Changing Food Consumption Patterns, Their Effect on the U.S. Food System, 1972-1987: An Input-Output Perspective

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Output growth of the U.S. Food System is examined to apportion first the importance of domestic food demand and then the importance of components of domestic food demand. Growth of U.S. food processing output is heavily dependent upon domestic food demand and particularly its personal consumption expenditures components -- food purchased for off-premise consumption and purchased meals and beverages.

As in other industries, changes in consumer demand can be driving forces for fundamental changes in the U.S. Food System. Consumer demands for products derived from farm output have changed. American consumers have become more discriminating food buyers. New lifestyles, shifting demographics, and growing concerns about nutrition and health have lead to wholesale changes in the way Americans eat and the foods they buy. Consumer demands set the agenda for the system. The most successful firms and sectors of the industry are the ones who satisfy the needs and wants of consumers. Responding to the needs of American consumers, the emphasis of the Food System may be shifting from volume production for general consumer markets to marketing and production for specialized markets.

This paper examines the sources of Food System's sectoral output change directly related to changes in domestic food final demand, 1972-1987. The domestic final demand includes changes in: (1) Food purchased for off-premises consumption (OPC), (2) Purchased meals and beverages (PMB), (3) Food furnished to employees (MFE), and (4) Food produced and consumed on farms (FCF). The analysis uses an Input-Output (I/O) demand-based output decomposition procedure. An I/O approach provides an economy-wide environment in which to analyze demand changes and explain output changes directly and indirectly due to these demand changes. This I/O-based technique requires compatible beginning and ending I/O tables. We use the years, 1972 and 1987. The year 1972 is the first year that U.S. I/O tables were constructed based on the use (U) and make (V) matrices, the convention suggested by the United Nations' System of National Accounts [13]. The year, 1987, is the latest year for which published United States I/O tables are available. An I/O model provides a common framework to isolate the elements of structural change and to relate them to each other. The U.S. Food System is specified in 14 I/O sectors.

The U.S. Food System: A Consumer-Driven Industry

This paper follows the spirit of Davis and Goldberg [3] who first systematically explored the contribution to total economic activity required to support the delivery of food, clothing, shoes, and tobacco to domestic consumers and to support agricultural exports. They called their concept "agribusiness". Lee, et al., [9] used the term "the Food and Fiber System" for the same concept plus farm capital investment. Other more narrowly defined, but still generic terms used are "food marketing system" by Greig [6] and "food manufacturing industries" by Connor and others [2]. Manchester distinguishes the total food and fiber system and the farm food and fiber system [10].

The term "Food System" used in this paper is closer to "food manufacturing industries" defined by Connor, et al., in the sense that this paper excludes farm products from the analysis. However, the definition is also close to "food and fiber system" defined by Lee, et al., in the sense that

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this analysis includes supporting activities such as transportation, trade, and other manufacturing.

Whatever the definition, the industry is undertaking a fundamental change, a change that is consumer-driven. Senauer, Asp, and Kinsey observe:

> "The consumer is setting the agenda for the entire food system. Consumer demands are transmitted from food retailers to wholesalers and processors and ultimately back to the farmers. The industry has become consumer-driven" [11:pp.v].

Management emphasis may be shifting from production for general consumer markets to marketing for specialized consumer markets. Understanding of ultimate consumer-demand is the basis of successful marketing. Recently, nutrition, safety, and quality have been major attributes for which consumers look in food products. Barkema notes: "consumers are challenging the food industry to tailor food products for more precisely defined market niches" [1:pp.1126]. Such consumer trends have important implications for the Food System. Our analysis focuses on output growth and structural changes of the industry driven by consumer demand.

Table 1 shows output and value-added share by the 14 sectors of the Food System for 1972 and 1987. The 14 sectors include 11 processed food sectors, two marketing margin sectors, transportation (sector 12) and wholesale and retail trade (sector 13) and an eating and drinking places sector(sector 14). Real output (in 1987 prices) grew for 10 of 11 processed food sectors. The fats and oil mills (sector 8) showed the largest growth, 179% (from $5,600.3 million in 1972 to $15,627.5 million in 1987), followed by the poultry & eggs (sector 2), 104.5% (from $7,215.6 million to $14,752.9 million). The meat packing (sector 1) showed the least growth, 8.7% (from $53,460.2 million to $58,128.8 million) over this period. Refined sugar (sector 7) output declined 29.4% (from $8,024 million in 1972 to $5,665 million in 1987). Overall, the total output of processed food sectors grew by 35.1% ($87.8 billion, from $241.8 billion to $329.6 billion).

