source: USDA/Economic Research Service; Data for all U.S.industries are compiled from National Science Foundation.

stuffs drove down the prices of processed foods paid by consumers. Productivity growth apparently contributed little to the price decline.

Another issue of much public interest has been the effect of many mergers and acquisitions in recent years on food manufacturing productivity. According to *Mergerstat Review*, which tracked purchases valued at $1 million or higher and transfers of ownership involving at least 10 percent of a company's equity, the pace of merger and acquisition activity in food processing increased steadily from 60 transactions in 1991 to 157 in 1998 (table 7). Annually, there was an average of 97 transactions involving 12 foreign buyers and 24 foreign sellers. Meanwhile, the number of transactions valued at $100 million or more increased from 10 in 1991 to 23 in 1998, with an annual average of 17. On the basis of the measured multifactor productivity index, it appears that heightened merger and acquisition activity had little effect on productivity. Some argued that R&D labs were consolidated and total resources reduced in association with a high number of mergers and acquisitions (Connor and Schiek, p. 385).

In measuring labor productivity, the major focus was on the productivity of production workers, who constitute more than 70 percent of the total labor force. As shown in table 5, the average annual rate of change in labor productivity was 1.33 percent. Labor productivity increased over all subperiods, with a peak at 3.21 percent in 1980-84, mainly because of the high growth of nonlabor input intensity, at an annual rate of 4.58 percent. Multifactor productivity, however, showed a negative growth rate of -1.38 percent in 1980-84. The labor productivity index (fig. 5b) moved steadily upward until leveling off somewhat after 1985, while

Figure 5b
The food sector: Gross-output labor productivity



Source: USDA/Economic Research Service.

the nonlabor intensity index closely mirrored this movement. Evidently, a yearly 1.33-percent growth in labor productivity was closely related to improvements in nonlabor intensity per production worker, especially with workers having more and better machinery.

Table 8 presents the gross-output productivity results of each food manufacturing industry. In the table, the average rates of change in multifactor productivity range from -0.42 for meat products to 1.12 percent for beverages. Many food industries stay roughly even with the level in the base year 1975 with small gains and losses over the subperiods. In 1980-84, the multifactor productivity index sharply decreased for most food industries. For example, multifactor productivity of the dairy industry was estimated at -1.92 percent, because the growth rate of output was only 2.25 per-

Table 7—U.S. food processing merger and acquisition activity, 1990-1998

	1991	1992	1993	1994	1995	1996	1997	1998	Annual average
Number of transactions[1]	60	75	74	84	86	111	130	157	97
Number transactions of $100 million more	10	8	11	17	20	19	26	23	17
Foreign buyers	8	8	6	13	13	12	15	23	12
Foreign sellers	14	26	30	20	17	24	32	31	24
Value offered, million $	3,101	4,328	3,525	11,061	10,833	8,287	10,856	11,450	7,930
Foreign buyers value, million $	543	446	930	4,248	6,187	425	3,041	1,382	2,150
Foreign sellers value, million $	721	2,976	1,705	381	1,844	2,812	3,435	6,170	2,505

[1] Mergers are included only if the purchase price was at least $1 million and transfers of ownership involved at least 10 percent of a company's equity.

Source: Mergerstat Review. Selected issues.

Table 8—Gross-output productivity of the food manufacturing industries, 1975-97

		1975-79	1980-84	1985-89	1990-94	1995-97	Average annual growth
		Calculated annual change rate (percent)					
Meat products							
Gross output	(1)	3.56	-1.37	1.93	1.74	2.03	1.45
Inputs:							
Combined inputs	(2)	2.11	0.75	2.17	2.80	1.38	1.87
Nonlabor/labor intensity	(3)	0.89	1.55	-2.29	-1.35	-0.24	-0.34
Productivity:							
Multifactor productivity	(4)=(1)-(2)	1.46	-2.12	-0.24	-1.06	0.65	-0.42
Labor productivity	(5)=(3)+(4)	2.35	-0.57	-2.53	-2.41	0.41	-0.77
Dairy products							
Gross output	(1)	2.18	2.25	1.29	0.95	0.76	1.52
Inputs:							
Combined inputs	(2)	-0.20	4.17	1.11	1.60	1.41	1.72
Nonlabor/labor intensity	(3)	0.20	5.64	0.05	1.69	0.74	1.82
Productivity:							
Multifactor productivity	(4)=(1)-(2)	2.38	-1.92	0.18	-0.65	-0.65	-0.20
Labor productivity	(5)=(3)+(4)	2.58	3.72	0.23	1.04	0.09	1.62
Preserved fruits and vegetables							
Gross output	(1)	4.68	2.87	1.89	2.24	-0.95	2.31
Inputs:							
Combined inputs	(2)	2.61	3.27	0.38	2.16	-1.11	1.64
Nonlabor/labor intensity	(3)	0.72	5.67	0.87	1.51	0.10	1.97
Productivity:							
Multifactor productivity	(4)=(1)-(2)	2.08	-0.40	1.51	0.08	0.16	0.67
Labor productivity	(5)=(3)+(4)	2.79	5.27	2.38	1.59	0.26	2.64
Grain mill products							
Gross output	(1)	0.69	2.18	3.11	2.51	1.70	2.13
Inputs:							
Combined inputs	(2)	-0.51	3.49	1.29	1.98	4.90	2.11
Nonlabor/labor intensity	(3)	-0.25	6.92	0.19	0.97	5.45	2.53
Productivity:							
Multifactor productivity	(4)=(1)-(2)	1.21	-1.31	1.82	0.53	-3.20	0.02
Labor productivity	(5)=(3)+(4)	0.96	5.61	2.01	1.50	2.25	2.55
Bakery products							
Gross output	(1)	0.29	2.38	2.88	3.35	0.79	2.11
Inputs:							
Combined inputs	(2)	-1.80	2.50	1.14	1.90	1.46	1.13
Nonlabor/labor intensity	(3)	-1.84	5.34	0.25	-0.43	3.13	1.27
Productivity:							
Multifactor productivity	(4)=(1)-(2)	2.09	-0.12	1.74	1.45	-0.67	0.99
Labor productivity	(5)=(3)+(4)	0.25	5.22	1.99	1.03	2.46	2.25

