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An Econometric Model of the U.S. Asparagus Industry

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AN ECONOMETRIC MODEL OF THE U. S. ASPARAGUS INDUSTRY

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I. INTRODUCTION

During the past 30 years the U. S. asparagus industry has experienced major losses in export markets, increased competition from imports, and declining domestic demand. These factors have led to large reductions in total acreage and changes in the relative utilization of the crop for processing and fresh markets. In addition, there have been shifts in regional shares of asparagus production. Since asparagus is a perennial crop involving long-term investments, accurate anticipation of the impacts of changes in the economic environment is especially important. It is also difficult.

This report develops an econometric model of the industry which may be used to gain insight into the adjustment processes and as a framework for dynamic economic projections. Specific applications presented here include evaluations of the effects of future population growth, changes in export demands, changes in imports and the impacts of potential cost changes that might occur with improved technology or changes in input prices.

The report is organized as follows: Section II describes key characteristics of the asparagus industry; Section III describes the major changes that have occurred over the past 30 years; Section IV briefly reviews previous economic studies pertaining to the industry; Section V develops a structural model of the asparagus economy; Section VI presents the empirical estimates of the model equations; Section VII reports the results of simulation experiments with the complete dynamic model; and Section VIII contains a summary and general evaluation. Data pertaining to the industry and used to estimate the model are given in Appendix A.

II. COMMODITY AND INDUSTRY CHARACTERISTICS

Asparagus is a perennial crop, the edible part consisting of spears which emerge from the plants' root crown in the spring. The spears are cut (or in some areas snapped) when they are 7 to 10 inches above the ground. Harvest typically continues from February in the earliest areas, or April in later areas, until June. After harvest the plants are allowed to grow to ferns which generate a food supply for the root crown. The tops are killed by frost and are cut and mulched. The cycle is repeated with the emergence of spears again the following spring. The plants bear a small amount the second year after planting but are not harvested heavily until the third season. Thereafter, the asparagus beds remain productive for 8-15 years.[1]

Asparagus spears are marketed in three forms: fresh, frozen, and canned. In the five-year period 1977-1981, about 43 percent of the total production was canned, 18 percent frozen, and 39 percent shipped to the fresh market. The fresh share increased to over half in the early 1980s. In California, nearly all asparagus harvested during the early period from February to the end of March is marketed fresh. Starting in April, as harvest begins in other regions, an increasing share of California production is allocated to processing uses.

Asparagus production is centered mainly in four areas of the United States: California, the northwest (primarily Washington), the midwestern states of Illinois and Michigan, and the eastern states of New Jersey, Delaware, and Maryland. Minor quantities are grown in several other states.

Table II.1 shows numbers of farms and average acreage per farm producing asparagus in California and the United States, as reported by the Bureau of the Census from 1954 to 1982. Since the acreages reported by the Census differ considerably in some years from the estimates of the California Crop and Livestock Reporting Service, the figures should be viewed as approximations, rather than precise values. The 1974 figures are based on data estimated by the U.S. International Trade Commission (1976). The data show a moderate decline in the number of farms in California and a very large decline in farm numbers in other regions. Average acreage per farm in California declined from 299 acres in 1954 to 220 in 1974 and has since averaged between 220 and 225 acres. Acreages per farm in other regions, although still much smaller than in California, have increased considerably since 1954.

In 1981, U.S. producers of asparagus received $99 million for their crop. About $57 million was for fresh market sales and $42 million from sales to processors. By 1987, the values had increased to $136 million total, $91 million fresh, and $45 million for processing.

The output of U.S. asparagus not sold in the fresh

[1]For more on cultural practices, see Sims, Souther, and Mullen (1988).

Table II.1. The Number and Size of Asparagus Producing Units in the United States and California, 1956 to 1982

	1954	1959	1964	1969	1974[a]	1978	1982
Number of farms reporting							
California	244	288	248	200	200	130	154
Other States	9,455	8,060	5,361	3,010	2,200	2,600	2,485
United States	9,699	8,348	5,609	3,210	2,400	2,730	2,639
Total Acres							
California	73,055	82,618	65,144	47,837	44,100	29,013	34,718
Other States	70,172	80,296	74,295	68,555	68,400	57,143	62,484
United States	143,227	162,914	139,439	116,392	112,500	86,156	97,202
Average acreage per farm							
California	299	287	263	239	220	223	225
Other States	7	10	14	23	31	22	25
United States	15	20	25	36	47	32	37

[a]Data for 1974 are from U. S. International Trade Commission, *Asparagus*, January 1976

Source: Bureau of the Census, *U. S. Census of Agriculture* , 1954, 1959, 1964, 1969, 1978, 1982.

market was processed by 38 canners and 19 freezers in 1972 and by 27 canners and 8 freezers in 1975 (U.S. International Trade Commission, 1976). The 1984-85 Directory of the Canning, Freezing and Preserving Industry lists 22 canners and 18 freezers. Of these, two canners and four freezers were located in California.

The production of asparagus appears to fit the competitive model of many independent price-taking firms (see Table II.1). However, the marketing of processing asparagus has been influenced at various times by the existence of grower bargaining associations, especially in Washington and Michigan. These associations have bargained with processors over prices and other terms of trade. The California Asparagus Growers Association, while operating to a limited extent as a bargaining agent, has functioned mainly as a service bureau. In this role it has provided cohesiveness and assistance to growers by (a) assisting in obtaining labor supplies; (b) providing information on price, quantity, plantings, plowouts and other economic data; (c) acting as a liaison between growers and canners and freezers; and (d) providing representation in matters such as tariff negotiations.

Following the enactment of marketing order legislation in the early and mid-1930s, California asparagus growers experimented with several types of marketing order programs. They included provisions for advertising and sales promotion, quality control, surveys and research and volume controls. Volume controls on fresh market asparagus were in effect from 1934 to 1936 and again in 1954. The quantity limitation provisions were applied to processing asparagus in 1953, 1954, 1956. The extent of these volume restrictions apparently was not large. Increasing grower and processor dissatisfaction led to elimination of all volume-control marketing order programs since that time.

III. ECONOMIC TRENDS AND CHANGES[2]

Production

Historical data pertaining to the acreage, yields, and production of asparagus are given in Appendix Tables A1, A2, A3, and A4. Table A1 shows that U.S. asparagus acreage declined from a peak of 161,200 in 1959 to a little over 80,000 acres in 1981 and since increased to 99,800 acres in 1987.[3] Most of the acreage decline occurred in California, New Jersey, Illinois and minor states while acreage and production in Washington and Michigan about doubled over the period (Table A1).

[2]At the time this report was completed, data series were available only through 1986 or 1987. During the manuscript review period some additional observations were published and have been added to the appendix tables. However, the later observations have not been incorporated in the analysis.

[3]The U.S. Department of Agriculture discontinued reporting of total U.S. asparagus acreage and production in 1982 and 1983. Collection and reporting of U.S. data was resumed in 1984.

Appendix Table A2 indicates how acreage has shifted within California. Most of the decline has been in and around the Delta counties of Contra Costa, San Joaquin, Sacramento, Yolo, and Solano.

Asparagus yields have not shown any clear trend within California and Washington, but give the appearance of some decline in other areas and in the overall U.S. average (Table A3). However, the decline is somewhat misleading since a substantial part of this decrease is due to changes in midwestern harvesting methods from cutting to snapping. Snapping reduces the proportion trimmed, but results in little change in the yield of usable product. Yields in the eastern states apparently declined in part because of changes in harvest methods but also due to some disease problems. Yields also vary with the age distribution of asparagus beds. The fields are harvested for only a short period in their first year of bearing and then gradually increase in productivity, finally declining again as they age.

Utilization

The historical allocation of U.S. asparagus production to fresh, canned, and frozen uses is given in Appendix Table A4, Part E. These values are expressed as proportions of total production in Table III.1. In the decade of 1960s more than half the crop was utilized for canning, with 16 to 22 percent frozen and the balance to the fresh market. Primarily as a result of

Table III.1. Proportions of U.S. Asparagus Production Utilized for Fresh Market, Canning and Freezing [a]

Year	Fresh Market (QGRU ÷ QGU)	Canning (QGCU ÷ QGU)	Freezing (QGFU ÷ QGU)	Total Processed (QGPU ÷ QGU)
1950	.360	.505	.135	.640
1951	.326	.530	.144	.674
1952	.364	.478	.158	.636
1953	.384	.417	.199	.616
1954	.334	.509	.157	.666
1955	.280	.565	.155	.720
1956	.329	.461	.210	.671
1957	.368	.463	.169	.632
1958	.370	.482	.148	.630
1959	.343	.476	.181	.657
1960	.327	.478	.195	.673
1961	.297	.525	.178	.703
1962	.280	.554	.166	.720
1963	.276	.559	.165	.724
1964	.284	.553	.163	.716
1965	.317	.511	.172	.683
1966	.255	.551	.194	.745
1967	.279	.500	.221	.721
1968	.279	.524	.197	.721
1969	.276	.558	.166	.724
1970	.343	.471	.186	.657
1971	.299	.482	.219	.701
1972	.319	.427	.254	.681
1973	.334	.486	.180	.666
1974	.316	.574	.110	.684
1975	.408	.404	.188	.592
1976	.399	.358	.243	.601
1977	.333	.440	.227	.667
1978	.377	.465	.158	.623
1979	.335	.413	.252	.665
1980	.469	.413	.118	.531
1981	.475	.411	.114	.525
1982	NA	NA	NA	NA
1983	NA	NA	NA	NA
1984	.550	.353	.097	.450
1985	.539	.317	.144	.461
1986	.622	.263	.114	.378
1987	.590	.283	.127	.410

[a]Computed from Appendix Table A4, Part E.

a loss of canned export markets, the share going to canning dropped to a little over 40 percent by the end of the 1970s. The frozen share fluctuated widely in the range between 11 and 25 percent. In 1980 and 1981 the reported proportion marketed fresh jumped substantially to about 47 percent, with most of this apparently coming out of the share for freezing. Reporting of U.S. asparagus production was discontinued in 1982 and 1983. When reporting was resumed in 1984 the share going to the fresh market was reported in the range of 54 to 55 percent, with further declines in the share canned and with the share going to freezing remaining well below historical levels. There were further increases in the reported fresh market share in 1986 and 1987.

Whether the 1984-87 data accurately reflect further shifts in allocations among product forms or are in part a result of some change in reporting may be open to question. Appendix Table A11 shows that the ratios of reported farm weight of asparagus utilized for freezing to frozen pack (KFU) were substantially below historical values—dropping from an average near 2.0 to as low as 1.22 in 1984. This suggests the possibility that some of the asparagus reported as utilized fresh

Table III.2. Regional Market Shares of Asparagus Production[a]

	Processed			Fresh			Total		
	California	Northwest	Other	California	Northwest	Other	California	Northwest	Other
Year	MSPC	MSPN	MSPO	MSRC	MSRN	MSRO	MSC	MSN	MSO
1950	0.55	0.10	0.35	0.53	0.08	0.39	0.54	0.10	0.36
1951	0.53	0.10	0.38	0.44	0.10	0.46	0.50	0.10	0.40
1952	0.50	0.12	0.37	0.50	0.11	0.40	0.50	0.12	0.38
1953	0.49	0.13	0.38	0.52	0.09	0.39	0.50	0.12	0.38
1954	0.51	0.12	0.38	0.47	0.12	0.40	0.50	0.12	0.38
1955	0.58	0.10	0.32	0.43	0.10	0.47	0.53	0.10	0.36
1956	0.52	0.13	0.35	0.54	0.09	0.37	0.52	0.12	0.36
1957	0.49	0.13	0.37	0.54	0.08	0.35	0.52	0.12	0.36
1958	0.53	0.11	0.36	0.49	0.13	0.38	0.52	0.12	0.37
1959	0.50	0.11	0.38	0.54	0.09	0.37	0.51	0.11	0.38
1960	0.51	0.13	0.36	0.51	0.09	0.40	0.51	0.12	0.37
1961	0.53	0.14	0.33	0.55	0.11	0.34	0.54	0.13	0.34
1962	0.53	0.15	0.32	0.55	0.11	0.33	0.54	0.14	0.33
1963	0.53	0.14	0.34	0.59	0.07	0.34	0.54	0.12	0.34
1964	0.49	0.16	0.35	0.58	0.09	0.33	0.52	0.14	0.34
1965	0.40	0.19	0.41	0.61	0.10	0.29	0.47	0.16	0.37
1966	0.46	0.17	0.37	0.54	0.14	0.32	0.48	0.16	0.36
1967	0.40	0.19	0.41	0.62	0.08	0.30	0.46	0.16	0.38
1968	0.39	0.21	0.41	0.67	0.10	0.23	0.47	0.18	0.36
1969	0.37	0.23	0.40	0.69	0.09	0.22	0.46	0.19	0.35
1970	0.36	0.25	0.39	0.72	0.09	0.19	0.48	0.20	0.32
1971	0.40	0.29	0.31	0.71	0.10	0.18	0.49	0.24	0.27
1972	0.43	0.28	0.29	0.76	0.08	0.16	0.54	0.21	0.25
1973	0.36	0.34	0.31	0.77	0.09	0.14	0.50	0.25	0.25
1974	0.38	0.33	0.30	0.74	0.13	0.13	0.49	0.27	0.25
1975	0.33	0.36	0.31	0.75	0.13	0.12	0.50	0.27	0.23
1976	0.38	0.39	0.23	0.79	0.13	0.08	0.54	0.29	0.16
1977	0.38	0.39	0.22	0.77	0.12	0.11	0.51	0.31	0.18
1978	0.22	0.51	0.27	0.75	0.12	0.13	0.42	0.37	0.21
1979	0.35	0.41	0.24	0.75	0.10	0.15	0.48	0.31	0.20
1980	0.17	0.53	0.30	0.80	0.05	0.14	0.47	0.31	0.22
1981	0.20	0.59	0.22	0.80	0.09	0.12	0.48	0.36	0.16
1982	b								
1983									
1984	0.14	0.59	0.27	0.71	0.20	0.09	0.45	0.38	0.17
1985	0.17	0.58	0.25	0.71	0.21	0.08	0.46	0.38	0.16
1986	0.13	0.58	0.29	0.71	0.21	0.08	0.49	0.35	0.16

[a]For a description of the variables, see Appendix B, Sources and Descriptions of Data.
[b]Blanks indicate unavailable data.

actually may have been frozen. If enough asparagus is transferred from the reported fresh quantity to freezing use to bring the conversion ratio (KFU) equal to 2.0, the fresh market shares decrease and the frozen shares increase about 5 or 6 percentage points. The fresh market shares still have increased compared to the 1980-81 levels, but the adjusted results seem more plausible. In any case, the reported 1984-87 data probably should be viewed with some caution—at least as related to consistency of reporting methods compared with previous procedures.

Changes in utilization have also varied considerably among regions. Appendix Table A4 gives the quantities produced for fresh and processing use by regions. Table III.2 converts these values to market share proportions. Most notable is the large decline in California's share of processing asparagus production. The Northwest (primarily Washington) has replaced California as the dominant processing region. All other states' share of processing production declined in the 1970s but has been relatively stable over the past decade.

California, which has always been the dominant producer of fresh-market asparagus became even more dominant in the 1970s and has remained that way—accounting for over 70 percent of fresh market sales. Overall, California continues to be the largest asparagus producer with 45-50 percent of total production.

The U.S. Department of Agriculture statistics do not show regional breakdowns of processing production between canned and frozen uses except for California. Farm weight approximations for regions other than California were obtained by multiplying the regional canned and frozen pack data in Appendix Tables A5 and A6 by the conversion ratios in Table A11 for all regions other than California. These values were then used to compute estimates of the proportion of processing asparagus utilized for canning in each region and for the United States (Table III.3). The freezing proportions are one minus the canning proportions. The data show that the proportion of processed product utilized for canning has decreased in relation to the proportion utilized for freezing in California, but has increased in other regions. For the total United States, there has been no clear trend in the relative shares of processed product used for canning and freezing. Canned asparagus has accounted for 65 to 79 percent in most years.

Table III.4 shows how regional market shares of canned and frozen asparagus have varied. California's share of the canned market has decreased while both the Northwest and all other states have increased. California increased, then maintained its share of the frozen asparagus market. However, there has been some recent decline in this share. California and the Northwest together account for nearly 90 percent of frozen asparagus production.

Table III.3 Proportions of Processed Product Utilized for Canning

Year	California SQCC	Northwest SQCN	Midwest-East SQCME	U.S. SQCU
1950	0.92	0.36	0.72	.79
1951	0.92	0.41	0.71	.79
1952	0.89	0.40	0.68	.75
1953	0.82	0.38	0.59	.68
1954	0.89	0.49	0.69	.76
1955	0.89	0.50	0.68	.78
1956	0.76	0.45	0.66	.69
1957	0.81	0.41	0.74	.73
1958	0.88	0.54	0.74	.79
1959	0.80	0.48	0.69	.72
1960	0.79	0.40	0.71	.71
1961	0.80	0.46	0.76	.75
1962	0.81	0.55	0.81	.77
1963	0.81	0.54	0.81	.77
1964	0.78	0.60	0.83	.77
1965	0.73	0.59	0.84	.75
1966	0.69	0.62	0.85	.74
1967	0.59	0.54	0.87	.69
1968	0.61	0.58	0.83	.70
1969	0.67	0.60	0.94	.77
1970	0.62	0.53	0.89	.72
1971	0.56	0.59	0.89	.69
1972	0.44	0.60	0.90	.63
1973	0.63	0.64	0.92	.73
1974	0.78	0.76	0.96	.84
1975	0.38	0.74	0.91	.68
1976	0.33	0.67	0.86	.60
1977	0.36	0.78	0.91	.66
1978	0.45	0.78	0.88	.75
1979	0.27	a	a	.62
1980	0.49			.78
1981	0.39			.78
1982	0.32			
1983	0.44			
1984	a			.78
1985				.69
1986				.70
1987				.69

[a]Blanks indicate unavailable data.

Exports and Imports

Data pertaining to exports and imports of asparagus are given in Appendix Tables A7, A8, A9, and A10. Table A7 shows the change in exports of canned asparagus; from a peak of 62 million pounds in 1963 to less than 5 million pounds beginning in 1972. As shown in Table A10, most of the export loss was in the European market, especially West Germany, whose imports were largely taken over by Taiwan. Meanwhile, U.S. imports of canned asparagus increased in the 1970s and have since fluctuated in the range of 4 to 13 million pounds, with no clear trend.

Table III.4. Regional Market Shares of Canned and Frozen Asparagus Packs

	Canned			Frozen		
	CA	North-west	Other	CA	North-west	Other
Year	MSCC	MSCN	MSCO	MSFC	MSFN	MSFO
1950	0.59	0.06	0.35	0.25	0.33	0.42
1951	0.55	0.07	0.39	0.21	0.30	0.49
1953	0.53	0.08	0.39	0.27	0.25	0.48
1954	0.54	0.09	0.37	0.25	0.27	0.48
1955	0.59	0.07	0.33	0.27	0.23	0.50
1956	0.53	0.08	0.39	0.38	0.21	0.41
1957	0.54	0.07	0.38	0.32	0.29	0.38
1958	0.59	0.08	0.33	0.29	0.26	0.45
1959	0.55	0.09	0.36	0.33	0.25	0.41
1960	0.53	0.08	0.38	0.32	0.30	0.38
1961	0.55	0.09	0.36	0.40	0.29	0.31
1962	0.55	0.10	0.35	0.41	0.30	0.29
1963	0.57	0.09	0.34	0.41	0.29	0.30
1964	0.50	0.11	0.39	0.49	0.25	0.26
1965	0.37	0.14	0.49	0.41	0.30	0.29
1966	0.43	0.12	0.44	0.49	0.25	0.26
1967	0.34	0.15	0.53	0.50	0.31	0.19
1968	0.34	0.15	0.51	0.49	0.26	0.25
1969	0.33	0.15	0.52	0.51	0.36	0.13
1970	0.27	0.17	0.56	0.50	0.34	0.16
1971	0.29	0.22	0.49	0.53	0.33	0.14
1972	0.23	0.25	0.52	0.63	0.27	0.09
1973	0.22	0.29	0.50	0.56	0.35	0.10
1974	0.27	0.26	0.47	0.54	0.37	0.09
1975	0.15	0.37	0.49	0.62	0.28	0.10
1976	0.19	0.39	0.42	0.64	0.26	0.10
1977	0.18	0.40	0.42	0.65	0.25	0.10
1978	0.09	0.42	0.49	0.47	0.34	0.19
1979	a	0.45	0.55	0.70	0.18	0.12
1980		0.47	0.53		0.31	
1981		0.54	0.46		0.34	
1982		0.56	0.44	0.48		
1983				0.34		
1984						

[a]Blanks indicate unavailable data.

There are no reported exports of frozen asparagus. Such quantities as may occur apparently are grouped with other vegetables. Quantities are believed to be small. Small quantities of frozen asparagus are imported (Table A8), primarily from Mexico.

Exports of fresh asparagus (Table A9) gradually increased into the 1980s. Imports, primarily from Mexico, increased significantly in the 1970s, more or less leveled out, and then have expanded greatly in the 1980s. The potential impact of further changes in fresh and canned imports and exports are evaluated in the economic analysis which follows.

Prices and Margins

Appendix Table A12 gives prices received by California growers for fresh, canning, and freezing asparagus and Table A13 gives such data as are available for other regions and for the United States. F.o.b. processor prices are given in Tables A14, A15, and A16. Table A16 compares nominal prices with values deflated by the Personal Consumption Expenditure Deflator. As indicated by the upward trends in deflated prices, nominal asparagus prices have increased more rapidly than the general price level as measured by the PCE deflator. However, when the average grower price is divided by the index of farm wage rates (the primary input cost for asparagus), the increase seems less pronounced (see RU in Table A20).

Appendix Table A17 computes indicators of changes in processor margins for asparagus. They are computed by subtracting the cost of the raw product in a pound of processed product from the f.o.b. price. Like prices, the margin indicators have increased substantially since the 1950s, as would be expected with increased costs of labor, capital, and other inputs. When divided by an index of processing cost (IPC, Table A18), the margin indicators, while fluctuating, showed little overall change until the late 1970s. Then they increased substantially. It is possible that the processing cost index is not a good measure of processing cost change for asparagus—at least in the 1980s. The margin indicators could also reflect some restructuring of the industry with higher profit positions for processors.

Per Capita Consumption

Per capita consumption data for fresh, canned, and frozen asparagus are given in Appendix Table A19 [see variables DRDN (fresh), DCDN (canned), and DFDN (frozen)]. These figures may not coincide exactly with USDA per capita consumption calculations because they are based on crop-year data, may use slightly different conversion factors, and are less rounded. Per capita consumption of processed asparagus has declined since the 1960s. Fresh per capita consumption declined until the late 1970s but has since increased markedly, more than doubling between 1980 and 1986.

IV. PREVIOUS ECONOMIC STUDIES PERTAINING TO THE ASPARAGUS INDUSTRY

The first quantitative economic analysis of the asparagus industry, of which we are aware, was a doctoral dissertation by Jim L. Matthews completed in 1966.[4] Matthews estimated demand and supply functions using data for the period 1950-1963. While the study seemed generally well formulated, the statistical results were mixed, in part due to the short data set available. Matthews obtained good estimates of demand relationships for fresh asparagus, weaker estimates of demand functions for canned and frozen asparagus and generally poor results on the supply side. Later, French and Matthews (1972) reformulated the supply model and with nine additional observations (1947-1969) obtained statistically significant estimates of regional relationships between current asparagus acreage, lagged acreage and lagged values of prices relative to cost.

In 1973, Grossman, in another doctoral dissertation, formulated a simultaneous equation model of the asparagus industry in terms of only farm-level demand and supply functions. The general model was applied at different levels of regional aggregation, but Grossman noted that "the specification of the asparagus model appears to break down as the model is disaggregated." (p. 172) The generally weak statistical results obtained for the supply component and the omission of the processed product component suggest that an alternative formulation could achieve improved results.

For a number of years Professor Sidney Hoos at the University of California, Berkeley, along with various assistants, compiled annual detailed economic statistics for California asparagus as a service to the industry. A 1977 report (with D. Runsten) included linear and logarithmic multiple regression equations which predicted the grower price for processing asparagus as a function of the California volume for processing, the March wholesale price index for canned asparagus, U.S. current disposable income and the March wholesale price index for canned vegetables and juices. The data period was 1960-1976. The competing canned vegetable variable (wholesale price index) was not statistically significant. The coefficient for California volume for processing was significant in both cases at either the 5 or 10 percent level. However, omission of the important carry-in stock variables raises some uncertainty about the quality of the estimated equations.

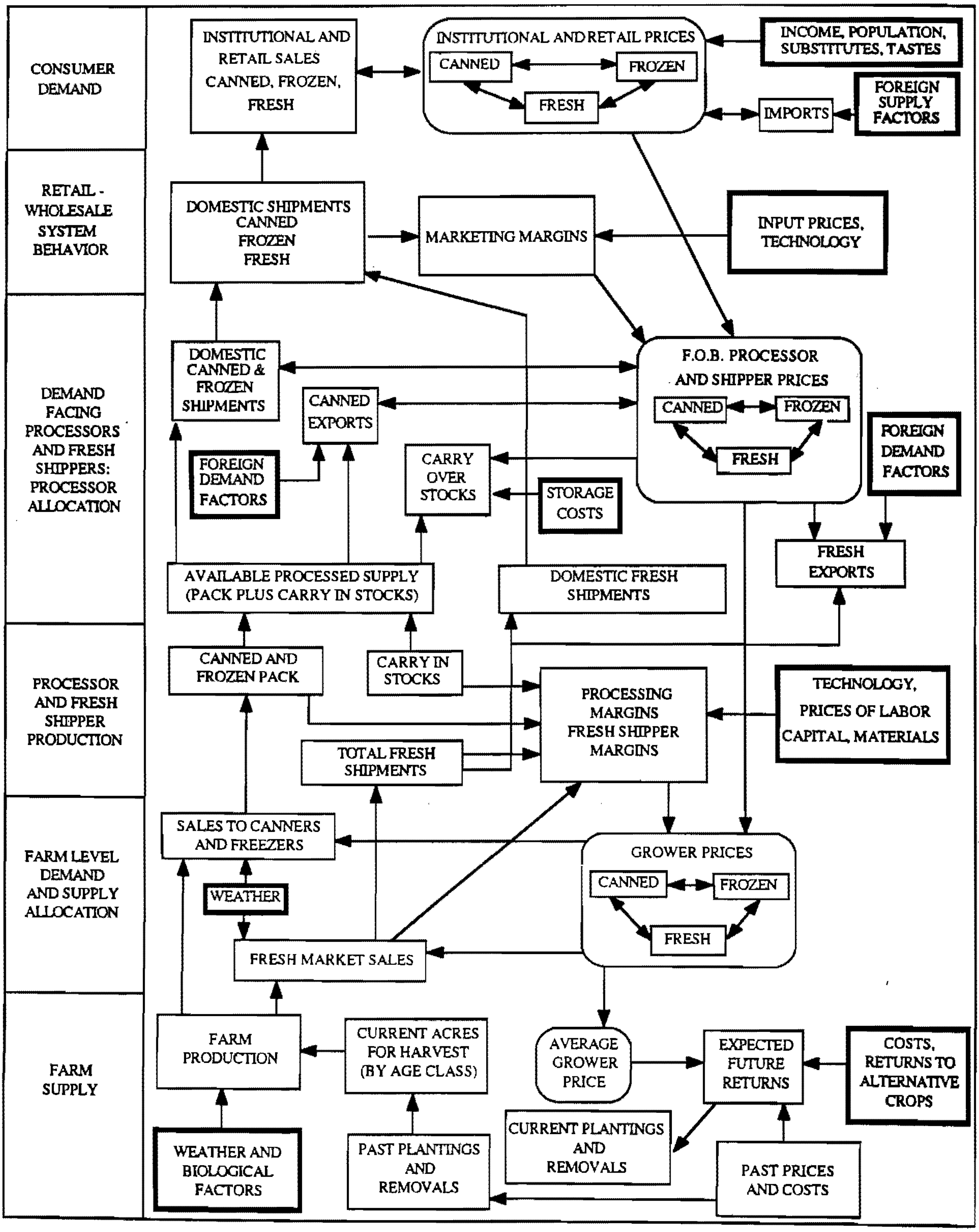
A 1982 study by Bbuyemusoke, Harrington, and Mittelhammer presented some insightful diagrams of economic interrelationships in the asparagus industry and reported estimated percentage-change demand and supply relationships based on a statistical analysis of data for the period 1954-1980. However, they apparently combined the canned and frozen demand components and did not report on the statistical properties of the model equations. It is not possible, therefore, to evaluate the quality of the results.

Three International Trade Commission (previously the U.S. Tariff Commission) reports (1973, 1976, 1988) also deserve mention. These studies, undertaken in response to asparagus industry concerns about increased imports, compiled substantial amounts of information about the asparagus industry structure and developments, but did not attempt to estimate supply and demand functions.

This brief review of previous research suggests that there remains a place for further econometric analysis. We turn now to that task.

[4]Foote (1958) described a simultaneous equation regional model of the asparagus demand and allocation system (production predetermined) developed by H. Carstensen in an unpublished paper. However, no empirical results were presented.

FIGURE 1 MAJOR ECONOMIC RELATIONSHIPS IN THE U. S. ASPARAGUS INDUSTRY



V. A STRUCTURAL MODEL OF THE ASPARAGUS INDUSTRY

Economic structure refers to the set of supply, demand, and pricing relationships which underlie the determination of farm production, the establishment of farm-level prices, the allocation of farm production to the major end uses (fresh, canning, freezing) and the determination of f.o.b. processor prices, annual product movement, and inventory carryover of canned and frozen asparagus. An ideal model of the asparagus industry would include separate supply response functions for each producing region, demand functions for each product form in all geographically-separated consumer centers, transfer costs among all producing regions and consumer centers and regional processor-grower interaction relationships. Unfortunately, the data required for such detailed model development are not available. Hence, the analysis that follows is restricted to a simpler formulation based mainly on aggregate U. S. relationships, with some limited exploration of factors affecting regional supply shifts.

Figure 1 provides a schematic picture of the interrelationships among commodity prices, quantities produced and sold and factors such as costs, income, and the like. Table V.1 outlines the types of demand and supply relationships that must be estimated in order to form a mathematical model of the system. Part A of Table V.2 defines the symbols used for the basic endogenous variables of the system.[5] Part B defines the exogenous variables and Part C defines additional endogenous variables which are computed from the

Table V.1. Structural Relationships of the Asparagus Industry Model [a]

A. Demand and Marketing Subsector

1. F.o.b. demand facing canners
   $PPCCE_t = f_1(DCDN_t, DFDN_t, DRDN_t, \underline{IDNE}_t, \underline{TRND})$
2. F.o.b. demand facing freezers
   $PPFCE_t = f_2(DCDN_t, DFDN_t, DRDN_t, \underline{IDNE}_t, \underline{TRND})$
3. Canned product market allocation
   $DCDN_t = f_3(QSCNI_t, PPCCE_t, PPCCE_{t-1}, \underline{IPCE}_t, PGPUE_t)$
4. Frozen product market allocation
   $DFDN_t = f_4(QSFNI_t, PPFCE_t, PPFCE_{t-1}, \underline{IPCE}_t, PGPUE_t)$
5. Fresh market demand facing growers
   $PGRUE_t = f_5(DCDN_t, DFDN_t, DRDN_t, \underline{IDNE}_t, \underline{TRND})$
6. Pricing equation for raw processing asparagus
   $PGPUE_t = f_6(QSGPUN_t, \underline{IPC}_{t-1}, MPPCE_{t-1}, DPN2_t)$

B. Production Subsector

7. Total acreage response
   $AU_t = f_7(RU_{t-1}, RU_{t-2}, RU_{t-3}, \ldots, RU_{T-\infty}, AU_0, AU_{-1}, \underline{T65}, \underline{D1}, \underline{D65}, \underline{D66})$
8. Production and allocation
   a. $QGU_t = YU_t \cdot AU_t$ and $QGUN = QGU + \underline{N}$
   b. $QGRUN = f_8(QGUN_t, \underline{NRN2}_{t-1}, DPN2_t, SPN_t, MPPCE_{t-1}, \underline{IPCE}_{t-1}, \underline{TRND}, \underline{IDNE}_t)$
   c. $QGCUN = f_9(QGUN_t, \underline{NRN2}_{t-1}, NCN2_{t-1}, SCFN_t, SFFN_t, PPCCE_{t-1}, PPFCE_{t-1}, \underline{IPCE}_{t-1}, \underline{TRND}, \underline{IDNE}_t)$
   d. $QGFUN_t = QGUN_t - QGRUN_t - QGCUN_t$
   e. $QGRU = QGRUN \cdot \underline{N}$
   f. $QGCU = QGCUN \cdot \underline{N}$
   g. $QGFU = QGFUN \cdot \underline{N}$

[a]Underlined variables are exogenous.

[5]Endogenous variables include prices, outputs and shipments whose values are determined by solution of the model. Exogenous variables consist of costs, income, population, and other variables whose values are treated as determined outside the system. The endogenous variables may be further separated into *current endogenous* whose values are determined by model solution for a particular year and *lagged endogenous* whose values are *predetermined* for that year, but not over time.

