Common and Diverse Economic Forces Affecting the Growth and Structural Change on U.S. Food and Kindred Product Industry, 1972-1992

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Food consumption by U.S. households provides the primary demand for output of the U.S. food and kindred product industry. The share of sector production needed to meet domestic household food demand ranges from 65 percent in fats and oil mills to nearly 200 percent in the supply-enhanced-by-imports beverages and flavorings sector. The common dominance of domestic household food demand as a source of demand for food and kindred product output masks a diversity of economic forces that affect individual food and kindred product sectors and firms differently and influence the economic environment in which food processors produce food for domestic households. These common and diverse economic forces affect the growth of and structural change in the U.S. food and kindred product industry.

To assess this changing environment, this paper examines the changing U.S. food and kindred product industry from 1972-1992, using an input-output-based economic model. The model uses data from the 1972 and 1992 national I/O tables. We explore the demand sources of food and kindred product output change during this period. We analyze five broad demand sources - (1) direct domestic household demand, (2) other domestic final demands (indirect domestic household and government demand), (3) export demand, (4) changes in processed food products used as inputs for other sectors, and (5) import penetration, the import share of domestic supply. Then, because of the dominant role of direct domestic household demand we analyze 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. The technique requires compatible beginning and ending I/O tables. We use the years of 1972 and 1992. The year 1972 is the first year that U.S. I/O tables are constructed based on the Use (U) and make (V) matrices and 1992 is the latest year for which published United States I/O tables are available.

The I/O model is used as a common framework to isolate the elements of structural change and to relate them to each other. The U.S. food and kindred product industry is specified in 12 composite sectors. This specification

is useful for identifying the effects of economic policies, particularly the effects of agricultural and food policies on output growth and structural change in individual food and kindred product sectors.

II. The U.S. Food and Kindred Product industry: A Consumer-Driven Industry

The food and kindred product industry is fundamentally a consumer-driven industry. 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" [9:p.v].

Management emphasis in the food and kindred product industry 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 and kindred product industry. Our analysis focuses on output growth and structural changes of the industry driven by consumer demand. But direct purchases by domestic consumers are only part of the effects of changing consumer demand on the U.S. food and kindred products industry. Purchases by consumers in other nations influence the demand for U.S. food and kindred products exports. Consumer tastes/preferences for other nation's U.S. food and kindred products influence the share of U.S. domestic food consumption supplied by the U.S. food and kindred products industry. Consumer tastes/preferences for the level of preparation of foods purchased by consumers influence the amount of U.S. food and kindred products output used as ingredients or inputs into the production of other sectors.

Table 1 shows the output the 12 composite sectors of the U.S. food and kindred products industry for 1972 and 1992. Real U.S. food and kindred product output (in 1987 prices) grew for more than forty percent in total and output in 11 of 12 U.S. food and kindred products sectors increased. The poultry and egg-processing sector showed the largest growth, 269%. Refined sugar output declined twenty-six percent.

The remainder of the paper explores the demand basis for these observed real output changes. In the next section we present a method for formally relating changes in direct and indirect consumer demand to

changes in sector outputs. Following sections present and discuss our estimates, first in broad demand categories, then in finer category detail for domestic food demand.

III. Methodology

Our estimation procedure draws on previous studies [5, 6, and 10] 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:

$$X_i = D_i + W_i + E_i - M_i, \hspace{4cm} \{1\}$$

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, $W = AX$, (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,

$$X = (I - uA)^{-1}(uD + E) \hspace{4cm} \{2\}$$

where u is a diagonal matrix of, 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 are 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:

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

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

$$\partial A^{-1}/\partial\alpha \; = - A^{-1} \, \partial A/\partial\alpha \; A^{-1}, [4, pp. 540]$$

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

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

Thus, equation {3} becomes,

$$dX = (I - uA)^{-1} (u\partial D + \partial uD + \partial E) \; + (I - uA)^{-1} (u\partial A + \partial uA) (I - uA)^{-1} (uD + E). \qquad \{4\}$$