Table 1. Output and Value-added Shares in the U.S. Food System.

Sector number & name	1972 output	1972 value-added share	1987 output	1987 value-added share
	in million 1987 dollars			
1. Meat packing plants	53,460.2	0.128	58,128.8	0.096
2. Poultry & eggs	7,215.6	0.205	14,752.9	0.238
3. Dairy plants	33,210.4	0.212	42,046.2	0.223
4. Canning, freezing, & dehydrating	24,633.6	0.307	35,824.8	0.406
5. Feed & flour milling	11,990.9	0.304	23,109.6	0.308
6. Prepared feeds (nec)	10,885.3	0.150	13,984.7	0.073
7. Refined sugar	8,024.0	0.262	5,665.0	0.217
8. Fats & oil mills	5,600.3	0.153	15,627.5	0.150
9. Confectionery, bakery & macaroni	30,487.6	0.458	41,690.4	0.564
10. Beverage & flavorings	40,695.1	0.503	51,095.1	0.458
11. Misc. food processing	15,650.6	0.305	27,710.9	0.362
Total processed food	**241,853.6**	**0.291**	**329,635.9**	**0.305**
12. Transportation	204,994.9	0.600	290,146.1	0.523
13. Wholesale & retail trade	502,369.6	0.768	846,711.1	0.700
14. Eating & drinking	129,776.1	0.431	211,020.6	0.520
Total Food System	**1,078,994.2**	**0.589**	**1,677,513.7**	**0.566**

Value-added per dollar of output rose in six food processing sectors and fell in five. Other things equal, value-added per dollar of output can increase with specialization[1]. The 1972-87 value-added shares roughly reflect this expectation. Except beverages and flavoring, the sectors with higher value-added shares in 1987 than 1972 tend to produce more differentiated products and the sectors with lower value-added shares in 1987 than 1972 tend to produce less differentiated products. The sectoral value-added shares rose the most in canning, freezing, and dehydration over the period, 32.2% (from 0.307 to 0.406) followed by confectionery, bakery and macaroni 23.1% (from 0.458 to 0.564).

The non-food processing sector in the Food System sectors grew strongly during the period. Transportation output (sector 12) rose 42% from $204,995 million to $290,146 million. During this period, wholesale and retail trade output (sector 13) grew 69%, from $502.4 billion to $846.7 billion. Eating and drinking output (sector 14) grew 63%, from $129.8 billion to $211.0 billion.

Methodology

Previously, we characterized the Food System as a consumer-driven industry and listed some recent changes in consumer demands and interests. In the previous section, we noted what has happened to real output and value-added shares in 14 Food System sectors. In this section, we more formally relate changes in consumer demand to changes in sector outputs. We draw on previous studies [7, 8, and 12] for the choice of methodology. We use, however, a new decomposition and more recent U.S. I/O tables in this study than previous studies.

In an open Leontief system, the basic material balance between demand and supply can be written as:

$$(1)\quad X_i = D_i + W_i + E_i - M_i,$$

where X_i, D_i, W_i, E_i, and M_i denote output, domestic final demand, intermediate demand, exports, and imports of sector i, respectively. Noting that intermediate demand is determined by production and by the input-output coefficients matrix, $\mathbf{W} = \mathbf{AX}$, (where a_{ij} of A is the share of total output of sector j accounted for by purchases from sector i) and letting the import share of demand be $m_i = M_i/(D_i + W_i)$, equation (1) can be represented in matrix notation as:

$$X = D + AX + E - m(D + AX).$$

Define $u_i = (1-m_i)$ as sector i's domestic supply ratio, the share of sector i's supply produced in the domestic economy. Then,

$$(2)\quad X = (I - uA)^{-1}(uD + E)$$

where u is a diagonal matrix of the domestic supply ratios (u_i). A is the matrix of input-output coefficients (a_{ij}), and X, D, and E are vectors. The "u" here differs from the approach used by Kubo et al. In their approach, imports of commodity i, M_i, are divided into intermediate use, M_W, and final use, M_F. They derive import coefficients, m_i, for both intermediate and final uses as $(1-u_i)$. The u_i's stand for the domestic supply ratios (the portion of intermediate and of final demand produced domestically). However, the United States presentation of I/O tables does not distinguish between intermediate and final uses of imports and enters imports as a vector in the final demand. Because of this treatment, we must assume that the import coefficients, m_i, are the same for both intermediate and final uses imports.