Table V.2. Variable Identification

A. Basic Endogenous Variables	
Variable	Definition[a]
AU	U.S. harvested asparagus acreage, thousands. (Table A1)
DC	U.S. canner total shipments of canned asparagus, million pounds. (Table A7)
DCD	U.S. consumption of canned asparagus, million pounds. (Table A7)
DF	U.S. freezer total shipments of frozen asparagus, million pounds. (Table A8)
DFD	U.S. consumption of frozen asparagus, million pounds. (Table A8)
DRD	U.S. consumption of fresh market asparagus, million pounds. (Table A9)
PGPU	U.S. average grower price for asparagus utilized for processing, cents per pound. (Table 13)
PGRU	U.S. average grower price for fresh market asparagus, cents per pound. (Table A13)
PPCC	Representative California f.o.b. price for canned asparagus in cases of 24/300 cans, cents per pound, 21.1 pounds per case. (Table A16)
PPFC	Representative California f.o.b. price for frozen asparagus in cases of 24 10-ounce packages, cents per pound. (Table A16)
QCU	U.S. pack of canned asparagus, million pounds. (Table A7)
QFU	U.S. pack of frozen asparagus, million pounds. (Table A8)
QGCU	U.S. production of asparagus for canning, million pounds. (Table A4)
QGFU	U.S. production of asparagus for freezing, million pounds. (Table A4)
QGPU	U.S. production of asparagus for processing, million pounds. (Table A4)
QGRU	U.S. production of fresh market asparagus, million pounds. (Table A4)
QGU	U.S. total production of asparagus. (Table A4)
QSC	U.S. seasonal supply of canned asparagus (pack plus carry-in stocks), million pounds. (Table A7)
QSF	U.S. seasonal supply of frozen asparagus (pack plus carry-in stocks), million pounds. (Table A8)
SC	Carry-in stocks of canned asparagus, million pounds. (Table A7)
SF	Carry-in stocks of frozen asparagus, million pounds. (Table A8)

B. Exogenous Variables[b]	
Variable	Definition
D1	Dummy shifter: D1 = 1 for all years prior to 1965, zero thereafter.
D65	Dummy shifter: D65 = 1 in 1965, zero all other years.
D66	Dummy shifter: D66 = 1 in 1966, zero all other years.
EC	Exports of canned asparagus, million pounds. (Table A7)
ER	Exports of fresh asparagus, million pounds (Table A9)
IC	Imports of canned asparagus, million pounds. (Table A7)
IDNE	Index of per capita disposable income deflated by the PCE deflator. (Table A18)
IF	Imports of frozen asparagus, million pounds. (Table A8)
IFN	Per capita frozen imports, IF ÷ N.
IPCE	Index of processing cost deflated by the PCE deflator. (Table A18)
IR	Imports of fresh market asparagus, million pounds. (Table A9)
KCU	Ratio of fresh weight to canned weight, U.S. average. (Table A11)
KFU	Ratio of fresh weight to frozen weight, U.S. average. (Table A11)
N	U.S. population including armed forces overseas as of July 1 of the crop year. (Table A18)
NC	Net canned exports. (EC-IC). (Table A7)
NCN	Per capita net canned exports, NC ÷ N.
NCN2	$(NCN_t + NCN_{t-1}) \div 2$. (Table A20)
NR	Net fresh exports. (ER-IR). (Table A9)
NRN	Per capita net fresh exports, NR ÷ N.
NRN2	$(NRN_t + NRN_{t-1}) \div 2$. (Table A20)
PCE671	Personal consumption expenditure delfator, 1967 = 1.0. (Table A18)
T65	Time shift variable, T = 0 before 1965. Then T = 1 in 1965, 2 in 1966, etc.
TRND	Time shift variable, TRND = 56 in 1956, 57 in 1957, etc.
WU	Index of U.S. farm wage rates, 1967 = 100. (Table A18)
YU	U.S. average total yield of asparagus, thousand pounds per acre. (Table A3)

Table V.2. Variable Identification (continued)

C. Computed Endogenous Variables[c]	Reference Table
Deflated Prices	
MPPCE = (DC · PPCCE + DF · PPFCE) ÷ (DC + DF)	A19
PGPUE = (PGPU ÷ PCE671)	A16
PGRUE = (PGRU ÷ PCE671)	A16
PPCCE = (PPCC ÷ PCE671)	A16
PPFCE = (PPFC ÷ PCE671)	A16
RPPCCE = $PPCCE_t$ ÷ $PPCCE_{t-1}$	A19
RPPFCE = $PPFCE_t$ ÷ $PPFCE_{t-1}$	A19
Average Farm Price and Profit Measures	
PGU = (PGRU · QGRU + PGPU · QGPU) ÷ QGU	A13
RU = (PGU ÷ WU) 100	A20
Per Capita Production, Shipments, Stocks and Supply	
DCDN = DCD ÷ N	A19
DCN = (DCD + NC) ÷ N	—
DDN = KCU · DCDN + KFU · DFDN + DRDN	A19
DFDN = DFD ÷ N	A19
DFN = (DFD – IF) ÷ N	—
DPN = DCN + DFN	—
DPN2 = (DPN_{t-1} + DPN_{t-2}) ÷ 2	A19
DRDN = DRD ÷ N	A19
QGUN = QGU ÷ N	—
QGCUN = QGCU ÷ N	—
QGFUN = QGFU ÷ N	—
QGRUN = (DRD + NR) ÷ N	—
QGSPUN = (QGCU ÷ N) + SCFN + (QGFU ÷ N) + SFFN	A19
QSCN = (QCU + SC) ÷ N	A19
QSCNI = QSCN – NCN	A19
QSFN = (QFU + SF) ÷ N	A19
QSFNI = QSFN + IFN	A19
SCFN = (SC · KCU) ÷ N	A20
SFFN = (SF · KFU) ÷ N	A20
SPN = SCFN + SFFN	A20

[a] Table references are to the appendix tables containing the data series.
[b] Variables whose values are determined outside the system (or so treated).
[c] Variables computed from combinations of basic endogenous variables or basic endogenous variables and exogenous variables.

variables in parts A and B.[6] To gain a clearer picture of the structure of the total model (including identities) readers may find it helpful to refer ahead to Table VI.9 which summarizes the complete empirical model. An explanation of the reasoning behind the structural specifications follows.

Demand and Marketing Subsector

Equations 1 to 6 in Table V.1 specify the behavioral relationships involved in the demand and marketing subsector of the industry. The first four equations pertain to the processed product component. Equations 1 and 2 are demand relationships facing processors.

[6]Note that in defining quantity variables, Q is used for a production quantity, S for carry-in stocks, and D for a movement (disappearance). Quantities canned, frozen, and fresh are designated by adding C, F, or R. A U is added to production and acreage values where needed to indicate a U.S. value. Prices are indicated by a P, with a G added to indicate a grower level price and another P added for a processed product price. Again, a C, F, P (all processed), or R appended refers to canned, frozen, processing, or fresh market asparagus. A C at the end is a California price and U a U.S. price. An N appended to a quantity variable indicates a per capita value and an E appended to a price indicates a deflated value.

Consistent time series data required to estimate retail-level demand functions are not available. However, retail demand functions are not required in order to form a complete system since the lower level demand functions are derived from them with appropriate consideration of marketing and distribution costs.

Equations 1 and 2 express the deflated f.o.b. prices of canned and frozen asparagus as functions of U.S. per capita sales of canned (DCDN), frozen (DFDN) and fresh market (DRDN) asparagus, U.S. per capita deflated income (IDNE), and a time trend (TRND). The quantities include imports and exclude exports. Imports and exports are treated as exogenous variables in this model since their values are influenced to a very large extent by difficult-to-measure factors outside of the system being modelled (see background discussion in Section II). The f.o.b. prices are prices received by California processors, the only consistent time series of f.o.b. prices available. They are assumed to be representative of general U.S. price movements over time.

Attempts to include additional demand-shift variables to reflect the competitive influence of other vegetables were not successful, in large part because of the wide variety of vegetable commodities available. Those effects are therefore reflected in TRND and the unexplained disturbances. The TRND variable is also included to account for possible shifts in consumer tastes over time. Factors such as distribution costs which also affect derived demands have been highly correlated with the general price level. Hence, unit distribution costs may remain nearly constant in deflated terms, with any shifts not correlated with the price deflator absorbed by TRND.

Equations 3 and 4 determine the amount of seasonal supply (pack plus carry-in stocks) to be marketed during the immediate year, with the balance carried to the next crop year. The equations express U.S. processor per capita shipments less exports plus imports (DCDN = DCN – NCN, DFDN = DFN + IFN) as functions of the per capita seasonal supply less exports plus imports (QSCNI = QSCN – NCN, QSFNI = QSFN + IF), current year price (PPCCE, PPFCE), the previous year price, and the costs of the processed product as reflected by the index of processing cost (IPCE) and the raw product cost (PGPUE).[7]

This formulation of the supply allocation relationship is a modification of a model developed by French and King (1986) for canned peaches and fruit cocktail. French and King argued that a primary objective of processors is to set prices so as to cover costs. Processors are also concerned about moving the available supply and the potential price for inventory carried to year t+1. The lagged price reflects the most recent annual price experience of processors and is taken as a base for projecting possible sales in t+1. Quantities carried to t+1 (SC_{t+1}, SF_{t+1}) are predicted by subtracting predicted movement from the seasonal supply. In initial statistical explorations, the current *canned* price had no effect on the *frozen* product allocation, and vice versa.

Since processed product prices and quantities shipped (consumed) are jointly determined within the model, the choice of normalized (dependent) variable in each equation cannot be specified theoretically. It depends to a large extent on how one views the causal structure of the subsector and the nature of the data set. French and King expressed their model with the market allocation relationship normalized on price and called it a price-markup function. This reflects a primary emphasis on price setting. The demand equations were than normalized on quantity. For asparagus, somewhat better results (larger t-ratios, more consistency of signs with theoretical expectations) were obtained by normalizing demand on price and the supply allocation on quantity. This is a result, in large part, of the more complex structure of demand which involves price interrelationships among three product forms.

Per capita fresh market shipments are treated as essentially predetermined by current acreage and previously established utilization plans (discussed more fully in the next section).

Equations 5 and 6 pertain to grower-level demand and price relationships. Equation 5 specifies the derived demand function facing growers for fresh market asparagus. It includes the same variables as the processed product demand function. Marketing costs, reflected in the intercept, would differ.

Equation 6 predicts the price outcomes of interactions between processors and growers of processing asparagus. In a perfectly competitive environment it would be viewed as the derived demand function for processing asparagus facing growers. However, in view of the existence of grower bargaining associations in some regions, it is not clear that such a function exists in the strict sense. Following French (1987), it is argued that the price outcomes of the bargaining process may still be predicted by a function with essentially the same variables as the derived demand function in

[7]An alternative specification is to express total shipments including exports (DCN, DFN) as the dependent variable and replace QSCNI and QSFNI with QSCN, QSFN (total supply including exports). The system then would include the identities DCDN = DCN – NCN and DFDN = DFN + IFN. However, this specification yields reduced-form solutions of the model only with linear specifications. The formulation in Table V.1 also yields reduced form solutions with all variables in logarithms. The choice of equation form is discussed in Section V.

a competitive model. However, it is designated simply as a price prediction function rather than a derived demand function.

Equation 6 expresses the U.S. grower price as a function of total seasonal supply (carry-in stocks plus current production) of asparagus for processing (QSGPUN = QGPUN + SCFN + SFFN), the previous-year value of an index of processing cost deflated by PCE67 ($IPCE_{t-1}$), previous year weighted average representative f.o.b. price of canned and frozen asparagus ($MPPCE_{t-1}$) and a lagged two-year average of per capita processed product sales [$DPN2_t = \frac{1}{2}(DPN_{t-1} + DPN_{t-2})$ where DPN = DCN + DPN]. We would expect increases in supply and increases in processing cost to have negative impacts on the grower price. The lagged f.o.b. price and per capita sales variables are indicators of shifts in the level of demand. If the lagged price increases with average per capita movement constant, it is an indicator of an increase in demand. Similarly, an increase in sales with price constant would be an indicator of an upward shift in demand and hence should increase the grower price. With consumer tastes changing over time, these variables have proved to be better indicators of demand shifts (to processors and growers) than the usual income and trend variables.

Production Subsector

The supply structure for asparagus is complex. Since it is a perennial crop, the total bearing acreage and production each year are affected by both previous plantings reaching bearing age (generally two years) and acres removed from production. Asparagus acreage may be harvested for either fresh market sales, for processing (canning and freezing), or more commonly for both. Grower profit expectations for both forms affect planting and removal decisions and relative changes in fresh market and processing demand may influence the fresh and processing utilization. The supply adjustment process thus involves time lags and both complementary and substitution effects.

One possible approach to modelling supply response is to specify separate functions for fresh-market and processing asparagus. However, it has proved difficult to obtain good empirical measurements of the substitution and complementarity relationships. Therefore, we have used a somewhat simpler approach which first estimates a total acreage response relationship involving lagged values of combined average returns to growers for fresh and processed utilization. Predicted total production is then obtained by multiplying acres by average yield, which is treated as an exogenous variable (for reasons explained in the section on Total Production). Another set of equations is specified to allocate the predicted production among fresh market, canning, and freezing uses.

Acreage Response

A basic structure for modeling acreage adjustment for asparagus was developed some years ago by French and Matthews (FM, 1971). The foundation for the model was the simple identity:

(1) $A_t = A_{t-1} + aN_{t-k} - RM_{t-1}$

where A is total bearing acreage, N is new plantings, RM_{t-1} is bearing acres removed from t-1 acreage, a is a number slightly less than 1.0 to account for plantings removed prior to reaching bearing age, and k is years from planting to bearing age (usually 2 for asparagus). A model to predict changes in bearing acres was obtained by relating plantings and removals to past measures of profitability, then substituting these functions in (1).

FM formulated the plantings function by first expressing desired bearing acres as a function of profit expectations over the life of the plants, usually 10-15 years (perhaps more in some regions). Expected profits were expressed as functions of past average returns.[8] Simple two year averages of the ratio of the average grower price to an index of farm wage rates gave the best predictions among alternative lags and weighting schemes. Desired plantings were expressed as a function of desired and existing bearing acres. Actual plantings were expressed as a proportion of desired plantings and a random disturbance. With appropriate substitutions, plantings then were expressed as a function of the measure of past profitability and past acreage.

Removals were expressed as a function of the existing acreage by age class and the profit expectations per unit of product in year t-1 for year t. The latter were expressed as a function of the grower price-wage index ratio in t-1. Since data on ages of plants were not available, changes in the age distribution over the sample period were approximated as a function of past average acreage.

It was not possible for FM to estimate the planting and removal functions because continuous data on plantings and removals of asparagus have been compiled only for a limited region within California.

[8]The index of farm wage rates was selected as an indicator of asparagus production cost since labor, especially harvest labor, accounts for the major share of cost and is the most visible to growers. Efforts to include the opportunity costs of returns to alternative crops in the profitability expectations were not successful because of the large number of possible crops and their variations in importance within subareas of production. The alternative crop effects thus were accounted for as part of the unexplained disturbance, and in the present extension of the FM model, are reflected as a component of a systematic trend as well as part of the disturbance term.

However, substitution of the theoretical specifications for these functions into (1) allowed the acreage adjustment relationship to be estimated directly as a single equation.[9]

The French-Matthews model provided plausible and statistically significant estimates of acreage change relationships for California, the Northwest, and the Midwest-East combined for the period of 1947-1969. However, straightforward extension of the model with data for the period 1956-1981 yielded less significant and less plausible results. There were two primary reasons. First, the FM approximations for missing age distribution data apparently did not hold up over time. Second, and most importantly, there were significant structural changes in the industry beginning in the mid- to late-1960s which continued over the period, perhaps about running their course by 1981. Major factors involved were changes in sources of labor with termination of the Bracero Program, the dramatic loss of canned export markets, the first appearance and then increase of asparagus imports, and the disappearance of most of the asparagus production from Eastern regions and Illinois for reasons not directly related to price changes (for example, diseases and access to processing markets). Therefore, we have modified the original French-Matthews model so as to take account more fully of the lag distribution and the changes in industry structure.[10] The model focuses on U.S. aggregate adjustments.

We retain the FM basic acreage-change identity [equation (1)] as a starting point and, as did FM, replace removals by a function of the previous year profitability measure and the acreage in the various age classes. Most removals are older asparagus. Since we do not have data by age, the weighted sum of acreage by age class is replaced by total bearing acreage (unweighted sum) and a disturbance, recognizing that the latter likely follows an autoregressive process since the age distribution may change autoregressively.[11]

New plantings are expressed as a function of expected long-run profitability of asparagus production, but with two modifications of the original FM model. First, profit expectations are assumed to be formed according to the adaptive expectations model—i.e., the expected long-run profit return in t is the expected long-run return in t-1 plus some proportion of the difference between actual returns in t-1 and expected long-run returns in t-1.[12] Applying the Koyck transformation, the expected return becomes a geometric lag distribution of past actual returns.[13] The second modification is the deletion of acreage variables in the

[9]Combining the planting and removal relationships in this way restricts the choice of functional form for empirical estimation and reduces the degrees of freedom compared to separate estimation of planting and removal equations. Hence, where planting and removal data can be obtained, separate estimation may be preferred (see French, King, and Minami, 1985).

[10]We are indebted to Oscar R. Burt for insightful discussions in formulating the distributed lag structure and especially his assistance in estimating the parameters of the model, as further noted with presentation of the empirical findings.

[11]Removals are dominated by productivity considerations associated with age. However, if the expected return in t+1 is high, some removals may be deferred; if low some may be accelerated. The expected profitability in t+1 seems likely to be based on the profitability experience in t. Removal rates may also be affected by changes in the economic environment, to be discussed later.

[12]Various hypotheses have been proposed about how price and profit expectations are generated. Most common are the extrapolative, rational, and adaptive expectations models. All have limitations. The adaptive expectations model, which may be similar in final form to the extrapolative model, is viewed by the authors as most appropriate for the long-term decisions involved in asparagus plantings. The rational expectations model assumes grower expectations to be consistent with the equilibrium predictions of the supply-demand structure of the industry. However, this assumption requires growers to behave as though they have accurate forecasts, over a long period, of both the supply-demand structure and the variables which cause the structure to shift. The model presented here assumes less sophisticated behavior in which growers are guided mainly by their past profit experience. Average profit experience over a recent period contains substantial economic information since it reflects the combined effects of changes in demand, supply and costs. In responding to their profit experience, growers may be assumed to recognize that they face negatively sloped demand functions and that other growers may be reacting similarly to changes in profit experience. The extent of this recognition will be reflected in the magnitude of the derivative of plantings (and total acreage) with respect to the past profitability measure and possibly in the stochastic properties of the disturbance term.

[13]The geometric lag distribution of past actual returns is

$$R^*_t = (1-\lambda)(R_{t-1} + \lambda R_{t-2} + \lambda^2 R_{t-3} + ...),\ 0 \le \lambda < 1.$$

Lagging R^*_t one period, multiplying by λ and subtracting from R^*_t gives

$$R^*_t - \lambda R^*_{t-1} = (1-\lambda)R_{t-1} \quad \text{or} \quad R^*_t - R^*_{t-1} = (1-\lambda)(R_{t-1} - R^*_{t-1})$$

which is the adaptive expectations hypotheses.

planting equation. While planting response might be expected to be affected to some extent by the size of the industry, neither existing total acreage nor past average acreage at the time of planting proved to be significant in this model.

Assuming initially that the planting and removal relationships can be approximated by linear functions, the acreage change identity (1) may be transformed as follows:

$$(2) \quad A_t = A_{t-1} - (b_0 + b_1A_{t-1} + b_2R_{t-1} + v_{1t-1}) + (a_0 + a_1R^*_{t-2} + v_{2t-2}) = c + \mu A_{t-1} - b_2R_{t-1} + a_1R^*_{t-2} + v_t$$

where R is a measure of net returns and the v's are unexplained disturbances. The first term in parentheses predicts the removals from acreage in t-1, the second term in parentheses predicts new plantings in t-2, and the consolidated terms are:

$c = a_0 - b_0$,

$\mu = 1 - b_1$, and

$R^*_{t-2} = (1-\lambda)(R_{t-3} + \lambda R_{t-4} + \lambda^2 R_{t-5} + \ldots), \quad 0 \leq \lambda < 1.$

$v_t = + v_{2t-2} - v_{1t-1}.$

The disturbances v_1 and v_2 are assumed to be independent—i.e., positive or negative deviations of plantings seem unlikely to have much effect on removals a year later since removals are mainly from older acreage.[14] Applying the Koyck transformation, equation (2) may be expressed as

$$(3) \quad A_t = c(1-\lambda) + (\lambda+\mu)A_{t-1} - \lambda\mu A_{t-2} - b_2(R_{t-1} - \lambda R_{t-2}) + a_1(1-\lambda)R_{t-3} + v_t - \lambda v_{t-1}.$$

As noted previously, the asparagus industry has been affected by several factors, not directly reflected in prices, which have altered the supply response. To account for the effects of the Bracero Program termination in 1964 (which led to larger than normal removals immediately following), 0-1 variables were added for 1965 and 1966. This permits the acreage base to adjust to new starting values as a result of this change, which technically allows the difference equation to assume a new pair of initial conditions in 1965-66 and thus start anew on a sequential path over the period 1967, onward. To account for the other structural changes, a dummy shifter was added which is 1.0 prior to 1965 and zero thereafter, and a trend variable was inserted beginning in 1965. With these added specifications the final linear estimation equation takes the form

$$(4) \quad A_t = \beta_0 + \beta_1(R_{t-1} - \lambda R_{t-2}) + \beta_2R_{t-3} + \beta_3D65 + \beta_4D66 + \beta_5D1 + \beta_6T65 + (\lambda+\mu)A_{t-1} + (-\lambda\mu)A_{t-2} + U_t$$

where $\beta_0 = c(1-\lambda)$, $\beta_1 = -b_2$, $\beta_2 = a_1(1-\lambda)$, and $U_t = v_t - \lambda v_{t-1}$. D65 and D66 are the 0-1 variables introduced to account for the Bracero Program effect, D1 is 1 prior to 1965, zero thereafter, and T65 is zero through 1964, then takes the counting integers thereafter (i.e., T65 = 1 in 1965, 2 in 1966, etc.).

While the linear specification of (4) is most convenient for purposes of model development and estimation (especially in view of the linear identity), there is reason to expect that the error structure of the removal function may be multiplicative and the planting function may also be nonlinear. Referring to equation (2), it seems likely that b_2 may vary with the disturbance term (v_1) of the removal equation (when there is a high proportion of older asparagus plants, the value of b_2 may increase) and b_2 may also vary with A. However, specifying the planting and removal functions directly in nonlinear form (say in logs) and then inserting these functions in (1) gives an equation form that would be very difficult to deal with empirically. One means of approximating the nonlinear relationship in a form more analytically convenient is simply to respecify equation (4) with all variables except the shifters and trend in logs. This simplification may be justified by noting that while equation (2) provides a logical structure for viewing the dynamic process, the real dynamics are likely to be much more complex. Even if we inserted nonlinear functions for plantings and removals directly in (1), rather than the linear equations, we would still have only a reduced form approximation to the actual adjustment process. The simpler log-linear form may approximate the dynamic relationships about as well and is computationally much simpler. Therefore, the acreage adjustment model is respecified as

$$(5) \quad \ln A_t = \beta_0 + \beta_1 (\ln R_{t-1} - \lambda \ln R_{t-2}) + \beta_2 \ln R_{t-3} + \beta_3D65 + \beta_4D66 + \beta_5D_1 + \beta_6T65 + (\lambda+\mu)\ln A_{t-1} + (-\lambda\mu)\ln A_{t-2} + U_t.$$

where

λ = the parameter in the adaptive expectations model for R_t, where

$$\ln R^*_t = (1-\lambda) \sum_{j=1}^{\infty} \lambda^{j-1} \ln R_{t-j}$$

$\mu = 1-b_1$, where b_1 is the coefficient on $\ln A_{t-1}$ in the removal equation

$\beta_1 = -b_2$, where b_2 is the coefficient on $\ln R_{t-1}$ in the removal equation

$\beta_2 = a_1(1-\lambda)$, where a_1 is the coefficient on $\ln R^*_{t-2}$ in the new plantings equation

U_t = an unexplained disturbance.

[14]While some plantings may be to replace older acreage to be removed, the decisions to plant (or replace) and to remove existing acreage are influenced by different factors: removals by productivity considerations and short-term profit expectations and plantings by long-term profit expectations.

The log formulation has the further property that the trend component reflects a proportional rather than absolute shift, which seems consistent with our *a priori* expectations.

Note that an equation similar to (5) may be derived by combining a partial adjustment model for A (expressed in logs) with an adaptive expectations model modified to include R_{t-1} as a return variable affecting removals. That is,

(6) $\ln A_t = \ln A_{t-1} + \alpha(\ln A^*_t - \ln A_{t-1})$ and

(7) $\ln A^*_t = \gamma_0 + \gamma_1 \ln R_{t-1} + \gamma_2 \ln R^*_{t-2} + v_2$

where A^*_t is desired total bearings acres in t and R_{t-1} and R^*_{t-2} are as defined above. Substituting (7) in (6) gives

(8) $\ln A_t = \alpha\gamma_0 + (1-\alpha)\ln A_{t-1} + \alpha\gamma_1 \ln R_{t-1} + \alpha\gamma_2 \ln R^*_{t-2} + \alpha v_t$

which, with the Koyck transformation and the addition of the variables to account for structural shifts, yields an equation with a form similar to (5).

Because of the adaptive expectations formulation and the presence of lagged dependent variables, the disturbance U_t in equation (5) is correlated with lagged values of $\ln A_t$, so ordinary least squares estimates of the parameters would be inconsistent. Therefore, equation (5) must be expressed in a form suitable for an estimation procedure (nonlinear least squares) that provides parameter estimates with desirable properties.

Taking the unconditional expectation of (5) yields an expression which replaces $\ln A_t$ with $E(\ln A_t)$, $\ln A_{t-1}$ with $E(\ln A_{t-1})$, $\ln A_{t-2}$ with $E(\ln A_{t-2})$ and omits U since $E(U) = 0$. Since $\ln A_t = E(\ln A_t) + e_t$ (e_t is a random disturbance with as yet unspecified properties), it follows that $U_t = e_t + (\mu+\lambda)e_{t-1} + (-\lambda\mu)e_{t-2})$ and (5) has the form of a rational lag. With appropriate substitutions, the equation can be expressed as

$$
\begin{aligned}
(9)\quad \ln A_t = {} & \beta_0 + \beta_1(\ln R_{t-1} - \lambda \ln R_{t-2}) + \beta_2 \ln R_{t-3} \\
& + \beta_3 D65 + \beta_4 D66 + \beta_5 D1 + \beta_6 T65 \\
& + (\lambda+\mu)E(\ln A_{t-1}) + (-\lambda\mu)E(\ln A_{t-2}) + e_t.
\end{aligned}
$$

The $E(\ln A_t)$ are not observable but there exists an explicit solution which expresses $\ln A_t$ as a function of the parameters (β_j, μ, λ), the initial-year starting values of acreage (A_0 and A_{-1}) and the observable independent variables $R_{t-1}, R_{t-2}, ..., R_{t-n}$. The initial values are treated as parameters. The algebra to derive the explicit solution is cumbersome and thus is not shown. However, following Burt (1980), an explicit solution is not required in order to devise an algorithm for nonlinear least squares estimation of the parameters.

The structure of the disturbance term, e_t, is complex. It includes the effects of removal disturbances lagged one year and plantings disturbances lagged two years and is almost certainly serially correlated. The time distribution of the disturbances appears to be approximated reasonably well by a second order autoregressive scheme. That is,

$$e_t = \rho_1 e_{t-1} + \rho_2 e_{t-2} + \varepsilon$$

where ε is a random disturbance with mean zero and variance σ^2_ε. With this specification ρ_1 and ρ_2 are added parameters of the model, and initial-year values of e are set at their expected values (zero).[15]

A final restriction sets $\hat{\mu} = \hat{\lambda}$. This converts the rational lag to a Pascal lag and assures that the roots of the characteristic equation of the difference equation are real (actually on the boundary between real and complex roots). With real roots the difference equation yields a smooth lag distribution without any change in sign (as specified in the original behavioral hypothesis) rather than oscillating as in the case of complex roots.[16]

Equation (9) corresponds to 7 in Table V.1 where AU corresponds to A and RU corresponds to R. The U's are added in the data set to distinguish U.S. values from regional values.

Total Production

The predicted total production (QGU) is obtained by multiplying the total acres (AU) by the annual average yield (YU), as in equation 8a, Table V.1. While it is technically possible to vary the length of the harvest season, and hence yields, in response to prices, the possibilities are limited by cultural requirements. Harvesting over too long a period may leave insufficient time for the plants to build food reserves for the next year and thus may affect future yields. In a year of low prices, harvest could be terminated early, but this occurs infrequently as long as prices cover harvest costs. The empirical analysis did not reveal any significant relationship between average yields and prices. Therefore, yield (YU) is treated as an exogenous variable.[17]

[15]The model was also estimated as a first order and third order autoregressive error process but the AR2 model provided a better fit and more plausible results. In the AR3 case, the estimate ρ_3 was not significantly different from zero.

[16]The equation was also estimated with $\hat{\mu}$ and $\hat{\lambda}$ unconstrained. The estimated values were relatively close, with large standard errors. Formally, their estimated values were not significantly different at even the 50 percent level.

[17]Recall that in addition to the effects of weather and biological factors, yields are affected by the age composition of the plants (not reported) and by variations in practices followed with respect to harvest method and trim length.

Allocation of Total Production

Rational growers will attempt to allocate their asparagus production so as to achieve equal net returns for each use. Since fresh-market and processing asparagus involve different spear lengths and different post-harvest costs, different prices are required to give equal net returns. The precise nature of the required differences is not known. However, given the profit maximizing objective, it seems reasonable to assume that observed grower prices for each form may reflect approximately equal net returns, plus or minus a disturbance due to errors and frictions in adjustments.[18] If we impose this requirement, the allocations to fresh and processing use may be obtained as solutions to the set of demand functions facing growers and the identity which equates total production with the sum of the quantities allocated to each form.

Because of contractual arrangements with processors and time requirements in making utilization adjustments, most of the allocation decisions are determined prior to the start of the current marketing season. Hence, the allocations (expressed in per capita terms) may be viewed as solutions to a set of demand functions involving the known or *projected* values of the demand shift variables in equations 1 to 6 in Table V.1. Depending on the forms of the expected demand functions, the allocation solutions may be expressed as either exact or approximate functions of the per capita total production (QGUN), the demand shift variables and a variable to reflect the difference in prices required to give equal net returns. The latter may be a random variable whose mean may be constant or vary as a function of time (TRND).

Equation 8b (Table V.1) emphasizes the allocation of total production between fresh market and processing use while 8c focuses mainly on the factors influencing the allocation between canning and freezing. The two equations include essentially the same variables, but the processed product shifters are combined in 8b. All variables appear either directly or indirectly as shifters in the demand and allocation subsector equations.

Referring first to 8b, the variables DPN2 (lagged average per capita canned and frozen product movement), $IPCE_{t-1}$ (index of processing cost) and $MPCCE_{t-1}$ (weighted average processed product price) all appear as shifters in the processed product pricing equation. $PPCCE_{t-1}$ and $PPFCE_{t-1}$ in the canned and frozen product allocation equations also are components of $MPCCE_{t-1}$. The total per capita carry-in stock of processed product (SPN) is a component of QSGPUN in equation 6 and is an important shifter of processor raw product demand. The variable $NRN2_{t-1}$ (two-year average value of fresh exports less imports) is assumed to reflect year t expectations of the export-import situation. Net exports of fresh asparagus enters the demand system through the identity, DRDN = QGRUN - NRN. The income variable (IDNE) and TRND appear in both processed product and fresh market demand equations.

Equation 8c includes essentially the same variables as 8b but with disaggregated values of processing demand shifters in order to capture the shifts in allocation between canning and freezing use. The aggregate carry-in stock variable, SPN, is separated into canned and frozen components (SCFN and SFFN) and MPPCE is separated into canned and frozen product prices, PPCCE and PPFCE. Separating DPN into lagged average values of DCDN and DFDN did yield significant predictors of the canning allocation. However, lagged average net canned exports ($NCN2_{t-1}$) proved to be a significant shifter along with lagged average net fresh exports. There have been no reported exports of frozen asparagus. The per capita frozen imports have been minor and have not varied enough to affect allocations measurably.

[18]Average fresh market prices for California asparagus may exceed processing returns because of the high early season prices. However, net returns will tend to equate at the time processors enter the market.

VI. EMPIRICAL ESTIMATES

This section presents estimates of the functional relationships outlined in Table V.1. The data set covers the period 1951 to 1981 and 1984 to 86. Because of the lag structure and some concerns about the early year data, the acreage adjustment relationship was estimated with the first observation on the dependent variable in 1957. All other equations (with shorter lags) were estimated with the first dependent variable observation in 1956. As noted previously, the U.S. Department of Agriculture stopped reporting acreage and production statistics in 1982 and 1983. They resumed again in 1984 and have continued since. However, because of the lagged variables in the model, it was not possible to include the more recent observations (1984-86) in the data used for estimation of all equations. Some limited prediction tests for 1984 to 86 were obtained using approximations of the missing 1982 and 1983 observations.

The values of all endogenous price and quantity variables are expressed on a crop year basis. For canned asparagus the crop year begins March 1, this being the date for which carry over stocks are reported. For frozen asparagus, carry over stocks are reported April 1 and the crop year is made to correspond. Fresh asparagus harvest starts as early as January in southern California and terminates, for the most part, in the summer, so the crop year and calendar year coincide. Exogenous variables such as deflated disposable personal income (IDNE) and the deflated index of processing cost (IPCE) are for the calendar year corresponding to the beginning of the crop year.

Prices of canned and frozen asparagus are represented by f.o.b. California processor quotations for the dominant package type, under the expectation that prices for various types and sizes move together. Inspection of available quotations suggests that this expectation has been generally fulfilled. Historical f.o.b. price series have been available on a consistent basis only for California. These prices are assumed to reflect general price movements. Quantities canned and frozen are aggregated over style and package type within each form, expressed in equivalent units. All processed quantities are measured in pounds of product weight and farm quantities in raw product weight. Prices are expressed in cents per pound. The monetary variables have been deflated by the Personal Consumption Expenditure deflator, 1967 = 1.0 (PCE671). Per capita quantities were calculated by dividing total values by the U.S. 50-state population including armed forces overseas as of July 1 of the crop year.