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

$$= (I - uA)\text{-}1 \; u\partial D \qquad\qquad\qquad \text{[domestic demand]}$$

$$+ (I - uA)^{-1} \; \partial E \qquad\qquad\qquad \text{[export demand]} \qquad \{5\}$$

$$+ (I - uA)^{-1} \; \partial u (D + AX) \qquad\qquad \text{[domestic supply ratios]}$$

$$+ (I - uA)^{-1} u\partial AX. \qquad\qquad\qquad \text{[intermediate demand]}$$

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

$$dx9272_1 = ddx92_1 + eex92_1 + das92_1 + ddu92_1$$

$$dx9272_2 = ddx92_2 + eex92_2 + das92_2 + ddu92_2$$

$$\begin{matrix} . & . & . & . & . \end{matrix} \qquad\qquad\qquad \{6\}$$

$$\begin{matrix} . & . & . & . & . \end{matrix}$$

$$dx9272_n \; = ddx92_n + eex92_n + das92_n + ddu92_n$$

————————————————————————————

$$dx9272_i \; = ddx92_i + eex92_i + das92_i + ddu92_i$$

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 $ddx92_i$ compared to total sector output change, $dx9272_i$ (Table 2), then upon food demand categories of domestic food demand (Table 3)

IV. Empirical Analysis

This study uses data from the 1972 and 1992 published United States I/O tables [11 and 12]. The detailed BEA/USDC tables have been collapsed in a manner that maintains available agricultural sector detail. Estimations of changes in the sector output and sources of output changes during 1972 - 1992 for 12 food and kindred product sectors are based on equation {5}.

Table 2 shows total output changes that are due to changes in domestic demand, export demand, domestic supply ratios, and intermediate demand. That is, the output changes between 1972 and 1992 shown in the table l are re-examined in detail with respect to the influence of the these source of demand changes. Changes in the sector output, measured in 1987 prices, are shown in the last column. The changes in output are attributed to four different factors: domestic demand, export demand, interindustry demand , and domestic supply ratios, as shown in columns two, three, four, and five, respectively.

The total output of the food and kindred product industry (sum of sector 1 through sector 12) increased by $105 billion (from $259 in 1972 to $364 billion in 1992 in 1987 prices), an average increase of 1.7 percent per year. Among the 12 sectors of the food and kindred product industry, the real value of output increased in 11 sectors and decreased in 1 sector. For example, the real value of output of Grain milling, excluding prepared feeds expanded by $10.7 billion between 1972 and 1992 of which $10.1 billion originated from domestic demand expansion and $1.4 billion due to export demand expansion. Declining use of grain products as intermediate inputs led to a decrease of $.5 billion. An additional $0.3 billion decrease resulted from a decrease in the domestic supply ratio of the product.

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Restating these results from another perspective, in 1992 grain mill output was $10.7 billion (1987 prices) higher than it would have been if domestic demand had remained at its 1972 level. Grain mill output was $10.1 billion higher than it would have been if exports remained at 1972 levels. . Grain mill output was $0.5 billion lower than it would have been if other sectors' use of grain products as inputs into their production had remained at 1972 rates rather than 1992 rates. And, grain mill output in 1992 would have been $0.3 billion higher if the domestic grain processing sector would have provided the same share of domestic consumption in 1992 as it did in 1972, i.e. import penetration cost domestic producers $0.3 billion in lost output in 1992. (sector 6) experienced a decline in output, attributable mostly.