Continued--

Table 8—Gross-output productivity of the food manufacturing industries, 1975-97--Continued

		1975-79	1980-84	1985-89	1990-94	1995-97	Average annual growth
		Calculated annual change rate (percent)					
Sugar and confections							
Gross output	(1)	-2.46	3.19	0.66	1.98	2.61	1.23
Inputs:							
Combined inputs	(2)	-3.26	3.49	-0.79	2.04	1.70	0.72
Nonlabor/labor intensity	(3)	-3.87	4.51	0.30	1.25	2.36	1.00
Productivity:							
Multifactor productivity	(4)=(1)-(2)	0.80	-0.30	1.44	-0.06	0.92	0.51
Labor productivity	(5)=(3)+(4)	-3.08	4.21	1.75	1.18	3.27	1.51
Fats and oils							
Gross output	(1)	3.55	-1.82	-1.55	-0.54	5.35	0.49
Inputs:							
Combined inputs	(2)	1.69	0.53	-2.46	1.06	5.62	0.87
Nonlabor/labor intensity	(3)	-0.59	6.06	1.06	2.11	7.42	3.00
Productivity:							
Multifactor productivity	(4)=(1)-(2)	1.86	-2.34	0.91	-1.59	-0.27	-0.38
Labor productivity	(5)=(3)+(4)	1.28	3.72	1.98	0.51	7.15	2.62
Beverages							
Gross output	(1)	3.96	3.32	1.72	2.70	2.15	2.77
Inputs:							
Combined inputs	(2)	2.31	4.41	-1.14	0.56	2.69	1.65
Nonlabor/labor intensity	(3)	1.82	7.35	2.74	0.49	-0.39	2.68
Productivity:							
Multifactor productivity	(4)=(1)-(2)	1.65	-1.09	2.87	2.15	-0.54	1.12
Labor productivity	(5)=(3)+(4)	3.48	6.26	5.61	2.64	-0.92	3.80
Miscellaneous foods							
Gross output	(1)	7.61	1.40	1.32	3.01	0.63	2.77
Inputs:							
Combined inputs	(2)	5.35	2.29	0.75	1.93	2.95	2.50
Nonlabor/labor intensity	(3)	-0.39	3.09	0.11	-0.22	1.09	0.75
Productivity:							
Multifactor productivity	(4)=(1)-(2)	2.27	-0.89	0.56	1.08	-2.33	0.27
Labor productivity	(5)=(3)+(4)	1.87	2.20	0.68	0.86	-1.24	1.02

Notes: Gross output = real adjusted value of shipments; Combined inputs = weighted average of all inputs; Nonlabor/labor input = nonlabor intensity or combined nonlabor inputs per worker-hour.

Source: USDA/Economic Research Service.

cent, far less than the 4.17-percent growth of the combined inputs. Some significant decreases in multifactor productivity in 1980-84 occurred in fats and oils (-2.34 percent) and meats (-2.12 percent). In 1995-97, the multifactor productivity indexes of most food industries showed little change or were negative for industries like grain mill products (-3.2 percent) and miscellaneous foods (-2.33 percent).

The labor productivity index increased steadily for most food industries and was closely related to increased use of inputs other than labor. Table 8 shows that the average annual rates of change in labor productivity range from -0.77 for meat products to 3.8 percent for beverages. In contrast to low multifactor productivity in 1980-84, the annual rate of change in labor productivity of the dairy industry was 3.72 percent because of a high growth rate (5.64 percent) of nonlabor intensity. In 1980-84, the labor productivity indexes showed significant increases in preserved fruits and vegetables (5.27 percent), grain mill products (5.61 percent), bakery products (5.22 percent),

sugar and confections (4.21 percent), fats and oils (3.72 percent), and beverages (6.26 percent).

In 1995-97, fats and oils as a capital-intensive industry registered remarkably high labor productivity with an annual rate of 7.15 percent, which was related to the 7.42-percent increase in nonlabor intensity. For other industries, some high labor productivity growth rates were found in sugar and confections (3.27 percent), grain mill products (2.25 percent), and bakery products (2.46 percent), but others showed only a small increase.

Figures 6a to 6i show the movements of gross output, multifactor productivity, and labor productivity for nine food industries in 1975-97. The general pattern of variations for most industries was similar to variations in the overall food manufacturing sector, characterized by a steady upward movement of the gross output and labor productivity. On the other hand, the multifactor productivity indexes moved downward or were slightly above the base year level.

Net-Output Productivity Measures

The main purpose of measuring net-output productivity is to show the industry's contribution to the Nation's gross domestic product (GDP). Given the measured input-output relationships, a change in the quantity of inputs will affect the amount of combined inputs and capital intensity per production worker so that the quantity of net value added and labor productivity will be affected simultaneously. Therefore, net-output productivity results are useful indicators for showing the contribution of food manufacturing to the Nation's GDP.