The "true" algebraic forms of the model equations cannot be specified theoretically. For statistical analysis we are limited, as a practical matter, mainly to linear forms and some types of logarithmic transformations. In either case, the selected form is likely to be only an approximation of the true shapes of the functions. For the demand and marketing subsector, a logarithmic specification provided results with slightly superior statistical properties (Durbin-Watson values and standard errors) and yielded estimates of price flexibilities that were intuitively more plausible than those obtained with a linear specification. In the latter case, the estimated flexibilities in some equations dropped to very low values by 1981.

The logarithmic specification of the acreage adjustment relationship, (equation 7, Table V.1) was explained previously. The crop utilization equations (8b and 8c) were expressed with the dependent variable as a proportion of total production. This form may be viewed as an approximation to the allocation equations obtained as solutions to the nonlinear equations in the demand and marketing subsector.

The model of the asparagus economy, which consists of the nine behavioral equations listed in Table V.1 plus identities, was estimated in three component parts.

The acreage adjustment equation (equation (9) in the model development section and (7) in Table V.1) was estimated independently since the disturbances in (7) are not affected by and do not affect the current-year disturbances of any other equations. New plantings are not included in bearing acres (AU), and removals in year t, which may be affected by demand in t, normally would occur after the harvest in year t and hence would impact only AU_{t+1}.

The production allocation equations (8b and 8c in Table V.1) were estimated jointly as a second independent component, and the demand system (equations 1 to 6 in Table V.1) was estimated separately as a third block of jointly related equations. Estimating the raw product allocation and the consumer product demand equations separately, rather than jointly, reduces the complexity of the estimation process and is justified by the previously-discussed argument that allocations of total production among outlets for the current year are largely predetermined by decisions in year t–1 (based on projected demand conditions) and by regional specializations which limit opportunities for rapid switches among markets.[19]

Demand and Marketing Subsector Estimation Results

With current-year fresh and processed production treated as predetermined, as noted previously, equations 1 through 6 in Table V.1 form a simultaneous system consisting of six current endogenous variables (PPCCE, PPFCE, DCDN, DFDN, PGRUE, PGPUE), four exogenous variables (TRND, IPCE, $IPCE_{t-1}$, IDNE) and eight variables that are endogenous in the total dynamic system, but predetermined in this set of equations (DRDN, QSCNI, QSFNI, $PPCCE_{t-1}$, $PPFCE_{t-1}$, QGSPUN, $MPPCE_{t-1}$, DPN2). All variables except TRND were expressed as natural logarithms of the original values. In equations 3 and 4, current and lagged prices were expressed as ratios (RPPCCE, RPPFCE). The log of the ratio is a first difference in logs. Hence, the total system is linear in logs.

Structural Parameter Estimates

Three-stage-least squares estimates of the log-linear demand and market allocation equations specified in Table V.1 are presented in Table VI.1.[20] The data set used for estimation is given in Appendix Tables A18 and A16 (1956-1981 observations). Most coefficients are large relative to their standard errors and all have signs consistent with theoretical expectations. The (log of) per capita consumption of frozen asparagus (LDFDN) was initially included in all demand equations [(1), (2), and (5)] but it was statistically insignificant and positive in the canned and fresh market demand equations. Therefore, the system was re-estimated with LDFDN excluded from equations (1) and (5). The values of the Durbin-Watson statistics provide little indication of serially correlated disturbances.

The coefficients of the equations indicate percentage changes in the dependent variable for a 1 percent change in an explanatory variable. For example, a 1 percent increase in the per capita movement of *canned* asparagus is predicted (with other variables constant) to decrease the canned f.o.b. price by .31 percent, the frozen f.o.b. price by .32 percent and the grower price for fresh market sales by .20 percent. Such percentage relationships between prices and quantities are often called "price flexibilities." In this case, the value .31 would be an "own price" flexibility and .32 and .20 are "cross price" flexibilities.

The per capita disappearance of *frozen* asparagus was not revealed to have a significant effect on prices of canned or fresh asparagus. It did affect its own price but the estimated price flexibility is low (-.0329). One might expect the own price flexibility to be higher in relation to the cross flexibilities. The relatively weak estimation results for frozen asparagus may be a result in large part of the limited variability of frozen per capita sales in the data set. There has been less change in the sales of frozen asparagus compared to the variation in sales of canned and fresh forms (see Appendix Table A19). Hence, the price-quantity relationship is less fully revealed. It is also possible that the low price flexibility (high elasticity) for frozen asparagus reflects to some extent its high price relative to other frozen vegetables.

A 1 percent increase in per capita *fresh* movement has been associated with a .31 percent decrease in the f.o.b. canner price, a .13 percent decrease in f.o.b. freezer price and a .36 percent decrease in the grower price for fresh market asparagus.

The coefficients for the per capita deflated income and trend variables suggest a general positive demand response to real income growth, but with income and other variables constant, a general negative trend in per capita demand for asparagus in all forms.

The market allocation equations (3) and (4) indicate that quantities of canned and frozen asparagus marketed (DCN, DFN) have been determined primarily by the seasonal supply (less exports, plus imports). However, the current and lagged prices, expressed as first differences in logs, and the level of cost (IPCE, PGRUE) appear also to influence the allocation. A 1 percent increase in f.o.b. price from t-1 to t has increased per capita canned quantities allocated to the current market by .64 percent and per capita frozen quantities by .46 percent. Or put another way, an increase in the current price increases quantities processors desire to allocate to the current market. An

[19]If the allocation decisions were considered to be jointly determined by current-year demand conditions, it is not clear that the equation system 8b and 8c would remain appropriate as specified. Under one set of assumptions, demands might be projected as indicated by these equations, but with the allocation disturbances affected by current-year demand disturbances, mainly in the fresh market. However, current-year demand functions include current-year demand shifters so the allocation equations would need to be respecified to take this into account. Statistical explorations with models involving allocations determined jointly with current-year demands yielded coefficient estimates with generally low statistical significance.

[20]A possible alternative procedure would be to use nonlinear three stage least squares via the maximum likelihood estimator applied to the untransformed data. However, with no clear indication of the precise structure of the disturbances, we elected to use the simpler linear 3SLS applied to the log transformed data. Possible prediction biases resulting from using logarithmic dependent variables are discussed in Section VII which presents the dynamic analysis of the complete model.

Table VI.1. Three-Stage-Least Squares Estimates of the U.S. Demand and Market Allocation System for Asparagus, Log Form[a]

	(1)	(2)	(3)	(4)	(5)	(6)
Explanatory Variables	Dependent Variable[b]					
	LPPCCE	LPPFCE	LDCDN	LDFDN	LPGRUE	LPGPUE
Constant	5.3964 (7.742)	5.2541 (8.762)	3.6780 (1.311)	3.1624 (1.826)	4.5825 (8.275)	5.7205 (2.273)
LDCDN	-.3081 (-5.292)	-.3193 (-4.733)	— —	— —	-.1990 (-4.160)	— —
LDFDN	— —	-.0329 (-.429)	— —	— —	— —	— —
LDRDN	-.3066 (-3.202)	-.1295 (-1.561)	— —	— —	-.3562 (-4.509)	— —
LIDNE	1.0709 (2.832)	1.1250 (3.446)	— —	— —	1.2959 (4.245)	— —
TRND	-.0289 (-2.709)	-.0218 (-2.386)	— —	— —	-.0289 (-3.419)	— —
LQSCNI	— —	— —	.7657 (4.988)	— —	— —	— —
LQSFNI	— —	— —	— —	.6611 (7.001)	— —	— —
LRPPCCE	— —	— —	.6375 (4.020)	— —	— —	— —
LRPPFCE	— —	— —	— —	.4605 (2.085)	— —	— —
LIPCE	— —	— —	-.7485 (-1.326)	-.6012 (-1.605)	— —	— —
LPGPUE	— —	— —	-.1790 (-1.301)	-.4439 (-2.902)	— —	— —
LQGSPUN	— —	— —	— —	— —	— —	-.6309 (-4.943)
LIPCEL	— —	— —	— —	— —	— —	-1.1301 (-2.460)
LMPPCEL	— —	— —	— —	— —	— —	.6344 (3.333)
LDPN2	— —	— —	— —	— —	— —	.4006 (2.173)
R^2	.915	.952	.955	.957	.949	.816
D.W.[c]	1.61	1.46	2.18	1.78	2.08	1.94

[a]An L prefix indicates a variable expressed in natural logarithms. An L suffix indicates a variable lagged one year. Identities required to complete the system are as follows:
LRPPCCE = LPPCCE - LPPCCEL, LRPPFCE = LPPFCE - LPPFCEL

[b]Values in parentheses are t-statistics.

[c]Durbin-Watson statistic.

increase in the previous year's price decreases current allocation because carryover to the next year is viewed relatively more favorably. Increases in both the index of processing cost (IPCE) and the raw product cost (PGPUE) reduce current marketings. This reaction occurs because a primary objective of processors is to allocate supplies so as to receive prices that cover costs. Hence, as costs increase, with other variables constant, processors are motivated to reduce current marketings (and thus increase carryover) in the hope of achieving their cost-covering objective.

Equation 6 predicts the raw product price for processing asparagus that results from processor-grower bargaining and contractual interaction. All of the explanatory variables in this equation are treated as predetermined with respect to the price. However, the disturbance term seems likely to be correlated with disturbances of other equations, so the equation was estimated as part of the simultaneous set. The results indicate that with other variables constant, a 1 percent increase in the per capita supply of asparagus for processing (stocks carried in plus the quantity produced for canning, QGSPUN) has decreased price by .63 percent. An increase in the lagged deflated index of processing cost (IPCEL) of 1 percent has decreased the grower price by about 1.1 percent as processors attempt to cover their cost. An increase of 1 percent in the weighted average price for canned and frozen asparagus in t-1 (MPPCEL) has increased PGPUE in t by .634 percent, reflecting an improvement in expected processed product demand. A 1 percent change in the lagged average per capita disappearance of canned and frozen asparagus (DPN2), with other variables constant, has been associated with a .40 percent change in PGPUE in the same direction, again reflecting a change in expected demand for the processed products.

Reduced Form Equations

The equation system in Table VI.1 jointly determines the f.o.b. prices, per capita movements of canned and frozen asparagus, and the grower prices for fresh and processed asparagus, given the values of the predetermined endogenous variables and the exogenous variables. Table VI.2 presents the reduced form solutions which express each endogenous variable of the system as a function only of variables whose values are known (or treated as known) in year t, thus providing a basis for short-run predictions. To illustrate the interpretation of Table VI.2, a 1 percent increase in the U.S. per capita supply of canned asparagus (QSCNI) would decrease the f.o.b. price of canned asparagus (PPCCE) by .197 percent, frozen asparagus (PPFCE) by .201 percent, and the grower price of fresh asparagus by .127 percent, with all other variables constant. These equations are also used in formulating a complete dynamic model of the total asparagus economy.

1984-86 Prediction Test, Demand and Market Allocation Subsector

It may be recalled that because of an interruption in the U.S. Department of Agriculture production reports for asparagus in 1982 and 1983, the data set used for model estimation terminated with 1981 values. Reporting was resumed in 1984 and has continued since, but with the lagged variables it was not possible to incorporate the later observations in all equations. However, it is possible to make limited tests to determine whether the model based on 1956-1981 data still appears applicable under more recent conditions.

The 1984-86 predictions of the structural equations of the demand and market allocation subsector (equations 1 to 6, Table VI.1) are compared with observed values in Table VI.3. The predictions were obtained by inserting actual (observed) values of the right side variables in each equation. For more general forecasting purposes, the reduced form (Table VI.2) would be utilized. However, our interest here is in detecting possible changes in individual structural equations. Predictions of f.o.b. prices (PPCCE, PPFCE) and market allocations (DCDN, DFDN) are limited to 1984 and

Table VI.2 Reduced Form Equations for the U.S. Demand and Market Allocation System[a]

Explanatory Variables	Dependent Variables (1.1) LPPCCE	(2.1) LPPFCE	(3.1) LDCDN	(4.1) LDFDN	(5.1) LPGRUE	(6.1) LPGPUE
Constant	3.82701	3.5534	5.0938	2.2594	3.5688	5.7205
LDRDN	-.2563	-.0762	-.1634	-.0351	-.3237	—
LIDNE	.8951	.9287	.5706	.4277	1.1824	—
LQSCNI	-.1972	-.2013	.6400	-.0927	-.1274	—
LQSFNI	—	-.0214	—	.6512	—	—
LPPCCEL	.1642	.1676	-.5328	.0772	.1060	—
LPPFCEL	—	.0149	—	-.4536	—	—
LIPCE	.1928	.2163	-.6256	-.5016	.1245	—
LQGSPUN	-.0291	-.0388	.0944	.2622	-.0188	-.6309
LIPCEL	-.0521	-.0694	.1691	.4697	-.0337	-1.1301
LMPPCEL	.0292	.0390	-.0949	-.2637	.0189	.6344
LDPN2	.0185	.0246	-.0599	-.1665	.0119	.4006
TRND	-.0242	-.0166	-.0154	-.0077	-.0258	—

[a]Exogenous variables are underlined. An L prefix indicates a variable expressed in natural logarithms, an L suffix indicates a variable lagged one year.

Table VI.3. Comparison of Actual and Predicted Values of Endogenous Variables in the Demand and Marketing Subsector, 1984-86. (TRND = 81)

		Natural Logarithms			Original Values		
	Year	Actual A	Predicted P	Difference A-P	Actual A	Predicted P	Difference A-P
Canned f.o.b. price, PPCCE	1984	4.07499	4.06966	.00533	58.85	58.54	.31
(Equation 1, Table VI.1)	1985	3.89121	4.07102	-.17981	48.97	58.62	-9.65
S[a] = .0532	1986	b					
Frozen f.o.b. price, PPFCE	1984	4.52872	4.47891	.04981	92.64	88.14	4.50
(Equation 2, Table VI.1)	1985	4.51918	4.48243	.03675	91.76	88.45	3.31
S[a] = .0443	1986						
Per capita canned allocation, DCDN	1984	-1.16155	-1.21057	.04902	.313	.298	.015
(Equation 3, Table VI.1)	1985	-1.18417	-1.29278	.10861	.306	.275	.031
S[a] = .0717	1986	-1.20397			.339		
Per capita, frozen allocation, DFDN	1984	-2.67365	-2.59039	-.08326	.069	.075	-.006
(Equation 4, Table VI.1)	1985	-2.59027	-2.52171	-.06856	.075	.080	-.005
S[a] = .0693	1986	-2.56395			.077		
Grower price, fresh, PGRUE	1984	3.30322	3.28076	.02246	27.20	26.60	.60
(Equation 5, Table VI.1)	1985	3.33292	3.25348	.07944	28.02	25.88	2.14
S[a] = .0454	1986	3.09558	3.17539	-.07981	22.10	23.94	-1.84
Grower price, processing, PGPUE	1984	2.82731	2.91592	-.08861	16.90	18.47	-1.57
(Equation 6, Table VI.1)	1985	2.80336	2.88508	-.08172	16.57	17.90	-1.33
S[a] = .0678	1986	2.77259	2.93591	-.16332	16.00	18.83	-2.83

[a]S = standard error of the regression

[b]Blanks indicate values either not available or not computable because of incomplete data.

1985 because of incomplete price series. The observed price for canned asparagus (PPCCE) for 1985 is also subject to considerable uncertainty.[21]

Initial predictions of f.o.b. canned and frozen prices and the grower fresh price with TRND extended forward were all well below observed values, suggesting that the general downward trend over the 1956-1981 period has not continued. Therefore, the price predictions were recomputed with TRND held at 81. With two exceptions, all of the differences between actual and predicted values are well within the 95 percent confidence interval suggested by the standard error of the regression (values given in left side of table).[22] The first exception is the 1985 prediction of PPCCE, but as noted, the actual value for that year is somewhat uncertain. The other exception is the 1986 prediction of the grower price for processing asparagus (PGPUE). But even this difference seems likely to be within the probability range based on the standard forecast error. There is some indication that the model may slightly overpredict PGPUE, but overall the predictions seem generally consistent with the 1984-86 data.

[21]The f.o.b. price for canned asparagus is the price received by California processors. For most of the time period of the data set, this was the most complete and consistent series. However, as the California production of canned asparagus declined (see Table III.3 and Appendix Table A4, part A), so did the quantity and quality of f.o.b. price reports. Pacific Fruit News continues to report a list price but the recent quotation has remained unchanged over a period of more than two years, suggesting that it may not be a reliable indicator of actual transaction prices. The 1985 price (see Appendix Table A16) was calculated from American Institute of Food Distribution periodic reports for Michigan, linked back by relative movement to the California series. The accuracy and representativeness of the calculated value is unknown.

[22]The prediction differences might more appropriately be examined in relation to confidence intervals based on the equation standard forecast errors, rather than the standard error of the regression. However, the standard error of forecast, in general, will not be less than the standard error of the regression. Since the prediction differences fall within the narrower range, standard forecast errors, which involve complex calculations in this context, were not computed.

Production Subsector Estimation Results

The acreage adjustment equations and the allocation of production among alternative forms are modelled as a sequential process—i.e., acreage is determined by past average returns for all utilization forms, production is computed as a product of acreage and exogenous yields, then the quantity utilized in each form is determined by the predetermined production and demand shift variables. For reasons explained previously, the acreage adjustment equations and allocations are estimated independently.

Acreage Response

It may be recalled that the acreage response function (equation 7 in Table V.1) was expressed in both linear form (equation 4) and logarithmic form (equation 5) in the formal model development. These equations are expressed as nonstochastic difference equations for estimation purposes (see equation (9)).The empirical estimates of the linear and logarithmic equations yielded similar measures of statistical reliability but the parameter estimates of the log form proved to be more stable over different segments of the data set and the trend variable has a declining influence which seems appropriate for our hypothesis about the nature of structural change in the industry. As noted previously, the log form is also more consistent with our expectations concerning the stochastic properties of the disturbances.

The parameters of equation (9) were estimated by a nonlinear least squares procedure developed by Oscar R. Burt (see Burt, 1980), which yields results approximately equal to maximum likelihood estimates. It is a modification of the method of Maddala and Rao (1971).

The estimation results are given in Table VI.4.[23] With these parameter estimates, the final acreage response relationship may be written as:

$$(9a)\ \ln AU_t = -1.1465 + 1.5283\ E(\ln AU_{t-1}) - .5839\ E(\ln AU_{t-2}) + .4533\ \ln RU_{t-1} - .3464\ \ln RU_{t-2} + .4006\ \ln RU_{t-3} - .0527\ D65 - .0425\ D66 + .0173\ D1 - .00638\ T65 + .9117\ e_{t-1} - .8272\ e_{t-2}$$

As noted previously, the U symbols are added to A and R to indicate U.S. rather than regional values as defined in the Appendix Tables. The variable e_t is the difference between the actual and expected value of lnAU—i.e., $e_t = \ln AU - E(\ln AU_t)$ where E(lnAU) is the prediction of AU with $e_t = 0$ (see equation (9)).

Table VI.4. Estimates of the Parameters of the Acreage Response Function (Equation 5)

Parameter	Estimated Value	Standard Error	t-ratio
β_0	-1.1465	.3392	-3.38
β_1	.4533	.1080	4.20
$(-\beta_1\lambda)$	-.3464		
β_2	.4006	.0783	5.11
β_3	-.0527	.0254	-2.08
β_4	-.0425	.0272	-1.57
β_5	.0173	.0052	3.33
β_6	-.00638	.00165	-3.86
$\lambda = \mu$	.7641	.0756	10.11
ρ_1	.9117	.1124	8.11
ρ_2	-.8272	.1124	-7.36

$R^2 = .997$

Recall that the coefficient for $\ln RU_{t-3}$ may be written as $\beta_2 = a_1(1-\lambda)$ where a_1 is the coefficient on $\ln R^*_{t-2}$ in the new plantings equation (see the discussion of equation 5). Hence $\hat{a}_1 = \hat{\beta}_2 + (1-\hat{\lambda}) = .4006 + (1-.7641) = 1.6981$, which, as would be expected, is a much larger value than the coefficient for $\ln RU_{t-1}$ ($\hat{\beta}_1 = -b_2 = .4533$) in the removal equation.

The coefficients for $\ln RU_{t-1}$, $\ln RU_{t-2}$, and $\ln RU_{t-3}$ may be interpreted as the percentage acreage response in year t to a 1 percent change in the return (profitability) variable in t-1, t-2, and t-3, with lagged acreage constant. The coefficient for $\ln RU_{t-2}$ is $-\beta_1\lambda$. Since both $\hat{\beta}_1$ and $\hat{\lambda}$ are positive, the $\ln RU_{t-2}$ coefficient is negative. The short-run responses are relatively inelastic. However, the long-run response, calculated by removing the t subscripts on AU and RU and solving for AU as a function of RU, has a high elasticity value of 9.13. A 1 percent increase in RU, if maintained, is predicted to increase acreage about 9 percent, given a long enough response period.

The coefficients for D65 and D66 suggest that the termination of the Bracero Program had a significant (but temporary) negative impact on total acreage. The variable D1 indicates that the level of acreage was a bit higher for a given level of returns during the period prior to 1965. The coefficient for T65 indicates a downward trend in bearing acres of about 0.64 percent per year due to structural factors and opportunity costs not accounted for by the return variables.

[23]Because of the lag structure, data were utilized from 1954, but with the sample starting in 1957.

1984-86 Acreage Prediction Test

Prediction of asparagus acreage for 1984, 1985, and 1986 (equation 9a) requires observations on RU (the grower profitability measure) for the three years prior to the predicted year. This includes 1982 and 1983 when U.S. average grower prices were not reported. Since RU could not be computed for these years, precise predictions of 1984-86 acreage could not be obtained. However, it is still possible to obtain an indication of the model's applicability to 1984-86 conditions by utilizing approximations of the U.S. average grower price based on prices reported in the three main producing states—California, Washington, and Michigan. The weighted average grower price (cents per pound) for these three regions was PG = 56.16 in 1982 and 63.86 in 1983. Dividing by the farm wage rate index, WU (see Appendix Table A18), gives approximate values of $RU_{82} = 20.13$ and $RU_{83} = 22.56$.

Observed values of AU_t for 1982 and 1983 are not required to obtain predictions for AU for 1984 to 1986 if the autoregressive error structure is suppressed. Setting $e_t = 0$ permits expected values of AU to be generated by successive predictions starting with the initial condition parameters. The 1982 and 1983 values for expected acreage are obtained utilizing the expected values for 1980 and 1981; the 1984, 1985, and 1986 predictions then are obtained using the 1982 and 1983 expected values.

Predictions that utilize the additional information contained in the autoregressive error structure require actual values of acreage for 1982 and 1983 in order to compute $e = \ln AU - E(\ln AU)$ for these years. Approximations of these values were obtained from reported total acreage in California, Washington, and New Jersey, inflated to U.S. quantities based on observed differences between U.S. and regional values in 1981 and 1984. The approximate values are $AU_{82} = 87.2$ and $AU_{83} = 89.7$.

Actual values of AU and values predicted by equation (9a) with and without the autoregressive error structure are given in Table VI.5. The predictions continue the negative trend (T65) forward to 1986 (i.e., T65 = 17 in 1981, 22 in 1986). All differences between actual and predicted values fall well within the 95 percent confidence intervals based on the standard error of forecast, both with and excluding the autoregressive error structure.[24] As might be expected, utilizing the lagged error information provides generally

Table VI.5. Comparison of Actual and Predicted Values of Total U.S. Asparagus Acreage (AU), 1984-86

		1984	1985	1986
		Natural logarithms		
Actual Value	(A)	4.49870	4.51634	4.56643
Predicted value, AR2[a]	(P_1)	4.56163	4.50396	4.57385
Difference	($A-P_1$)	-.06293	.01238	-.00742
SF_1[b]		.08110	.10224	.14027
Predicted value, not AR[c]	(P_2)	4.55213	4.57818	4.58712
Difference	($A-P_2$)	-.05343	-.06184	-.02069
SF_2[d]		.13925	.18472	.22636
		Original values		
Actual	(A)	89.9	91.5	96.2
Predicted, AR2	(P_1)	95.7	90.4	96.9
Difference	($A-P_1$)	-5.8	1.1	-.7
Predicted, not AR	(P_2)	94.8	97.3	98.2
Difference	($A-P_2$)	-4.9	-5.8	-2.0

[a]AR2 refers to predicted values based on equation (9a) which includes the autoregressive error structure, $e_t = .9117\, e_{t-1} - .8272\, e_{t-2} + \varepsilon_t$, where ε_t is set at zero.

[b]Standard error of forecast utilizing equation (9a).

[c]Predicted value based on equation (9a) with e_t set at zero.

[d]Standard error of forecast based on equation (9a) with $e_t = 0$.

[24]The predictions of original values from equations estimated with logarithmic dependent variables are biased. Kennedy (1983) discusses a correction for this bias but notes that it may worsen mean square error. The original value predictions were not adjusted for possible bias, which is believed to be small. Kennedy reported a bias of about 2 percent for two studies examined that had well-fitting equations

closer predictions, but in either case, the estimated equation appears to be consistent with 1984-86 data.

Farm Production Allocation Equations

Equations to predict the allocation of total production among fresh, canning, and freezing utilization were derived as solutions to (a) the set of perceived demand functions facing growers, (b) the identity which requires quantities in each use to add to total production, and (c) the assumption that observed differences in grower prices reflect equal net returns plus or minus a disturbance term. If the perceived demand functions were linear, the solution equations would be linear functions of the total production and the predetermined variables that account for shifts in demands. Perceived demand functions need not be identical in form to the empirically estimated demand equations. However, since the empirical functions are nonlinear, it seems reasonable that the perceived demand functions also may be nonlinear.

Algebraic solutions to nonlinear demand and allocation models may be very complex or even nonexistent. Approximate solution equations were obtained by regressing the *proportions* of production marketed fresh (RQGR) and for canning (RQGC) on the demand shift variables as specified in equations 8b and 8c in Table V.1. The proportion frozen is obtained residually as RQGF = 1 - RQGR - RQGC. The proportion processed is RQGP = 1 - RQGR = RQGC + RQGF.

Since the demand and allocation subsectors were expressed in logarithms, all demand shift variables except TRND and NRN2 and NCN2 were expressed in logs. The net export variables include negative values in some years and therefore were expressed in original values. As a further simplification for empirical estimation, PPCCE, PPFCE, and MPPCE were expressed as ratios to the index of processing cost, IPCE. The variables TRND and IDNE (per capita income), which affect all demand equations about equally, did not significantly affect the allocations in initial estimates, so the equations were re-estimated with these variables excluded. Because disturbances affecting the allocation to fresh use seem likely to be correlated with disturbances affecting the allocation to processing use, equations 8b and 8c were estimated as seemingly unrelated regressions.

The estimation results are given in Table VI.6.[25] Referring first to equation 8b, all coefficients for the explantory variables except NRN2L are large relative to their standard errors and have signs consistent with theoretical expectations. The Durbin-Watson statistic provides no evidence of serial correlation among disturbances. The proportion of production allocated to fresh use has increased with lagged average per capita fresh exports (NRN2L), has shifted inversely with lagged average per capita movement of processed products (LDPN2), has increased with increases in carryover stocks of processed products (LSPN) and has shifted opposite to changes in lagged average processed product price relative to the index of processing cost (LRMIPCL). The latter is an indicator of processing profitability and hence may shift the demand for asparagus for processing.

Table VI.6. Seemingly Unrelated Regression Estimates of the Asparagus Production Allocation Equations, 1956-1981

	(8b)	(8c)
	Dependent Variable	
Explanatory Variable	RQGR[b]	RQGC[c]
Constant	.1732 (7.920)	.7124 (9.072)
NRN2L	.2497 (1.265)	-.9215 (-1.653)
NCN2L		.1556 (2.452)
LDPN2	-.2516 (-11.127)	
LSPN	.0758 (5.438)	
LRMIPCL[d]	-.2828 (-6.066)	
LSCFN		-.0168 (-.823)
LSFFN		.0451 (2.556)
LMIPCL[e]		.3244 (2.741)
LMIPFL[f]		-.2007 (-1.427)
R^2	.867	.606
D.W.[g]	2.05	2.20

[a]Values in parentheses are t ratios. An L prefix is a value in natural logs. An L suffix means a value lagged one year.
[b]RQGR = QGRUN + QGUN.
[c]RQGC = QGCUN + QGUN.
[d]RMIPCL = (MPPCEL + IPCEL).
[e]MIPCL = PPFCEL + IPCEL.
[f]MIPFL = PPFCEL + IPCEL.
[g]Durbin-Watson statistic.

[25]Actual proportions utilized for fresh market, canning, and freezing over the sample period are given in Table III.1.

Equation 8c predicts the proportion of production allocated to canning. The variables included reflect divisions between freezing and canning within the processing component as well as between fresh and processing use. Again, all signs are consistent with theoretical expectations, most coefficients are large relative to their standard errors and the Durbin-Watson statistic does not indicate any significant serial correlation of disturbances. The equation indicates that the proportion utilized for canning has decreased with lagged increases in per capita net fresh exports (NRN2L), increased with lagged average net canned exports (NCN2L), decreased with increases in per capita canned carryover stocks (LSCFN), and increased with increases in per capita frozen carryover stocks (LSFFN), increased with increases in the lagged f.o.b. price for canned asparagus relative to the index of processing cost (LMIPCL), and decreased with increases in the lagged f.o.b. price for frozen asparagus relative to the index of processing cost (LMIPFL).

1984-86 Production Allocation Prediction Test

Table VI.7 compares actual 1984-86 utilization proportions with values predicted by the 1956-1981 regressions using observed 1984-86 values of the explanatory variables. These comparisons suggest there has been a shift in utilization from processing to fresh market sales that is not accounted for by changes in the explanatory variables. Some of this could be due to changes in reporting methods after the 1982 and 1983 gap or possibly changes due to differing trim lengths for asparagus. Omitted demand shift or cost factors could also be involved. In either case, some adjustment in prediction level is needed for purposes of further analysis.

It is possible that the shift to high fresh allocations reflects changes in both the level and slope coefficients of the explanatory variables. However, there are too few observations to test for this. The procedure followed, therefore, was to add the 1984-86 observations to the data set and also to add a dummy variable, D2, which is 1.0 in 1984, 1985, and 1986, zero all other years. This permits the equations to shift to new levels in the later years. The estimation results are given in Table VI.8.

Most coefficients remain very close to the values estimated with 1956-1981 data. The coefficient for D2 suggests an upward shift in the share utilized fresh of a little over 10 percent of total production, with an offsetting decrease in the canning share. The intercept of the residually-derived equation to predict the proportion allocated to freezing increases from .1144 to .1430.

The Complete Dynamic Model

Each of the estimated behavioral equations presented previously provides a basis for making conditional short-run predictions. If past grower returns and lagged acreage are known, we can predict current acreage. If acreage is known, we can predict production (QGU). If production, lagged net fresh exports, lagged net canned exports, lagged average processed product movement, carry-in stocks and lagged processed product prices are known we can predict the quantities of total production sold for fresh, canning, and freezing use. If these allocations are known, along with carry-in stocks, lagged prices, lagged average processed movement, and fresh per capita disappearance, the model can predict grower raw product prices, f.o.b. processor prices, and canned and frozen product movement. These predictions feed back into the system to generate further changes the next period, which feed back again, and so on. Hence, in order to predict the full effects of changes in variables such as costs, population, imports, exports, or other exogenous factors, it is necessary to solve the model as a dynamic system. The complete U.S. model, arranged in sequence for computer simulation, is summarized in Table VI.9. Disturbance terms, including the autoregressive error structure in the acreage equation, are omitted for ease of reference. Stochastic considerations are discussed later.

Performance Tests

The validity of the model as a representation of the U.S. asparagus industry may be judged according to the following criteria: (1) the appropriateness of the theoretical specifications and the equation forms selected for the behavioral relationships, (2) the extent to which the econometric estimates provide results which

Table VI.7. Comparison of Actual and Predicted Values of Fresh and Canning Utilization Proportions, 1984-86

		1984		1985		1986	
		Fresh RQGR	Canning RQGC	Fresh RQGR	Canning RQGC	Fresh RQGR	Canning RQGC
Actual value	(A)	.5498	.3532	.5393	.3169	.6220	.2630
Predicted value	(P)	.4740	.4567	.4542	.3850	.4807	.3390
Difference	(A-P)	.0758	-.1035	.0851	-.0681	.1413	-.0760
SF[a]		.0328	.0593	.0290	.0594	.0286	.0665

[a]Approximate standard error of forecast.

Table VI.8. Seemingly Unrelated Regession Estimates of the Asparagus Production Allocation Equations, 1956-1981, 1984-1986[a]

	8b	8c
	Dependent Variable	
	RQGR	RQGC
Constant	.1580 (7.711)	.7004 (9.912)
NRN2L	.5423 (1.995)	-.8520 (-1.728)
NCN2L		.1653 (2.781)
LDPN2	-.2508 (-10.726)	
LSPN	.0738 (5.127)	
LRMIPCL	-.2885 (-5.977)	
LSCFN		-.0184 (-.948)
LSFFN		.0410 (2.722)
LMIPCL		.2766 (3.209)
LMIPFL		-.1396 (-1.342)
D2	.1075 (4.989)	-.1061 (-2.996)
R^2	.945	.800
D.W.	1.93	2.20

[a]Values in parentheses are t ratios. An L prefix is a value in natural logs. An L suffix means a value lagged one year. See footnotes to Table VI.6 for further definitions

are good fits to the data, (3) how the model predicts beyond the data set used for estimation and (4) the behavior of the model as a dynamic system.

1. Specification Tests

The behavioral assumptions and theoretical specifications of the model appear to be supported by the previously-presented estimation results. All coefficients have signs consistent with the theoretical model and most coefficients are large relative to their standard errors. The specifications pertaining to stochastic properties are also supported by test statistics.