The interacting and often offsetting forces on production exerted by the four sources of demand being analyzed is dramatically illustrated by the refined sugar sector. Domestic demand growth for refined sugar products was positive, exerting forces leading to $457 million more production. There was some growth due to expanded exports as well ($394 million). However, inroads made by reduced interindustry demands as the result of the increased use of HFCS (high fructose corn syrup) led to $4,477 million less sugar output needed than if the 1972 industry structure prevailed. The situation could have been worse for the domestic sugar refineries, however, had not import penetration lessened. The shrinking role of imported sugar led to $1,526 million more domestic output than if 1972 import conditions continued. Thus, while domestic and export demand expansion and changes in the domestic supply ratio of the products contributed to increases in output, large decreases in interindustry resulted in net decreases in output ($2,101 million). The results of this sector's output change strongly imply that during the 1972-92 period, domestic final demand and exports demand grew for the sugar product industry, production fell because interindustry markets eroded. The loss of interindustry markets were almost as important to foreign sugar refiners as it was to domestic refiners.

Table 2 shows that most of the food and kindred product sectors' output growth result primarily from the growth in domestic demand. In fact, comparing the sum of the "Domestic demand" column and the sum of the "Total Change" column suggests output related to changes in domestic demand more than explains total output change. This is the most robust result of our study. In spite of globalization of nations' economies, Free trade

agreements, and changes in production techniques within the food and kindred product sectors, the net effect of changes in export demand, interindustry demand, and domestic supply ratios is a small negative. For the aggregate industry, domestic demand changes are the story. Because of their importance, we will explore these effects further in the next section.

Foreign markets for food and kindred products contributed positively to all twelve sectors, but for red meat processing, prepared animal feed, and fats and oil mills the increase in output supported by exports was more than twenty-five percent.

Because the income elasticity of demand of food and kindred products is generally lower than for other goods and services in the economy, food and kindred product prices tend to rise slower over time than other prices. Over time business services have become a larger component of the cost structure of most sectors. The first situation leads to a "terms-of-trade effect" which lowers the food and kindred product sectors' direct requirements coefficients in a constant dollar series of I/O tables. The second situation leads to an erosion of goods producing sectors' direct requirements coefficients compared to service sectors' direct requirements coefficients in either a current dollar or a constant dollar series of I/O tables. In fact, we find that for the 1972-1992 period eight of the twelve food and kindred product sectors the effect was negative. The four sectors with positive interindustry demand effects, the effect was small, nine percent of output or less. The largest, Poultry and egg-processing, benefited from gaining market share from red meats. The next two largest, Canning, freezing, and drying and Confectionery, bakery, and macaroni, benefited from the trend to more prepared meals, i.e. microwave and TV dinners. Of the eight sectors with negative interindustry demand effects, two sectors, red meat processing which lost market share to poultry meats and the previously discussed refined sugar sector which lost market share to corn sweeteners accounted for more than half of the negative output effects. Decreases in the domestic supply ratios had negative output effects upon all sectors except the previously discussed refined sugar sector.

V. Decomposition of Domestic Demand

Because of the dominance of domestic demand in explaining change in food and kindred product output, this section explores in more detail the domestic demand components. Table 3 decomposes of output changes similar to those in Table 2. However, rather than being an aggregated demand, the domestic demand is broken down into the components of the United States national income and product accounts personal consumption expenditures for food categories and all other domestic final demands. The four U.S. National Income and Product accounts (NIPA) food consumption categories are: (1) Food for off-premises consumption (OPC), (2) Purchased meals and beverages (PMB), (3) Food furnished for employees, (MFE), and (4) Food produced and consumed on farms (FCF).

Thus, table 3 presents the expansion effects of these five detailed domestic demand categories on changes in sector output. The last column of table 3 shows the sum of the five columns representing the individual category effects on output changes in domestic demand during the period. An examination of contribution of the five domestic demand categories on output growth enables us to understand some of the apparent ambiguities in table 2. First, as columns 1-4 of table 3 shows, most of the output changes due to changes in domestic demand result from PCE-Food changes. Thus, PCE dominates the contribution to changes in output during the period due to the domestic demand expansion. One exception is in Dairy plants (sector 2) where the government program purchases are an important source of demand driven output changes.