Taking the total derivative of (2) with respect to D, E, A, and u, we obtain the total differential of X as:

$$(3)\quad dX = (I - uA)^{-1}(u\partial D + \partial u\, D + \partial E) + \partial (I - uA)^{-1}(uD + E).$$

The derivative of an inverse matrix, A^{-1}, with respect to an element, α, of A is given by:

$$\partial A^{-1}/\partial\alpha = -A^{-1}\,\partial A/\partial\alpha\, A^{-1}, \text{ [Dhrymes, pp. 540]}$$

$$(I - uA)^{-1} = -(I - uA)^{-1}[-u\,\partial A - \partial uA](I - uA)^{-1}$$

$$= (I - uA)^{-1}(u\,\partial A + \partial uA)(I - uA)^{-1}.$$

[1] We thank an anonymous reviewer for reminding us of this point.

Thus, equation (3) becomes,

(4)

$$dX = (I - uA)^{-1}(u\,\partial D + \partial uD + \partial E) + (I - uA)^{-1}(u\,\partial A + \partial uA)(I - uA)^{-1}(uD + E).$$

Arranging terms in equation (4), the change in outputs can be decomposed into its sources by category of demand as:

(5)

$$\begin{aligned} &= (I - uA)^{-1} u\partial D && \text{[domestic demand]} \\ &+ (I - uA)^{-1} \partial E && \text{[export demand]} \\ &+ (I - uA)^{-1} \partial u\,(D + AX) && \text{[domestic supply ratios]} \\ &+ (I - uA)^{-1} u\,\partial AX. && \text{[intermediate demand]} \end{aligned}$$

Furthermore, since the total change in Food System output equals the sum of the changes in each sector, the total change in Food System output can be decomposed either by sector or by category of demand. These relations can be shown schematically as:

(6)

$$dx8772_1 = ddx87_1 + eex87_1 + das87_1 + ddu87_1$$

$$dx8772_2 = ddx87_2 + eex87_2 + das87_2 + ddu87_2$$

$$\begin{array}{ccccc} . & . & . & . & . \\ . & . & . & . & . \\ . & . & . & . & . \end{array}$$

$$dx8772_n = ddx87_n + eex87_n + das87_n + ddu87_n$$

$$dx8772_i = ddx87_i + eex87_i + das87_i + ddu87_i$$

Each column of equation (6) shows the sectoral composition of each demand category and each row shows the decomposition of changes in sectoral demand by different demand category. For this analysis, we first concentrated on the domestic food demand component of $ddx87_i$ compared to total sector output change, $dx8772_i$ (Table 2), then upon food demand categories of domestic food demand (Table 3).

Empirical Analysis

This study uses data from the 1972 and 1987 published United States I/O tables [15 and 16]. We collapsed the detailed BEA/USDC tables in a way that maintains available Food System sector detail. Our estimates of sector output changes and demand sources of output changes during 1972 - 1987 for 14 Food System sectors are based on equation (5). Our focus of analysis will be demand-driven output changes between 1972 and 1987 (Table 2).[2]

The first data column of Table 2 shows the total output changes during 1972-1987. Percent growth in real output from 1972 to 1987 is given in the second column. The third column shows the total output changes that are due to the domestic food demand expansion, and the last column of the table shows percentage of total output changes that are due to this expansion. As the last column shows, the growth of U.S. Food System output is heavily dependent upon on growth in domestic food demand.[3] This contrasts with the growth of U.S. farm products for which export demand as well as domestic demand play an important role. For the processed food sectors (sectors 1 to 11), production to meet domestic food demand growth contributed 83.3% ($73.1 billion of $87.8) of the total output growth.

