1984

A supply response model for Iowa soybeans and net farm income implications

Mark S. Ash
Iowa State University

A supply response model for Iowa soybeans and net farm income implications

by

Mark Sheldon Ash

A Thesis Submitted to the
Graduate Faculty in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE

Department: Economics
Major: Agricultural Economics

Signatures have been redacted for privacy

Iowa State University
Ames, Iowa

1984

TABLE OF CONTENTS

CHAPTER 1. INTRODUCTION TO SOYBEAN AND SOYBEAN PRODUCT MARKETS

In order to understand the soybean sector in Iowa, one must abstract it from a much broader context. To analyze past behavior and future trends in Iowa, we must recognize that the state is merely one small, but integral, component in a soybean market that is international in scope. In the 1970s and 1980s, modern producers have become painfully aware of how dependent they are upon world trade, and that they are no longer insulated from the uncertainty of macroeconomic influences. So, it is against this background that our attention will be focused first.

The soybean industry has experienced phenomenal growth since 1945. Dominating this expansion has been the United States, which has increased its production over five times its postwar level. The U.S. currently accounts for about 65 percent of the world's supply of soybeans. The reasons for such a multiplication of output are legion, however, a few major causal factors can be readily identified (see Table 1.1).

The demand for soybeans is derived from the demand for the products of the crushing process, that is, soybean meal and soybean oil. Although some consumers use whole beans for food preparation (mainly in China and Japan), most consumption is in the form of meal and oil.

Soybean meal has become the more valuable component from the crushing process. It is used as a major source for the making of high-protein feed supplements for livestock and poultry. Since the demand for red meat and poultry has been on the increase in the developed countries,

Table 1.1. Soybeans: supply, disappearance, and price, U.S.[a]

Year beginning September 1	Supply			Disappearance					Price
	Beginning stocks	Production	Total	Crush	Total exports	Seed and residual	Total	Ending stocks	Season average received by farmers
	Million bushels								Dollars/bushel
1960	37	555	592	406	135	39	580	27	2.13
1961	27	679	706	431	149	47	627	78	2.28
1962	78	669	747	473	181	48	702	46	2.34
1963	46	699	745	437	187	54	678	67	2.51
1964	67	701	768	479	212	47	738	30	2.62
1965	30	846	876	537	251	52	840	36	2.54
1966	36	928	964	559	262	53	874	90	2.75
1967	90	976	1,066	576	267	57	900	166	2.49
1968	166	1,107	1,273	606	287	54	946	327	2.43
1969	327	1,131	1,458	737	433	60	1,228	230	2.35
1970	230	1,127	1,357	760	434	64	1,258	99	2.85
1971	99	1,176	1,275	721	417	66	1,203	72	3.03
1972	72	1,201	1,273	722	479	82	1,213	60	4.37
1973	60	1,548	1,608	821	539	76	1,437	171	5.68
1974	171	1,216	1,387	701	421	80	1,199	188	6.64
1975	188	1,548	1,736	865	555	67	1,491	245	4.92
1976	245	1,289	1,534	790	564	75	1,431	103	6.81
1977	103	1,767	1,870	927	700	82	1,709	161	5.88
1978	161	1,869	2,030	1,018	739	99	1,856	174	6.66
1979	174	2,268	2,442	1,123	875	85	2,083	359	6.28
1980	359	1,792	2,151	1,020	724	89	1,833	313	7.57
1981	318	2,000	2,318	1,030	929	93	2,052	254	6.05
1982	254	2,229	2,483	1,108	905	96	2,109	345	5.65

[a]Source: Statistics on oilseeds and related data, 1965-1982, USDA-ERS, Statistical Bulletin, 1983.

i.e., the U.S., Japan, and the European community, soybean meal has been much favored for its excellent protein content. Rising populations and growing real disposable incomes have been a major impetus for this greater meat consumption. In response to this demand, U.S. production of soybean meal rose by 156 percent between the years 1961 and 1982 (see Table 1.2).