Table 9 presents the net-output productivity results of the food manufacturing sector. The results are obtained from a production function in which the net output (real net value added) is a function of capital and labor. The information is arranged similar to that in table 5 by dividing the whole sample period into five subperiods. As indicated in the table, the annual rate of change in the multifactor productivity (4) is obtained by subtracting the combined inputs of capital and labor (2) from the net output (1). The annual rate of change in labor productivity (5) is a summation of capital intensity per worker-hour (3) and multifactor productivity (4).

In table 9, multifactor productivity of the net value added was characterized by a yearly 2.73-percent growth. The annual rate of change was 3.1 percent in 1975-79, increasing to a peak of 5.41 percent in 1985-89 before slowing to 4.21 percent in 1990-94 and -0.91 percent in 1995-97. The gains in the multifactor productivity index constituted the major force of growth in the net value added, which grew at an annual rate of 3.58 percent. The contribution of combined labor and capital inputs to the growth of the net value added, however, was not certain; there were significant contributions of 3.05 percent in 1980-84 and 2.58 percent in 1995-97, but not in other subperiods.

Table 9 also shows that the average annual rate of change in labor productivity was 3.03 percent. The productivity index showed a gain of 2.99 percent in 1975-79, reaching a peak of 5.43 percent in 1980-84 before slowing to 2.71 percent in 1985-89 and 1.14 percent in 1995-97. The rates of change in technological progress and capital intensity per production worker determine the rates of change in labor productivity. For example, the average annual rate of change in labor productivity peaked at 5.43 percent in 1980-84, mainly because of the high annual rates of growth in

Table 9—Net-output productivity of the food manufacturing sector, 1975-97

		1975-79	1980-84	1985-89	1990-94	1995-97	Average annual growth
		Calculated annual change rate (percent)					
Net output	(1)	4.24	3.50	3.73	4.13	1.66	3.58
Inputs:							
Combined inputs	(2)	1.15	3.05	-1.68	-0.08	2.58	0.85
Capital/labor intensity	(3)	-0.11	4.99	-2.69	-2.09	2.06	0.31
Productivity:							
Multifactor productivity	(4)=(1)-(2)	3.10	0.45	5.41	4.21	-0.91	2.73
Labor productivity	(5)=(3)+(4)	2.99	5.43	2.71	2.12	1.14	3.03

Notes: Net output = real net value added; Combined inputs = weighted average of all inputs; Capital/labor input = capital intensity or capital services per worker-hour.

Source: USDA/Economic Research Service.