Output of beverages and flavorings (sector 10) due to domestic food demand expansion grew more than total sector output from 1972 to 1987. Having the domestic food demand related outputs increase more than the total output change suggests increased imports, e.g., wine, or substituting other ingredients for flavorings helped meet domestic food demand. In refined sugar (sector 7) domestic food demand related output decreased less than total output. For this sector the positive effect of direct growth in consumable products

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[2] In a similar study based on the 1982 U.S. table, Lee and Schluter [8] analyzed all four demand sources of structural change included in equation 5. In this paper, our interest is in "domestic food demand driven" structural change. Thus we concentrate our analysis on a subset of the first terms of equation 5.

[3] Other demands that influence the sector output growth are: non-food domestic demand, export demand, intermediate demand, and domestic supply-ratio as shown in Lee and Schluter [8].

Table 2. Total Output Changes Due to Domestic Food Demand Expansion: 1972-1987.

Sector # and name	Total Output Change	Percent Change	Due to Food Demand Expansion	Expansion Percentage
	---------- in million 1987 dollars ----------			
1. Meat packing plants	4,668.7	9	4,270.2	91.5
2. Poultry & egg	7,537.3	104	5,576.9	74.0
3. Dairy plants	8,835.8	27	4,347.2	49.2
4. Canning, freezing dehydrating	11,191.1	45	9,584.8	85.6
5. Feed and flour milling	11,118.7	93	9,724.9	87.5
6. Prepared feed	3,099.3	28	2,542.4	82.0
7. Refined sugar	-2,359.0	-29	-350.8	14.9
8. Fats and oil mills	10,027.2	179	2,662.5	26.6
9. Confectionery, bakery, and macaroni	11,202.8	38	10,147.3	90.6
10. Beverages and flavorings	10,400.0	26	14,910.3	143.4
11. Misc. food processing	12,060.3	77	9,686.6	80.3
Total processed food	**87,782.2**	**36**	**73,102.4**	**83.3**
12. Transportation	85,151.2	42	2,437.7	2.9
13. Wholesale and retail trade	344,341.5	69	46,753.9	13.6
14. Eat & drinking places	81,244.5	77	71,135.9	87.6
Total Food System	**595,519.4**	**55**	**193,429.9**	**32.5**

Table 3. Sources of Domestic Food Demand Expansion: 1972-1987.

Sector # and name	Change (OPC)	Change (PMB)	Change (MFE)	Change (FCF)	Total
	---------- in million 1987 dollars ----------				
1. Meat packing plants	515.8	3,488.9	648.0	-382.5	4,270.2
2. Poultry & egg	4,560.4	847.3	179.3	-10.2	5,576.9
3. Dairy plants	633.4	3,075.9	638.8	-.9	4,347.2
4. Canning, freezing, dehydrating	7,023.6	1,890.4	671.9	-1.1	9,584.8
5. Feed & flour milling	9,007.4	523.8	197.7	-4.1	9,724.9
6. Prepared feed (nec)	1,748.1	701.2	153.0	-59.9	2,542.5
7. Refined sugar	-699.2	316.1	33.9	-1.6	-350.8
8. Fats & oil mills	1,980.6	548.0	159.0	-25.1	2,662.5
9. Confectionery, bakery & macaroni	7,160.8	2,592.7	394.0	-.2	10,147.3
10. Beverage & flavorings	12,232.9	2,584.4	94.1	-1.1	14,910.3
11. Misc. food processing	7,704.0	1,798.8	185.5	-1.6	9,686.6
Total processed food	**51,867.8**	**18,367.5**	**3,355.1**	**488.3**	**73,102.4**
12. Transportation	-212.4	2,491.7	215.9	-57.6	2,437.7
13. Wholesale and retail trade	40,329.0	5,668.2	849.5	-92.8	46,753.9
14. Eat & drinking places	785.1	70,330.0	25.4	-4.6	71,135.9
Total Food System	**92,679.5**	**96,857.4**	**4,445.9**	**643.3**	**193,429.9**

was offset by a decline in demand for output of this sector as ingredients in other products. Total output decreased from $8,024 million in 1972 to $5,665 million in 1987, attributable mostly to a decrease in interindustry demands resulting from the increased use of a competing sweetener, HFCS (high fructose corn syrup).