The world has also seen a greater substitution from other oils and animal fatsto soybean oil consumption. The primary use for such oils is more directly linked to human diets, as they are used in cooking, salads, and margarines. The larger supply of soybean oil (up 149 percent during 1961-1982) is due to its joint production with soybean meal, for which demand has grown relatively faster. As a consequence, soybean oil has become comparatively cheaper with competing oils such as palm, coconut, and peanut oil. Even so, much of the U.S. oil production went unsold in commercial markets and was disposed of by concessionary sales to less-developed countries, namely through the Public Law 480 (Food for Peace) program. Oil exports under P.L. 480 rose from 282 million pounds in 1955 to a high of 831 million pounds in 1967 and generally accounted for more than half of total exports. But, by the early 1970s, commercial sales began to outstrip P.L. 480 exports. So, by 1981, commercial exports had increased over fivefold, reaching 1.740 billion pounds, whereas P.L. 480 exports have since fallen to 350 million pounds (see Table 1.3).

Change in the supply side of the market has been occurring, also. Yields per acre of soybeans have nearly doubled since World War II. This is a result of improved techniques of cultivation and irrigation, pest

Table 1.2. Soybean meal: supply, disappearance, and price, U.S.[a]

Year beginning October 1	Supply			Disappearance				Price
	Beginning stocks[b]	Production[c]	Total	Total exports	Domestic	Total	Ending stocks	44 percent protein, Decatur
	1,000 short ton							Dollars/ton
1960	83	9,452	9,535	590	8,867	9,457	78	60.60
1961	78	10,342	10,420	1,064	9,262	10,326	94	63.60
1962	94	11,127	11,221	1,476	9,586	11,062	159	71.30
1963	159	10,609	10,768	1,478	9,168	10,646	122	71.00
1964	122	11,286	11,408	2,036	9,266	11,302	106	70.20
1965	106	12,901	13,007	2,604	10,271	12,875	132	81.50
1966	132	13,483	13,615	2,657	10,820	13,477	138	78.83
1967	138	13,660	13,798	2,900	10,753	13,653	145	76.93
1968	145	14,581	14,726	3,044	11,525	14,569	157	74.12
1969	157	17,597	17,754	4,036	13,581	17,617	137	78.45
1970	137	18,035	18,172	4,559	13,467	18,026	146	78.51
1971	146	17,024	17,170	3,805	13,173	16,978	192	90.20
1972	192	16,709	16,901	4,558	12,160	16,718	183	228.99
1973	183	19,674	19,857	5,558	13,792	19,350	507	146.35
1974	507	16,702	17,209	4,299	12,552	16,851	358	130.86
1975	358	20,754	21,112	5,145	15,612	20,757	355	147.78
1976	355	18,488	18,843	4,559	14,056	18,615	228	199.80
1977	228	22,371	22,599	6,080	16,276	22,356	243	163.56
1978	243	24,354	24,597	6,610	17,720	24,330	267	190.06
1979	267	27,105	27,372	7,932	19,214	27,146	226	181.91
1980	226	24,312	24,538	6,784	17,591	24,375	163	218.18
1981	163	24,634	24,797	6,908	17,714	24,622	250	182.52
1982	250	26,714	26,964	7,109	19,306	26,415	474	187.40

[a]Source: Statistics on oilseeds and related data, 1965-1982, USDA-ERS, 1983.

[b]Stocks at processor plants.

[c]Includes production of millfeed (hull meal).