2. Historical Goodness of Fit

The measures of statistical reliability presented with the estimates of the acreage equation and the demand system pertain to equations expressed in logarithms of the endogenous variables. As noted previously, transforming the model predictions from logs to original values yields predictions which are not the expected values of the original variables. Hence, while the estimates of slope coefficients are unbiased, the overall measures of fit do not apply directly to the data in original values. No attempt was made to correct for the bias, which is believed to be small. An indication of the goodness of fit in original values may be obtained by comparing historical predictions of the model with actual values transformed back into original values. These measures apply to performance within the data set, but not necessarily outside of the range of the data.

Measures of historical one-period-ahead prediction errors are presented in Table VI.10. The predictions are for year t, given the values of the exogenous variables, the carry-in stocks and the known (t-1 and before) values of other endogenous variables. They involve the reduced form solutions to the structural equations (Table VI.2) and exclude the autoregressive error terms in the acreage equation.[26] Most average absolute prediction errors are within 4 to 5 percent of the mean values of the predicted variables.

3. Out-of-Sample Predictions

When the model's predictions were extended to 1984-86, two structural changes were revealed. First, it appears that the downward shifts in the levels of the asparagus demand equations, reflected by the negative coefficients for TRND, have not continued beyond 1981. Therefore, TRND is set at 81 in the further analysis. The trend associated with the acreage equation (T65), however, continues through 1986—i.e., T65 in 1981 is 17, T65 in 1986 is 22.

Second, the 1984-86 predictions of shares of production utilized for fresh market and canning, based on the 1956-1981 equations, allocated too much to

[26]AU was predicted using actual rather than expected values of lagged AU. This expresses (9a) in the form of (5) with all e_t (and therefore U_t) set at zero. This simplifies the use and interpretation of the model. Setting $e_t = 0$ rather than utilizing the lagged disturbances in the predictions (which is necessary in long future projections) results in only a small increase in the root-mean-square error for AU.

Table VI.9. The Complete U.S. Model[a]

1. Total acreage in year t (thousands), (equation 5a)
   a. $LAU = -1.1465 + 1.5283\ LAUL - .5838\ LAUL2 + .4533\ LRUL - .3464\ LRUL2 + .4006\ LRUL3 - .0527\ \underline{D65} - .0425\ \underline{D66} + .0173\ \underline{D1} - .00638\ \underline{T65}$
   b. $AU = \exp(LAU)$
2. Total production (million pounds)
   $QGU = \underline{YU} \cdot AU$
3. Carry-in stocks, canned (million pounds)
   a. Product weight: $SC = QSCL - DCL$
   b. Farm weight equivalent: $SCF = SC \cdot \underline{KCU}$
4. Carry-in stocks, frozen (million pounds)
   a. Product weight: $SF = QSFL - DFL$
   b. Farm weight equivalent: $SFF = SF \cdot \underline{KFU}$
5. Per capita processed stocks, farm weight (million pounds)
   a. Canned: $SCFN = SCF \div \underline{N}$
   b. Frozen: $SFFN = SFF \div \underline{N}$
   c. Total: $SPN = SCFN + SFFN$
6. Lagged average processed product movement (pounds per capita)
   $DPN2 = (DPNL + DPNL2) \div 2$
7. Fresh market utilization (million pounds), (equation 8b)
   $QGRU = QGU[.1580 + .5423\ \underline{NRN2L} - .2508\ LDPN2 + .0738\ LSPN - .2885\ (LMPPCEL - \underline{LIPCEL}) + .1075\ \underline{D2}]$
8. Canning utilization (million pounds), (equation 8c)
   $QGCU = QGU[.7004 - .8520\ \underline{NRN2L} + .1653\ \underline{NCN2L} - .0184\ LSCFN + .0410\ LSFFN + .2766\ (LPPCCEL - \underline{LIPCEL}) - .1396(LPPFCEL - \underline{LIPCEL}) - .1061\ \underline{D2}]$
9. Freezing utilization (million pounds)
   $QGFU = QGU - QGRU - QGCU$
10. Total processing utilization
    $QGPU = QGCU + QGFU$
11. Canned pack (million pounds)
    $QCU = QGCU \div \underline{KCU}$
12. Frozen pack (million pounds)
    $QFU = QGFU \div \underline{KFU}$
13. Seasonal supply, canned (million pounds)
    $QSC = QCU + SC$
14. Seasonal supply, frozen (million pounds)
    $QSF = QFU + SF$
15. Canned per capita supply less net exports (pounds)
    $QSCNI = (QSC - \underline{NC}) \div \underline{N}$
16. Frozen per capita supply plus imports (pounds)
    $QSFNI = (QSF + \underline{IF}) \div \underline{N}$
17. Per capita farm weight supply for processing (pounds)
    $QGSPUN = (QGCU + SCF + QGFU + SFF) \div \underline{N}$
18. Fresh market per capita consumption (pounds)
    $DRDN = (QGRU - \underline{NR}) \div \underline{N}$
19. Canned product per capita consumption (pounds)
    a. LDCDN: see equation (3.1), Table VI.2
    b. $DCDN = \exp LDCDN$
20. Frozen product per capita consumption (pounds)
    a. LDFDN: see equation (4.1), Table VI.2
    b. $DFDN = \exp(LDFDN)$
21. Canned product f.o.b. price (cents per pound)
    a. LPPCCE: see equation (1.1), Table VI.2
    b. $PPCCE = \exp(LPPCCE)$
    c. $PPCC = PPCCE \cdot \underline{PCE671}$
22. Frozen product f.o.b. price (cents per pound)
    a. LPPFCE: see equation (2.1), Table VI.2
    b. $PPFCE = \exp(LPPFCE)$
    c. $PPFC = PPFCE \cdot \underline{PCE671}$
23. Fresh market price received by growers (cents per pound)
    a. LPGRUE: see equation (5.1), Table VI.2
    b. $PGRUE = \exp(LPGRUE)$
    c. $PGRU = PGRUE \cdot \underline{PCE671}$
24. Price received by growers for processing asparagus (cents per pound)
    a. LPGPUE: see equation (6.1) Table VI.2
    b. $PGPUE = \exp(LPGPUE)$
    c. $PGPU = PGPUE \cdot \underline{PCE671}$
25. Weighted average grower price (cents per pound)
    $PGU = (QGRU \cdot PGRU + QGPU \cdot PGPU) \div QGU$
26. Grower price-cost ratio
    $RU = (PGU \div \underline{WU})\ 100$
27. Shipments by U.S. canners (million pounds)
    $DC = (DCDN \cdot \underline{N}) + \underline{NC}$
28. Shipments by U.S. freezers (million pounds)
    $DF = (DFDN \cdot \underline{N}) - \underline{IF}$
29. Total processed product shipments (million pounds)
    $DP = DC + DF$
30. Per capita processed product shipments (pounds)
    $DPN = DP \div \underline{N}$
31. Weighted average f.o.b. processed product price (cents per pound)
    $MPPCE = (DC \cdot PPCCE + DF \cdot PPFCE) \div DP$

[a] Exogenous variables are underlined. An L suffix means the variable is lagged one year—e.g., $RUL \equiv RU_{t-1}$. An L3 suffix is a 3-year lag—e.g., $RUL3 \equiv RU_{t-3}$. Otherwise, the values are for the current year (year t). An L prefix is a value in natural logarithms. The term exp refers to the antilog of the logged variable. See Table V.2 for variable definitions.

canning and not enough to the fresh market. It is not clear to what extent this may reflect some change in reporting and/or some shifts in demand and relative costs not accounted for by the 1956-1981 regressions. But in either case, future projections need to take account of this shift. The procedure followed, as noted previously, was to re-estimate the allocation functions with 1984-86 observations added and with a dummy shifter for the period beginning in 1984. The estimation results were presented in Table VI.8 and are repeated in Table VI.9.

4. Dynamic Predictions

To predict the effects of changes in endogenous variables more than one period ahead, the model must be solved as a dynamic system. That is, starting with some initial set of values of the endogenous variables, further predictions are generated sequentially, conditioned on the values assigned to the exogenous variables. Before applying the model we need some indication of how well it may predict as a dynamic system and whether or not it is stable (i.e., whether endogenous variables approach stationary values over time if the exogenous variables remain constant).

The closeness with which the dynamic model tracks actual values of endogenous variables over the historical period of the data set is often used as a measure how well the model may be expected to forecast in the future, given known values of exogenous variables. There are, however, some significant limitations to such comparisons. A too-high or too-low prediction in year t affects the prediction in t+1 and onward. Hence, the sequentially computed deterministic predictions with disturbances suppressed soon may be out of phase with actual values which include the effects of omitted disturbances. As noted by Howry and Kelejian (1969), Hendry and Richard (1982) and others, the historical differences between predicted and actual values will be autocorrelated and heteroskedastic even if the individual equation disturbances are not serially correlated. A poor tracking record may not reflect necessarily on the structural integrity of the model, but may be due to the cumulative effects of omitted disturbances in some component of the model. Further, a very good fit can be due in large part to the influence of a major exogenous variable whose future values may be difficult to project.

Table VI.10. Goodness-of-fit Measures for One-period-ahead Predictions of Key Endogenous Variables, 1956-1981

	Mean of variable 1957-81 (M)	Mean absolute error (MAE)	MAE / M	Root-mean square error (RMSE)
Bearing acres, thousands (AU)	120.89	1.757	.015	2.518
Total production, million pounds (QGU)	289.10	4.208	.015	6.031
Fresh market production, million pounds (QGRU[9])	94.16	4.898	.052	6.408
Production for canning, million pounds (QGCU)	142.18	7.526	.053	9.749
Production for freezing, million pounds (QGFU)	194.94	3.978	.020	5.470
U.S. per capita consumption, pounds				
Fresh (DRDN)	.455	.024	.054	.032
Canned (DCDN)	.629	.026	.042	.033
Frozen (DFDN)	.139	.011	.078	.014
Deflated grower prices, 1967 cents per pound				
Fresh (PGRUE)	21.07	.915	.043	1.150
Processing (PGPUE)	16.08	.748	.046	.895
Deflated f.o.b. processor price, 1967 cents per pound				
Canned (PPCCE)	47.90	2.110	.044	2.934
Frozen (PPFCD)	62.89	2.209	.035	2.852
Grower average price-cost ratio (RU)	17.39	.656	.038	.804

With these caveats, Table VI.11 presents some measures of the historical goodness of fit of the dynamic simulation. As would be expected, the errors from dynamic simulation are somewhat larger than the one-period-ahead errors in Table VI.10. However, they still appear to fall within reasonably narrow ranges.

A dynamic model should have the additional property that if all exogenous variables are held constant, future dynamic predictions of the endogenous variables should approach stationary values. Otherwise the model predictions may diverge explosively—a phenomenon not observed in actual economic systems. The estimation procedures used to obtain the equation parameters do not guarantee stability when the model is solved as a dynamic system. Hence, it is necessary to test to see if the model in fact satisfies these requirements.

For simple linear models the stability properties may be determined by analytical solutions. However, such calculations are not possible for this model which involves complex nonlinear relationships as a complete system. The test procedure followed was simply to hold the exogenous variables constant at recent values, then allow the model to generate predictions of the endogenous variables a number of years into the future. The predictions all closely approached stationary values after about 15-20 years. The specific stability test results are presented in the next section along with the analysis of other dynamic properties of the model.

Table VI.11. Goodness-of-fit Measures for Dynamic Sequential Predictions of Key Endogenous Variables, 1956-1981

	Mean of variable 1957-81 (M)	Mean absolute error (MAE)	MAE / M	Root-mean square error (RMSE)
Bearing acres, thousands (AU)	120.89	5.993	.050	7.319
Total production, million pounds (QGU)	289.10	14.327	.050	17.606
Fresh market production, million pounds (QGRU⁹	94.16	12.738	.135	15.787
Production for canning, million pounds (QGCU)	142.18	12.400	.087	15.479
Production for freezing, million pounds (QGFU)	52.76	8.833	.167	11.362
Total production for processing, million pounds (QGPU)	194.94	11.662	.060	13.470
U.S. per capita consumption, pounds				
Fresh (DRDN)	.455	.063	.139	.079
Canned (DCDN)	.629	.045	.072	.054
Frozen (DFDN)	.139	.013	.090	.016
Deflated grower prices, 1967 cents per pound				
Fresh (PGRUE)	21.07	1.758	.083	2.372
Processing (PGPUE)	16.08	1.323	.082	1.627
Deflated f.o.b. processor price, 1967 cents per pound				
Canned (PPCCE)	47.90	4.377	.091	5.821
Frozen (PPFCD)	62.89	3.015	.048	3.853
Grower average price-cost ratio (RU)	17.39	1.208	.069	1.497

VII. DYNAMIC ANALYSIS

The model presented in Table VI.9 provides a framework for economic projections and policy analysis. Like most econometric models, its use as a forecasting tool is subject to some important limitations. First, it may be difficult to project future values of the exogenous variables of the system. This is especially the case for trend variables which are relevant only over the historical data period. Second, there may be structural changes not fully accounted for by the exogenous variables of the system; for example, the recent shift in the proportion of asparagus production sold for fresh use. Third, the model equations leave a considerable amount of variation unexplained, as reflected by the disturbance terms. Also, the equation parameters are estimates subject to error rather than true values. The effects of unexplained disturbances may be cumulative so that predicted values may be above or below actual values for considerable time periods; predicted and actual values that may be close as long-term averages may deviate systematically over interim periods.

Because of these difficulties, we have not attempted to make specific forecasts of future values of the price and output variables. Instead, we have focused on the dynamic properties of the model—in particular, the dynamic effects on prices and outputs of single changes in the exogenous variables of the system. This permits us to isolate and evaluate the likely time-path effects of changes in factors such as farm production cost, processing cost, imports, exports, and population.

If the model equations were linear, the dynamic properties could be determined by analytical solution of the deterministic model—i.e., the model with all disturbances set at zero. However, since the model is nonlinear, it is solved by computer simulation.

The deterministic simulation may be contrasted with stochastic simulation where the model predictions are calculated as means of repeated simulation runs with different sets of random disturbances for each run (for an illustration, see Pindyck and Rubinfeld, pp. 405-412). If the objective was to use the model to make specific forecasts of future conditions, the stochastic simulation would be advantageous in providing estimates of the variances of model predictions. However, even under the most simple assumptions about the stochastic process, generation of the jointly distributed errors is not a trivial task and the repeated simulation runs are costly in computer time. Weighing the possible added precision of stochastic simulation predictions against the greater simplicity and lower cost of the deterministic simulation, we conclude that the deterministic model serves adequately for purposes of this analysis. The deterministic computations appear to provide good indicators of dynamic response patterns and general magnitudes of multiplier effects.[27]

The Base Run

The simulation procedure was first to set all exogenous variables at either their 1986 values or their 1984-86 mean values as indicated in Table VII.1. Predictions for 1986 were obtained by reading in actual values of RU for 1983, 1984, and 1985 (1983 value estimated as noted previously), expected values of AU for 1984 and 1985 (94.8 and 97.3 Table VI.5), actual values of DPN for 1984 and 1985 and actual 1985 values for MPPCCE, PPCCE, PPFCE, QSC, DC, QSF, and DF. The model then was allowed to generate sequential predictions of the endogenous variables over future periods. These predictions are called the Base Run. It serves the dual purpose of a stability test and a base from which to compare the effects of changing particular exogenous variables.

Table VII.1. Base-Run Values of Exogenous Variables for Simulation Experiments

Variable	Value	Comment	Variable	Value	Comment
YU	2.23	a	KCU	.903	a
TRND	81	b	KFU	1.393	a
T65	22	c	IPCE	122.1	c
EC	1.700	a	IDNE	1.53	c
IC	5.657	a	WU	343.6	c
NC	-3.957	a	PCE671	2.90	c
ER	17.100	a			
IR	17.967	a	D1	0	
NR	-.867	a	D65	0	
IF	1.357	a	D66	0	
N	241.5	c	D2	1	

[a]1984-86 mean value.
[b]1981 value.
[c]1986 value.

[27]Given the nonlinearities and complex disturbance structure of the model, the means of stochastic simulations may differ from the predictions of the deterministic model. The previous comparisons of actual and historical predictions suggest this difference may be small. But in any case, since both the base model and the change model are subject to the same biases, the final effects of the bias on the estimated multiplier effects may be minor and certainly not of a magnitude to greatly alter the response estimates.

Table VII.2. Base Run Predictions of Key Endogenous Variables, 1986-2030

Variable	Year									
	1986	1987	1988	1989	1990	1995	2000	2005	2010	2030
Bearing Acres (AU)	98.12	97.13	94.48	89.12	84.22	84.07	87.61	83.69	86.76	85.46
Total production (QGU)	218.8	216.6	210.7	198.7	187.8	187.5	195.4	186.6	193.5	190.6
Fresh market production (QGRU)	126.5	110.7	107.4	103.9	97.3	98.4	102.1	96.9	101.3	99.5
Processing utilization (QGPU)	92.3	105.9	103.3	94.9	90.5	89.1	93.3	89.7	92.2	91.3
Quantity canned (QCU)	69.6	85.4	83.8	78.7	73.5	73.9	76.0	73.9	75.5	74.8
Quantity frozen (QFU)	21.2	20.7	19.9	17.1	17.3	16.1	17.8	16.5	17.3	17.0
Per capita consumption										
Fresh (DRDN)	.527	.462	.448	.434	.407	.411	.426	.405	.423	.415
Canned (DCDN)	.345	.337	.342	.343	.332	.319	.333	.321	.329	.326
Frozen (DFDN)	.086	.808	.086	.081	.079	.072	.079	.074	.077	.076
Deflated price (1986 $)										
Grower price fresh (PGRU)	73.67	77.59	78.20	79.12	81.47	81.81	80.03	82.13	80.44	81.15
Grower price, processing (PGPU)	51.64	55.08	56.40	57.28	59.16	59.73	58.05	59.91	58.45	59.05
F.O.B. canner (PPCC)	163.37	171.38	172.19	173.91	179.16	180.75	176.30	181.21	177.37	178.96
F.O.B. freezer (PPFC)	254.03	260.08	260.10	261.71	266.92	270.67	267.84	270.38	266.36	268.0
Grower price-cost ratio (RU)	18.74	19.38	19.65	19.99	20.58	20.75	20.24	20.79	20.36	20.54

The Base Run predictions for the major endogenous variables of the system are given in Table VII.2 for selected years.[28] These are not forecasts. Population, trend factors and other exogenous variables affecting consumption and production remain constant. Prices are expressed in 1986 dollars. The predicted acreage (AU) follows a dampening cyclical path which induces similar cyclical behavior in the other endogenous variables. The predictions cycle with decreasing amplitude around stationary values. The cycle amplitudes become very small by 2030 and the values reported for that year closely approximate the long-run stationary equilibrium values. Under the conditions imposed for the Base Run, acreage and output approach levels below the initial 1986 values and prices approach values above the 1986 levels.[29] However, changes in some of the Base Run constants, especially population and per capita income, could easily result in future acreage and output values at or above the 1986 levels. The simulation experiments that follow show how changes in the exogenous variables affect the level and dynamic behavior of the model predictions, compared to Base Run values.

Simulation Experiment No. 1: Effects of a Change in Farm Production Cost

Asparagus is a costly vegetable to produce. There have been no major technological breakthroughs during the past three decades that have greatly affected harvesting or production costs. Research continues, however, on improving varieties and cultural practices so it is of interest to evaluate the potential dynamic impacts of achieving some cost reduction. To that end, we consider a scenario in which unit production costs, as reflected by the farm wage rate index, are reduced by 10 percent—i.e., WU is reduced from its 1986 value of 343.6 to 309.2. All other exogenous variables, including average yields, are held at the values indicated in Table VII.1.

Table VII.3 shows in continuous detail how the 1986 reduction in cost affects the total acreage of asparagus (AU). In practice, costs might be reduced a bit more gradually so the impact might be softened a bit in the first few years compared to the values in Table VII.3 but the final values would be the same. In any event, with the reduced cost in this scenario, acreage at first increases to almost 102,000, then approaches 100,000 in

[28]The year designation is to facilitate interpretation since the experiments were initialized with data pertaining to 1986. More generally, however, the years might be considered as year 1 (1986), year 2 and so on, given a set of initial conditions as specified for the Base Run.

[29]As the variables in Table VII.2 approach long-run equilibrium values, carry-over stocks of canned and frozen asparagus (SC and SF, not shown in Table VII.2) approach levels such that the ratio to previous year supply approach values of about .22 for $SCN_t + QSCNI_{t-1}$ and .25 for $SFN_t + QSFNI_{t-1}$. These ratios are a little higher than the long-run average ratios (over the period of the historical data set) of .203 and .231. An alternative base run was computed in which $SCN_t + QSCNI_{t-1}$ and $SFN_t + QSFNI_{t-1}$, were constrained to their historical ratios. Under these specifications the long-run values of bearing acres (AU) were about 1.5 thousand higher (about 2 percent) and prices shifted slightly. However, the dynamic effects of changes in exogenous variables on the endogenous prices and outputs are essentially the same with either base run specification.

small dampening cycles. This may be compared to acreage predictions under the Base Run conditions where AU declines in dampening cycles toward a stationary equilibrium value of about 85,500 acres (the value for 2030 in Table VII.2).

Table VII.3. Effect on Total Acreage (AU) of a 10 Percent Reduction in Farm Cost

Year	Base Run (WU=343.7)	Experiment 1 (WU=309.2)	Difference	Percent Change from Base Run
1986	98.13	98.13	0	0
1987	97.13	101.89	4.76	4.9
1988	94.48	101.73	7.25	7.7
1989	89.12	101.28	12.16	13.6
1990	84.22	101.83	16.61	19.7
1992	79.50	100.18	20.68	26.0
1993	79.78	99.78	20.00	25.1
1994	81.51	99.51	18.00	22.1
1995	84.07	99.44	15.37	18.3
1996	86.67	99.55	12.88	14.9
1997	88.56	99.76	11.20	12.6
1998	89.31	100.00	10.69	11.5
1999	88.88	100.20	11.31	12.7
2000	87.61	100.32	12.71	14.5
2001	85.99	100.33	14.34	16.7
2002	84.54	100.26	15.72	18.6
2003	83.61	100.13	16.51	19.7
2004	83.34	99.98	16.64	20.0
2005	83.69	99.87	16.18	19.3
2006	84.47	99.82	15.35	18.2
2007	85.39	99.82	14.43	16.9
2008	86.20	99.87	13.67	15.9
2009	86.68	99.95	13.27	15.3
2010	86.76	100.03	13.27	15.3

Looking at the multiplier effects (the last two columns of Table VII.3), the 10 percent reduction in cost induces increases in acreage up to about 20,000 by 1992 and 1993. The differences then decrease in dampening cycles, reaching a value of a little over 13,000 acres more by 2010. The comparable percentage changes are given in the last column. Note that while the long-run supply elasticity was estimated as about 9 (see the section on empirical estimates), when evaluated in the context of the complete system, with feedback through the demand system, the 10 percent reduction in cost leads to maximum interim increases in acreage of only about 26 percent and a long-run response of about 15 percent.

Table VII.4 summarizes the effects of the 10 percent cost reduction on other variables of the system. As would be expected, prices show an inverse pattern compared to acreage. They decline increasingly compared to the Base Run for about five years, then cyclically approach new levels about 8-10 percent below the Base Run. The grower profitability measure (RU) increases relative to the Base Run, but at a decreasing rate, eventually approaching a level 1 to 3 percent above the Base Run. Not all of the profitability gain is dissipated since some increase is required to induce and maintain the higher levels of production.

An issue of concern is whether the predicted effects of a change in cost may be affected significantly by changes in the Base Run conditions. Three additional cost change experiments were run in order to shed some light on this question. First, the farm production cost experiment was rerun using the Base Run with carry-over stock ratios restricted to their long-run average values (.203 for canned, .231 for frozen); the changes from these Base Run values were similar to those in Tables VII.3 and VII.4 for acreage, total production, and prices. There were larger differences in the predicted changes in canned and frozen allocations but the values were of the same general order of magnitude obtained with the unrestricted Base Run conditions.

A second test was to change the conversion factors for raw product to processing weight, KCU and KFU, from their apparent recent values to the longer term historical ratios of about 1.0 and 2.0. Again, farm production cost was reduced by 10 percent and changes from the new Base Run were calculated. The results were similar to the first test. There were some differences in the canned and frozen allocations but the predicted differences were of the same general order of magnitude as the first case.

Finally, yields were increased by 10 percent, from 223 to 245, the latter near the average reported for the decades of the 1960s and 1970s. While the increase in yields led to lower long-run acreage predictions, slightly higher outputs and slightly lower prices, the effects of the *change* in cost on *changes* in the endogenous variables remained about the same as the scenario based on the Table VII.2 conditions. It appears that the predicted effects of changes in one exogenous variable are not highly sensitive to the values assigned to the other exogenous variables, at least within reasonable ranges. Therefore, the remaining experimental results reported will pertain only to the Base Run represented in Table VII.2.

Simulation Experiment No. 2: Effects of an Increase in Canned Exports

Appendix Table A7 shows that exports of canned asparagus dropped from a peak of 62 million pounds in 1963 to two million pounds or less in the mid-1980s. While the prospects for gaining back much of the canned export market may be dim, it is nevertheless of interest to see what impact a modest gain might have on the industry. This experiment increases canned exports by 10 million pounds per year (equivalent to about 474,000 cases of 24 No. 300 cans). The variable EC increases from the 1984-86 average of 1.70 to 11.70 and net exports (NC) increases from -3.957, in Table VII.1, to 6.043. Per capita net exports (NCN) increase

Table VII.4. Experiment No. 1: Effects of Reducing Farm Cost (WU) by 10 Percent (From 343.6 to 309.2)[a]

Variable	1986	1987	1988	1989	1990	1995	2000	2005	2010
Bearing acres (AU)	0	4.76 (4.9)	7.25 (7.7)	12.16 (13.7)	16.61 (19.7)	15.37 (18.3)	12.71 (14.5)	16.18 (19.3)	13.27 (15.3)
Total production (QGU)	0	10.6 (4.9)	16.17 (7.7)	27.12 (13.7)	37.02 (19.7)	34.28 (18.3)	28.35 (14.5)	36.09 (19.3)	29.60 (15.3)
Fresh market production (QGRU)	0	5.43 (4.9)	10.33 (9.6)	16.45 (15.8)	22.31 (22.9)	17.78 (18.1)	15.36 (15.1)	19.76 (20.4)	15.69 (15.5)
Processing utilization (QGPU)	0	5.19 (4.9)	5.83 (5.6)	10.68 (11.3)	14.72 (16.3)	16.49 (18.5)	12.99 (13.9)	16.32 (18.2)	13.91 (15.1)
Quantity canned (QCU)	0	4.18 (4.9)	5.43 (6.5)	8.45 (10.7)	11.45 (15.6)	11.44 (15.5)	9.88 (13.0)	11.76 (15.9)	10.23 (13.6)
Quantity frozen (QFU)	0	1.01 (4.9)	.67 (3.4)	2.19 (12.8)	3.14 (18.1)	4.42 (27.5)	2.92 (16.4)	4.10 (24.8)	3.35 (19.4)
Per capita consumption Fresh (DRDN)	0	.023 (4.9)	.043 (9.6)	.068 (15.7)	.092 (22.7)	.074 (17.9)	.064 (14.9)	.082 (20.2)	.065 (15.4)
Canned (DCDN)	0	.008 (2.3)	.017 (5.0)	.028 (8.3)	.042 (12.5)	.051 (15.9)	.038 (11.5)	.051 (15.6)	.042 (12.7)
Frozen (DFDN)	0	.003 (2.8)	.003 (3.9)	.007 (8.8)	.011 (14.2)	.018 (25.3)	.012 (15.7)	.017 (22.3)	.014 (18.5)
Delfated price (1986 $) Grower price, fresh (PGRU)	0	-1.64 (-2.1)	-3.23 (-4.1)	-5.19 (-6.6)	-7.49 (-9.2)	-6.90 (-8.4)	-5.50 (-6.9)	-7.40 (-9.0)	-5.79 (-7.2)
Grower price, processing (PGPU)	0	-1.34 (-2.5)	-2.58 (-4.6)	-4.28 (-7.5)	-6.23 (-10.5)	-6.04 (-10.1)	-4.67 (-8.0)	-6.37 (-10.6)	-4.96 (-8.5)
F.O.B. canner (PPCC)	0	-3.673 (-2.1)	-7.24 (-4.2)	-11.63 (-6.7)	-16.91 (-9.4)	-16.56 (-9.2)	-12.94 (-7.3)	-17.42 (-9.6)	-13.73 (-7.7)
F.O.B. freezer (PPFC)	0	-3.65 (-1.4)	-7.34 (-2.8)	-12.04 (-4.6)	-17.68 (-6.6)	-19.81 (-7.3)	-14.82 (-5.6)	-19.98 (-9.6)	-16.06 (-7.7)
Grower price-cost ratio (RU)	2.08 (11.1)	1.67 (8.6)	1.31 (6.7)	.76 (3.8)	.16 (.8)	.20 (1.0)	.62 (3.1)	.11 (.5)	.53 (2.6)

[a]Values in parentheses are percentage changes from Base Run values.

from -.0164 to .0250. The exports are increased in the first year of the simulation experiment (1986) and assumed to remain constant at that level.[30]

The results of the simulation experiment are given in Table VII.5. The time frame of the adjustment process merits careful study. In the initial period, the primary effect of the increase in exports is to reduce domestic per capita consumption of canned asparagus (DCDN) and to increase the price received by both canners and freezers (PPCC and PPFC). There is also some shift in the utilization of processing asparagus from freezing to canning. In the second year, there is a small increase in acreage and production and a further shift from fresh market utilization to canning and freezing utilization and further increases in prices for all utilization forms. The price enhancement reaches a peak in the third year. Prices remain above Base Run values, as time moves forward, but by a declining amount. Meanwhile, acreage and total production continue to expand for about 10 years, then decline somewhat, but remain above the Base Run values.

The predicted values in Table VII.5 are reported only at five-year intervals to keep the table within bounds. Continuous annual predictions would reveal more fully a continuation of the dampening cyclical pattern of convergence noted in Experiment No. 1. In view of these cyclical patterns, the long-term prediction results may be best described in terms of ranges of values.

The long-term effect of the 10 million pound increase in canned exports is that acreage increases between two and three thousand (about 3 percent), there is a shift in allocation from fresh to processing utilization, U.S. per capita consumption of fresh and canned asparagus (but not frozen) decrease, and grower prices increase between roughly .5 and 1.5 percent. The grower profitability measure (RU) increases in the range of 1 to 2 percent in the third and fourth year, but with a final gain of something less than 1/2 percent as production expands in response to the increased exports.

[30]In practice, exports might increase more gradually. In that case, there would be less effect in the early years, but the longer-run impacts would be the same.

Table VII.5. Experiment No. 2: Effect of Increasing Canned Exports (EC) by 10 Million Pounds[a]

Variable	1986	1987	1988	1989	1990	1995	2000	2005	2010
Bearing acres (AU)	0	.35 (.4)	.79 (.8)	1.56 (1.8)	2.20 (2.6)	3.20 (3.8)	1.94 (2.2)	2.87 (3.4)	2.41 (2.8)
Total production (QGU)	0	.77 (.4)	1.77 (.8)	3.49 (1.8)	4.90 (2.6)	7.14 (3.8)	4.32 (2.2)	6.40 (3.4)	5.37 (2.8)
Fresh market production (QGRU)	0	-5.60 (-5.1)	-5.63 (-5.2)	-3.19 (-3.1)	-1.61 (-1.7)	-1.35 (-1.4)	-2.91 (-2.9)	-1.55 (-1.6)	-2.35 (-2.3)
Processing utilization (QGPU)	0	6.38 (6.0)	7.39 (7.2)	6.69 (7.1)	6.51 (7.2)	8.49 (9.5)	7.23 (7.8)	7.95 (8.9)	7.72 (8.4)
Quantity canned (QCU)	1.65 (2.4)	3.23 (3.8)	6.14 (7.3)	6.38 (8.1)	6.15 (8.4)	7.18 (9.7)	6.30 (8.3)	6.82 (9.2)	6.62 (8.8)
Quantity frozen (QFU)	-1.08 (-5.1)	2.48 (12.0)	1.33 (6.7)	.66 (3.9)	.69 (4.0)	1.44 (9.0)	1.11 (6.2)	1.29 (7.8)	1.25 (7.2)
Per capita consumption									
Fresh (DRDN)	0	-.023 (-5.0)	-.023 (-5.2)	-.013 (-3.2)	-.007 (-1.6)	-.006 (-1.4)	-.012 (-2.8)	-.006 (-1.6)	-.010 (-2.3)
Canned (DCDN)	-.020 (-5.8)	-.023 (-6.9)	-.023 (-6.6)	-.020 (-5.7)	-.017 (-5.0)	-.011 (-3.6)	-.015 (-4.6)	-.013 (-4.1)	-.014 (-4.2)
Frozen (DFDN)	-.001 (-1.7)	.004 (4.0)	.003 (4.0)	.003 (4.1)	.004 (4.4)	.006 (8.1)	.005 (6.0)	.005 (7.0)	.005 (6.8)
Deflated price (1986 $)									
Grower price, fresh (PGRU)	.88 (1.2)	2.58 (3.3)	2.59 (3.3)	12.82 (2.3)	1.32 (1.6)	1.00 (1.2)	1.59 (2.0)	1.17 (1.4)	1.36 (1.7)
Grower price, processing (PGPU)	0	.40 (.7)	1.18 (2.1)	.82 (1.4)	.34 (.6)	-.02 (-.03)	.53 (.9)	.13 (.2)	.33 (.6)
F.O.B. canner (PPCC)	3.02 (1.9)	6.63 (3.9)	6.54 (3.8)	4.86 (2.8)	3.76 (2.1)	2.82 (1.6)	4.16 (2.4)	3.28 (1.8)	3.65 (2.1)
F.O.B. freezer (PPFC)	5.01 (2.0)	7.48 (.29)	7.21 (2.8)	5.65 (2.2)	4.57 (1.7)	2.95 (1.1)	4.51 (1.7)	3.62 (1.3)	3.90 (1.5)
Grower price-cost ratio (RU)	.147 (.8)	.242 (1.3)	.345 (1.8)	.225 (1.1)	.100 (.5)	-.025 (-.1)	.141 (.7)	.022 (.1)	.079 (.4)

[a]Values in parentheses are percentage changes from Base Run values.