Figure 6a

Gross-output productivity: Meat products

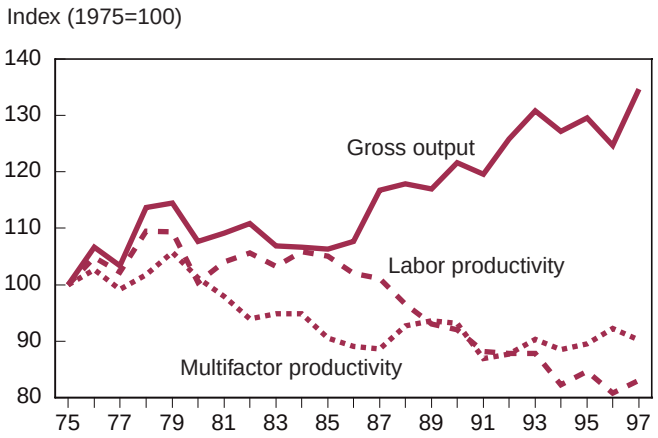


Figure 6b

Gross-output productivity: Dairy products

Figure 6c

Gross-output productivity: Preserved fruits and vegetables

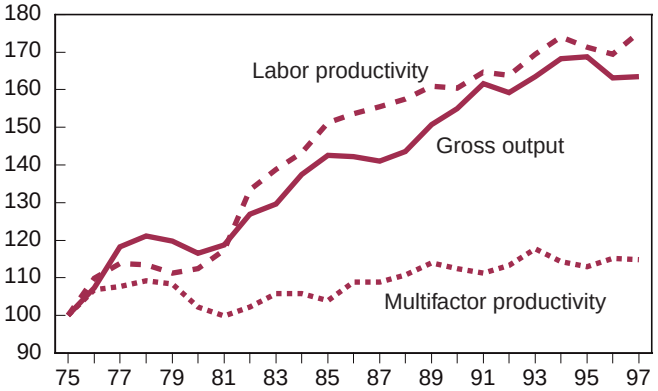


Figure 6d

Gross-output productivity: Grain mill products

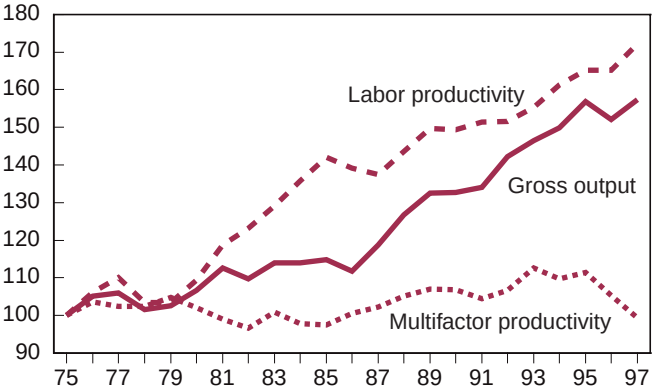


Figure 6e

Gross-output productivity: Bakery products

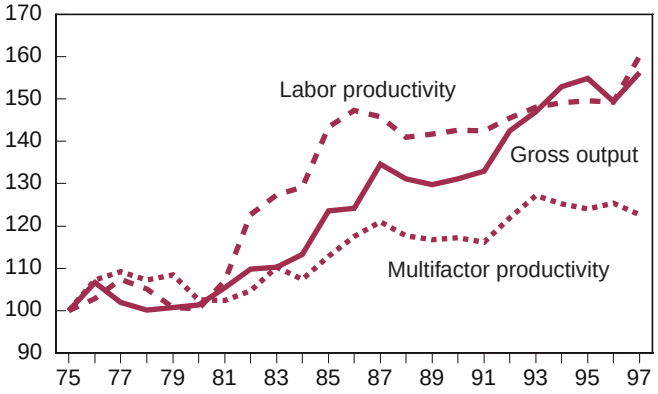
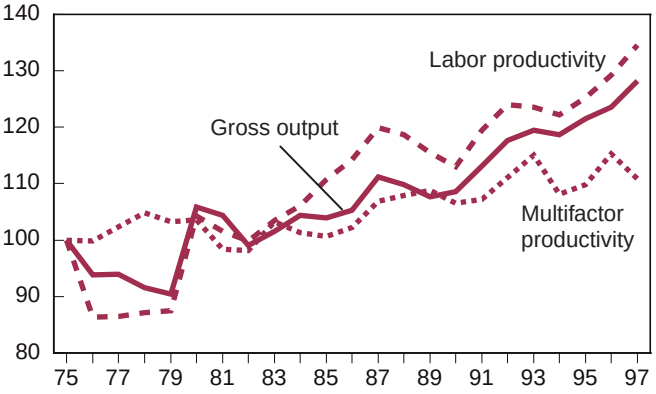


Figure 6f

Gross-output productivity: Sugar and confections



Source: USDA/Economic Research Service.

Figure 6g

Gross-output productivity: Fats and oils

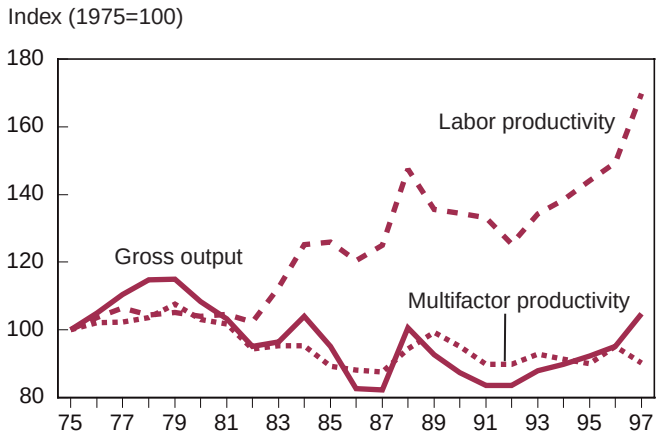


Figure 6h

Gross-output productivity: Beverages

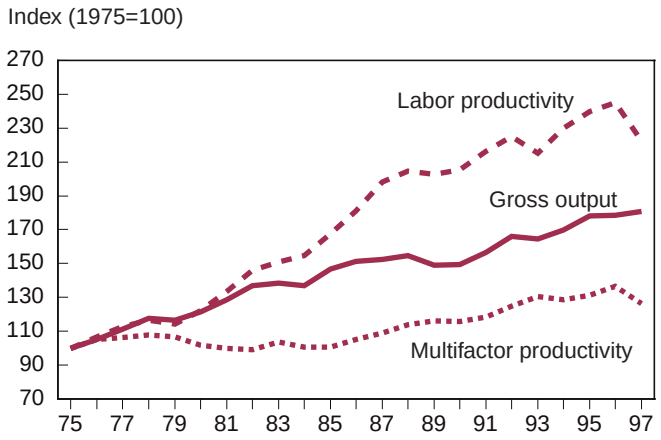
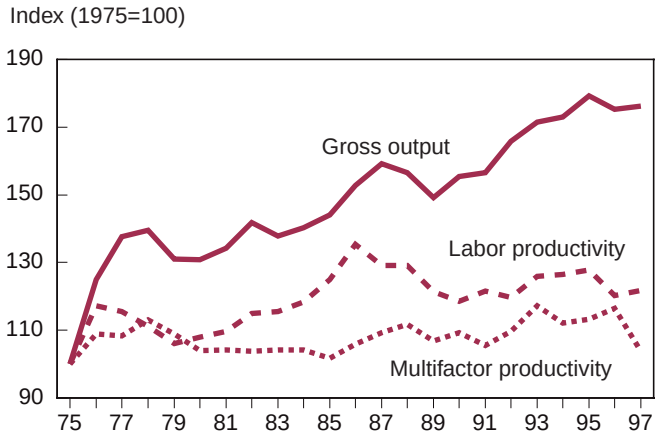


Figure 6i

Gross-output productivity: Miscellaneous foods



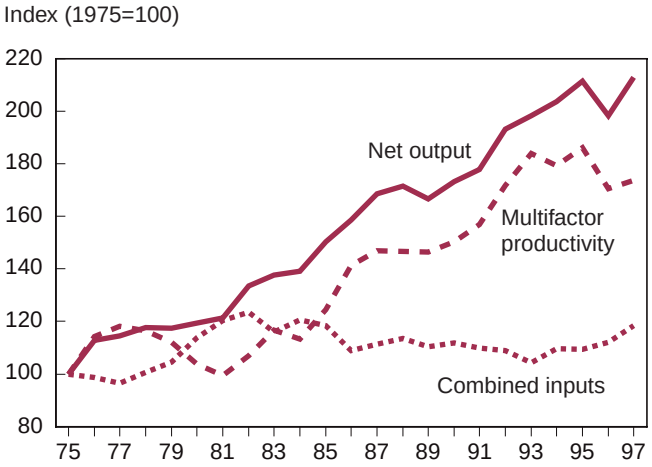
Source: USDA/Economic Research Service.

capital intensity of 4.99 percent. In 1975-79, however, labor productivity was 2.99 percent, mainly because of a significant increase in multifactor productivity of 3.1 percent. In general, it is difficult to ascertain the contribution of multifactor productivity or capital intensity to the growth of net-output labor productivity in the food manufacturing sector.