Table 1.3. Soybean oil: supply, disappearance, and price, U.S.[a]

Year beginning October 1	Supply			Disappearance				Price
	Beginning stocks	Production	Total	Total exports	Domestic	Total	Ending stocks	Crude, Decatur
	Million pounds							Cents/pounds
1960	308	4,420	4,728	721	3,329	4,050	677	11.30
1961	677	4,790	5,467	1,308	3,540	4,848	628	9.50
1962	628	5,091	5,709	1,165	3,624	4,789	920	8.90
1963	920	4,822	5,742	1,106	4,059	5,165	578	8.50
1964	578	5,146	5,724	1,339	4,086	5,425	297	11.30
1965	297	5,800	6,097	922	4,712	5,634	462	11.80
1966	462	6,076	6,538	1,077	4,865	5,942	596	10.13
1967	596	6,032	6,628	963	5,125	6,088	540	8.42
1968	540	6,531	7,071	870	5,786	6,656	415	8.42
1969	415	7,904	8,319	1,419	6,357	7,776	543	11.18
1970	543	8,265	8,808	1,743	6,292	8,035	773	12.84
1971	773	7,892	8,665	1,398	6,482	7,880	785	11.27
1972	785	7,501	8,286	1,066	6,704	7,770	516	16.46
1973	516	8,995	9,511	1,249	7,468	8,717	794	31.53
1974	794	7,375	8,169	1,028	6,580	7,608	561	30.69
1975	561	9,630	10,191	976	7,964	8,940	1,251	18.30
1976	1,251	8,578	9,829	1,547	7,511	9,058	771	23.87
1977	771	10,288	11,059	2,057	8,273	10,330	729	24.51
1978	729	11,323	12,052	2,334	8,942	11,276	776	27.15
1979	776	12,105	12,881	2,690	8,981	11,671	1,210	24.32
1980	1,210	11,270	12,480	1,631	9,113	10,744	1,736	22.73
1981	1,736	10,979	12,715	2,077	9,535	11,612	1,103	18.95
1982	1,103	12,041	13,144	2,025	9,858	11,883	1,261	20.60

[a]Source: Statistics on oilseeds and related data, 1965-1982, USDA-ERS, Statistical Bulletin 695, 1983.

control, and better strains of soybeans. Oil yields have gone up as well since 1945 with the introduction of mills using solvents in the separation process, in lieu of the older screw press method. And, to keep pace with the burgeoning demand for meal both here and abroad, domestic crushing capacity has expanded 323 percent since 1955.

The U.S. accounts for about 60 percent of the world's total harvested acreage, hitting a record 72.2 million acres in 1982. This is nearly double the acreage of 1960 and it represents the bulk of the increase in total world soybean acreage. Another major producer, China, has not increased its acreage much and has relied on imports from the U.S. and South America to satisfy its domestic needs.

World exports of beans and bean products amounted to 10.5 billion dollars in 1981, with the U.S. by far the most dominant exporter. Currently, about 80-85 percent of the beans, 30-40 percent of the soymeal, and 25-35 percent of the soyoil exports come from America, and account for about a quarter of the value of U.S. agricultural exports. However, some nations, such as Brazil and Argentina, have emerged as major rivals, especially in the soymeal market. Government assistance has enabled them to lure away customers who would have otherwise purchased from American sources.

The Soviet Union has had a significant impact on the export market. Although their own production has climbed, they still need imports to satisfy their desire to upgrade the diets of their citizens with more meat. In the late 1970s, the U.S. was the source of 60-90 percent of their imports. Such trade has not been uncontroversial, however.

Short domestic supplies and the invasion of Afghanistan have prompted embargoes on sales to the U.S.S.R. in 1973 and again in 1980, which have encouraged the Soviets and others to diversify their sources of supply and soften the impact of an American pullout from the market. China has also bought substantial quantities in the past decade, but U.S. sales there have dropped off recently due to political disagreements about American textile quotas and the Taiwan situation.

Recent economic developments have curtailed export trade somewhat. Stagnant economies, foreign debt problems, and the weakness of foreign currencies relative to the U.S. dollar has slowed the rapid growth of the 1970s. Our high interest rates are held responsible for keeping the dollar high and our exports more expensive to foreign customers. For example, although the Chicago cash soybean price in the first quarter of 1984 is nearly the same as three years earlier, the price paid in foreign currencies has risen 62 percent against the British pound, 30 percent versus the German mark, and ten percent over the Japanese yen.