While increased food demand was important to food processing, increased food demand accounted for a small share of total output increases from 1972 to 1987 for transportation and for wholesale and retail trade. Not surprisingly, increased food demand accounted for most of the increased output for eating and drinking places.

Decomposition of Domestic Food Demand

Table 3 shows a further decomposition of the output related to domestic food demand. Because domestic food demand changes dominated other demand changes for explaining change in Food System output, this section explores the domestic food demand components in more detail. Table 3 decomposes output changes shown in Table 2, breaking domestic food demand into its components in the United States national income and product accounts (NIPA). Food for off-premises consumption (OPC), purchased meals and beverages (PMB), food furnished employees, (MFE), and food produced and consumed on farms(FCF) are the four components. Thus, table 3 presents the expansion effects of these four detailed domestic food demand categories on changes in sector output. The last column of table 3 shows the sum of the four columns representing the individual domestic food demand category effects on 1972 to 1987 output changes.

Examining the contribution of the four domestic food demand categories to output growth enables us to understand the differing forces exerted on sectors of the Food System. First, entries in column one of table 3 shows the expected result of food purchased for off-premise consumption being the largest food demand category, i.e., most of the output changes due to changes in domestic food demand result from OPC changes. Thus, just as domestic food demand was the dominating broad demand category explaining Food System output, OPC dominates the contribution to Food System changes in output during the period due to the domestic food demand expansion.

Consumer demand changes since 1972 have come from both more consumers and changing needs and tastes among consumers. The U.S. population rose 16%, from 210 million in 1972 to 243 million in 1987. Per capita disposable personal income grew 30% from $10,414 in 1972 to $13,552 in 1987 (in $87). Besides consumers being more numerous and more affluent, American lifestyles become faster paced and demographic trends shortened the consumer's available time for preparing meals [1:pp.1126]. Accordingly, the demand for consumer-ready processed food grew and likely will grow faster than the demand for traditional food cooked in the home. Although our sectoring plan is too broad to show this totally, generally output of sectors producing more highly processed foods - miscellaneous food processing; canning, freezing, and dehydrating; etc. grew more than that of sectors producing less highly processed food - meat packing plants, dairy plants; etc. (Table 2). Furthermore, consumers dined out more both as households' incomes grow and as the number of dual income households increased (Table 2, eating and drinking places output rose 63%). From 1972 to 1987, PCE at eating places nationwide went up from $101.2 billion in 1972 to $169.6 billion (in $87, up 67.5%) in 1987. This also increased demand for processed food. In particular, the sectors processing red meat, dairy, and sugar were importantly influenced by these demands (Table 3, col. 2). In the past, consumers were willing to do more meal preparation themselves, purchasing less processed food products at grocery stores. Consumers now, however, count on the food industry to play a larger role in meal preparation. The proportion of women aged 25 to 50 who are in the work force has climbed steadily during the past two decades to about three-fourth. This change has boosted sharply the number of single-individual and dual-income households [1:pp.1126]. Both types of households probably spend less time preparing meals than do traditional single-earner families. As a result, today's consumers spend less time in the kitchen and are increasingly shopping for conveniently prepared food products that fit faster-paced lifestyles. Others have also identified changing patterns of consumer demand [e.g., 1, 5, and 11]. Besides these demographic and cultural trends, many U.S. domestic markets for food and fiber products are mature and domestic food demand may grow mainly with U.S. population growth.

While production for domestic food demands dominated the food processing sectors of the

Food System from 1972 to 1987, growth in food demand has been less important to the wholesale and retail trade and transportation sectors. Domestic food demand expansion accounted for three percent of the growth in transportation output from 1972 to 1987 and fourteen percent of wholesale and retail trade output. Domestic food demand expansion accounted for seven-eighths of the growth in eating and drinking place output from 1972 to 1987. Business travel and entertainment and the normal intersectoral linkages noise of an I/O analysis likely accounted for the rest.