Larger increases in exports would have proportionately larger interim impacts, and larger effects on outputs. For example, with a 20 million pound increase in canned exports (equivalent to about 948,000 cases of 24 No. 300 cans), the numbers in Table VII.5 are approximately doubled. By 2010, acreage and production increase by a little over 5 percent, but the net return measure which initially increased by over 3 percent falls to less than a 1 percent gain. Increasing imports by 10 or 20 million pounds could have similar effects, but of opposite sign.

Simulation Experiment No. 3: Effects of a Change in Fresh Imports

Appendix Table A9 shows that imports of fresh asparagus have increased considerably since 1981. There has also been some increase (and decrease) in fresh exports, but not of the same magnitude as the imports. Some of the asparagus imports arrive in the United States at times when U.S. shipments are light or nonexistent and, hence, are not directly competitive with U.S. production. Table VII.6 provides a more detailed picture of the changes in levels of competitive production for the period 1975 to 1987. The monthly import data for earlier years appeared to contain some inconsistencies or to be incomplete in some cases. Estimates of direct import competition for these years, therefore, are omitted.

The data in Table VII.6 show that for the period 1975-1981, imports were relatively stable and that about 80 percent of the imports arrived during the January-April period (mainly in March) and were, therefore, competitive with California production.[31] Beginning in 1982, imports increased substantially both during January-April and in the rest of the year, but with relatively larger increases in the May-December period beginning in 1984.

[31]Federal-State Market news data indicate that virtually all of the calendar year imports arrived during the January-April period in 1981. This seems so unusual that we wonder about the accuracy or completeness of the data for that year.

Table VII.6. U.S. Asparagus Imports: January-April and May-December, 1975-1987

Year	January-April	May-December	Calendar Year Total	Proportion January-April
	million pounds			
1975	6.69	1.79	8.48	.79
1976	6.62	1.64	8.26	.80
1977	5.50	1.60	7.10	.77
1978	3.98	1.02	5.00	.80
1979	6.28	1.18	7.46	.84
1980	6.37	1.67	8.04	.79
1981	7.47	0.01	7.48	.99
1982	12.41	3.75	16.16	.77
1983	14.37	4.09	18.46	.78
1984	8.08	6.27	14.35	.56
1985	11.41	5.95	17.36	.66
1986	13.13	11.22	24.35	.54
1987	20.45	9.51	29.96	.68

Source: Computed from Federal-State Market News Service, *Marketing California Asparagus* , Annual reports.

The demand functions of the model (Table VI.1) were estimated utilizing data only for the period 1956 to 1981. Therefore, the estimated equations reflect conditions where the level of import competition is generally consistent with or proportional to the annual levels of reported imports. This apparently would not be true from 1984 onward. It is possible, therefore, that the level of net fresh exports (NR) specified for the Base Run, may slightly overstate the level of import competition existent during the 1984-86 period.

This experiment evaluates the effects of a change of 5 million pounds of fresh imports, assumed to occur in the January-April period. More specifically, it evaluates the effects of decreasing imports from their mean of 17.97 million in the Base Run (10.87 during January-April) to a mean of 12.967 million pounds. With 1984-86 fresh exports averaging 17.1 million pounds, exports minus imports, (NR) increase from the Base Run value of -.867 to 4.133. Per capita net exports (NRN) correspondingly increase from -.0036 to .0171.

The simulation results are given in Table VII.7. In the first year there is no change in total production but there is a shift of 2.46 million pounds from processing to fresh utilization. This, combined with the reduced imports, decreases U.S. per capita fresh consumption

Table VII.7. Experiment 3: Effects of a 5 Million Pound Decrease in Fresh Imports[a]

Variable	1986	1987	1988	1989	1990	1995	2000	2005	2010
Bearing acres (AU)	0	.74 (.8)	1.26 (1.3)	2.02 (2.3)	2.72 (3.2)	2.77 (3.3)	2.15 (2.5)	2.80 (3.4)	2.34 (2.7)
Total production (QGU)	0	1.65 (.8)	2.81 (1.3)	4.50 (2.3)	6.07 (3.2)	6.17 (3.3)	4.80 (2.5)	6.24 (3.4)	5.23 (2.7)
Fresh market production (QGRU)	2.46 (1.9)	1.87 (1.7)	3.63 (3.4)	4.90 (4.7)	5.72 (5.9)	5.21 (.53)	4.65 (4.6)	5.41 (5.6)	4.82 (4.8)
Processing utilization (QGPU)	-2.46 (-2.7)	-.20 (-.2)	-.83 (-.8)	-.40 (-.4)	.35 (.4)	.95 (1.1)	.16 (.2)	.84 (.9)	.41 (.4)
Quantity canned (QCU)	-4.30 (-6.2)	-1.40 (-1.6)	-1.12 (-1.3)	-1.06 (-1.3)	-.53 (-.7)	-.29 (-.4)	-.79 (-1.0)	-.30 (-.4)	-.64 (-.9)
Quantity frozen (QFU)	1.02 (4.8)	.76 (3.7)	.13 (.7)	.40 (2.3)	.60 (3.4)	.87 (5.4)	.62 (3.5)	.79 (4.8)	.71 (4.1)
Per capita consumption									
Fresh (DRDN)	-.011 (-2.0)	-.013 (-.28)	-.006 (-1.3)	-.001 (-.1)	.003 (.7)	.001 (.2)	-.002 (-.3)	.002 (.4)	-.001 (-.2)
Canned (DCDN)	-.010 (-2.8)	-.009 (-.27)	-.008 (-2.2)	-.005 (-1.5)	-.003 (-.8)	-.001 (-.2)	-.004 (-1.1)	-.001 (-.3)	-.003 (-.8)
Frozen	.002 (2.3)	.002 (2.3)	.001 (1.6)	.002 (2.2)	.002 (3.0)	.004 (4.9)	.003 (3.4)	.003 (4.4)	.003 (3.9)
Deflated price (1986 $)									
Grower price, fresh (PGRU)	.96 (1.3)	1.22 (1.6)	.70 (.9)	.26 (.3)	-.08 (-.1)	-.04 (-.1)	.28 (.3)	-.07 (-.1)	.18 (.2)
Grower price processing(PGPU)	.69 (1.3)	.76 (1.4)	.50 (.9)	.09 (.2)	-.27 (.5)	-.26 (-.4)	.06 (.1)	-.29 (-.5)	-.04 (-.1)
F.O.B. canner (PPCC)	2.47 (1.5)	2.96 (1.7)	1.86 (1.1)	.86 (.5)	.06 (.03)	-.03 (-.02)	.79 (-.5)	-.04 (-.02)	.54 (.3)
F.O.B. freezer (PPFC)	2.81 (1.1)	3.04 (1.2)	2.15 (.8)	1.10 (.4)	.19 (.1)	-.37 (-.1)	.77 (.3)	-.23 (-.1)	.41 (.2)
Grower price-cost ratio (RU)	.317 (1.7)	.319 (1.7)	.241 (1.2)	.133 (.7)	.037 (.2)	.025 (.1)	.119 (.6)	.022 (.1)	.090 (.4)

[a]Values in parentheses are percentage changes from Base Run values.

(DRDN) by 2 percent and canned per capita consumption by 2.8 percent while increasing U.S. per capita frozen consumption by 2.3 percent. The net effect is to increase the grower price fresh (PGRU) by about 1 cent per pound, the processing price by .69 cents per pound and the f.o.b. processor prices (PPCC and PPFC) by 2.47 and 2.81 cents per pound. The grower profitability measure (RU) increases a little less than 2 percent.

Total production increases a bit in the second year and the quantity allocated to processing, while still less than in the Base Run, increases compared to the first year. Prices increase slightly compared to the first year. As time moves forward, acreage and production gradually increase so that eventually the reduced imports are replaced by U.S. production and prices return to levels near the Base Run values. However, per capita fresh consumption stabilizes at a slightly higher level (not fully revealed in Table VII.7), attributable to minor differences in the long-run levels of carry-in stocks QSCNI (see Table VI.2).

A simulation experiment which increased the level of fresh imports by 5 million pounds (rather than a decrease) yielded numbers very similar to those in Table VII.7, but of opposite sign. Changing imports by 10 million pounds (rather than 5 million) yielded numbers approximately twice the value of those in Table VII.7 for the years included in the simulation analysis. However, a larger shock may require a longer period to reach stable equilibrium levels.

Simulation Experiment No. 4: Effects of a Change in Processing Cost

Appendix Table A17 provides some limited indications of changes in the processing margins for canned and frozen asparagus—the difference between the f.o.b. price per pound received by processors and the cost of the raw product in a pound of final product. While there have been variations in per-unit profits obtained by processors, the main factor affecting margins in the longrun appears to be the unit cost of processing. Since a measure of unit processing cost was not available, changes in processing cost in this study were approximated by an index of processing cost, IPC in Table A18, or its deflated value, IPCE = IPC ÷ PCE671.

This experiment shows how a 10 percent increase in the unit cost of processing, as reflected by IPCE, may affect asparagus outputs and prices in a dynamic context. All conditions are the same as in the Base Run except IPCE is increased from 122.1 to 134.3. The simulation results are given in Table VII.8.

Table VII.8. Experiment No. 4: Effect of Increasing IPCE by 10 Percent (from 122.1 to 134.3)[a]

Variable	1986	1987	1988	1989	1990	1995	2000	2005	2010
Bearing acres (AU)	0	.48	-.80	-1.41	-2.42	-4.61	-1.80	-3.87	-2.89
		(.5)	(-.9)	(-1.6)	(-2.9)	(-5.5)	(-2.1)	(-4.6)	(-3.3)
Total production (QGU)	0	1.05	-1.79	-3.15	-5.39	-10.27	-4.02	-8.63	-6.45
		(.5)	(-.9)	(-1.6)	(-2.9)	(-5.5)	(-2.1)	(-4.6)	(-3.3)
Fresh market production (QGRU)	0	10.58	11.46	8.41	5.62	3.61	8.33	4.49	6.61
		(9.6)	(10.7)	(8.1)	(5.8)	(3.7)	(8.2)	(4.6)	(6.5)
Processing utilization (QGPU)	0	-9.52	-13.26	-11.55	-11.00	-13.88	-12.35	-13.13	-13.06
		(-9.0)	(-12.8)	(12.2)	(-12.2)	(-15.6)	(-13.2)	(-14.6)	(-14.2)
Quantity canned (QCU)	-3.16	-.71	-8.40	-9.27	-8.62	-10.00	-8.77	-9.49	-9.28
	(-4.5)	(-.8)	(-10.0)	(-11.8)	(-11.7)	(-13.5)	(-11.6)	(-12.9)	(-12.3)
Quantity frozen (QFU)	2.05	-6.38	-4.07	-2.29	-2.31	-3.49	-3.18	-3.27	-3.36
	(9.7)	(-30.8)	(-20.5)	(-13.4)	(-13.3)	(-21.7)	(-17.9)	(-19.8)	(-19.5)
Per capita consumption									
Fresh (DRND)	0	.044	.048	.035	.023	.015	.035	.019	.027
		(9.5)	(10.6)	(8.0)	(5.7)	(3.6)	(8.1)	(4.6)	(6.5)
Canned (DCDN)	-.027	-.019	-.021	-.028	-.033	-.042	-.036	-.039	-.039
	(-7.8)	(-5.7)	(-6.1)	(-8.2)	(-10.1)	(-13.2)	(-10.9)	(-12.1)	(-11.8)
Frozen (DFDN)	.0001	-.011	-.013	-.011	-.011	-.014	-.013	-.014	-.014
	(.1)	(-12.5)	(-14.7)	(-13.9)	(-13.8)	(-19.7)	(-16.9)	(-18.1)	(-18.1)
Deflated price (1986 $)									
Grower price, fresh (PGRU)	1.20	-1.58	-1.81	-.82	.11	1.26	-.38	.80	.22
	(1.6)	(-2.0)	(02.3)	(-1.0)	(.1)	(1.5)	(-.5)	(1.0)	(.3)
Grower price, processing (PGPU)	0	-4.37	-5.29	-4.82	-4.21	-3.19	-4.38	-3.59	-3.93
		(-7.9)	(-9.4)	(-8.4)	(-7.1)	(-5.3)	(-7.6)	(-6.0)	(-6.7)
F.O.B. canner (PPCC)	4.16	-1.65	-1.97	.49	2.82	5.97	2.07	4.79	3.49
	(2.6)	(-1.0)	(-1.1)	(.3)	(1.6)	(3.3)	(1.2)	(2.6)	(2.0)
F.O.B. freezer (PPFC)	6.69	2.98	3.20	5.91	8.56	13.20	8.85	11.61	10.47
	(2.6)	(1.2)	(1.2)	(2.3)	(3.2)	(4.9)	(3.3)	(4.3)	(3.9)
Grower price-cost ratio (RU)	.20	-.52	-.59	-.41	-.21	.15	-.26	.01	-.11
	(1.1)	(-2.7)	(-3.0)	(-2.0)	(-1.1)	(.7)	(-1.3)	(.1)	(-.5)

[a]Values in parentheses are percentage changes from Base Run values.

In reviewing the findings, the predictions for the first few years are of less interest than the later years. This is because a 10 percent cost increase in one year is a substantial shock to the system that leads to some relatively large short-term fluctuations in inventories and utilization. Ordinarily, a cost increase of 10 percent might be spread over several years, with smoother adjustments to the change in cost. However, the longer-run effects of the cost change are the same whether the cost increase is incurred in one year or spread over four or five years.

Processors respond to the cost increase, as expected, by decreasing the quantity processed. By the fifth year the quantity allocated to processing (QGPU) has decreased by 11 million pounds. This is offset by a decrease in total asparagus production of 5.39 million pounds and an increase in fresh market utilization of 5.62 million pounds. Along with this, the price received by growers for processing asparagus has decreased by a little over 4 cents per pound and the f.o.b. prices of canned and frozen asparagus (PPCC, PPFC) have increased by 2.8 and 8.6 cents per pound. The grower profitability measure (RU) has declined by a small amount and this is reflected in the decreased acreage and production.

After the fifth year, the deviations from Base Run values follow dampening cyclical paths as they approach constant equilibrium values. Beyond the 15th year, the 10 percent processing cost increase has caused total acreage and production to decrease from about 3.3 to 4.6 percent. Processing utilization declines by about 13 million pounds (14.2 to 14.6 percent) and fresh market production increases in the range of 4.5 to 6.6 million pounds (4.6 to 6.5 percent). Frozen asparagus production and consumption decrease by lesser absolute amounts, but higher percentage amounts than canned asparagus. The grower price for processing asparagus declines by about 3.6 to 3.9 cents per pound (6.0 to 6.7 percent) while the grower fresh market price has slightly increased (less than 1 cent per pound). The f.o.b. processor prices have increased by 3.5 to 4.8 cents per pound for canned asparagus (2.0 to 2.0 percent) and by 10.5 to 11.6 cents per pound for frozen asparagus (3.9 to 4.3 percent). The weighted average grower price (and therefore, the profitability measure, RU) has returned to values not far from the Base Run values. If the calculations were extended forward for additional years, we would expect RU to stabilize at values slightly lower than in the Base Run to be consistent with the reduction in acreage and production.

It is of interest to look at the model predictions of the effects of the 10 percent increase in the processing cost index on the processing margins (not shown directly in the Table VII.8). The margins are defined as the f.o.b. processor price less the cost of the raw product in a unit of processed product. More specifically,

For canning: $MC = PPCC - PGPU \cdot KCU$

For freezing: $MF = PPFC - PGPU \cdot KFU$.

By the fifth year, the canning margin (MC) increased by 6.62 cents per pound (5.3 percent) over the Base Run value and the freezing margin (MF) increased by 14.42 cents per pound (7.8 percent) over the Base Run. In the 10th to 20th periods the margins increased 6 to 7 percent over the Base Run for canning and 8 to 9 percent for freezing.

If all of the margins were attributable to the level of the index of processing cost (IPC), we might expect margins to increase by 10 percent when the index increased by 10 percent. However, the margins may also include other profit factors not contained in the processing cost index so a given percentage change in the cost index could well involve a lesser percentage change in the margin. The values generated by the model appear consistent with this concept and, in any case, appear reasonable relative to the range of possible statistical error in the model.

Simulation Experiment No. 5: Effects of Population Growth

The future levels of demand for asparagus products will be affected by a number of factors, such as changes in consumer tastes, which are very difficult to project and to measure. One important variable that can be projected with some reasonable degree of accuracy is U.S. population growth, at least over the next 10 to 15 years. This experiment attempts to isolate the effects that population growth alone may have on the asparagus industry up to the year 2000, holding all other factors, including consumer tastes, at the Base Run values. Population is projected using a mid-range of the U.S. Bureau of Census projections. Total imports and exports remain at Base Run values, which means that per capita net exports decline as population increases. The simulation results are given in Table VII.9.

With per capita demand (equations 1, 2, 5, 6 in Table VI.1) constant, the growth in population leads to slightly higher prices compared to the Base Run. In response, growers expand acreage, but the growth lags behind population growth, so per capita consumption is less than in the Base Run. The major effects to note are that by 2000, acreage and production expand about 8.5 percent compared to the Base Run. Prices are about 1.0 to 1.5 percent higher than in the base run, with the differences fluctuating cyclically. With population growth continuing, the system never achieves a stationary equilibrium.

Table VII.9. Experiment 5: Effects of Increasing U.S. Population Through 2000[a]

Variable	1986	1987	1988	1989	1990	1995	2000
Bearing acres (AU)	0	0	.18 (.2)	.46 (.5)	.93 (1.1)	5.15 (6.3)	7.43 (8.5)
Total production (QGU)	0	0	.40 (.2)	1.03 (.5)	2.08 (1.1)	11.49 (6.3)	16.57 (8.5)
Fresh market production (QGRU)	0	-.12 (-.1)	-.32 (-.3)	-.05 (-.1)	.50 (.5)	5.82 (5.9)	7.99 (7.8)
Processing utilization (QGPU)	0	.13 (.1)	.72 (.7)	1.09 (1.1)	1.58 (1.8)	5.67 (6.4)	8.57 (9.2)
Quantity canned (QCU)	0	-.05 (-.1)	.36 (.4)	.83 (1.1)	1.31 (1.8)	4.68 (6.3)	6.89 (9.1)
Quantity frozen (QFU)	0	.12 (.6)	.28 (1.4)	.24 (1.4)	.29 (1.7)	1.04 (6.5)	1.69 (9.5)
Per capita consumption							
Fresh (DRDN)	0	-.004 (-.9)	-.008 (-1.8)	-.011 (-2.5)	-.011 (-.28)	-.006 (1.5)	-.012 (-2.9)
Canned (DCDN)	0	-.002 (-.5)	-.004 (-1.0)	-.005 (-1.6)	-.006 (-1.9)	-.005 (1.6)	-.007 (-2.23)
Frozen (DFDN)	0	-.0003 (-.3)	-.001 (-.6)	-.001 (-1.2)	-.001 (-1.8)	-.001 (-1.8)	-.002 (-2.11)
Deflated price (1986 $)							
Grower price, fresh (PGRU)	0	.33 (.4)	.68 (.9)	.96 (1.2)	1.15 (1.4)	.70 (.9)	1.20 (1.5)
Grower price, processing (PGPU)	0	.25 (.5)	.53 (1.0)	.80 (1.4)	.97 (1.6)	.58 (1.0)	.98 (1.7)
F.O.B. canner (PPCC)	0	.75 (.4)	1.54 (.9)	2.20 (1.3)	2.65 (1.5)	1.73 (1.0)	2.81 (1.6)
F.O.B. freezer (PPFC)	0	.74 (.3)	1.55 (.6)	2.29 (.9)	2.81 (1.1)	2.06 (.8)	3.09 (1.2)
Grower price-cost ration (RU)	0	.081 (.4)	.161 (.8)	.238 (1.2)	.288 (1.4)	.182 (.9)	.298 (1.5)
U.S. population (N)	241.5	243.5	245.3	247.5	249.7	259.6	268.0

[a]Values in parentheses are percentage changes from Base Run values.

VIII. SUMMARY COMMENTS

The econometric model formulated and estimated in this study provides a framework for better understanding and quantitative evaluation of the supply-demand structure of the U.S. asparagus industry. The main components of the model are (a) an equation that predicts acreage (and therefore production) as a function of past grower prices and costs, (b) equations that allocate production among fresh, canning, and freezing utilization as functions of variables which shift the demand functions facing growers and (c) a set of six jointly related equations which predict grower prices for fresh market and processing asparagus, f.o.b. processor prices for canned and frozen asparagus, and quantities of canned and frozen asparagus allocated between current movement and quantities carried as inventory to the next period.

The individual equations may be used to make one-period-ahead predictions of production and prices. More importantly, the model is solved as a complete dynamic system that takes account of the interaction among components and the feedback effects over time. This provides a means of observing the adjustment process that follows changes in exogenous variables (or variables treated as exogenous) such as costs, imports, exports, and population.

There are some caveats to be observed in using and interpreting the results of the study.

First, as was noted, some of the available data utilized in the study are of uncertain quality. This concern seems especially relevant for the period after 1981. Because of this, and because USDA asparagus production and acreage reports were discontinued during 1982 and 1983, the primary equations of the model were estimated with data only through 1981. Concerns about data for the 1984-86 period include (a) significant shifts in the apparent ratios of raw to final product for canning and freezing asparagus, (b) the consolidation of reports on frozen asparagus pack and (c) the difficulty in extending the f.o.b. canner price series on a consistent basis.

Second, with any econometric model, there is the possibility that equation coefficients may differ in future periods from those estimated historically. This concern is especially relevant if the data set excludes recent observations. One means of testing for possible structural change is to see how closely the equations estimated with historical data predict the more recent observed values of prices and quantities. Prediction tests utilizing the 1956-1981 estimated equations applied to 1984-86 data indicated that the *acreage* predictions were well within confidence intervals indicated by the standard errors of forecast. For the *demand system*, it seemed clear that the downward trends in per capita demand observed over the historical period had not continued into the 1980s. With the trend shifter held at the 1981 level, the 1984-86 predictions of the demand model appeared generally consistent with the observed data for these years, especially given some uncertainties as to some of the price series for the period. In the case of the *allocation equation* for fresh asparagus, there appeared to have been a shift toward the fresh market that was not explained fully by the historical demand shift variables. To account for this, the allocation model was re-estimated adding 1984-86 data and a zero-one shifter. This equation was used in the dynamic analysis.

Third, the model relates only to total U.S. quantities and prices, again largely because of inadequate regional data. However, the data in the Appendix Tables and in Tables III.2 to III.4 provide some basis for rough extension of the U.S. model predictions to regional implications.

Finally, the model is necessarily nonlinear with a complex multiplicative error structure. The effects on prediction accuracy are difficult to evaluate. Because of the nonlinear structure, the deterministic predictions may not coincide with the means of repeated stochastic simulations and the model predictions involve some bias as a result of the logarithmic transformations. However, it was noted that prediction tests indicate the model performs reasonably well within data set and the simulation experiments do not involve large extensions beyond the range of historical data. Further, we would expect at least a portion of any bias to wash out in the analysis of dynamic effects of changes in exogenous variables on changes in the endogenous variables of the system. Therefore, the study appears to provide estimates of dynamic multiplier effects that, while not precise measures, are reasonable approximations of likely ranges of values.

With these caveats, the following are some of the major findings of the study.

- The price flexibilities of demand (percentage change in price with respect to a percentage change in quantity) were estimated to be approximately –.31 for canned asparagus (f.o.b. processor) and –.36 for fresh asparagus measured at the farm level. The estimated price flexibility for frozen asparagus was low and statistically not significant (–.03). Changes in the f.o.b. freezer prices were predicted more closely by changes in the quantity of canned asparagus (Table VI.1). However, the latter result may be revealing of limitations in data variations and reporting for frozen asparagus rather than a fundamental relationship. The equation that predicts the price received by growers for processing asparagus has a flexibility of -.63—i.e., a 1 percent decrease in the per capita supply of processed asparagus has been associated with a .63 percent increase in price.

- Asparagus supply response is inelastic in the shortrun but is quite elastic (9.13) in the longrun.
- The proportion of total asparagus allocated to fresh utilization is predicted significantly by an equation that includes as explanatory variables a two-year average of lagged per capita fresh net exports, a two year average of lagged per capita movement of canned and frozen asparagus, the level of total carry-in stocks of processed asparagus and the ratio of the weighted average f.o.b. processor price for canned and frozen asparagus to the index of processing cost for the previous year. The intercept of this predicting equation increased significantly in the 1984-86 period (Table VI.8).
- The proportion of total asparagus allocated to canning is predicted significantly by an equation that includes as explanatory variables two-year averages of lagged per capita net fresh exports and lagged per capita net canned exports, per capita carry-in stocks of canned asparagus, per capita carry-in stocks of frozen asparagus, the ratio of the f.o.b. canner price to the index of processing cost in the previous year and the ratio of the f.o.b. freezer price to the index of processing cost in the previous year. In 1984-86, the share (proportion) of asparagus allocated to canning decreased by almost identically the amount of the fresh market increase. The share to freezing is determined residually as one minus the shares to fresh market and canning.
- The main results of the simulation analysis involving the complete dynamic model include
  1. A 10 percent reduction in farm production cost is associated eventually with about a 15-19 percent increase in acreage and production of asparagus.
  2. An increase of 10 million pounds of canned exports (equivalent to about 474,000 cases of 24 No. 300 cans) may be expected to lead to price increases for all product forms of roughly 3 to 4 percent in the shortrun (3 to 4 years). Prices then fall as output increases in response to the initially higher prices. Eventually, acreage and production are increased by about 3 percent, with prices holding 1.0 to 1.5 percent higher. Total output of canned asparagus increases by a little less than 7 million pounds and frozen asparagus by 1.25 million pounds. Allocation to fresh use decreases by 1.5 to 2.4 million pounds (1.6 to 2.3 percent). The values are approximately double for a 20 million pound increase in exports and are reversed in sign for a decrease in exports or increases in imports.
  3. A decrease of fresh imports of 5 million pounds during the competitive period (January-April) is predicted to increase the grower price in the fresh market a little over 1 cent per pound initially (about 1.5 percent). Other prices increase by similar percentage amounts. As acreage and production expand in response to the initial price increase, prices return to levels near their initial values, but with grower profitability slightly increased. Acreage and total production increase by 2.7 to 3.4 percent. Fresh market production increases by roughly 5 million pounds—the amount of the reduction in fresh imports. These values would be of similar magnitudes, but reversed signs, if imports were increased (rather than decreased) by 5 million pounds. The values are approximately doubled for a 10 million change in imports (or net exports).
  4. A 10 percent increase in (deflated) unit processing cost is associated with a long-run decrease in acreage and production in the range of 3.3 to 4.6 percent. The grower price for processing asparagus decreases by 6.0 to 6.7 percent and the prices of processed asparagus products increase in the range of 2.0 to 4.3 percent. The price for fresh market asparagus increases slightly. There is a small net decline in the grower profitability measure. Marketing margins are predicted to increase eventually in the range of 6 to 7 percent for canning and 8 to 9 percent for freezing.
  5. The projected growth of population up to year 2000 will, with all other factors constant, cause acreage and production to expand about 8.5 percent and prices to be about 1.0 to 1.5 percent higher than with a constant population.

APPENDIX A: REFERENCE TABLES

(Sources given in Appendix B.)

APPENDIX TABLE A1

HARVESTED ACREAGE OF ASPARAGUS BY MAJOR U.S. REGIONS

(thousand acres)

		Northwest			Other					
	CA	WA	OR	Total	MI	IL	NJ	All Other a/	Total	U.S.
Year	AC	AW	AOR	AN	AM	AI	AJ	AOO	AOT	AU
1950	71.7	10.3	0.4	10.7	6.5	8.4	24.5	9.8	49.2	131.6
1951	70.9	10.6	0.4	11.0	6.8	7.9	25.5	9.0	49.2	131.1
1952	69.4	10.4	0.4	10.8	7.7	8.1	27.0	8.8	51.6	131.8
1953	69.2	10.9	0.4	11.3	8.1	8.3	28.0	10.0	54.4	134.9
1954	72.4	11.1	0.4	11.5	8.7	8.4	31.9	10.8	59.8	143.7
1955	76.7	11.5	0.4	11.9	9.8	9.2	32.2	11.6	62.8	151.3
1956	76.2	12.5	0.4	12.9	10.3	8.9	32.5	12.0	63.7	152.7
1957	75.8	14.0	0.5	14.5	10.6	9.7	32.8	12.3	65.4	155.7
1958	76.3	15.8	0.6	16.4	10.9	9.5	32.2	12.8	65.4	158.1
1959	77.8	15.8	1.3	17.1	11.2	10.2	31.5	13.4	66.3	161.2
1960	73.5	16.1	1.6	17.7	11.0	10.7	30.7	13.4	65.8	157.0
1961	66.0	15.4	1.9	17.3	10.8	10.8	29.8	13.0	64.4	147.7
1962	66.6	15.3	1.4	16.7	10.8	10.2	28.6	13.1	62.7	146.0
1963	65.9	14.9	1.4	16.3	11.0	10.2	28.5	13.3	63.0	145.2
1964	65.4	14.7	1.6	16.3	11.0	10.1	28.4	13.5	63.0	144.7
1965	54.9	15.2	1.3	16.5	11.2	10.2	25.0	13.4	59.8	131.2
1966	51.9	16.5	1.3	17.8	11.4	10.0	24.0	13.0	58.4	128.1
1967	50.2	16.7	1.2	17.9	11.5	9.9	22.9	13.5	57.8	125.9
1968	46.7	17.1	1.3	18.4	11.7	8.8	22.1	13.7	56.3	121.4
1969	44.7	17.4	1.3	18.7	12.0	9.0	17.5	13.5	52.0	115.4
1970	42.9	17.7	1.2	18.9	12.4	9.6	16.3	12.2	50.5	112.6
1971	43.0	19.0	1.3	20.3	13.5	9.5	14.9	13.0	50.9	114.2
1972	45.7	21.7	1.1	22.8	14.5	9.4	13.8	12.9	50.6	119.1
1973	45.0	22.0	1.3	23.3	15.4	8.7	10.4	12.6	47.1	115.4
1974	44.1	23.4	1.1	24.5	17.0	7.2	6.8	12.9	43.9	112.5
1975	38.2	21.0	0.7	21.7	17.8	6.8	4.6	13.5	42.7	102.6
1976	33.9	20.4	0.6	21.0	18.0	5.2	3.3	11.2	37.7	92.6
1977	30.3	20.2	0.6	20.8	19.0	4.5	2.3	10.6	36.4	87.5
1978	28.0	21.0	0.4	21.4	19.5	4.2	1.9	8.8	34.4	83.8
1979	26.4	21.0	0.4	21.4	19.5	3.1	1.6	8.7	32.9	80.7
1980	27.9	22.2	0.4	22.6	19.5	2.9	1.5	8.6	32.5	83.0
1981	27.3	23.7	0.7	24.4	19.0	2.7	1.5	5.8	29.0	80.7
1982	29.6	28.4	0.8	29.2	20.0		1.5		21.5	
1983	31.8	29.3	1.1	30.4	21.0		1.4		22.4	
1984	34.2	29.0	b/	c/	20.0	1.4	2.0	4.1	27.5	89.9 d/
1985	35.3	29.0			21.0	1.3	1.9	4.9	29.1	91.5 d/
1986	37.8	30.0			21.0	1.3	1.9	4.7	28.9	96.2 d/
1987	39.7	31.0			22.0	0.7	1.8	4.6	29.1	99.8 d/
1988	40.1	32.0			22.5	0.8	1.7	3.8	28.8	100.9 d/

a/ For description of states included see Sources and Descriptions of Data, Appendix B.

b/ In other.

c/ Blanks indicate unavailable data.

d/ U.S. total may not be the exact sum of regional values due to minor reporting inconsistencies.

APPENDIX TABLE A2

LOCATION OF CALIFORNIA ASPARAGUS ACREAGE
(thousand acres)

	Sacramento San Joaquin Valley					
	Contra Costa, San Joaquin	Sacramento, Yolo, Solano	Total	Riverside, Imperial	Other a/	Total
Year	ACCS	ACOD	ACD	ACI	ACO	AC
1950	b/		68.68	0.10	2.92	71.70
1951			68.16	0.20	2.54	70.90
1952			67.46	0.20	2.24	69.40
1953			66.49	0.30	2.41	69.20
1954			69.71	0.30	2.39	72.40
1955			73.88	0.30	2.52	76.70
1956	66.92	6.59	73.51	0.41	2.28	76.20
1957	65.85	6.54	72.39	0.65	2.76	75.80
1958	65.44	6.49	71.93	0.91	3.46	76.30
1959	64.94	7.53	72.47	2.10	3.23	77.80
1960	60.58	6.89	67.47	2.37	3.66	73.50
1961	53.37	6.31	59.68	3.36	3.53	66.00
1962	53.97	6.10	60.07	3.16	3.37	66.60
1963	52.70	6.50	59.20	3.46	3.24	65.90
1964	51.10	6.33	57.43	3.85	4.12	65.40
1965	41.90	4.60	46.50	4.79	3.61	54.90
1966	37.75	4.96	42.71	4.60	4.59	51.90
1967	35.66	5.14	40.80	4.57	4.83	50.20
1968	32.80	4.94	37.74	5.01	3.95	46.70
1969	31.07	4.08	35.15	4.70	4.85	44.70
1970	28.30	3.35	31.65	5.59	5.66	42.90
1971	28.60	3.16	31.76	5.30	5.94	43.00
1972	29.91	3.15	33.06	5.98	6.66	45.70
1973	29.23	2.97	32.20	5.22	7.58	45.00
1974	27.66	2.73	30.39	5.62	8.09	44.10
1975	23.79	1.74	25.53	4.86	7.81	38.20
1976	20.91	1.38	22.29	4.58	7.03	33.90
1977	20.81	1.49	22.30	3.40	4.60	30.30
1978	19.28	1.40	20.68	2.96	4.36	28.00
1979	17.75	1.27	19.02	3.10	4.28	26.40
1980	18.77	1.34	20.11	4.11	3.68	27.90
1981	18.33	1.35	19.68	3.52	4.10	27.30
1982	20.29	1.54	21.83	3.64	4.13	29.60
1983	21.39	1.54	22.93	4.39	4.48	31.80
1984			23.24	5.35	4.60	34.19
1985			22.55	6.14	5.53	35.22
1986			21.61	8.95	7.11	37.67
1987			22.19	9.80	7.68	39.67
1988			22.49	9.27	8.38	40.14

a/ For description of counties included see Sources and Descriptions of Data, Appendix B.
b/ Blanks indicate unavailable data.