Soybean meal exports have slumped in the last several years, and some of this may be due to foreign governments promoting the development of their own domestic soybean processing industries. They may do this through higher import tariffs on meal, export taxes and quotas on soybeans, or subsidies to both processors and exporters. Thus, these exports lure away customers for American soybeans and provide foreign soybean producers with a much needed means for obtaining foreign exchange, allowing them to purchase other imports and service their mounting debt costs on foreign loans.

Soybeans have not been a major focus of government programs to control supply. The tremendous growth in demand has not made intervention by the government necessary. But, farm policies have had a more indirect effect through their impact on crops that compete for the same land and resources as soybeans. These crops include corn, wheat, rice, and cotton. Price supports, diversion payments, acreage set asides, and Commodity Credit Corporation activities have all made a difference in the acreage allocation decision of the farmer.

The 1983 payment-in-kind program has had an indirect effect on soybean acreage. Since many soybeans are double cropped with winter wheat, which experienced reduced acreage when farmers agreed to idle land in exchange for government grain stocks, soybean acres also went down. In addition, producers who declined to participate in the program may have shifted from normal soybean acreage to corn, wheat, and cotton because they expected higher returns on those crops included in the program.

Iowa Soybean Sector

For many years, Iowa has been the second ranking soybean state, behind only Illinois with 12-13 percent of total U.S. acreage, 12-17 percent of total production, and 12-21 percent of all U.S. cash receipts from soybeans. Acreage planted to soybeans has risen from 25 percent of the total harvested acreage in Iowa during the early 1960s to 30 percent by 1982. Soybean acreage grew 224 percent over this period, an average 9.7 percent per year. Acreage declined in the years 1974-1976, but went on to reach new highs by 1982. In addition, Iowa's share of U.S. soybean acreage peaked in 1974 at 13.7 percent, but has since fallen due to increased production in the southern Delta states.

Soybean yield per harvested acre in Iowa increased 57 percent from a low 25.5 bushels in 1960 to 40.0 bushels in 1981. The drought of 1983 sharply cut yield to 34 bushels, a 15 percent drop from 1981. The Iowa average soybean yield declined by 18 percent in 1974, but returned to its trend level the following year when more normal weather conditions prevailed. Iowa's average yield is generally above the U.S. average by about 20 percent.

Total bean production went up by 40 percent during the past 25 years. Output dipped whenever acreage fell and weather disasters struck, such as 1974, 1976, and 1983 (see Table 1.4).

Season ending stocks in Iowa have generally trended upward since 1960, but are highly variable from year to year depending on the demand conditions. Total stocks fell to low points from 1970-1973 as prices began to pick up because of smaller world bean supplies. Stocks climbed to new heights after 1976, reaching 99.2 million bushels in the 1982 crop year, a 177 percent increase over the 1960 level.

Soybean crushings in Iowa mills expanded about 160 percent over the period, totaling 189.4 million bushels crushed by 1980. About half of Iowa's soybean crop is shipped outside the state to be crushed. Soybean meal production increased 171 percent to 4.3 million tons in 1982, and soybean oil output swelled to 1.95 billion pounds in 1982. Crushing yields did not significantly change over this period, as most mills had converted to using the solvent method of extraction by 1960.

Table 1.4. Soybeans: Iowa total supplies and relative to U.S.