Production to meet domestic food demand growth exceeded of the total food and kindred product output growth ($106.7 billion due to food demand, Table 3 versus $105.1 billion total output change, Table 2). The contribution of the four domestic food demand categories to output growth suggests differing forces exerted on sectors of the Food and kindred product industry. Most of the output changes due to changes in domestic food demand result from off premises consumption changes. Thus, OPC dominates the contribution to Food and kindred product industry 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. Per capita disposable personal income grew 37.5% from $10,414 in 1972 to $14,341 in 1992 (in $87). In addition to consumers being more numerous and more affluent, American lifestyles have

become faster paced and demographic trends shortened the consumer's available time for preparing meals. Accordingly, the demand for consumer ready processed food grew and likely will grow faster than the demand for traditional food cooked in the home. This phenomenon can be explained by the fact that Miscellaneous Food Processing; Canning, Freezing, and Dehydrating; etc. grew more than that of sectors producing less highly processed foods - Meat Processing, Dairy Processing, etc. (Table 1).

Furthermore, consumers dined out more both as households' incomes grow and as the number of dual income households increased. From 1972 to 1992, PCE for purchased meals and beverages nationwide went up from $101.2 billion in 1972 to $168.6 billion (in $87, up 67%) in 1992. 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 did 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-fourths. This change has boosted sharply the number of single-individual and dual-income households. 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. Aside from 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.

The output consequences for food and kindred product industry sectors of these demand changes have had important influences on the food and kindred product industry. Among the four components of domestic food demand expansion that influences change in total sector output, food purchased for off-premises consumption played the major role for eight of our food and kindred product industry sectors. Purchased meals and beverages played the major role for four of our food and kindred product industry 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 Products, Dairy Plants, Fish and Seafood, and Refined Sugar.

Market alert firms in the food and kindred product industry transform from a "here is what we produce" to "here is what consumers want" perspective. As consumers become more discriminating buyers, they shifted from traditional foods to more consumer-ready foods. Consumers became increasingly concerned about health and nutritional content of the food. 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. This paper has identified the gaining and losing sectors in the food and kindred product industry from these changes.

VI. Summary and Conclusions

This paper analyzed growth and structural changes in the U.S. food and kindred product industry for 1972-1992 from the perspective of decomposition of sources of output changes. The preceding discussion showed that there were changes in output due to changes in domestic demand, export demand, changes in I/O coefficients, and domestic supply ratios. Changes in sector output vary; in 11 of 12 food and kindred product sectors, output increased. The analysis identified several broad structural and technical trends stemming from changes in domestic demand, export expansion, domestic supply ratio, and from changes in I/O coefficients. For example, the large increase in processed food and fiber sector outputs suggests that the products produced by these sectors were becoming increasingly attractive mostly as domestic demand and some export demand. Conversely, the decline in the output of refined sugar reflects the declining importance of these products in contemporary production and consumption, particularly changes in the tastes of consumers.

This study raises three important points. First, for the twenty-year period, changes in production process of 8 of the 12 sectors led to a negative contribution to changes in output demand. Thus, structural changes resulting from changes in technology led to less use of processed food and fiber products in the production

process. The domestic supply ratios of intermediate inputs and final demand also contributed significantly to the negative output growth. This indicates that the U.S. food and kindred product industry's production processes as well as final use became increasingly import-dependent during the period. Second, since the domestic, especially food, demand expansion plays a crucial role in output growth, population growth, consumers' tastes, and increases in consumers' disposable income play the most important role in determining the change in the structure of the U.S. food and kindred product industry. Third, this paper indicates that while output due to total changes in domestic consumers' food demand exceeded total food and kindred product output growth from 1972 to 1992, ignoring the influence of the other demands would cause the sector analyst to miss important economic influences on particular sector outputs.