Figure 7a shows that the multifactor productivity index was in general moving upward continuously along with the net-output index during 1975-97, while the combined capital and labor inputs index showed little change. Figure 7b shows that the labor productivity

Figure 7a

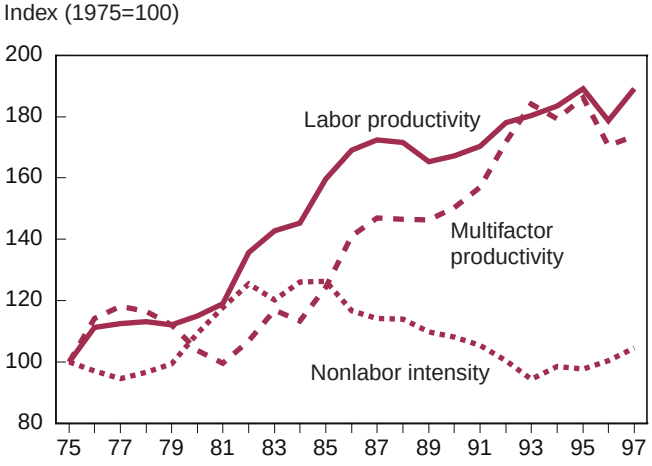
The food sector: Net-output multifactor productivity



Source: USDA/Economic Research Service.

Figure 7b

The food sector: Net-output labor productivity



Source: USDA/Economic Research Service.

index is moving upward continuously along with the net-output index during 1975-97, while the multifactor productivity index decreases slightly before 1981 and then increases steadily over most years. The combined capital and nonproduction worker intensity index trended upward before 1985 and declined thereafter.

Table 10 presents the net-output productivity results of each food manufacturing industry. The average growth rates of the multifactor productivity indexes vary widely across industries ranging from grain mill products (1.99 percent) to beverages (3.66 percent). Multifactor productivity accounted for the major growth of net value added in some subperiods, but in other subperiods the combined labor and capital inputs contributed significantly to changes in net value added. In the meat industry, for example, the average growth rate of net value added in 1995-97 was 7.92 percent because of a 4.16-percent increase in multifactor productivity and a 3.76-percent increase in combined inputs. In 1980-84, the annual increase of net value added was 1.18 percent, mainly spurred by a 1.3-percent increase in combined inputs. In 1985-89, however, the annual increase of net value added was 4.4 percent, mainly due to a 3.7-percent increase in multifactor productivity.

Regarding net-output labor productivity, table 10 shows that most of the average annual changes in labor productivity are positive ranging from meat products (1.64 percent) to beverages (4.85 percent), implying that the productivity index increased over time. In 1980-84, the increase of capital intensity was vital to the growth of labor productivity for most industries. For example, in the grain mill products, a 7.89-percent increase in capital intensity during that period caused a 7.59-percent increase in labor productivity. On the other hand, the average annual rates of change in capital intensity for most food industries was negative in 1985-89 and 1990-94, which affected labor productivity during those subperiods. For example, the average growth rate of capital intensity for meat products was -3.76 percent in 1985-89, causing labor productivity to drop by 0.06 percent, substantially lower than the 3.7-percent increase in multifactor productivity.

Figures 8a to 8i show the movements of net output, multifactor productivity, and labor productivity for the nine food industries in 1975-97. These indexes moved upward continuously over time, but their growth rates varied among industries. For dairy products, bakery products, and sugar and confections, all three indexes were closely correlated. For grain mill products and