	Iowa planted acreage (mil. ac.)	Iowa soybean yield (bu./ac.)	Iowa production (mil. bu.)	Year end total stocks (mil. bu.)	Iowa/U.S. acreage (%)	Iowa/U.S. yield (%)	Iowa/U.S. production (%)
1960	2.62	25.5	66.27	0.55	10.7	108.5	11.9
1961	3.43	28.5	97.04	24.79	12.3	113.5	14.3
1962	3.42	27.5	93.64	3.84	12.0	113.6	14.0
1963	3.59	30.5	109.04	11.30	12.2	125.0	15.6
1964	4.27	28.5	121.24	9.30	13.5	125.0	17.3
1965	4.86	26.0	126.10	5.97	13.8	106.1	14.9
1966	5.01	29.5	147.38	31.54	13.4	116.1	15.9
1967	5.36	27.5	144.27	58.66	13.1	112.2	14.8
1968	5.58	32.0	177.95	113.59	13.2	120.0	16.1
1969	5.63	32.5	177.13	86.26	13.2	118.6	15.6
1970	5.71	32.5	184.60	18.95	13.2	121.7	16.4
1971	5.52	32.5	178.75	12.87	12.7	118.2	15.2
1972	6.05	36.0	216.00	11.03	12.9	129.5	17.0
1973	7.70	34.0	260.10	36.95	13.6	122.3	16.8
1974	7.20	28.0	199.08	54.77	13.7	118.1	16.4
1975	7.00	34.0	236.98	73.39	12.8	117.6	15.3
1976	6.47	31.0	199.95	29.96	12.9	118.8	15.5
1977	7.10	35.5	251.34	46.23	12.1	116.0	14.2
1978	7.60	37.5	283.13	44.18	11.7	127.1	15.2
1979	8.20	37.5	306.38	66.51	11.4	116.5	13.5
1980	8.30	38.5	318.40	72.88	11.8	145.8	17.8
1981	8.20	40.0	326.00	74.40	12.0	132.9	16.3
1982	8.47	37.0	310.80	89.65	11.8	116.0	13.9

The season average soybean price received by Iowa farmers ranged from \$2.13 in 1960 to \$7.39 in 1980. A smooth upward trend during the 1960s suddenly gave way to volatile fluctuations of the 1970s. Prices soared 54, 38.5, and 21 percent in 1972, 1976, and 1980, respectively. Similar declines of 25, 19, and 25 percent were observed in 1975, 1977, and 1981. But, prices in Iowa tend to follow the U.S. average price closely. The largest variances from the U.S. mean were 8.5 percent above in 1972 and 4.2 percent below in 1974.

The soybean to corn price ratio is considered an important indicator for the acreage mix planted to each commodity. In the earlier years of the postwar period, this ratio had a range of 1.6-1.8. This changed generally by the 1970s to a ratio of about 2.0-3.0. An explanation for this may be a change in the relative costs of production between the two crops.

Iowa farmers received \$1.8 billion for sales of soybeans in 1982 (see Table 1.5). This represents 18 percent of the total cash receipts from all farm commodities and 43 percent of the cash receipts from crops in Iowa. Together, corn and soybeans account for 95-97 percent of all cash receipts from crops in the state. This is a 1,100 percent increase since 1960, but the cost of living has swelled considerably during the same period. So, real sales have risen by a still respectable 290 percent.

Crop production expenses have nearly tripled in the past 15 years, from \$2.30/bushel of soybeans in 1969 to \$6.76/bushel in 1983. Costs for equipment, hired labor, fertilizers and chemicals, and farmland have all