During the next decade, new technologies, increases in foreign demand, and changes in domestic consumer tastes and income are likely to reshape virtually every product in the food and kindred product industry. With these changes will be associated changes in the industry's income and employment. With this type of analysis that examines the structural changes in the past, we can identify the underlying strength of various economic forces inducing these changes.

The issue is not whether structural change is occurring at greater or lesser rate than it has in the past. In some sectors of food and kindred product it has and in others it has not. The critical point is that the collective effect in the decade 1972-1992 of change left U.S. food and kindred product with a much clearer perspective that endogenous forces such as domestic demand and government polices and exogenous forces such as foreign demand will play crucial roles in changing the nature of U.S. food and kindred product industry structure.

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Table 1- Food and Kindred Product Output Changes, 1972-1992				
	Output	Output	Output	Percent
Sector name	1972	1992	change	change
		million $1987		%
Red meat processing	56,340	62,440	6,100	10.8
Poultry and egg processing	6,472	23,865	17,393	268.7
Dairy plants	34,848	42,120	7,272	20.9
Canning, freezing, and dehydrated	27,152	40,449	13,297	49.0
Grain milling, excluding prep feeds	14,391	25,134	10,743	74.7
Prepared Feeds	10,655	15,191	4,536	42.6
Refined sugar	8,010	5,909	-2,101	-26.2
Fats and oil mills	11,920	16,886	4,966	41.7
Confectionery, bakery, and				
macaroni	23,252	43,118	19,866	85.4
Beverage and flavorings	44,330	57,688	13,358	30.1
Fish & Seafood	5,099	6,740	1,641	32.2
Miscellaneous food processing	16,656	24,662	8,006	48.1
Total processed food	259,125	364,202	105,077	40.6

Table 2.   Contribution of Demand Categories to Food and Kindred Product
          Sector Output Changes, 1972-92, Mil. 1987$.

	Domestic Demand	Export Demand	Intermediate Demand	Domestic Supply Ratio	Total Change
Red meat processing	7027	4135	-4184	-877	6100
Poultry and egg processing	14706	1176	1525	-14	17393
Dairy plants	7380	663	-415	-356	7272
Canning, freezing, and dehydrated	12150	1527	609	-988	13297
Grain milling, excluding prep feeds	10126	1469	-516	-336	10743
Prepared Feeds	4753	1144	-1065	-296	4536
Refined sugar	457	394	-4477	1526	-2101
Fats and oil mills	3798	1711	130	-673	4966
Confectionery, bakery, and macaroni	17988	1404	1193	-719	19866
Beverage and flavorings	18642	1270	-3742	-2812	13358
Fish & Seafood	1974	67	-210	-189	1641
Miscellaneous food processing	8910	931	-1460	-375	8006
Total Food & Kindred	107910	15890	-12612	-6111	105077

	Food-Off Premise	Meals and Beverages	Furnished Employees	Farm Home Consumption	Non-Food Domestic	Total Domestic
Red meat processing	1023	4859	285	-556	1417	7027
Poultry and egg processing	12423	1500	277	-11	517	14706
Dairy plants	179	4536	286	-1	2378	7380
Canning, freezing, and dehydrated	7604	2931	283	0	1332	12150
Grain milling, excluding prep feeds	8785	819	156	-4	370	10126
Prepared Feeds	3104	963	96	-71	660	4753
Refined sugar	-228	492	26	-2	168	457
Fats and oil mills	2307	811	124	-27	583	3798
Confectionery, bakery And macaroni	12474	3801	307	0	1406	17988
Beverage and flavorings	21231	5213	58	-1	-7859	18642
Fish & Seafood	599	1259	17	-2	100	1974
Miscellaneous food processing	7519	1191	22	-3	181	8910
Total Food & Kindred	77020	28376	1937	-678	1254	107910

Table 3. Contribution of Domestic Demand Categories to Food and Kindred Product Sector Output Changes, 1972-92, Mil. 1987$.