Figure 8a
Net-output productivity: Meat products

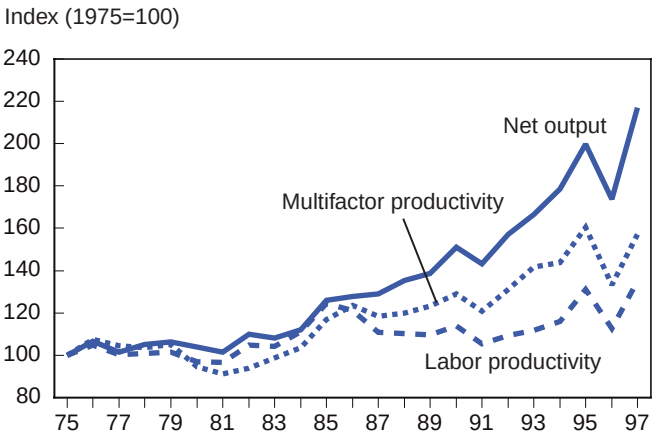


Figure 8b
Net-output productivity: Dairy products

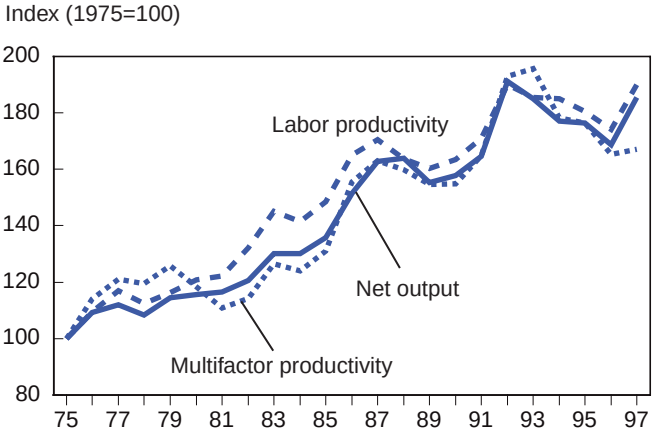
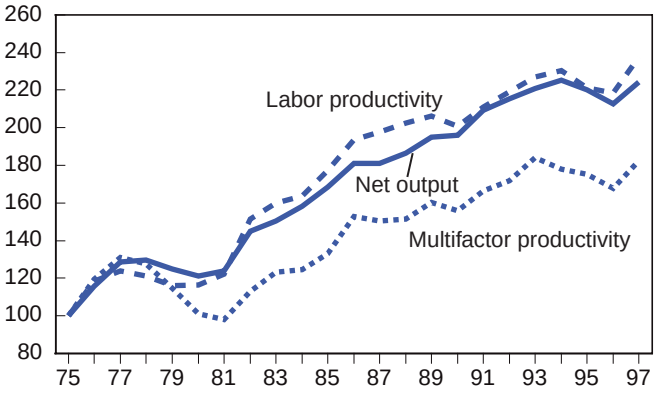


Figure 8c
Net-output productivity: Preserved fruits and vegetables



Source: USDA/Economic Research Service.