APPENDIX TABLE A3

ASPARAGUS YIELDS BY MAJOR U.S. REGIONS
(thousand pounds per acre)

		Northwest			Other					
	CA	WA	OR	Total	MI	IL	NJ	All Other b/	Total	United States
Year	YC	YW	YOR	YN	YM	YI	YNJ	YOO	YTOT	YU
1950	2.50	3.00	2.00	2.96	2.20	2.20	2.80	2.02	2.46	2.52
1951	2.20	2.80	2.75	2.80	2.29	2.10	2.90	2.18	2.56	2.38
1952	2.20	3.30	2.75	3.28	2.10	1.80	2.50	2.13	2.27	2.32
1953	2.20	3.10	3.00	3.10	1.51	1.80	2.50	1.94	2.14	2.25
1954	2.10	3.20	2.75	3.18	1.49	1.70	2.20	1.90	1.97	2.13
1955	2.50	3.10	2.75	3.08	1.50	1.70	2.40	2.01	2.08	2.38
1956	2.40	3.20	3.00	3.19	1.50	1.80	2.20	1.87	1.97	2.29
1957	2.50	2.90	2.20	2.88	1.60	1.70	2.20	2.06	2.00	2.33
1958	2.40	2.50	2.17	2.49	1.40	1.71	2.30	1.88	1.98	2.24
1959	2.40	2.30	1.62	2.25	1.50	1.60	2.50	1.92	2.08	2.25
1960	2.60	2.60	1.88	2.54	1.70	1.60	2.60	1.84	2.13	2.40
1961	3.00	2.80	2.11	2.72	1.50	1.50	2.30	1.78	1.93	2.50
1962	3.00	3.10	2.71	3.07	1.50	1.60	2.30	1.74	1.93	2.55
1963	3.10	2.80	2.50	2.77	1.30	1.70	2.50	1.75	2.00	2.59
1964	2.80	3.00	2.38	2.94	1.50	1.70	2.30	1.65	1.93	2.43
1965	2.81	3.20	3.08	3.19	1.70	1.80	2.40	1.81	2.04	2.50
1966	3.10	3.00	2.38	2.96	1.50	1.60	2.50	1.95	2.03	2.59
1967	2.79	2.70	2.67	2.70	1.70	1.70	2.40	1.81	2.01	2.42
1968	3.20	3.10	2.38	3.05	1.50	1.80	2.50	1.90	2.04	2.64
1969	2.90	2.90	2.31	2.86	1.70	1.60	2.30	1.73	1.89	2.44
1970	3.10	2.90	2.08	2.85	1.60	1.70	2.00	1.64	1.76	2.45
1971	3.20	3.30	2.46	3.25	1.40	1.31	1.60	1.58	1.49	2.44
1972	3.40	2.70	2.45	2.69	1.50	1.50	1.30	1.44	1.43	2.43
1973	2.80	2.80	2.08	2.76	1.60	1.20	1.20	1.33	1.36	2.21
1974	2.90	2.90	2.00	2.86	1.50	1.19	1.29	1.66	1.46	2.31
1975	2.80	2.70	2.43	2.69	1.10	1.40	1.39	1.45	1.29	2.09
1976	3.70	3.20	2.67	3.19	1.00	0.90	1.30	1.36	1.12	2.49
1977	3.70	3.30	2.67	3.28	1.10	1.11	1.39	1.29	1.18	2.51
1978	2.80	3.20	2.75	3.19	1.30	0.90	1.42	1.16	1.22	2.22
1979	3.50	2.80	3.00	2.80	1.30	1.10	1.69	1.13	1.26	2.37
1980	2.80	2.30	2.75	2.31	1.20	1.31	1.53	1.57	1.32	2.01
1981	3.00	2.50	2.86	2.51	0.90	1.00	1.93	1.71	1.12	2.11
1982	2.70	2.40	3.00	2.42	0.93		2.13			
1983	2.00	2.33	2.82	2.35	0.88		1.71			
1984	2.50	2.50	a/		1.20	1.00	1.50	1.00	1.14	2.10
1985	2.80	2.80			1.20	1.00	1.90	1.20	1.16	2.30
1986	2.90	2.60			1.20	.80	1.90	1.30	1.22	2.30
1987	3.00	2.60			1.10	1.40	1.80	1.40	1.20	2.40
1988	2.90	2.80			1.10	1.20	1.90	2.10	1.26	2.40

a/ Blanks indicate unavailable data.
b/ For description of states included see Sources and Descriptions of Data, Appendix B.

APPENDIX TABLE A4

PART A
PRODUCTION AND UTILIZATION OF ASPARAGUS BY REGION
(million pounds - raw product weight)

	California						
	Processed						
	Canned						
	White	Green	Total	Frozen	Total	Fresh	Total
Year	QWGCC	QGGCC	QSGCC	QGFC	QGPC	QGRC	QGC
1950	63.1	43.4	106.5	9.5	116.0	63.2	179.2
1951	48.2	53.2	101.4	9.3	110.7	45.3	156.0
1952	52.5	34.8	87.3	10.4	97.7	55.0	152.7
1953	40.6	34.6	75.0	16.7	91.7	60.5	152.2
1954	41.6	50.0	91.6	11.9	103.5	48.5	152.0
1955	68.5	64.2	132.7	16.3	149.0	42.8	191.8
1956	52.8	39.1	91.9	29.3	121.2	61.7	182.9
1957	45.0	47.2	92.2	21.0	113.2	76.3	189.5
1958	64.1	40.7	104.8	14.0	118.8	64.3	183.1
1959	47.3	48.6	95.9	24.1	120.0	66.7	186.7
1960	46.7	54.8	101.5	26.5	128.0	63.1	191.1
1961	65.3	44.5	109.8	27.8	137.6	60.4	198.0
1962	69.4	45.0	114.4	27.6	142.0	57.8	199.8
1963	70.3	45.8	116.1	26.8	142.9	61.4	204.3
1964	63.2	34.1	97.3	27.3	124.6	58.5	183.1
1965	30.4	35.2	65.6	24.7	90.3	63.7	154.0
1966	44.4	34.3	78.7	36.0	114.7	46.1	160.8
1967	11.9	39.9	51.8	35.8	87.6	52.6	140.2
1968	18.8	36.1	54.9	34.6	89.5	59.8	149.3
1969	12.9	37.9	50.8	25.1	75.9	53.6	129.5
1970	8.7	31.7	40.4	24.6	65.0	67.9	132.9
1971	b/	43.9	43.9	34.3	78.2	59.5	137.7
1972		37.2	37.2	47.8	85.0	70.4	155.4
1973		37.8	37.8	22.2	60.0	66.0	126.0
1974		52.4	52.4	14.7	67.1	60.8	127.9
1975		15.7	15.7	25.6	41.3	65.7	107.0
1976		17.7	17.7	35.2	52.9	72.5	125.4
1977		20.4	20.4	35.6	56.0	56.1	112.1
1978		11.5	11.5	14.0	25.5	52.9	78.4
1979		11.9	11.9	32.5	44.4	48.0	92.4
1980		7.3	7.3	7.7	15.0	63.1	78.1
1981		6.9	6.9	10.6	17.5	64.4	81.9
1982		6.7	6.7	14.1	20.8	59.1	79.9
1983		3.5	3.5	4.4	7.9	55.7	63.6
1984		a/			11.6	73.9	85.5
1985					16.8	81.8	98.6
1986					10.6	99.0	109.6
1987					13.6	105.5	119.1
1988					c/	c/	116.3

a/ Blanks indicate unavailable data.
b/ Small quantities no longer reported.
c/ Not reported separately.

APPENDIX TABLE A4

PART B
PRODUCTION AND UTILIZATION OF ASPARAGUS BY REGION
(million pounds - raw product weight)

...continued...

	Northwest								
	Washington			Oregon			Total		
	Processed	Fresh	Total	Processed	Fresh	Total	Processed	Fresh	Total
Year	QGPW	QGRW	QGW	QGPOR	QGROR	QGOR	QGPN	QGRN	QGN
1950	21.3	9.6	30.9	0.4	0.4	0.8	21.7	10.0	31.7
1951	20.5	9.2	29.7	0.5	0.6	1.1	21.0	9.8	30.8
1952	22.9	11.4	34.3	0.7	0.4	1.1	23.6	11.8	35.4
1953	23.2	10.6	33.8	0.8	0.4	1.2	24.0	11.0	35.0
1954	23.2	12.3	35.5	0.7	0.4	1.1	23.9	12.7	36.6
1955	25.5	10.1	35.6	0.8	0.3	1.1	26.3	10.4	36.7
1956	29.9	10.1	40.0	0.9	0.3	1.2	30.8	10.4	41.2
1957	30.0	10.6	40.6	0.8	0.3	1.1	30.8	10.9	41.7
1958	22.6	16.9	39.5	0.9	0.4	1.3	23.5	17.3	40.8
1959	26.0	10.3	36.3	1.3	0.8	2.1	27.3	11.1	38.4
1960	32.0	9.9	41.9	2.0	1.0	3.0	34.0	10.9	44.9
1961	32.5	10.6	43.1	2.8	1.2	4.0	35.3	11.8	47.1
1962	36.8	10.6	47.4	2.8	1.0	3.8	39.6	11.6	51.2
1963	35.1	6.6	41.7	2.8	0.7	3.5	37.9	7.3	45.2
1964	36.3	7.8	44.1	3.1	0.7	3.8	39.4	8.5	47.9
1965	39.0	9.6	48.6	3.5	0.5	4.0	42.5	10.1	52.6
1966	38.0	11.5	49.5	3.1	0.0	3.1	41.1	11.5	52.6
1967	38.6	6.5	45.1	3.2	0.0	3.2	41.8	6.5	48.3
1968	44.4	8.6	53.0	3.1	0.0	3.1	47.5	8.6	56.1
1969	43.5	7.0	50.5	3.0	0.0	3.0	46.5	7.0	53.5
1970	43.2	8.1	51.3	2.5	0.0	2.5	45.7	8.1	53.8
1971	54.1	8.6	62.7	3.2	0.0	3.2	57.3	8.6	65.9
1972	51.5	7.1	58.6	2.7	0.0	2.7	54.2	7.1	61.3
1973	53.9	7.7	61.6	2.7	0.0	2.7	56.6	7.7	64.3
1974	57.1	10.8	67.9	1.9	0.3	2.2	59.0	11.1	70.1
1975	45.6	11.1	56.7	b/	b/	1.7	45.6 c/	11.1 c/	58.4
1976	53.6	11.7	65.3			1.6	53.6	11.7	66.9
1977	57.8	8.9	66.7			1.6	57.8	8.9	68.3
1978	58.8	8.4	67.2			1.1	58.8	8.4	68.3
1979	52.6	6.2	58.8			1.2	52.6	6.2	60.0
1980	47.0	4.1	51.1			1.1	47.0	4.1	52.2
1981	52.4	6.9	59.3			2.0	52.4	6.9	61.3
1982	59.8	8.4	68.2			2.4	59.8	8.4	70.6
1983	48.3	20.1	68.4			3.1	48.3	20.1	71.5
1984	50.8	21.7	72.5			a/	50.8	21.7	72.5
1985	57.0	24.2	81.2				57.0	24.2	81.2
1986	49.0	29.0	78.0				49.0	29.0	78.0
1987	56.9	23.7	80.6				56.9	23.7	80.6
1988	64.4	25.2	89.6				64.4	25.2	89.6

a/ Blanks indicate unavailable data.
b/ Oregon processed and fresh production included in "All Other" beginning in 1975.
c/ Washington only beginning in 1975.

APPENDIX TABLE A4

PART C
PRODUCTION AND UTILIZATION OF ASPARAGUS BY REGION
(million pounds raw - product weight)

...continued...

	Michigan			Illinois		
	Processed	Fresh	Total	Processed	Fresh	Total
Year	QGPM	QGRM	QGMT	QGPI	QGRI	QGIT
1950	12.5	1.8	14.3	14.5	4.0	18.5
1951	13.2	2.4	15.6	13.4	3.2	16.6
1952	14.0	2.2	16.2	11.9	2.7	14.6
1953	9.5	2.7	12.2	13.0	1.9	14.9
1954	11.8	1.2	13.0	12.4	1.9	14.3
1955	12.6	2.1	14.7	13.2	2.3	15.6
1956	13.3	2.1	15.4	13.2	2.8	16.0
1957	14.6	2.4	17.0	13.0	3.5	16.5
1958	13.2	2.1	15.3	12.6	3.6	16.2
1959	14.8	2.0	16.8	13.1	3.2	16.3
1960	17.0	1.7	18.7	13.2	3.9	17.1
1961	15.1	1.1	16.2	13.0	3.2	16.2
1962	14.8	1.4	16.2	13.4	2.9	16.3
1963	13.1	1.2	14.3	15.3	2.0	17.3
1964	15.1	1.4	16.5	15.3	1.9	17.2
1965	17.6	1.4	19.0	17.1	1.3	18.4
1966	15.7	1.4	17.1	14.8	1.2	16.0
1967	18.0	1.6	19.6	15.8	1.0	16.8
1968	16.1	1.5	17.6	15.0	0.8	15.8
1969	19.0	1.4	20.4	13.3	1.1	14.4
1970	18.2	1.6	19.8	15.3	1.0	16.3
1971	17.8	1.1	18.9	11.5	0.9	12.4
1972	20.3	1.5	21.8	13.1	1.0	14.1
1973	22.9	1.7	24.6	9.3	1.1	10.4
1974	24.1	1.4	25.5	7.7	0.9	8.6
1975	17.5	2.1	19.6	8.6	0.9	9.5
1976	16.0	2.0	18.0	4.0	0.7	4.7
1977	17.7	3.2	20.9	4.1	0.9	5.0
1978	21.0	4.4	25.4	3.2	0.6	3.8
1979	20.2	5.2	25.4	2.7	0.7	3.4
1980	16.4	7.0	23.4	b/	b/	3.8
1981	11.8	5.3	17.1			2.7
1982	16.0	2.5	18.5			b/
1983	16.0	2.5	18.5			
1984	19.2	3.8	23.0			
1985	19.4	3.6	23.0			
1986	19.8	4.8	24.6			
1987	20.2	4.0	24.2			
1988	20.6	4.2	24.8			

a/ Blanks indicate unavailable data.
b/ Illinois processed and fresh production included in "All Other" beginning in 1980. Illinois Total Production included in "All Other" beginning in 1982.

APPENDIX TABLE A4

PART D
PRODUCTION AND UTILIZATION OF ASPARAGUS BY REGION
(million pounds - raw product weight)

...continued...

	New Jersey			All Other c/			United States, less California, Northwest		
	Processed	Fresh	Total	Processed	Fresh	Total	Processed	Fresh	Total
Year	QGPNJ	QGRNJ	QGNJT	QGPAO	QGRAO	QGAOT	QGPTO	QGRTO	QGTOT
1950	40.3	28.3	68.6	7.4	12.4	19.8	74.7	46.5	121.2
1951	44.7	29.3	74.0	7.8	11.8	19.6	79.1	46.7	125.8
1952	38.9	28.6	67.5	7.9	10.8	18.7	72.7	44.3	117.0
1953	40.9	29.1	70.0	8.1	11.3	19.4	71.5	45.0	116.5
1954	42.2	28.0	70.2	10.4	10.1	20.5	76.8	41.2	118.0
1955	43.8	33.5	77.3	13.7	9.6	23.3	83.3	47.5	130.8
1956	41.6	29.9	71.5	14.2	8.2	22.4	82.3	43.0	125.3
1957	40.1	32.1	72.2	17.2	8.1	25.3	84.9	46.1	131.0
1958	38.6	35.5	74.1	16.1	7.9	24.0	80.5	49.1	129.6
1959	45.2	33.6	78.8	18.0	7.7	25.7	91.1	46.5	137.6
1960	44.0	35.8	79.8	17.0	7.6	24.6	91.2	49.0	140.2
1961	41.6	26.9	68.5	16.8	6.4	23.2	86.5	37.6	124.1
1962	40.7	25.1	65.8	17.3	5.5	22.8	86.2	34.9	121.1
1963	44.8	26.4	71.2	17.9	5.4	23.3	91.1	35.0	126.1
1964	41.0	24.3	65.3	16.9	5.4	22.3	88.3	33.0	121.3
1965	37.9	22.1	60.0	18.9	5.4	24.3	91.5	30.2	121.7
1966	40.1	19.9	60.0	20.7	4.6	25.3	91.3	27.1	118.4
1967	35.9	19.1	55.0	20.3	4.2	24.5	90.0	25.9	115.9
1968	40.5	14.8	55.3	22.3	3.7	26.0	93.9	20.8	114.7
1969	30.1	10.2	40.3	18.8	4.5	23.3	81.2	17.2	98.4
1970	20.0	12.6	32.6	16.8	3.2	20.0	70.3	18.4	88.7
1971	13.6	10.2	23.8	17.5	3.0	20.5	60.4	15.2	75.6
1972	8.7	9.2	17.9	15.6	3.0	18.6	57.7	14.7	72.4
1973	5.2	7.3	12.5	14.5	2.2	16.7	51.9	12.3	64.2
1974	2.4	6.4	8.8	19.6	1.8	21.4	53.8	10.5	64.3
1975	b/	6.4		13.7	7.6	21.3	39.8	10.6	48.7
1976		4.3		11.8	5.0	16.8	31.8	7.7	37.9
1977		3.2		11.1	4.2	15.3	32.9	8.3	39.6
1978		2.7		7.5	3.8	11.3	31.7	8.8	39.4
1979		2.7		7.1	3.9	11.0	30.0	9.8	38.6
1980		2.3		10.4	4.2	14.6	26.8	11.2	36.8
1981		2.9		7.6	4.3	11.9	19.4	9.6	27.0
1982		3.2							
1983		2.4							
1984		3.0		3.8	1.9	5.7	23.0	8.7	31.3
1985		3.6		5.2	2.0	7.2	24.6	9.2	33.8
1986		3.6		4.8	2.3	7.1	24.6	10.7	35.3
1987		3.7		5.1	2.4	7.5	25.3	9.6	34.9
1988		3.4		5.8	2.3	8.1	26.4	9.9	36.3

a/ Blanks indicate unavailable data.
b/ New Jersey processed production included in "All Other" beginning in 1975.
c/ For description of states included see Sources and Descriptions of Data, Appendix B.

APPENDIX TABLE A4

PART E
PRODUCTION AND UTILIZATION OF ASPARAGUS BY REGION
(million pounds - raw product weight)

...continued...

	United States Less California					United States				
	Processed					Processed				
	Canned	Frozen	Total	Fresh	Total	Canned	Frozen	Total	Fresh	Total
Year	QGCO	QGFO	QGPO	QGRO	QGO	QGCU	QGFU	QGPU	QGRU	QGU
1950	61.1	35.3	96.4	56.5	152.9	167.6	44.8	212.4	119.7	332.1
1951	64.2	35.9	100.1	56.5	156.6	165.6	45.2	210.8	101.8	312.6
1952	58.7	37.7	96.4	56.1	152.5	146.0	48.1	194.1	111.1	305.2
1953	51.7	43.8	95.5	56.0	151.5	126.7	60.5	187.2	116.5	303.7
1954	64.4	36.4	100.8	53.9	154.7	156.0	48.3	204.3	102.4	306.7
1955	70.4	39.3	109.6	57.9	167.7	203.1	55.6	258.6	100.7	359.4
1956	69.0	44.1	113.1	53.4	166.5	160.9	73.4	234.3	115.1	349.4
1957	75.5	40.3	115.7	57.0	172.7	167.7	61.3	228.9	133.3	362.2
1958	71.5	32.5	104.0	66.4	170.4	176.3	46.5	222.8	130.7	353.5
1959	76.6	43.8	118.4	57.6	176.0	172.5	65.9	238.4	124.3	362.7
1960	78.2	47.0	125.2	59.9	185.1	179.7	73.5	253.2	123.0	376.2
1961	78.2	37.8	121.8	49.4	171.2	193.8	65.6	259.4	109.8	369.2
1962	91.9	33.9	125.8	46.5	172.3	206.3	61.5	267.8	104.3	372.1
1963	94.1	34.8	129.0	42.3	171.3	210.3	61.6	271.9	103.7	375.6
1964	97.4	30.3	127.7	41.5	169.2	194.7	57.6	252.3	100.0	352.3
1965	101.9	31.8	133.7	40.3	174.0	167.5	56.5	224.0	104.0	328.0
1966	104.2	28.3	132.5	38.6	171.1	182.9	64.3	247.2	84.7	331.9
1967	100.5	31.7	132.2	32.4	164.6	152.3	67.5	219.8	85.0	304.8
1968	107.6	33.9	141.5	29.4	170.9	162.5	68.5	231.0	89.2	320.2
1969	106.4	21.4	127.8	24.2	152.0	157.2	46.5	203.7	77.8	281.5
1970	89.4	26.7	116.1	26.5	142.6	129.8	51.3	181.1	94.4	275.5
1971	90.5	27.1	117.6	23.8	141.4	134.4	61.4	195.8	83.3	279.1
1972	86.2	25.7	111.9	21.8	133.7	123.4	73.5	196.9	92.2	289.1
1973	85.8	22.7	108.5	20.0	128.5	123.6	44.9	168.5	86.0	254.5
1974	97.0	13.9	110.9	21.6	132.5	149.4	28.6	178.0	82.4	260.4
1975	70.7	14.7	85.4	21.7	107.1	86.4	40.3	126.7	87.4	214.1
1976	64.8	20.6	85.4	19.4	104.8	82.5	55.8	138.3	91.9	230.2
1977	76.5	14.2	90.7	17.2	107.9	96.9	49.8	146.7	73.3	220.0
1978	75.0	15.5	90.5	17.2	107.7	86.5	29.5	116.0	70.1	186.1
1979	67.0	15.6	82.6	16.0	98.6	78.9	48.1	127.0	64.0	191.0
1980	61.8	12.0	73.8	15.3	89.1	69.1	19.7	88.8	78.4	167.2
1981	63.0	8.8	71.8	16.5	88.3	69.9	19.4	89.3	80.9	170.2
1982	a/									
1983										
1984			73.8	30.4	104.2	67.0	18.4	85.4	104.3	189.7
1985			81.6	33.4	115.0	67.7	30.8	98.4	115.2	213.6
1986			73.6	39.7	113.3	58.7	25.5	84.2	138.7	222.9
1987			82.2	33.3	115.5	66.3	29.5	95.8	138.8	234.6
1988			90.8	35.1	125.9	65.9	28.2	94.1	148.1	242.2

a/ Blanks indicate unavailable data.

APPENDIX TABLE A5

U. S. PACK OF CANNED ASPARAGUS BY REGIONS
(million pounds canned weight)

	California							
	White	Green	Total	Northwest	Midwest	East & Other f/	Midwest & East & Other	United States
Crop Year	QWCC	QGCC	QCC	QCN	QCM	QCE	QCME	QCU
1950	44.29	31.61	75.90	7.62	23.55	22.34	45.89	129.42
1951	32.46	42.24	74.70	9.03	25.91	27.24	53.15	136.89
1952	37.50	28.93	66.43	9.68	24.66	23.53	48.19	124.30
1953	35.62	24.78	60.40	9.74	26.28	18.29	44.57	114.71
1954	35.60	41.72	77.32	12.63	25.81	26.36	52.17	142.11
1955	57.09	48.62	105.71	13.04	30.18	29.44	59.62	178.38
1956	51.22	31.02	82.24	12.49	32.34	27.72	60.06	154.79
1957	51.48	38.72	90.20	12.13	33.43	30.22	63.65	165.98
1958	70.25	34.05	104.30	14.07	29.50	28.56	58.06	176.44
1959	48.49	42.38	90.87	14.90	30.67	29.36	60.03	165.81
1960	53.16	46.23	99.39	15.43	35.90	35.79	71.69	186.52
1961	68.75	38.75	107.50	17.51	33.76	36.78	70.54	195.55
1962	76.85	39.17	116.02	21.96	35.87	38.00	73.87	211.84
1963	81.22	42.89	124.11	19.63	32.78	40.23	73.01	216.75
1964	67.62	28.14	95.77	21.78	38.73	35.97	74.70	192.28
1965	31.64	30.13	61.77	24.04 c/	45.00	37.88	82.88	168.67
1966	45.09	34.85	79.94	23.06	39.37	42.40	81.77	184.77
1967	13.17	39.42	52.59	22.95	43.84	38.95	82.79	155.33
1968	19.50	35.96	55.46	23.74	42.75	40.09	82.84	162.04
1969	14.85	37.48	52.33	23.84	44.23	39.10	83.33	159.52
1970	6.32	31.29	37.61	23.01	44.50	33.26	77.76	138.36
1971	a/	37.71	37.71	28.27	38.16	25.51	63.67	129.68
1972		31.45	31.45	34.91	49.52	21.23	70.75	137.12
1973		29.55	29.55	38.65	48.46	18.94	67.40	135.58
1974		36.08	36.08	34.05	45.64	16.29	61.93	132.05
1975		12.11	12.11	30.42	30.88	9.68	40.56	83.09
1976		16.39	16.39	32.52	25.20	10.32	35.52	84.45
1977		15.68	15.68	34.57	29.64	6.81	36.45	86.70
1978		6.92	6.92	33.41	32.37	6.44	38.81	79.14
1979		b/	b/	29.52	24.08	12.36	36.44	65.96
1980				27.81	14.16 e/	17.35	31.51	59.32
1981				36.18	14.53	15.84	30.37	66.55
1982				35.42	16.73	11.66	28.39	63.81
1983				d/				59.65
1984				37.94 g/			30.57	68.52
1985				45.22			28.07	72.47
1986				44.15			29.65	73.80
1987								78.65

a/ Small quantities no longer reported beginning in 1971.
b/ California quantities included in "East & Other" beginning in 1979.
c/ Washington only beginning in 1965, Oregon included in "East & Other" beginning in 1965.
d/ Blanks indicate unavailable data.
e/ Michigan only beginning in 1980. Illinois included in "East & Other" beginning in 1980.
f/ For description of states included see Sources and Descriptions of Data, Appendix B.
g/ Includes California, 1984 on.

APPENDIX TABLE A6

U. S. PACK OF FROZEN ASPARAGUS BY REGIONS
(million pounds)

Crop Year	California QFC	Northwest b/ QFN	Total West QFCN	East, South Midwest QFME	United States Less California QFO	United States QFU
1950	5.62	7.28	12.90	9.41	16.69	22.31
1951	5.03	6.99	12.02	11.54	18.53	23.56
1952	6.05	7.46	13.51	11.95	19.41	25.46
1953	8.99	8.15	17.14	15.81	23.96	32.95
1954	6.47	6.91	13.38	12.40	19.31	25.78
1955	7.79	6.67	14.46	14.20	20.88	28.67
1956	14.40	7.77	22.17	15.50	23.27	37.67
1957	10.02	9.16	19.18	12.01	21.18	31.20
1958	6.97	6.36	13.33	11.04	17.40	24.37
1959	10.94	8.22	19.16	13.58	21.80	32.74
1960	12.66	12.00	24.66	15.37	27.37	40.03
1961	13.74	9.77	23.51	10.65	20.42	34.16
1962	12.69	9.25	21.94	8.87	18.12	30.81
1963	12.56	8.70	21.26	9.06	17.76	30.32
1964	15.26	7.68	22.94	8.11	15.79	31.05
1965	12.73	9.26	21.99	8.88	18.16	30.89
1966	16.76	8.79	25.55	8.98	17.79	34.55
1967	16.22	9.99	26.21	6.25	16.24	32.46
1968	16.93	8.83	25.76	8.59	17.43	34.36
1969	11.85	8.30	20.15	2.89	11.18	23.03
1970	12.88	8.81	21.69	4.23	13.05	25.93
1971	15.83	9.98	25.81	4.15	14.13	29.96
1972	21.25	9.21	30.46	3.12	12.32	33.57
1973	11.20	6.98	18.18	1.98	8.96	20.16
1974	8.76	5.93	14.69	1.50	7.43	16.19
1975	11.43	5.09	16.52	1.89	6.98	18.41
1976	15.22	6.20	21.42	2.33	8.53	23.75
1977	14.59	5.70	20.29	2.18	7.88	22.47
1978	7.26	5.20	12.46	2.97	8.17	15.43
1979	16.77	4.29	21.06	2.93	7.22	23.99
1980	a/	3.52				11.23
1981		3.86				11.29
1982	8.11				8.85	16.96
1983	4.65				8.95	13.60
1984						15.10
1985	8.84				11.15	19.99
1986	11.15				6.86	18.01
1987	11.68				5.05	16.73
1988	12.95				5.11	18.10

a/ Blanks indicate data unavailable for proprietary reasons.
b/ Primarily Washington but includes small quantities of other western states.

APPENDIX TABLE A7

CANNED ASPARAGUS: U.S. PACK, BEGINNING STOCKS, SUPPLY AND SALES
(million pounds)

	U.S Pack	U.S. Stocks (March 1)	U.S. Total Supply	Government Purchases	Exports a/	Imports a/	Net Exports a/	Apparent Consumption		Apparent Total U.S. Packer Sales
								Civilian	Total	
Crop Year	QCU	SC	QSC	GCP	EC	IC	NC c/	DCCD d/	DCD e/	DC
1950	129.42	9.10	138.52	4.80	8.50	b/	8.50	110.72	115.52	124.02
1951	136.89	14.50	151.39	15.60	9.80		9.80	101.69	117.29	127.09
1952	124.30	24.30	148.60	4.20	9.50		9.50	109.70	113.90	123.40
1953	114.71	25.20	139.91	5.00	14.40		14.40	110.71	115.71	130.11
1954	142.11	9.80	151.91	3.80	15.30		15.30	115.61	119.41	134.71
1955	178.38	17.20	195.58	2.40	27.20		27.20	118.78	121.18	148.38
1956	154.79	47.20	201.99	0.50	29.70		29.70	124.09	124.59	154.29
1957	165.98	47.70	213.68	0.60	35.90		35.90	135.98	136.58	172.48
1958	176.44	41.20	217.64	3.60	46.50		46.50	129.64	133.24	179.74
1959	165.81	37.90	203.71	4.90	35.10		35.10	133.51	138.41	173.51
1960	186.52	30.20	216.72	7.20	42.10		42.10	131.52	138.72	180.82
1961	195.55	35.90	231.45	7.80	49.80		49.80	136.55	144.35	194.15
1962	211.84	37.30	249.14	3.30	61.00		61.00	146.14	149.44	210.44
1963	216.75	38.70	255.45	2.70	62.00		62.00	132.05	134.75	196.75
1964	192.28	58.70	250.98	3.00	61.90		61.90	143.78	146.78	208.68
1965	168.67	42.30	210.97	3.60	31.20		31.20	147.37	150.97	182.17
1966	184.77	28.80	213.57	13.30	30.00	1.20	28.80	134.17	147.47	176.27
1967	155.33	37.30	192.63	9.10	15.20	2.00	13.20	136.53	145.63	158.83
1968	162.04	33.80	195.84	5.50	12.80	0.80	12.00	137.04	142.54	154.54
1969	159.52	41.30	200.82	4.40	11.00	1.80	9.20	148.00	152.40	161.60
1970	138.36	39.22	177.58	2.58	10.00	1.80	8.20	144.69	147.27	155.47
1971	129.68	22.11	151.79	1.93	5.61	4.83	0.78	128.68	130.61	131.39
1972	137.12	20.40	157.52	2.40	4.02	9.10	5.08	126.08	128.48	123.40
1973	135.58	34.12	169.70	0.37	3.77	13.46	9.69	150.96	151.33	141.64
1974	132.05	28.06	160.11	1.44	5.39	7.38	1.99	104.48	105.92	103.93
1975	83.09	56.18	139.27	1.15	2.48	8.39	5.91	117.19	118.34	112.43
1976	84.45	26.84	111.29	0.19	2.65	6.26	3.61	107.50	107.69	104.08
1977	86.70	7.21	93.91	0.00	2.66	11.16	8.50	88.02	88.02	79.52
1978	79.14	14.39	93.53	1.53	3.29	5.01	1.72	72.22	73.75	72.03
1979	65.96	21.50	87.46	0.45	4.06	5.18	1.12	64.15	64.60	63.48
1980	59.32	23.98	83.30	0.63	4.91	8.05	3.14	68.77	69.40	66.26
1981	66.55	17.04	83.59	0.00	4.64	4.23	0.41	68.02	68.02	68.43
1982	63.81	15.16	78.97	0.88	2.53	4.31	1.78	59.56	60.44	58.66
1983	59.65	20.31	79.96	0.54	2.35	2.95	.60	59.58	60.12	61.54
1984	68.52	18.42	86.94	1.01	2.13	6.58	4.45	72.99	74.00	69.22
1985	72.47	17.72	90.19	.50	1.57	5.25	3.68	72.84	73.34	69.61
1986	73.80	20.58	94.38	.43	1.40	5.08	3.68	81.33	81.76	78.02
1987	78.65	16.36	95.00	.26	1.70	5.92	4.22	72.64	66.98	72.90
1988		22.51								

a/ 1950-1974 fiscal year (July-June). Calendar year corresponding to crop year thereafter.
b/ No imports reported from 1950-1965.
c/ NC = EC - IC.
d/ DCCD = DCD - QCP.
e/ DCD = DC - NC.