Summary and Conclusions

Domestic food demand expansion was the main support for increased total output in the Food System, 1972-1987. The demand environment in which the U.S. Food System operates and in which this expansion occurred is changing. Our findings show that the output consequences for Food System sectors of these demand changes have led to important changes in the Food System. Among the four components of domestic food demand expansion that cause change in total sector output, food purchased for off-premises consumption played the major role for nine of our Food System sectors and purchased meals and beverages played the major role for five of our Food System sectors. In a general view of the system, eating and drinking places could be viewed as a type of processing sector. From this perspective, purchased meals and beverages stimulates demand for eating and drinking places and the less highly processed foods - meat, milk, and sugar. And, one would not be surprised to see growth in purchased meals and beverages demand accounted for the largest share of output growth for meat packing plants, dairy plants, and refined sugar, as well as for eating and drinking places.

Market alert firms in the Food System transform from a "here is what we produce" to "here is what consumers want" perspective. As consumers became more discriminating buyers, they shifted from traditional foods to more consumer-ready foods. Consumers became increasingly concerned about nutritional content of the food, demanding less fat and lower cholesterol foods. The industry has tried to adapt to these changing demands by trying to shorten the path from farm to consumer with a more tightly integrated market structure and industrialization of the industry. We have identified the gaining and losing Food System sectors from these changes.

Studying structural change using I/O analysis inherently gives lagging information. This analysis carried from the period just before the food and commodity inflationary period of the 1970's through the early 80's recession to the mid-1980's strong dollar which forced the domestic economy to absorb production which may have been exported under more favorable exchange rate conditions. Reexamining structural changes in the U.S. Food System during 1972-1992 will be interesting, when BEA completes the 1992 I/O tables.

References

1) Barkema, Alan, "Reaching Consumers in the Twenty-first Century: The Short Way Around the Barn," *American Journal of Agricultural Economics*, Dec., 1993 Vol. 75, # 5, pp.1126-1131

2) Connor, J.M., R.T. Rogers, B.W. Marion, and W.F. Mueller. *The Food Manufacturing Industries*. Lexington, Mass: Lexington Books, 1985.

3) Davis, J.H., and R. Goldberg. *A Concept of Agribusiness*. Cambridge, Massachusetts: Harvard University Press, 1957.

4) Dhrymes, P.J. *Introductory Econometrics*. New York: Springer-Verlag, 1978.

5) Drabenstott, Mark, "Industrialization: Steady Current or Tidal Wave? ," *Choices*, 4th Q, 1994, p. 4-8

6) Greig, S.W. *Economics and Management of Food Processing*. Westport, Connecticut: AVI Publishing Co., Inc., 1984.

7) Kubo, Y., S. Robinson, and M. Syrquin. "The Methodology of Multisector Comparative Analysis," in *Industrialization and Growth; A Comparative Study*. (ed. H. Chenery, S. Robinson, and M. Syrquin), London: Oxford University Press, 1986.

8) Lee, Chinkook and Gerald Schluter, "Growth and Structural Change in U.S. Food and Fiber Industries: An Input-Output Perspective," *American Journal of Agricultural Economics*, Vol. 75, August 1993, pp.666-673

9) Lee, Chinkook, G. Schluter, W. Edmondson, and D. Wills. *Measuring the Size of the U.S. Food and Fiber System*. Agricultural Economic Report #566, Economic Research Service, U.S. Department of Agriculture, Mar. 1987.

10) Manchester, A.C. *Agriculture's Links With U.S. and World Economies*. Agricultural Information Bulletin # 496, Economic Research Service, U.S. Department of Agriculture, Sept. 1985.

11) Senauer, Ben, Elaine Asp, and Jean Kinsey, *Food Trends and the Changing Consumer*, Eagan Press, St. Paul, 1991.
12) Skolka, J. "Input-Output Structural Decomposition Analysis for Austria." *Journal of Policy Modeling*, Vol. II(1), (Spring 1989): 45-66.
13) United Nations, A System of National Accounts, Studies in Methods, Series F, No. 2, Rev.3 (United Nations publication sales No. E.69.XVII.3), 1968.
14) United States Department of Agriculture, *Agricultural Statistics*, various issues, Washington, D.C.
15) United States Department of Commerce, Bureau of Economic Analysis. *The Detailed Input-Output Structure of the U.S. Economy, 1972*, Washington, D.C., U.S. Government Printing Office, 1979.
16) United States Department of Commerce, Bureau of Economic Analysis. *Benchmark Input-Output Accounts for the U.S. Economy, 1987*. Washington, D.C. U.S. Government Printing Office, November 1994.