Figure 8d

Net-output productivity: Grain mill products

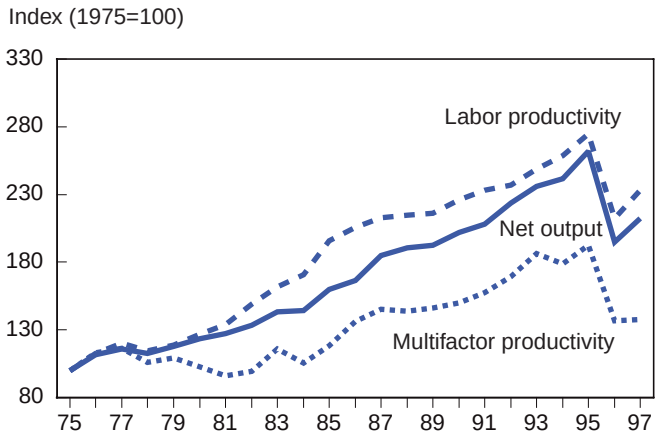


Figure 8e

Net-output productivity: Bakery products

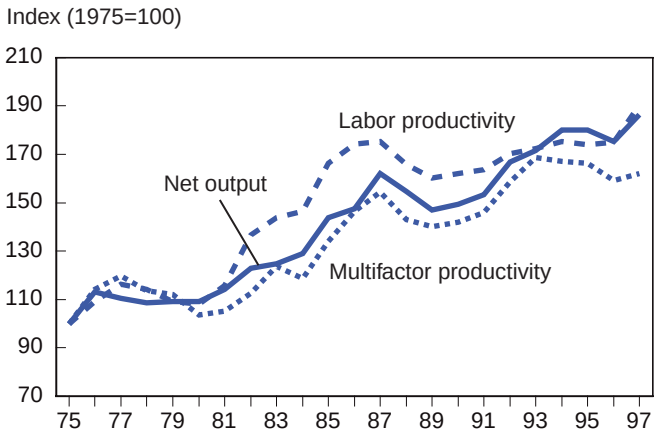


Figure 8f

Net-output productivity: Sugar and confections

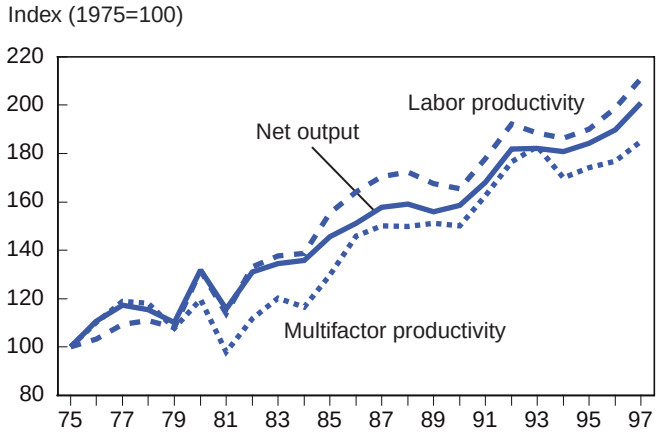


Figure 8g

Net-output productivity: Fats and oils

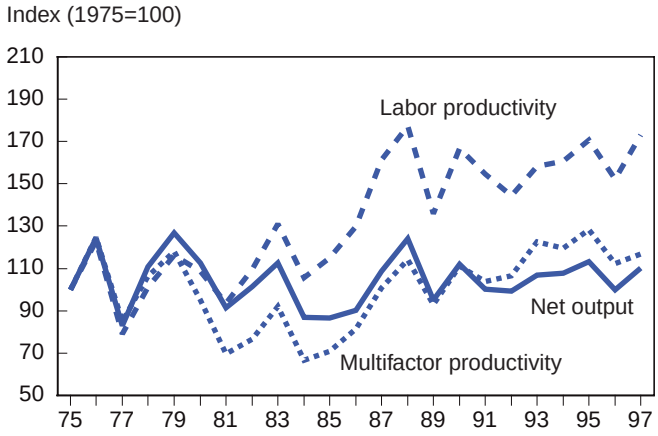


Figure 8h

Net-output productivity: Beverages

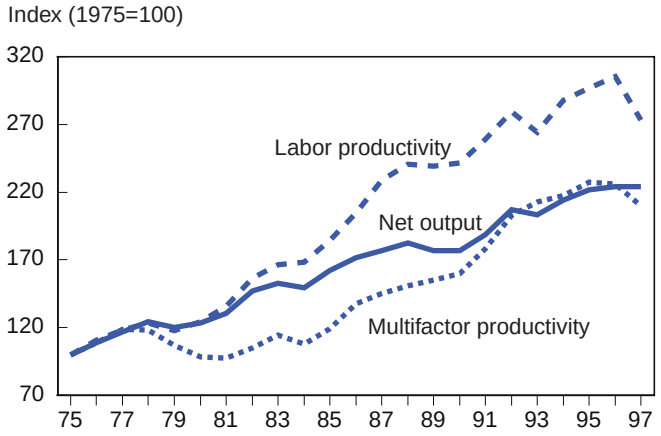
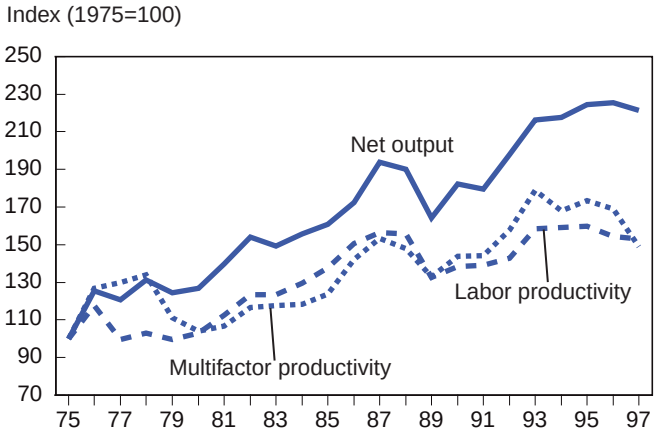


Figure 8i

Net-output productivity: Miscellaneous foods



Source: USDA/Economic Research Service.

Table 10—Net-output productivity of the food manufacturing industries, 1975-97

		1975-79	1980-84	1985-89	1990-94	1995-97	Average annual growth
		Calculated annual change rate (percent)					
Meat products							
Net output	(1)	1.62	1.18	4.40	5.34	7.92	3.86
Inputs:							
Combined inputs	(2)	0.30	1.30	0.70	2.07	3.76	1.49
Capital/labor intensity	(3)	-0.91	2.10	-3.76	-2.08	2.14	-0.72
Productivity:							
Multifactor productivity	(4)=(1)-(2)	1.32	-0.11	3.70	3.27	4.16	2.37
Labor productivity	(5)=(3)+(4)	0.41	1.99	-0.06	1.19	6.30	1.64
Dairy products							
Net output	(1)	3.54	2.65	3.73	2.93	1.71	2.99
Inputs:							
Combined inputs	(2)	-2.52	2.74	-1.07	-0.30	3.80	0.37
Capital/labor intensity	(3)	-2.12	4.21	-2.13	-0.21	3.12	0.47
Productivity:							
Multifactor productivity	(4)=(1)-(2)	6.06	-0.10	4.80	3.23	-2.09	2.62
Labor productivity	(5)=(3)+(4)	3.94	4.12	2.68	3.02	1.03	3.09
Preserved fruits and vegetables							
Net output	(1)	6.03	5.04	4.28	2.94	-0.04	3.88
Inputs:							
Combined inputs	(2)	1.96	2.93	-1.06	0.72	-0.98	0.81
Capital/labor intensity	(3)	0.07	5.33	-0.57	0.07	0.23	1.14
Productivity:							
Multifactor productivity	(4)=(1)-(2)	4.07	2.11	5.33	2.22	0.95	3.06
Labor productivity	(5)=(3)+(4)	4.14	7.44	4.77	2.29	1.17	4.21
Grain mill products							
Net output	(1)	4.28	4.16	6.05	4.64	-2.74	3.78
Inputs:							
Combined inputs	(2)	1.71	4.46	-0.85	0.42	4.14	1.79
Capital/labor intensity	(3)	1.98	7.89	-1.95	-0.59	4.68	2.21
Productivity:							
Multifactor productivity	(4)=(1)-(2)	2.57	-0.30	6.91	4.22	-6.87	1.99
Labor productivity	(5)=(3)+(4)	4.54	7.59	4.96	3.64	-2.19	4.20
Bakery products							
Net output	(1)	2.44	3.39	2.91	4.15	1.21	2.98
Inputs:							
Combined inputs	(2)	-0.74	2.03	-0.69	0.51	2.15	0.58
Capital/labor intensity	(3)	-0.77	4.87	-1.58	-1.82	3.83	0.72
Productivity:							
Multifactor productivity	(4)=(1)-(2)	3.17	1.37	3.60	3.65	-0.95	2.40
Labor productivity	(5)=(3)+(4)	2.40	6.24	2.02	1.83	2.88	3.12

Continued--

Table 10—Net-output productivity of the food manufacturing industries, 1975-97--Continued