APPENDIX TABLE A8

FROZEN ASPARAGUS: U.S. PACK BEGINNING STOCKS, SUPPLY AND SALES
(million pounds)

	U.S. Pack	U.S. Stocks (April 1)	U.S.Total Supply	Govern-ment Purchases a/	Imports b/	Apparent Consumption		Apparent Total U.S. Packer Sales
						Civilian	Total	
Crop Year	QFU	SF	QSF	GFP	IF	DFCD e/	DFD f/	DF
1950	22.31	3.40	25.71	c/	d/		20.41	20.41
1951	23.56	5.30	28.86				22.16	22.16
1952	25.46	6.70	32.16				26.26	26.26
1953	32.95	5.90	38.85				29.85	29.85
1954	25.78	9.00	34.78				27.08	27.08
1955	28.67	7.70	36.37	2.10		26.77	28.87	28.87
1956	37.67	7.50	45.17	2.60		28.67	31.27	31.27
1957	31.20	13.90	45.10	1.80		29.00	30.80	30.80
1958	24.37	14.30	38.67	2.20		25.97	28.17	28.17
1959	32.74	10.50	43.24	2.10		31.94	34.04	34.04
1960	40.03	9.20	49.23	1.10		36.83	37.93	37.93
1961	34.16	11.30	45.46	2.30		30.96	33.26	33.26
1962	30.81	12.20	43.01	1.90		30.11	32.01	32.01
1963	30.32	11.00	41.32	1.70		31.32	33.02	33.02
1964	31.05	8.30	39.35	1.60		30.65	31.65	31.65
1965	30.89	7.70	38.59	1.60		29.39	30.99	30.99
1966	34.55	7.60	42.15	0.80		30.45	31.25	31.25
1967	32.46	10.80	43.26	0.30		30.96	31.26	31.26
1968	34.36	12.00	46.36	1.70		32.76	34.46	34.46
1969	23.03	11.90	34.93	0.90	0.10	26.63	27.53	27.43
1970	25.93	7.48	33.41	1.50	0.50	28.81	30.31	29.81
1971	29.96	3.60	33.56	2.50	1.60	20.61	23.11	21.51
1972	33.57	12.05	45.62	1.89	3.10	32.30	34.19	31.09
1973	20.16	14.53	34.69	1.54	1.30	22.17	23.71	22.41
1974	16.19	12.28	28.47	0.76	1.40	23.12	23.88	22.48
1975	18.41	5.99	24.40	1.44	1.60	20.63	22.07	20.47
1976	23.75	3.93	27.68	1.09	1.21	24.32	25.41	24.20
1977	22.47	3.48	25.95	1.12	2.73	23.86	24.98	22.25
1978	15.43	3.70	19.13	1.30	0.52	16.49	17.79	17.27
1979	23.99	1.86	25.85	1.11	0.86	17.39	18.50	17.64
1980	11.23	8.21	19.44	0.86	1.30	14.88	15.74	14.44
1981	11.29	5.00	16.29	1.33	0.42	11.99	13.32	12.90
1982	16.96	3.39	20.35	1.03	0.40	13.72	14.75	14.35
1983	13.60	6.00	19.60	0.42	1.21	16.53	16.95	15.74
1984	15.10	3.86	18.47		.53		16.21	15.68
1985	19.99	2.79	22.78		.57		18.23	17.31
1986	18.01	5.47	23.48		1.00		18.60	16.01
1987	16.73	7.47	24.20		.22		17.48	17.26
1988	18.10	6.94	25.04					

a/ 1950-1974 fiscal year.
b/ Calendar year, except 1984 and 1985 which are Federal fiscal year values for the year ending. September 30 of crop year.
d/ No imports reported 1950-1968.
e/ DFCD = DFD = QFP
f/ DFD = DF + IF.

APPENDIX TABLE A9

FRESH MARKET ASPARAGUS:
U.S. PRODUCTION, EXPORTS, IMPORTS AND APPARENT CONSUMPTION
(million pounds)

	U.S. Production	Imports a/	Exports a/	Net Exports a/	Apparent Consumption
Year	QGRU	IR	ER	NR d/	DRD e/
1950	119.7	b/	4.2	4.2	115.5
1951	101.8		4.2	4.2	97.6
1952	111.1		4.2	4.2	106.9
1953	116.5		4.2	4.2	112.3
1954	102.4		4.2	4.2	98.2
1955	100.7		4.8	4.8	95.9
1956	115.1		4.8	4.8	110.3
1957	133.3		4.8	4.8	128.5
1958	130.7		4.8	4.8	125.9
1959	124.3		4.8	4.8	119.5
1960	123.0	1.2	5.2	4.0	119.0
1961	109.8	1.2	5.2	4.0	105.8
1962	104.3	1.2	5.2	4.0	100.3
1963	103.7	1.2	5.2	4.0	99.7
1964	100.0	1.2	5.2	4.0	96.0
1965	104.0	0.7	6.8	6.1	97.9
1966	84.7	2.4	6.7	4.3	80.4
1967	85.0	2.0	5.8	3.8	81.2
1968	89.2	2.1	6.9	4.8	84.4
1969	77.8	3.8	6.9	3.1	74.7
1970	94.4	5.0	6.8	1.8	92.6
1971	83.3	6.2	7.2	1.0	82.3
1972	92.2	8.2	10.1	1.9	90.3
1973	86.0	7.3	10.5	3.2	82.8
1974	82.4	9.1	10.9	1.8	80.6
1975	87.4	8.5	11.1	2.6	84.8
1976	91.9	8.2	10.4	2.2	89.7
1977	73.3	4.4	9.8	5.4	67.9
1978	70.1	5.1	11.7	6.6	63.5
1979	64.0	6.7	12.9	6.2	57.8
1980	78.4	7.2	16.4	9.2	69.2
1981	80.9	8.8	16.2	7.4	73.5
1982	c/	16.1	15.0	1.1	
1983		20.2	13.5	6.7	
1984	104.3	14.3	21.5	7.2	97.1
1985	115.2	16.0	18.6	2.6	112.6
1986	138.7	23.6	11.2	12.4	151.1
1987	138.8	28.4	20.6	7.8	146.6
1988	148.1				

a/ Figures for 1950-1954, 1955-1959, 1960-1964 are 5 year averages. Annual detail was not available. Values are fiscal year (June 30-July 1) to 1981. Calendar year thereafter.
b/ Imports in 1950-1959 were less than 50,000 pounds.
c/ Blanks indicate unavailable data.
d/ NR = ER – IR.
e/ DRD = QGRU – NR.

APPENDIX TABLE A10

U.S. EXPORTS OF CANNED ASPARAGUS BY AREA OF DESTINATION
(thousand cases 24/2's)

	Europe			Non-Europe			
	West Germany b/	Other	Total	Latin America e/	Other	Total	Total
Year a/	QEWG	QEOE	QEE	QELA	QEONE	QENE	QET
1950	6.7	164.0	170.7	85.8	40.1	125.9	296.6
1951	0.0	192.3	192.3	76.8	75.1	151.9	344.2
1952	25.2	135.7	160.9	99.6	73.0	172.6	333.5
1953	172.8	198.9	371.7	59.6	72.9	132.5	504.2
1954	142.3	244.2	386.3	47.4	102.8	150.2	536.5
1955	295.3	421.0	716.3	94.5	142.6	237.1	953.4
1956	429.1	290.5	719.6	69.8	180.5	250.3	969.9
1957	674.6	359.3	1033.9	62.7	164.0	226.7	1260.6
1958	954.9	471.7	1426.6	64.8	140.1	204.9	1631.5
1959	601.1	376.6	977.7	56.3	195.5	251.8	1229.5
1960	965.1	509.9	1475.0	31.8	199.0	230.8	1705.8
1961	746.3	524.6	1270.9	72.2	135.7	207.9	1478.8
1962	1310.2	669.6	1979.8	51.0	106.1	157.1	2136.9
1963	1188.9	727.4	1916.3	48.9	109.7	158.6	2074.9
1964	1084.9	744.3	1829.2	33.5	195.5	229.0	2058.2
1965	868.0	546.3	1414.3	14.6	119.2	133.8	1548.1
1966	322.1	518.8	840.9	19.6	104.7	124.3	965.2
1967	243.5	310.5	554.0	10.8	66.7	77.5	631.5
1968	174.5	287.1	461.6	9.3	51.9	61.2	522.8
1969	71.3	178.1	249.4	11.2	121.9	133.1	382.5
1970	21.2	9.6	203.6	9.1	37.4	46.5	250.1
1971	7.8	15.2	118.5	8.4	22.6	31.0	149.5
1972	7.0	89.3	96.3	7.4	23.7	31.1	127.4
1973	3.8	103.0	106.8	9.4	18.9	28.3	135.1
1974	1.7	46.2	78.6	9.4	82.6	92.0	170.6
1975	c/	57.0	57.0	6.9	30.9	37.8	94.8
1976	c/	65.8	65.8	4.9	15.3	20.2	86.0
1977	0.2	45.2	45.2	3.8	29.2	33.0	78.2
1978	c/	50.8	50.8	32.6	32.0	64.6	115.4
1979		62.4	62.4	25.6	48.8	74.4	136.8
1980		51.2	51.2	30.4	68.8	99.2	150.4
1981		48.8	48.8	15.2	100.0	115.2	164.0
1982		41.6	41.6	6.4	41.6	48.0	89.6
1983		32.8	32.8	1.6	44.8	46.4	79.2
1984		d/					

a/ 1950-1959 pack year.
b/ Reported as Germany in 1950-1951.
c/ Small quantities no longer reported.
d/ Blanks indicate unavailable data.
e/ For detail on Latin America statistics see Sources and Descriptions of Data, Appendix B.

APPENDIX TABLE A11

RATIOS OF FARM TO PROCESSED WEIGHT OF CANNED AND FROZEN ASPARAGUS a/

	Canned					Frozen		
	California			U.S. Less California	United States	California	U.S. Less California	United States
	White	Green	Total					
Year	KWCC	KGCC	KCC	KCO	KCU	KFC	KFO	KFU
1950	1.42	1.37	1.40	1.14	1.30	1.69	2.12	2.01
1951	1.48	1.26	1.36	1.03	1.21	1.85	1.94	1.92
1952	1.40	1.20	1.31	1.01	1.17	1.72	1.94	1.89
1953	1.14	1.40	1.24	0.95	1.10	1.86	1.83	1.84
1954	1.17	1.20	1.18	0.99	1.10	1.84	1.89	1.87
1955	1.20	1.32	1.26	0.97	1.14	2.09	1.88	1.94
1956	1.03	1.26	1.12	0.95	1.04	2.03	1.90	1.95
1957	0.87	1.22	1.02	1.00	1.01	2.10	1.90	1.96
1958	0.91	1.20	1.00	0.99	1.00	2.01	1.87	1.91
1959	0.98	1.15	1.06	1.02	1.04	2.20	2.01	2.01
1960	0.88	1.19	1.02	0.90	0.96	2.09	1.72	1.84
1961	0.95	1.15	1.02	0.89	0.99	2.02	1.85	1.92
1962	0.90	1.15	0.99	0.96	0.97	2.17	1.87	2.00
1963	0.87	1.07	0.94	1.02	0.97	2.13	1.96	2.03
1964	0.93	1.21	1.02	1.01	1.01	1.79	1.92	1.86
1965	0.96	1.17	1.06	0.95	0.99	1.94	1.75	1.83
1966	0.98	0.98	0.98	0.99	0.99	2.15	1.59	1.86
1967	0.90	1.01	0.98	0.98	0.98	2.21	1.95	2.08
1968	0.96	1.00	0.99	1.01	1.00	2.04	1.94	1.99
1969	0.87	1.01	0.97	0.99	0.99	2.12	1.91	2.02
1970	b/	1.01	1.07	0.89	0.94	1.91	2.05	1.98
1971		1.16	1.16	0.98	1.04	2.17	1.92	2.05
1972		1.18	1.18	0.82	0.90	2.25	2.09	2.19
1973		1.28	1.28	0.81	0.91	1.98	2.53	2.23
1974		1.45	1.45	1.01	1.13	1.68	1.87	1.77
1975		1.30	1.30	1.00	1.04	2.24	2.11	2.19
1976		1.08	1.08	0.95	0.98	2.31	2.42	2.35
1977		1.30	1.30	1.08	1.12	2.44	1.80	2.22
1978		1.66	1.66	1.04	1.09	1.93	1.90	1.91
1979		c/			1.20	1.94	2.16	2.01
1980					1.16			1.75
1981					1.05			1.72
1982						1.74		
1983						0.95 d/		
1984					.98			1.22
1985					.93			1.54
1986					.80			1.42
1987					.94			1.76
1988					.84			1.56

a/ For equations of ratios see Sources and Descriptions of Data, Appendix B.
b/ Small quantities not reported.
c/ Blanks indicate unavailable data.
d/ 1983 production data may be incomplete.

APPENDIX TABLE A12

CALIFORNIA GROWER PRICES FOR FRESH, CANNED AND FROZEN ASPARAGUS a/
(cents per pound)

	Canned						
	White	Green	Average	Frozen	All Processed	Fresh	Total Average
Year	PWGCC	PGGCC	PGCC	PGFC	PGPC	PGRC	PGC
1950	9.91	11.00	10.36	17.08	10.39	12.65	11.19
1951	12.04	13.19	12.64	11.63	12.55	14.35	13.07
1952	9.80	10.28	9.99	9.55	9.94	13.15	11.10
1953	8.71	9.72	9.18	9.35	9.21	12.65	10.58
1954	11.11	11.79	11.48	9.48	11.25	13.65	12.02
1955	12.57	13.31	12.92	10.41	12.65	16.65	13.54
1956	11.03	11.36	11.17	9.96	10.88	14.70	12.17
1957	8.44	9.31	8.89	8.16	8.76	13.60	10.71
1958	9.96	10.14	10.03	8.77	9.87	14.30	11.43
1959	9.91	10.20	10.06	9.00	9.85	14.40	11.48
1960	11.40	11.04	11.21	10.13	10.98	14.00	11.98
1961	13.14	12.47	12.87	10.99	12.49	15.70	13.47
1962	13.47	13.29	13.40	11.33	13.01	16.80	14.02
1963	15.13	13.84	14.62	11.02	13.98	16.80	14.83
1964	12.40	10.10	11.91	9.59	11.44	14.50	12.42
1965	17.38	14.95	16.08	12.44	15.08	16.40	15.63
1966	20.98	16.57	19.06	15.20	17.85	20.40	18.60
1967	19.18	17.65	18.00	15.07	16.81	21.60	18.60
1968	18.85	18.46	18.59	16.02	17.60	21.50	19.16
1969	18.19	17.62	17.77	18.20	17.91	23.90	20.40
1970	19.80	19.30	19.40	17.20	18.60	21.60	20.10
1971	b/	21.80	21.80	17.50	19.90	30.10	24.30
1972		23.30	23.30	19.70	21.30	26.30	23.60
1973		23.60	23.60	19.60	22.15	30.80	26.70
1974		24.10	24.10	22.10	23.70	34.60	28.90
1975		25.90	25.90	22.40	23.75	35.10	30.70
1976		27.90	27.90	23.10	24.70	37.60	32.20
1977		32.00	32.00	28.40	29.70	46.60	38.20
1978		36.45	36.45	32.25	34.15	50.20	45.00
1979		41.65	41.65	42.00	41.90	62.40	52.50
1980		38.75	38.75	39.25	39.00	55.40	52.20
1981		43.90	43.90	38.80	40.80	69.60	63.40
1982		45.40	45.40	42.80	43.65	67.40	61.20
1983		43.80	43.80	39.10	41.20	83.70	78.40
1984		c/			41.50	74.40	69.90
1985					38.85	83.30	75.70
1986					40.00	72.10	68.90
1987					37.17	66.10	62.80
1988					45.65	72.50	71.70

a/ See explanation of price detail in Sources and Descriptions of Data, Appendix B.
b/ Little or no production.
c/ Blanks indicate unavailable data.

APPENDIX TABLE A13

PART A
GROWER PRICES FOR FRESH AND PROCESSED ASPARAGUS FOR REGIONS OTHER THAN CALIFORNIA a/
(cents per pound)

	Northwest			Michigan and Illinois			New Jersey		
	Processed	Fresh	Total	Processed	Fresh	Total	Processed	Fresh	Total
Year	PGPN	PGRN	PGN	PGPMI	PGRMI	PGMI	PGPNJ	PGRNJ	PGNJ
1950	10.51	10.72	10.58	10.33	14.43	11.06	12.35	12.65	12.47
1951	10.87	11.17	10.97	12.06	16.56	12.84	13.86	13.50	13.72
1952	10.11	10.28	10.17	11.78	17.12	12.63	12.56	13.50	12.96
1953	10.34	10.44	10.37	12.03	17.30	12.93	12.40	12.50	12.44
1954	10.54	9.13	10.05	13.33	15.23	13.54	12.40	13.65	12.90
1955	11.57	11.00	11.41	13.27	15.93	13.66	13.39	13.65	13.50
1956	10.95	11.10	10.99	13.11	13.64	13.19	13.29	13.70	13.46
1957	8.82	9.64	9.03	12.20	15.44	12.77	10.33	11.10	10.67
1958	9.86	9.69	9.79	10.15	12.94	10.65	10.33	11.20	10.75
1959	10.64	10.82	10.69	10.72	12.82	11.05	10.64	12.50	11.43
1960	11.79	11.50	11.72	11.86	15.20	12.38	11.37	12.90	12.06
1961	12.50	12.04	12.38	12.82	15.88	13.22	12.35	14.40	13.16
1962	13.12	13.49	13.20	12.61	17.41	13.24	12.46	14.10	13.09
1963	13.35	13.73	13.41	13.18	17.74	13.64	13.18	15.40	14.00
1964	11.86	15.20	12.45	12.81	17.58	13.28	11.85	14.30	12.76
1965	13.06	16.74	13.77	13.71	18.44	14.05	14.50	15.10	14.70
1966	14.91	19.00	15.80	14.38	20.85	14.90	16.50	19.70	17.60
1967	15.45	20.10	16.09	16.13	20.74	16.45	17.45	19.80	18.30
1968	16.41	21.69	17.22	18.04	22.17	18.33	18.15	22.70	19.40
1969	17.21	22.50	17.93	19.29	23.38	19.59	18.20	22.20	19.20
1970	17.78	24.00	18.73	18.21	26.38	18.79	21.85	22.70	22.20
1971	19.20	26.90	20.90	20.86	27.91	21.31	22.55	26.50	24.20
1972	20.94	28.00	21.76	25.12	29.74	25.43	23.15	27.80	25.50
1973	21.97	30.80	23.03	28.33	34.81	28.81	25.75	31.70	29.20
1974	25.40	22.10	24.85	32.83	42.09	33.45	25.30	36.50	33.40
1975	25.40 b/	25.20 b/	25.40 b/	24.21	32.74	25.05	d/		36.30
1976	26.60	38.20	28.70	31.08	41.39	32.34			43.60
1977	30.75	45.40	32.70	41.24	49.97	42.65			55.10
1978	33.50	55.20	36.20	53.87	59.02	54.76			66.60
1979	42.85	61.80	44.85	55.52	75.26	59.51			81.60
1980	38.35	69.80	40.87	45.40 c/	65.00 c/	51.06			85.30
1981	46.15	73.70	49.36	58.25	72.00	61.80			78.50
1982	44.50	77.50	48.60	63.00	65.00	63.27c/			82.40
1983	42.50	72.80	51.40	62.00	62.00	62.00			79.60
1984	42.70	72.60	51.70	56.30	66.00	57.90			70.90
1985	45.25	68.80	52.30	55.90	71.00	58.40			68.70
1986	43.05	67.30	52.10	56.00	67.60	58.20			64.60
1987	44.40	63.30	49.90	57.00	66.40	58.60			65.30
1988	48.95	62.20	52.70	57.00	68.90	59.00			66.50

a/ For description of prices see Sources and Descriptions of Data, Appendix B.
b/ Washington only beginning in 1975. Oregon included in "Other."
c/ Michigan only beginning in 1980 for "Fresh" and "Processed." Michigan only beginning in 1982 for "Total." Illinois included in "Other."
d/ Blanks indicate unavailable data.

APPENDIX TABLE A13

PART B
GROWER PRICES FOR FRESH AND PROCESSED ASPARAGUS FOR REGIONS OTHER THAN CALIFORNIA a/
(cents per pound)

...continued...

	Other b/			United States				
	Processed	Fresh	Total	Canned	Frozen	Total Processed	Fresh	Total
Year	PGPO	PGRO	PGO	PGCU	PGFU	PGPU	PGRU	PGU
1950	11.54	15.78	14.17	d/	d/	10.95	12.90	11.65
1951	12.95	16.17	14.81			12.62	14.13	13.11
1952	13.07	16.88	15.20			10.88	13.47	11.82
1953	12.70	15.76	14.41			10.54	12.89	11.44
1954	12.93	16.87	14.50			11.73	13.50	12.32
1955	13.56	15.11	14.17			12.77	14.90	13.37
1956	13.51	16.51	14.57			11.73	14.20	12.54
1957	12.50	16.83	13.80			9.70	13.00	10.91
1958	11.14	15.25	12.49			10.07	12.80	11.08
1959	11.50	16.90	13.14			10.32	13.66	11.46
1960	12.17	15.98	13.34			11.36	13.63	12.10
1961	12.74	16.81	13.87			12.53	15.15	13.31
1962	13.28	16.68	14.10			12.92	15.80	13.73
1963	13.41	18.23	14.52	13.31	11.98	13.15	16.33	14.38
1964	13.85	17.44	14.71	12.25	10.75	11.90	14.77	12.71
1965	14.58	17.57	15.25	14.70	13.25	14.36	16.27	14.96
1966	15.65	21.28	16.66	16.85	15.55	16.53	20.12	17.44
1967	17.25	21.14	17.90	17.00	15.70	16.60	21.08	17.81
1968	18.34	24.24	19.17	17.85	16.75	17.58	21.89	18.80
1969	19.05	24.85	20.17	18.10	18.10	18.10	23.50	19.70
1970	18.52	26.99	19.88	19.05	17.70	18.65	22.30	19.90
1971	20.15	27.50	21.23	20.95	18.80	20.30	29.20	22.90
1972	21.79	28.61	22.89	22.85	20.50	21.95	26.70	23.50
1973	23.86	35.30	25.37	24.30	21.35	23.55	31.10	26.10
1974	27.22	36.23	28.54	26.60	24.65	26.30	33.40	28.50
1975	29.42	36.63	30.64	25.80	23.45	25.05	34.00	28.70
1976	30.14	43.60	30.90	28.00	25.05	26.80	38.10	31.30
1977	30.59	52.20	31.60	32.50	30.70	31.90	47.00	36.90
1978	43.39	63.60	45.00	37.75	40.80	38.55	52.20	43.70
1979	46.46	76.70	48.90	44.65	45.55	45.00	64.40	51.50
1980	50.55	75.40	54.30	40.80	42.60	41.20	58.10	49.11
1981	55.55	76.10	58.10	47.05	49.20	47.50	70.50	58.41
1982	c/							
1983								
1984				46.50	45.80	46.35	73.70	61.14
1985				47.55	45.45	46.90	79.30	64.37
1986				46.25	46.65	46.40	70.60	61.40
1987				47.20	45.20	46.60	65.60	57.80
1988				49.90	52.90	50.75	70.50	62.80

a/ For description of prices see Sources and Descriptions of Data, Appendix B.
b/ For detail of states included see Sources and Descriptions of Data, Appendix B.
c/ Blanks indicate unavailable data.
d/ Canning and freezing prices not reported separately prior to1963.

APPENDIX TABLE A14

CALIFORNIA CANNED ASPARAGUS: MIDPOINT VALUES OF MONTHLY F.O.B PRICE QUOTATIONS ALL GREENS SPEARS, LARGE OR MAMMOTH/LARGE FANCY GRADE IN #300 CANS
($/case of 24/300)

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	APR-MAR Average
1950	6.20	6.20	6.20	6.64	6.56	6.56	6.56	6.56	6.56	6.56	6.56	6.56	6.56
1951	6.56	6.56	6.56	6.56	6.56	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.82
1952	6.88	6.88	6.88	6.88	5.98	5.94	5.94	5.94	5.94	5.94	5.94	5.94	6.02
1953	5.94	5.94	5.98	5.94	5.82	5.82	5.82	5.82	5.82	5.82	5.82	5.82	5.84
1954	5.82	5.82	5.82	5.82	6.64	6.64	6.64	6.64	6.64	6.64	6.64	6.64	6.58
1955	6.64	6.64	6.64	6.64	7.26	7.46	7.46	7.46	7.46	7.46	7.46	7.46	7.26
1956	7.46	6.80	6.64	6.64	6.98	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.00
1957	7.10	6.80	6.84	6.84	6.50	6.50	6.50	6.50	6.50	6.50	6.46	6.40	6.50
1958	6.40	6.40	6.40	6.40	6.82	6.90	6.90	6.90	6.90	6.90	6.90	6.90	6.86
1959	6.90	6.90	6.90	6.90	6.80	6.76	6.76	6.76	6.76	6.76	6.76	6.76	6.78
1960	6.76	6.76	6.76	6.84	7.20	7.20	7.20	7.20	7.20	7.20	7.20	7.20	7.18
1961	7.20	7.20	7.42	7.54	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.68
1962	7.70	7.70	7.70	7.74	7.90	7.90	7.90	7.90	7.90	7.90	7.90	7.90	7.88
1963	7.90	7.90	7.90	7.94	8.06	8.06	8.06	8.06	8.06	8.06	8.06	8.06	8.06
1964	8.06	8.06	8.06	8.06	8.06	7.00	7.00	7.00	7.00	7.00	7.16	7.30	7.28
1965	7.30	7.30	7.30	7.30	7.54	8.26	8.58	8.70	8.70	8.70	8.70	8.70	8.44
1966	8.70	8.70	8.70	9.02	9.36	9.36	9.36	9.36	9.36	9.58	9.66	9.66	9.48
1967	9.58	9.58	9.58	9.58	9.58	9.76	9.76	9.82	10.10	10.10	10.10	10.10	9.94
1968	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10
1969	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.32	10.40	10.40	10.40	10.40	10.30
1970	10.40	10.40	10.40	10.40	10.58	11.10	11.10	11.10	11.10	11.10	11.10	11.10	11.10
1971	11.36	11.60	11.60	11.88	11.96	12.30	12.30	12.30	12.30	12.30	12.30	12.30	12.04
1972	12.30	12.30	12.64	12.64	13.24	13.24	13.24	13.24	13.50	13.14	13.14	13.14	12.98
1973	13.70	13.70	13.70	14.10	14.10	14.10	14.10	14.10	14.82	14.82	14.76	14.76	14.48
1974	14.76	14.76	14.76	14.76	14.76	15.70	15.70	16.25	16.25	16.70	16.48	16.48	15.61
1975	16.25	16.25	16.25	16.25	16.25	14.20	14.00	14.00	14.00	14.00	14.00	14.00	14.39
1976	14.00	14.00	14.00	14.00	14.80	15.40	15.40	16.60	16.60	16.60	16.60	16.60	16.19
1977	16.60	16.60	18.50	20.50	20.80	20.80	20.80	21.80	21.80	22.90	22.90	22.90	21.99
1978	22.90	22.90	22.90	25.50	27.50	30.00	30.00	30.00	30.00	30.00	30.00	30.00	29.42
1979	30.00	30.00	30.00	30.00	26.50	30.00	30.00	30.00	30.00	30.00	30.00	30.00	29.71
1980	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
1981	30.00	30.00	30.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.16
1982	a/		32.65			33.40				33.40			33.21
1983	33.40		33.40			33.40				33.78			33.59
1984	33.78		33.78			33.60				33.60			33.65
1985	33.60												

a/ Blanks indicate unavailable data.

APPENDIX TABLE A15

CALIFORNIA FROZEN ASPARAGUS: MIDPOINT VALUES OF MONTHLY F.O.B. PRICE QUOTATIONS GRADE A MEDIUM, 10 OUNCE PACKAGE OR EQUIVALENT a/
(Dollars per case of 24)

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	APR-MAR Average
1950	6.67	6.67	6.67	6.67* b/	5.92	6.68	6.64	6.67*	6.67	6.67	6.67	6.67	6.54
1951	5.67*	6.67	6.67	6.67	6.67	6.71	6.83	6.88	6.88	6.88	6.88	6.88	6.80
1952	6.79*	6.79*	6.71	7.00	6.90	6.90	6.60	6.60	6.60	6.95*	6.95*	7.00	6.90
1953	7.00	7.00	7.00	7.00	7.00	6.25	6.55	6.55	6.55	6.55	6.55	6.55*	6.60
1954	6.55*	6.55	6.55	6.55	6.47*	6.47	6.47	6.47	6.40*	6.40	6.40	6.47*	6.46
1955	6.47*	6.47	6.47	6.47	6.90	6.70	7.15	7.15	7.15	7.15	7.15	7.15	7.04
1956	7.14	7.14	7.14	6.95	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.82
1957	6.80	6.80	6.80	6.80	5.68	5.68	5.68	5.68	6.30	6.30	6.00	6.00	5.92
1958	5.65	5.65	5.65	5.65	5.70	5.70	5.70	5.70	5.70	5.70	5.90	6.20	5.88
1959	6.20	6.20	6.20	7.07*	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.96
1960	5.95	5.95	5.95	5.59*	6.55*	6.55	6.55	6.55	6.55	6.55	6.55	6.55	6.50
1961	6.55	6.55	6.55	6.55	6.55	6.55	6.55	6.55	6.55	6.55	6.55	6.55	6.56
1962	6.55	6.55	6.55	6.75*	6.94	6.94	6.94	6.94	7.10	7.10	7.10	7.10	7.02
1963	7.10	7.10	7.10	7.10	7.30	7.30	7.30	7.30	7.40	7.40	7.40	7.40	7.36
1964	7.50	7.50	7.50	7.50	6.50	6.40	6.40	6.40	6.40	6.40	6.60	6.60	6.60
1965	6.60	6.60	6.80	7.18*	7.55	7.55	7.55	7.64	7.64	7.64	7.64	7.64	7.64
1966	7.70	7.70	8.05	8.05	8.60	8.60	8.60	8.60	8.60	8.60	8.60	8.90	8.66
1967	8.90	8.90	8.90	8.90	8.90	8.80	9.00	9.00	9.00	9.00	9.00	9.00	9.00
1968	9.00	9.20	9.20	9.20	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.30	9.25
1969	9.25	9.25	9.25	9.50	9.50	9.50	9.50	9.50	9.75	9.75	9.75	9.75	9.68
1970	9.75	9.70	10.25	10.25	10.25	10.25	10.25	10.25	10.25	10.25	10.50	10.50	10.36
1971	10.50	10.50	10.50	11.50	11.80	11.80	11.80	11.80	11.80	11.80	11.80	11.80	11.44
1972	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.87	12.87	12.87	12.87	12.50	12.62
1973	12.50	12.50	12.88	13.25	13.25	13.25	13.25	13.25	13.25	13.25	13.25	13.25	13.25
1974	13.25	13.25	13.25	14.38	15.50	15.50	15.50	15.50	15.70	15.72	15.72	15.72	15.50
1975	15.50	15.50	15.50	15.50	15.50	15.50	15.50	15.50	15.72	15.92	15.92	15.42	15.78
1976	16.13	16.13	16.13	15.45	15.90	16.05	16.20	16.20	16.50	16.80	16.80	16.80	16.54
1977	16.80	16.80	18.20	18.68	18.68	19.80	19.80	19.80	20.00	20.00	20.50	20.50	19.79
1978	19.75	20.00	20.00	20.00	19.88	22.25	22.25	22.25	22.25	22.25	22.25	22.25	22.82
1979	22.33	27.92	27.92	28.30	28.30	28.30	28.30	28.30	30.05	30.05	30.05	30.05	29.26
1980	29.80	29.80	29.80	29.80	29.80	29.80	29.80	30.25	30.25	30.25	30.25	30.25	30.10
1981	30.25	30.25	30.25	30.25	32.50	32.50	32.50	33.33	34.65	34.65	34.65	35.53	34.15
1982	36.40	36.40	36.40	37.85	37.85	37.85	37.85	37.85	37.85	37.85	37.85	37.83	37.85
1983	37.85	37.85	37.85	26.25	26.25	26.25	31.00	31.00	31.00	31.20	31.20	31.20	29.91
1984	31.20	31.20	31.20	31.20	31.20	38.95	38.95	38.95	38.95	38.95	38.95	38.95	37.66
1985	38.95	38.95	38.95	38.95	38.95	38.95	38.95	38.95	38.95	38.95	38.95	38.95	38.95 c/

a/ Prices are for the first of the month.
b/ Asterisk (*) indicates a value interpolated or estimated from quotations for other package types.
c/ April December average only.