		1975-79	1980-84	1985-89	1990-94	1995-97	Average annual growth
		Calculated annual change rate (percent)					
Sugar and confections							
Net output	(1)	2.60	4.89	2.85	3.05	3.58	3.41
Inputs:							
Combined inputs	(2)	0.44	2.59	-2.62	0.51	0.69	0.28
Capital/labor intensity	(3)	-0.17	3.61	-1.54	-0.28	1.35	0.56
Productivity:							
Multifactor productivity	(4)=(1)-(2)	2.16	2.29	5.48	2.54	2.88	3.13
Labor productivity	(5)=(3)+(4)	1.99	5.91	3.94	2.26	4.24	3.69
Fats and oils							
Net output	(1)	9.77	-6.14	3.00	2.93	1.25	1.90
Inputs:							
Combined inputs	(2)	2.57	2.59	-4.99	-2.69	1.56	-0.47
Capital/labor intensity	(3)	0.29	8.13	-1.46	-1.64	3.36	1.65
Productivity:							
Multifactor productivity	(4)=(1)-(2)	7.20	-8.74	7.99	5.62	-0.31	2.37
Labor productivity	(5)=(3)+(4)	7.50	-0.60	6.52	3.98	3.05	4.03
Beverages							
Net output	(1)	4.84	4.54	3.47	4.01	1.55	3.83
Inputs:							
Combined inputs	(2)	2.89	4.10	-4.17	-3.05	2.57	0.17
Capital/labor intensity	(3)	2.40	7.04	-0.28	-3.11	-0.50	1.19
Productivity:							
Multifactor productivity	(4)=(1)-(2)	1.95	0.45	7.64	7.06	-1.02	3.66
Labor productivity	(5)=(3)+(4)	4.36	7.48	7.36	3.95	-1.52	4.85
Miscellaneous foods							
Net output	(1)	6.34	4.66	1.50	5.93	0.55	3.98
Inputs:							
Combined inputs	(2)	2.51	3.29	-1.22	0.88	4.30	1.71
Capital/labor intensity	(3)	-3.23	4.09	-1.86	-1.27	2.44	-0.04
Productivity:							
Multifactor productivity	(4)=(1)-(2)	3.83	1.37	2.72	5.05	-3.75	2.26
Labor productivity	(5)=(3)+(4)	0.60	5.46	0.86	3.78	-1.32	2.23

Notes: Net output = real net value added; Combined inputs = weighted average of all inputs; Capital/labor input = capital intensity or capital services per worker-hours.

Source: USDA/Economic Research Service.

preserved fruits and vegetables, there was a close correlation between the output and labor productivity indexes. For beverages and fats and oils, there was a close correlation between the output and multifactor productivity indexes.

The net-output productivity results are useful indicators for showing the contribution of food manufacturing to the Nation's GDP. This report concludes by assessing the effects of an increase in capital, labor (including production and nonproduction workers), or both by 10 percent on the rates of change in net value added and labor productivity. The upper part of table 11 presents the simulated results, showing the increases in net value added compared with the yearly average for 1995-97. These base values, for example, are $135 billion for the food sector and $19 billion for meat products. The simulated results indicate that an increase in capital input by 10 percent would increase the net value added of the food sector by $3.3 billion,

mainly from capital-intensive industries: beverages ($681 million), grain mill products ($476 million), and preserved fruits and vegetables ($463 million). A 10-percent increase in labor would increase the net value added of the food sector by $995 million, with the meat industry contributing the most among industries ($227 million) because of its labor-intensive meat-packing operations. The increase of both capital and labor would increase the value added of the food sector by $4.3 billion, with beverages contributing the most among all industries ($808 million).

The lower part of table 11 presents the simulated results, showing the increases in labor productivity compared with the yearly average in 1995-97. The base value of the food sector was $58.34 for the net value added per production worker-hour. Beverages and grain mill products, heavily capital-intensive industries, ranked high in labor productivity ($167.1 and $109.73 per worker-hour, respectively). On the other hand, labor productivity of the labor-intensive meat products industry ranked the lowest among the food industries—only $24.61 per worker-hour. A 10-percent increase in capital input alone would increase the food manufacturing sector's capital intensity, and consequently its labor productivity, by $1.43 per worker-hour. Most of the increases in labor productivity were realized by capital-intensive industries: $4.47 per worker-hour for beverages and $2.99 per worker-hour for grain mill products. A 10-percent increase in labor input alone would reduce the entire food manufacturing sector's capital intensity and cause a decrease in labor productivity of $1.58 per worker-hour. Finally, an increase of both capital and employees would yield a small increase in labor productivity of the food sector (15 cents per worker-hour), because of the counter-effects of changes between capital and labor.

Table 11—Effects of increases in inputs on net value added and labor productivity

	Base value	Changes in value added as a 10-percent increase of:		
		Capital	Labor	Both capital and labor
		Million $ at 1982 prices		
Food sector	135,166	3,299	995	4,294
Meat products	19,045	378	227	605
Dairy products	11,838	278	98	376
Preserved fruits & vegetables	18,503	463	125	588
Grain mill products	17,473	476	79	555
Bakery products	15,556	342	152	494
Sugar and confections	9,174	224	67	291
Fats and oils	3,267	84	20	104
Beverages	25,432	681	127	808
Miscellaneous foods	14,878	372	100	473
		Changes in net value added per worker-hour (dollars)		
Food sector	58.34	1.43	-1.58	0.15
Meat products	24.61	0.49	-0.55	0.07
Dairy products	65.99	1.55	-1.79	0.24
Preserved fruits & vegetables	53.29	1.33	-1.43	0.10
Grain mill products	109.73	2.99	-3.17	0.18
Bakery products	57.30	1.26	-1.51	0.25
Sugar and confections	63.22	1.55	-1.69	0.15
Fats and oils	82.19	2.12	-2.31	0.19
Beverages	167.14	4.47	-4.90	0.42
Miscellaneous foods	59.93	1.50	-1.66	0.16

Note: All values are measured at 1982 prices deflated by producer price of processed foods and feeds.
Base value = yearly ave rage value in 1995-97. Labor = production and nonproduction workers.

Source: USDA/Economic Research Service.