APPENDIX TABLE A16

AVERAGE ANNUAL CALIFORNIA F.O.B. PRICE QUOTATIONS FOR CANNED AND FROZEN GREEN ASPARAGUS SPEARS, U.S. WHOLESALE PRICE INDEX FOR CANNED ASPARAGUS, AND U.S. AVERAGE GROWER PRICES FOR PROCESSED AND FRESH ASPARAGUS
(cents/pound)

	California F.O.B. Price				Canned Asparagus Wholesale Price Index (1957-59 = 100)	Grower Price			
	Canned		Frozen			Processed		Fresh	
	Nominal Value	Deflated	Nominal Value	Deflated		Nominal Value	Deflated	Nominal Value	Deflated
Year	PPCC	PPCCE	PPFC	PPFCE	IWC	PGPU	PGPUE	PGRU	PGRUE
1950	31.09	a/	43.60		129.00	10.95		12.90	
1951	32.32		45.30		106.10	12.62		14.13	
1952	28.53		46.00		104.60	10.88		13.47	
1953	27.68		44.00		100.20	10.54		12.89	
1954	31.18	39.85	43.10	55.08	104.90	11.73	14.99	13.50	
1955	34.41	43.50	46.90	59.28	104.20	12.77	16.14	14.90	
1956	33.18	41.42	45.50	56.80	104.00	11.73	14.64	14.20	17.73
1957	30.81	37.35	39.50	47.88	102.20	9.70	11.76	13.00	15.76
1958	32.51	38.70	39.20	46.67	98.50	10.07	11.99	12.80	15.24
1959	32.13	37.40	39.70	46.22	99.40	10.32	12.01	13.66	15.90
1960	34.02	38.88	43.30	49.49	104.30	11.36	12.98	13.63	15.58
1961	36.40	41.08	43.70	49.32	105.90	12.53	14.14	15.15	17.10
1962	37.35	41.41	46.80	51.88	106.60	12.92	14.32	15.80	17.52
1963	38.20	41.75	49.10	53.66	108.40	13.15	14.37	16.33	17.85
1964	34.50	37.06	44.00	47.26	105.80	11.90	12.78	14.77	15.86
1965	40.00	42.24	50.90	53.75	108.30	14.36	15.16	16.27	17.18
1966	44.93	46.03	57.70	59.12	115.50	16.53	16.94	20.12	20.61
1967	47.10	47.10	60.00	60.00	126.50	16.60	16.60	21.08	21.08
1968	47.87	45.81	61.90	59.23	133.40	17.58	16.82	21.89	20.95
1969	48.80	44.77	64.50	59.17	135.00	18.10	16.61	23.50	21.56
1970	52.60	46.10	69.10	60.56	140.20	18.65	16.35	22.30	19.54
1971	57.06	47.79	76.30	63.90	157.40	20.30	17.00	29.20	24.46
1972	61.52	49.53	84.10	67.71	171.70	21.95	17.67	26.70	21.50
1973	68.63	52.03	88.30	66.94	189.20	23.55	17.85	31.10	23.58
1974	73.98	50.78	103.30	70.90	209.70	26.30	18.05	33.40	22.92
1975	68.20	43.30	105.20	66.79	193.70	25.05	15.90	34.00	21.59
1976	76.73	46.08	110.27	66.23	208.70	26.80	16.10	38.10	22.88
1977	104.22	58.75	131.93	74.37	275.30	31.90	17.98	47.00	26.49
1978	139.43	73.23	152.13	79.90	312.80	38.55	20.25	52.20	27.42
1979	140.81	67.70	195.07	93.78	343.60	45.00	21.63	64.40	30.96
1980	142.18	61.74	200.67	87.13	330.50	41.20	17.89	58.10	25.23
1981	152.42	60.99	227.67	90.49	353.10	47.50	18.88	70.50	28.02
1982	157.39	62.46	252.33	100.13	b/	47.38	18.80	68.53	27.19
1983	159.19	60.76	199.40	76.11		46.68	17.82	80.21	30.61
1984	159.48	58.85	251.06	92.64		45.80	16.90	73.70	27.20
1985	138.59	48.97	259.67	91.76		46.90	16.57	79.30	28.02
1986			259.67	89.54		46.40	16.00	70.60	22.10
1987			259.67	85.70		46.60	15.38	65.60	31.65
1988			259.67	82.17		50.75	16.06	70.50	22.31

a/ Blanks indicate unavailable data.
b/ Index no longer reported for canned asparagus.

APPENDIX TABLE A17

INDICATORS OF PROCESSOR MARGINS FOR CALIFORNIA CANNED AND FROZEN ASPARAGUS
(cents per pound of processed weight)

	Canned					Frozen		
	F.O.B. Price a/	Cost of Raw Product b/		Margin Indicator b/		F.O.B. Price c/	Cost of Raw Product b/	Margin Indicator b/
		Green	All	Green	All			
Year	PPCC	RGCC	RCC	MACC	MCC	PPFC	RFC	MFC
1950	31.09	15.10	14.54	15.99	16.55	43.60	28.87	14.73
1951	32.32	16.61	17.16	15.71	15.16	45.30	21.50	23.80
1952	28.53	12.37	13.13	16.16	15.40	46.00	16.42	29.58
1953	27.68	13.57	11.40	14.11	16.28	44.00	17.37	26.63
1954	31.18	14.13	13.60	17.05	17.58	43.10	17.44	25.66
1955	34.41	17.58	16.22	16.83	18.19	46.90	21.78	25.12
1956	33.18	14.32	12.48	18.86	20.70	45.50	20.27	25.23
1957	30.81	11.35	9.09	19.46	21.72	39.50	17.10	22.40
1958	32.51	12.12	10.08	20.39	22.43	39.20	17.62	21.58
1959	32.13	11.70	10.62	20.43	21.51	39.70	19.83	19.87
1960	34.02	13.09	11.45	20.93	22.57	43.30	21.20	22.10
1961	36.40	14.32	13.15	22.08	23.25	43.70	22.24	21.46
1962	37.35	15.27	13.21	22.08	24.14	46.80	24.64	22.16
1963	38.20	14.78	13.68	23.42	24.52	49.10	23.51	25.59
1964	34.50	12.24	12.10	22.26	22.40	44.00	17.16	26.84
1965	40.00	17.47	17.08	22.53	22.92	50.90	24.14	26.76
1966	44.93	16.31	18.76	28.62	26.17	57.70	32.65	25.05
1967	47.10	17.86	17.73	29.24	29.37	60.00	33.26	26.74
1968	47.87	18.53	18.40	29.34	29.47	61.90	32.74	29.16
1969	48.80	17.82	17.25	30.98	31.55	64.50	38.55	25.95
1970	52.60	19.55	20.84	33.05	31.76	69.10	32.85	36.25
1971	57.06	25.38	25.38	31.68	31.68	76.30	37.92	38.38
1972	61.52	27.56	27.56	33.96	33.96	84.10	44.31	39.79
1973	68.63	30.19	30.19	38.44	38.44	88.30	38.85	49.45
1974	73.98	35.00	35.00	38.98	38.98	103.30	37.09	66.21
1975	68.20	33.58	33.58	34.62	34.62	105.20	50.17	55.03
1976	76.73	30.13	30.13	46.60	46.60	110.27	53.42	56.85
1977	104.22	41.63	41.63	62.59	62.59	131.93	69.30	62.63
1978	139.43	60.57	60.57	78.86	78.86	152.13	62.19	89.94
1979	140.81					195.07	81.40	113.67
1980	142.18					200.67		
1981	152.42					227.67		
1982	157.39					252.33	74.41	177.92
1983	159.19					199.40 e/	37.00 f/	159.73
1984	159.48					251.06		
1985	138.59					259.67		
1986	d/					259.67		
1987						259.67		

a/ All large, green, fancy in No. 300 cans.
b/ For equations see Sources and Descriptions of Data.
c/ Grade A medium in 10 ounce packages or equivalent.
d/ Blanks indicate unavailable data.
e/ April December average only.
f/ Value uncertain due to possible incomplete reporting of 1983 production.

APPENDIX TABLE A18

ECONOMIC FACTORS AFFECTING THE U.S. ASPARAGUS INDUSTRY

	Index of Farm Wage Rates (1967 = 100) a/				U.S.Total Disposable Income Per Capita Deflated (1967=1.0)	U.S Population a/ (millions)	Personal Consumption Expenditure Deflator (1967=1.0)	Index of Processing Costs a/ (1967=100)
	West b/	East c/	Mid-West d/	U.S.e/				
Year	WC	WE	WM	WU	IDNE	N	PCE671	IPC
1950	57.50	57.45	60.14	58.36	f/	151.7		
1951	63.13	64.54	66.67	64.78		154.3		
1952	66.25	66.67	70.29	67.74		157.0		
1953	67.50	68.79	72.46	69.58		159.6		
1954	66.88	68.09	71.74	68.90		162.4	0.78	
1955	68.13	69.50	73.19	70.27		165.3	0.79	
1956	71.25	73.05	75.36	73.22	0.78	168.2	0.80	80.3
1957	71.88	75.89	76.81	74.86	0.78	171.3	0.82	84.5
1958	73.13	77.30	76.09	75.51	0.78	174.1	0.84	85.8
1959	74.38	77.30	78.26	76.65	0.80	177.9	0.86	86.8
1960	76.88	78.72	78.26	77.95	0.80	180.8	0.88	88.9
1961	79.38	80.14	79.71	79.74	0.81	183.7	0.89	89.7
1962	80.63	81.56	81.16	81.12	0.83	186.6	0.90	91.1
1963	82.50	82.98	82.61	82.70	0.85	189.3	0.92	91.6
1964	85.00	85.11	84.78	84.96	0.89	191.9	0.93	93.2
1965	88.13	89.36	87.68	88.39	0.94	194.4	0.95	94.6
1966	95.00	92.91	93.48	93.80	0.97	196.6	0.98	97.0
1967	100.00	100.00	100.00	100.00	1.00	198.8	1.00	100.0
1968	105.63	107.09	107.97	106.90	1.03	200.7	1.04	102.1
1969	112.50	116.31	117.39	115.40	1.04	202.7	1.09	106.9
1970	118.75	123.40	124.64	122.26	1.08	205.1	1.14	113.3
1971	122.50	129.08	131.16	127.58	1.11	207.7	1.19	120.6
1972	128.75	134.75	137.68	133.73	1.14	209.9	1.24	124.2
1973	136.88	144.68	149.28	143.61	1.21	211.9	1.32	135.6
1974	154.38	158.16	163.77	158.77	1.18	213.9	1.46	158.6
1975	169.38	185.11	176.81	177.10	1.20	216.0	1.58	179.2
1976	183.13	186.52	192.75	187.47	1.23	218.0	1.66	193.0
1977	197.50	201.42	204.35	201.09	1.27	220.2	1.77	207.1
1978	210.63	215.60	234.06	220.10	1.31	222.6	1.90	223.2
1979	228.13	229.08	247.10	234.77	1.33	225.1	2.08	248.9
1980	253.75	242.55	265.94	254.08	1.32	227.7	2.30	284.0
1981	270.00	254.61	300.00	274.87	1.35	229.8	2.52	313.6
1982	272.50	273.76	290.58	278.95	1.35	232.1	2.52	325.7
1983	286.25	272.34	290.58	283.06	1.38	234.5	2.62	332.7
1984	299.38	270.92	289.86	286.72	1.46	236.6	2.71	348.6
1985	310.72		339.84	329.76	1.48	239.3	2.83	352.4
1986	320.18		365.98	343.62	1.53	241.5	2.90	354.1
1987				356.05	1.59	243.9	3.03	360.8
1988				361.37	1.63	246.2	3.16	373.7

a/ For explanation of variables see Sources and Descriptions of Data, Appendix B.
b/ Includes California, Washington, Oregon.
c/ Includes New York, New Jersey, Pennsylvania.
d/ Includes Ohio, Indiana, Illinois, Michigan, Wisconsin.
e/ Simple average of West, East and Midwest.
f/ Blanks indicate data not available.

APPENDIX TABLE A19

VALUES OF VARIABLES USED IN ESTIMATING THE DEMAND AND MARKET ALLOCATION EQUATIONS a/
(not tabled elsewhere)

Year	DCDN	DFDN	DRDN	DDN	DPN2	QSCN	QSCNI	QSFN	QSFNI	QGSPUN	IPCE	RPPCCE	RPPFCE	MPPCE
1950	0.762	0.135	0.761	1.737		0.913		0.169		1.523				
1951	0.760	0.144	0.633	1.563		0.981		0.187		1.546				
1952	0.725	0.167	0.681	1.593	0.960	0.946		0.205		1.499				
1953	0.725	0.187	0.704	1.603	0.960	0.877		0.243		1.415				
1954	0.735	0.167	0.605	1.482	0.978	0.935		0.214		1.428	95.208			42.396
1955	0.733	0.175	0.580	1.509	0.999	1.183		0.220		1.773	95.942	1.092	1.076	46.068
1956	0.741	0.186	0.656	1.612	1.034	1.201	1.024	0.269	0.269	1.772	100.250	0.952	0.958	44.015
1957	0.797	0.180	0.750	1.737	1.088	1.247	1.038	0.263	0.263	1.777	102.424	0.902	0.843	38.941
1958	0.765	0.162	0.723	1.631	1.145	1.250	0.983	0.222	0.222	1.673	102.143	1.036	0.975	39.781
1959	0.778	0.191	0.672	1.696	1.190	1.145	0.948	0.243	0.243	1.681	101.048	0.966	0.990	38.849
1960	0.767	0.210	0.658	1.629	1.180	1.199	0.966	0.272	0.272	1.655	101.600	1.039	1.071	40.719
1961	0.786	0.181	0.576	1.545	1.188	1.260	0.989	0.247	0.247	1.724	101.242	1.057	0.997	42.289
1962	0.801	0.172	0.538	1.502	1.224	1.335	1.008	0.230	0.230	1.760	100.998	1.008	1.052	42.791
1963	0.712	0.174	0.527	1.415	1.269	1.349	1.022	0.218	0.218	1.753	100.109	1.008	1.034	43.461
1964	0.765	0.165	0.500	1.433	1.257	1.308	0.985	0.205	0.205	1.705	100.107	0.888	0.881	38.401
1965	0.777	0.159	0.504	1.423	1.233	1.085	0.925	0.199	0.199	1.441	99.894	1.140	1.137	43.912
1966	0.750	0.159	0.409	1.354	1.174	1.086	0.940	0.214	0.214	1.474	99.385	1.090	1.100	48.005
1967	0.733	0.157	0.408	1.350	1.076	0.969	0.903	0.218	0.218	1.403	100.000	1.023	1.015	49.221
1968	0.710	0.172	0.421	1.377	1.006	0.976	0.916	0.231	0.231	1.439	97.703	0.973	0.987	48.257
1969	0.752	0.136	0.369	1.384	0.949	0.991	0.945	0.172	0.173	1.324	98.073	0.977	0.999	46.861
1970	0.718	0.148	0.451	1.417	0.937	0.866	0.826	0.163	0.165	1.135	99.299	1.030	1.023	48.427
1971	0.629	0.111	0.396	1.276	0.918	0.731	0.727	0.162	0.169	1.089	101.005	1.037	1.055	50.056
1972	0.612	0.163	0.430	1.338	0.820	0.750	0.775	0.217	0.232	1.151	100.000	1.036	1.060	53.192
1973	0.714	0.112	0.391	1.291	0.736	0.801	0.847	0.164	0.170	1.095	102.805	1.050	0.989	54.069
1974	0.495	0.112	0.377	1.134	0.755	0.749	0.758	0.133	0.140	1.082	108.854	0.976	1.059	54.354
1975	0.548	0.102	0.393	1.186	0.683	0.645	0.672	0.113	0.120	0.918	113.778	0.853	0.942	46.920
1976	0.494	0.117	0.411	1.168	0.603	0.511	0.527	0.127	0.133	0.797	115.916	1.064	0.992	49.884
1977	0.400	0.113	0.308	1.007	0.602	0.426	0.465	0.118	0.130	0.738	116.742	1.275	1.123	62.164
1978	0.331	0.080	0.285	0.800	0.525	0.420	0.428	0.086	0.088	0.624	117.227	1.246	1.074	74.520
1979	0.287	0.082	0.257	0.765	0.432	0.389	0.394	0.115	0.119	0.695	119.663	0.924	1.174	73.370
1980	0.305	0.069	0.304	0.780	0.381	0.366	0.380	0.085	0.091	0.576	123.317	0.912	0.929	66.281
1981	0.296	0.058	0.320	0.730	0.357	0.364	0.362	0.071	0.073	0.504	124.642	0.988	1.039	65.672
1982	0.260	0.064	0.326	0.327	0.354	0.406	0.413	0.102	0.104	0.544	129.200	1.024	1.107	69.861
1983	0.256	0.072	0.384	0.358	0.334	0.426	0.432	0.109	0.114	0.446	127.000	0.973	0.760	63.885
1984	0.313	0.069	0.484	0.875	0.316	0.445	0.466	0.094	0.097	0.457	128.600	0.969	1.217	65.090
1985	0.306	0.075	0.542	0.943	0.338	0.451	0.466	0.107	0.110	0.498	124.500	0.979	0.990	57.490
1986	0.339	0.077	0.642		0.361	0.476	0.491	0.120			124.500			

a/ DCDN, DFDN, DRDN are U.S. per capita consumption of canned, frozen and fresh asparagus. DDN is total per capita consumption in fresh equivalent. DPN2 is a two-year average (lagged) of DCN and DFN. QSCN and QSFN are per capita supplies of canned and frozen asparagus. QSCNI and QSFNI add imports and subtract exports. QGSPUN is per capita supply of canned and frozen asparagus in raw weight equivalents. IPCE is an index of processing cost deflated by prices PCE67R, the personal consumption expenditure deflator. RPPCCE and RPPFCE are ratios of F.O.B. canned and frozen in t to prices in t-1. MPPCE is a weighted average of the canned and frozen F.O.B. prices. For further detail, see Table V.2.

APPENDIX TABLE A20

VALUES OF VARIABLES USED IN ESTIMATING THE PRODUCTION SUBSECTOR EQUATIONS
(not tabled elsewhere) a/

Year	RU	SPN	SCFN	SFFN	NCN2L	NRN2L
1950	19.966	0.123	0.078	0.045		
1951	20.240	0.180	0.114	0.066		
1952	17.454	0.262	0.182	0.081	0.120	0.055
1953	16.443	0.242	0.174	0.068	0.124	0.054
1954	17.882	0.170	0.066	0.104	0.151	0.053
1955	19.016	0.209	0.118	0.090	0.184	0.052
1956	17.131	0.379	0.292	0.087	0.259	0.055
1957	14.580	0.441	0.281	0.159	0.341	0.058
1958	14.673	0.393	0.236	0.157	0.386	0.057
1959	14.958	0.340	0.222	0.119	0.477	0.056
1960	15.525	0.254	0.161	0.093	0.464	0.055
1961	16.690	0.312	0.194	0.118	0.430	0.049
1962	16.923	0.325	0.195	0.131	0.504	0.044
1963	16.963	0.316	0.198	0.118	0.598	0.043
1964	14.965	0.390	0.310	0.080	0.654	0.043
1965	16.931	0.289	0.216	0.072	0.650	0.042
1966	18.600	0.217	0.145	0.072	0.483	0.052
1967	17.849	0.297	0.184	0.113	0.307	0.053
1968	17.569	0.288	0.169	0.119	0.213	0.041
1969	16.978	0.319	0.201	0.119	0.126	0.043
1970	16.277	0.252	0.179	0.072	0.105	0.039
1971	17.994	0.146	0.110	0.036	0.085	0.024
1972	17.547	0.213	0.087	0.126	0.044	0.014
1973	18.175	0.300	0.147	0.153	0.020	0.014
1974	17.980	0.250	0.148	0.101	0.070	0.024
1975	16.208	0.331	0.270	0.061	0.055	0.024
1976	16.702	0.163	0.120	0.042	0.037	0.020
1977	18.365	0.072	0.037	0.035	0.044	0.022
1978	19.851	0.102	0.071	0.032	0.055	0.035
1979	21.937	0.131	0.114	0.017	0.046	0.054
1980	19.334	0.186	0.123	0.063	0.013	0.057
1981	21.258	0.115	0.078	0.037	0.019	0.068
1982	20.130	0.089	0.065	0.024	0.006	0.032
1983	22.560	0.128	0.087	0.041	0.003	0.014
1984	21.324	0.096	0.076	0.020	0.005	0.016
1985	19.522	0.087	0.069	0.018	0.011	0.002
1986	17.870	0.100	0.068	0.032	0.018	0.021

a/ RU is the ratio of the average grower price to an index of farm wage rates. SPN is per capita carry in stocks of canned and frozen asparagus. SCFN and SFFN are per capita carry in stocks of canned and frozen asparagus in fresh equivalents. NCN2L and NRN2L are two-year average values of net canned exports and net fresh exports lagged one year.

APPENDIX B: SOURCES AND DESCRIPTIONS OF DATA

Appendix Table A1

States included in All Other are:

1950-52:	SC, MA, MD, OH, IA, IN, MN, VA, AR, DE, PA, MO, NY, NE, WI, ID
1953-58:	MA, MD, OH, IA, IN, MN, VA, AR, DE, PA, MO, NY, NE, WI, ID
1959-1963:	MA, MD, OH, IA, IN, MN, VA, AR, DE, PA, MO, NY, NE, TN
1964-68:	MA, MD, OH, IA, IN, MN, VA, AR, DE, PA, MO, TN
1969-1972:	MA, MD, OH, IA, IN, MN, VA, AR, DE, PA
1973:	MA, MD, OH, IA, IN, MN, VA, AR
1974:	MA, MD, OH, IA, IN, MN, VA, DE
1975:	MA, MD, IA, IN, MN, VA, DE
1976-1981:	MD, IA, IN, MN, VA, DE

Source:

1950-1981:	USDA, Statistical Reporting Service, *Vegetables for Fresh Market*, annual summaries.
1982-83:	Data from individual state crop reporting boards and extension service. USDA no longer reported asparagus acreage statistics.
1984 on:	U.S. Agricultural Statistics Board, *Vegetables*, annual summaries.

Appendix Table A2

Included in Other are: Gilroy-San Juan Batista area, Kingsburg Orosi area, Salinas Valley, Orange County.

Source: California Federal-State Market News Service, *Marketing Asparagus From California*, annual issues.

California Asparagus Growers Association, *Asparagus Survey for the Crop Year*, annual issues.

Appendix Table A3

States included in All Other are the same as those included in All Other in Appendix Table A1.

Source: Calculated from Appendix Tables A1 and A4.

Appendix Table A4

States included in All Other Processed and All Other Fresh are:

1950-52:	SC, MA, MD, OH, IA, IN, MN, VA, AR, DE, PA, MO, NY, NE, WI, ID
1953-58:	MA, MD, OH, IA, IN, MN, VA, AR, DE, PA, MO, NY, NE, WI, ID
1959-1963:	MA, MD, OH, IA, IN, MN, VA, AR, DE, PA, MO, NY, NE, TN
1964-68:	MA, MD, OH, IA, IN, MN, VA, AR, DE, PA, MO, TN
1969-1972:	MA, MD, OH, IA, IN, MN, VA, AR, DE, PA
1973:	MA, MD, OH, IA, IN, MN, VA, AR
1974:	MA, MD, OH, IA, IN, MN, VA, DE
1975:	MA, MD, IA, IN, MN, VA, DE, OR, NJ
1976-79:	MD, IA, IN, MN, VA, DE, OR, NJ
1980-81:	MD, IA, IN, MN, VA, DE, OR, NJ, IL

States included in All Other Total are:

1950-1974:	Same as All Other Processed and All Other Fresh
1975:	MA, MD, IA, ID, MN, VA, DE
1976-1981:	MD, IA, ID, MN, VA, DE

Source:

1950-1981:	USDA Statistical Reporting Service, *Vegetables for Fresh Market*, annual summaries.
1982-83:	Data from individual state crop reporting boards and extension service. USDA no longer reported asparagus production statistics.
1984 on:	U.S. Agricultural Statistics Board, *Vegetables*, annual summaries.

Appendix Table A5

California pack of canned asparagus estimated to be 300,000 actual cases or less beginning in 1979 (about 6.3 million pounds canned weight with an average of 21 pounds per case).

States included in East and Other are:

1950-1964:	NJ, MD, DE, other
1965-1978:	NJ, MD, DE, other, OR
1970:	NJ, MD, DE, other, OR, CA
1980-82:	NJ, MD, DE, other, OR, CA, IL

Converted from 24/303 at 23.4 pounds/case.

Northwest, Midwest, East and Other are calculated based on the regional percent of the total U.S. less California statistics of actual cases found in NFPA, *Canned Food Pack Statistics*, annual issues.

Source: Federal State Market News Service, *Marketing California Asparagus*, annual issues.

National Food Processors Association, *Canned Food Pack Statistics*, annual issues.

Appendix Table A6

Source: Federal State Market News Service, *Marketing California Asparagus*, annual issues.

American Frozen Food Institute, *Frozen Food Pack Statistics*, annual issues.

Conversations with Northwest Food Processors Association.

Appendix Table A7

Export/Import Values Converted from metric tons to pounds.

2204.622 lbs. = 1MT

Converted from cases of 24/303's to pounds.

23.4 pounds = 1 case of 24/303

Source: Bain, Beatrice and Sidney Hoos, *Asparagus - Processed and Fresh Market*, California Agricultural Experiment Station, Giannini Foundation, various issues.

USDA, Economic Research Service, *Vegetable Outlook and Situation*, monthly issues.

USDA, Economic Research Service, *U.S. Foreign Agricultural Trade of the United States*, monthly issues.

The Almanac of the Canning, Freezing and Preserving Industries, annual issues.

National Food Processors Association, *Canned Food Pack Statistics*, annual issues.

Federal State Market News Service, *Marketing California Asparagus*, annual issues.

Appendix Table A8

Import values converted from metric tons to pounds.

2204.622 lbs. = 1MT

Source: Federal State Market News Service, *Marketing California Asparagus*, annual issues.

American Frozen Food Institute, *Frozen Food Pack Statistics*, annual issues.

USDA, Statistical Reporting Service, Crop Reporting Board, *Cold Storage*, annual summary.

The Almanac of the Canning, Freezing and Preserving Industries, annual issues.

Wright, Mary L., "U.S. Imports of Fruits and Vegetables Under Plant Quarantine," USDA, ERS, International Economics Division, 1984 and 1985 issues.

U.S. Tariff Commission, *Conditions of Competition Between U.S. - Produced and Foreign-Produced Asparagus*, TC Publication 550, Washington, D.C., April 1973.

Appendix Table A9

Export/Import values converted from metric tons to pounds.

2204.622 lbs. = 1MT

Source: USDA, Statistical Reporting Service, *Vegetables for Fresh Market*, annual summaries.

USDA, Economic Research Service, *U.S. Foreign Agricultural Trade of the United States*, annual issues.

U.S. Tariff Commission, *Conditions of Competition Between U.S. - Produced and Foreign-Produced Asparagus*, TC Publication 550, Washington, D.C., April. 1973.

U.S. Tariff Commission, *Asparagus*, TC Publication 755, Washington, D.C., January 1976.

Appendix Table A10

Converted from pounds to cases to be consistent with methods of reporting foreign trade statistics.

30 pounds = 1 case of 24/2

Latin America data —

1959: Calculated from ratios of fiscal year quantities

1960-1978: Includes all North America except Canada

1979-1983: Includes Mexico and Latin America

Source: USDA, Economic Research Service, *U.S. Foreign Agricultural Trade of the United States*, annual issues.

USDA, Foreign Agriculture Service, *Data Relating to Foreign Trade in Fresh and Processed Vegetables*, May 1955, July 1966, December 1968.

Federal State Market News Service, *Marketing California Asparagus*, annual issues.

The Almanac of the Canning, Freezing and Preserving Industries, annual issues.

Appendix Table A11

KWCC = QWGCC/QWCC
KGCC = QGGCC/QGCC
KCC = QSGCC/QCC
KCO = KCN = KCME = QGCO/QCO
KCU = QGCU/QCU
KFC = QGFC/QFC
KFO = KFN = KFME = QGFO/QFO
KFU = QGFU/QFU

Source: Computed from Appendix Tables A4, A5, A6.

Appendix Table A12

Starting in 1964, the California Crop Reporting Service began measuring grower prices for canned and frozen vegetables at the processing plant door, rather than in the field as before. To make the total series more comparable, all prices for processing prior to 1964 were multiplied by a factor of 1.038. In addition, the total prices are a weighted average of the corrected processing prices and the fresh price. During the period 1964-67, California prices were measured at both the first delivery point and the processing plant door. The figure 1.038 is the average ratio of the two prices during 1964-1967.

Source: Bain, Beatrice, and Sidney Hoos, *Asparagus-Processed & Fresh Market*, California Agricultural Experiment Station, Giannini Foundation, various issues.

USDA, Statistical Reporting Service, *Vegetables for Fresh Market*, annual summaries.

California Crop and Livestock Reporting Service, *Asparagus for Processing*, annual issues.

Federal State Market News Service, *Marketing California Asparagus*, annual issues.

Appendix Table A13

Processed Prices prior to 1964 were adjusted to reflect the processing plant door level as indicated for California. See description for Appendix Table A12.

States included in Other Processed and Other Fresh are:

1950-52:	SC, MA, MD, OH, IA, IN, MN, VA, AR, DE, PA, MO, NY, NE, WI, ID
1953-58:	MA, MD, OH, IA, IN, MN, VA, AR, DE, PA, MO, NY, NE, WI, ID
1959-1963:	MA, MD, OH, IA, IN, MN, VA, AR, DE, PA, MO, NY, NE, TN
1964-68:	MA, MD, OH, IA, IN, MN, VA, AR, DE, PA, MO, TN
1969-1972:	MA, MD, OH, IA, IN, MN, VA, AR, DE, PA
1973:	MA, MD, OH, IA, IN, MN, VA, AR, DE
1974:	MA, MD, OH, IA, IN, MN, VA, DE
1975:	MA, MD, IA, ID, MN, VA, DE, OR, NJ
1976-79:	MD, IA, ID, MN, VA, DE, OR, NJ
1980-81:	MD, IA, ID, MN, VA, DE, OR, NJ, IL

States included in Other Total are:

1950-1974:	Same as Other Processed and Other Fresh
1975:	MA, MD, IA, ID, MN, VA, DE, OR
1976-1981:	MD, IA, ID, MN, VA, DE, OR

Source: Bain, Beatrice, and Sidney Hoos, *Asparagus-Processed & Fresh Market*, California Agricultural Experiment Station, Giannini Foundation, various issues.

USDA, Statistical Reporting Service, *Vegetables for Fresh Market*, annual summaries.

California Crop & Livestock Reporting Service, *Asparagus for Processing*, annual issues.

Federal State Market News Service, *Marketing California Asparagus*, annual issues.

Appendix Table A14

Source: *Pacific Fruit News*, San Jose, California, weekly issues.

Food Production/Management (formerly *Canning Trade*) Baltimore, MD, monthly issues.

The Food Institute Report, Report on Food Markets, American Institute of Food Distribution, Inc., Fair Town, NJ.

Appendix Table A15

Source:

1950-1972: *Quick Frozen Foods*, E. W. Williams Publications, New York.

1973-1985: *The Food Institute Report, Report on Food Markets*, American Institute of Food Distribution Inc., Fair Town, NJ.

Appendix Table A16

Canned Prices are converted from cases to pounds of actual product per case.

1 case of 24/300 = 21.1 pounds of actual product.

Frozen Prices are directly per pound of product weight in 10 oz. packages.

Source: USDL, Bureau of Labor Statistics, *Wholesale Prices and Price Indexes*, annual summaries.

USDL, Bureau of Labor Statistics, *Producer Price Indexes*, annual summaries.

Computed from Appendix Tables A14 and A15.

Appendix Table A17

$$RGCC = KGCC \cdot PGGCC$$
$$RCC = KCC \cdot PGCC$$
$$MACC = PPCC - RGCC$$
$$MCC = PPCC - RCC$$
$$RFC = KFC \cdot PGFC$$
$$MFC = PPFC - RFC$$

Source: Computed from Appendix Tables A11 and A16.

Appendix Table A18

Wage rate index is computed from *Farm Labor*, USDA, Statistical Reporting Service.

- 1950-1974: $/hour without room or board.
- 1975-1980: $/hour receiving cash wages only (excludes perquisites).
- 1981: Calculated using 1980 ratio of $/hour receiving cash wages only and field and livestock $/hour wage rates.
- 1982-1984: Calculated using average of 1979 & 1980 ratios fo $/hour receiving cash wages only and $/hour July rates of all hired workers.
- 1983: Linear interpolation of 1982 and 1984.

U.S. population is 50-state population including Armed Forces Overseas as of July 1.

Index of Processing Costs includes measures for labor for processing, packaging and containers, transportation services, short-term interest, services (community, water and sewage, rent, maintenance and repair, business services, supplies, property tax and insurance), fuel and power.

Source: Harp, Harry H. *The Food Marketing Cost Index*, USDA, ESCS, Technical Bulletin No. 1633, August 1980.

USDA, Economic Research Service, *Agricultural Outlook*, annual issues.

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Appendix Table A19

See variable definitions, Table V.2.

Appendix Table A20

See variable definitions, Table V.2.

Table III.2

MSPC = QGPC/QGPU
MSPN = QGPN/QGPU
MSPO = QGPTO/QGPU
MSRC = QGRC/QGRU
MSRN = QGRN/QGRU
MSRO = QGRTO/QGRU
MSC = QGC/QGU
MSN = QGN/QGU
MSO = QGTOT/QGU

Source: Computed from Appendix Table A3.

Table III.3

SQCC = QSGCC + QGPC
SQCN = (KCN · QCN) + (KCN · QCN + KFN · QFN)
SQCME = (KCME · QCME) + (KCME · QCME + KFME · QFME)
SQCU = QGCU + QGPU

Source: Computed from Appendix Table A3, A5, A6, A16.

Table III.4

MSCC = QCC/QCU
MSCN = QCN/QCU
MSCO = QCME/QCU
MSFC = QFC/QFU
MSFN = QFN/QFU
MSFO = QFME/QFU

Source: Computed from Appendix Tables A5 and A6.

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