Table 1.5. Soybeans: Prices, sales, and receipts

	Iowa soybean ave. farm price ($/bu.)	Iowa soybean ave. support price ($/bu.)	Total soybeans sold (mil. bu.)	Total cash receipts (mil. $)	Iowa/U.S. price (%)	Iowa soybean/corn price (%)
1960	2.13	1.81	63.56	153.1	100.0	219.6
1961	2.28	2.26	94.27	169.8	100.0	209.2
1962	2.33	2.21	90.84	214.8	99.6	213.8
1963	2.44	2.21	106.11	248.3	97.2	232.4
1964	2.57	2.21	118.14	307.1	98.1	229.5
1965	2.61	2.21	123.03	264.4	102.8	231.0
1966	2.69	2.47	144.15	342.4	97.8	230.0
1967	2.50	2.47	141.04	353.9	100.4	247.5
1968	2.44	2.47	175.14	367.0	100.4	228.0
1969	2.36	2.21	174.61	405.6	100.4	212.6
1970	2.82	2.21	182.36	582.0	98.9	225.6
1971	3.07	2.21	175.76	529.1	101.3	295.2
1972	4.74	2.21	212.61	688.6	108.5	287.3
1973	5.65	2.22	252.65	1,081.6	99.5	219.0
1974	6.36	2.22	176.70	1,532.4	95.8	214.1
1975	5.09	2.22	234.85	939.7	103.5	203.6
1976	7.05	2.47	197.55	1,399.5	103.5	343.9
1977	5.92	3.47	248.58	1,395.3	100.7	297.5
1978	6.64	4.47	280.58	1,543.5	99.7	306.0
1979	6.17	4.47	303.92	1,877.3	98.2	255.0
1980	7.39	4.99	315.82	2,172.4	97.6	234.6
1981	5.88	4.98	322.74	2,051.8	97.2	244.0
1982	5.60	4.98	307.69	1,854.5	99.1	211.3

risen steadily. Fuel shortages, inflation, and high interest rates have all contributed to this spiral, although soybeans have been less affected than other more energy intensive crops. After years of constant price rises, many farmers anticipated continued increases and expanded their operations through purchases of new equipment and land. But, the Federal Reserve began its anti-inflation policy in 1979 and since that time farmers have been squeezed by high credit payments and stagnant farm prices.

Objectives

The specific objectives for carrying out this study are:

1) to specify a simultaneous equations system reflecting the supply and demand for soybeans, meal, and oil at the national level;

2) to generate an acreage response elasticity for Iowa given the parameters of the national model;

3) to estimate a cost function for Iowa and calculate net income from soybeans; and

4) to evaluate, within this framework, the impacts of changes in basic market relationships and government agricultural policies upon Iowa.

CHAPTER 2. THEORETICAL MODEL SPECIFICATION

Review of Relevant Literature

The first studies of soybean and related product markets began to take shape during the mid-1960s. Vandenborre's 1966 study induced a ten equation simultaneous model for soybean oil and meal demand. Using first differences and two-stage least squares, he found that the demand for oil and meal exports was less inelastic (-0.9 for oil, -0.58 for meal) compared to domestic demand (-0.45 for oil, -0.28 for meal).

Houck, Ryan, and Subotnik (1972) put together the first really comprehensive work on the domestic and foreign markets for the soybean complex. Their book brought together an historical analysis of the product markets and substitute products, with empirical work on regional acreage response, import demand, and impact multipliers of policy changes. Their econometric model has set a pattern for the formulation of later studies.

Heady and Rao (1965) estimated soybean acreage response and production supply functions for the major soybean producing states, including Iowa, and for the U.S. as a whole. They found that for a ten percent change in the soybean to corn price ratio, there was a corresponding 2.31 percent change in acreage in Iowa, compared to a 3.37 percent change in total U.S. acreage. In general, their results indicated that soybeans were influenced more by corn prices than those of other competing crops, such as cotton, wheat, oats, or hay.

Matthews et al. (1971) used a model with 13 simultaneous demand relationships and six regional acreage response functions. They discovered that a ten cent increase in the soybean price would increase total U.S. acreage by 628,000 acres, corn belt acreage by 255,000, and would reduce corn acreage by 987,000 overall and by 481,000 in the corn belt. They also estimated the impact of a devaluation of the U.S. dollar. Given a ten percent drop in the value of the dollar, one could expect a soybean price rise of 24 cents.

Meyers and Hacklander (1979) developed a 16 equation econometric model for bean, meal, and oil markets to determine the effects of a transformation in important market relations. Reduced form impact multipliers were generated for shifts in soybean yield, corn price, the exchange value of the dollar, the level of competing bean and meal exports, the level of high-protein animal units, and the disappearance of oil substitutes in the U.S.

Fryar and Hoskin (1981) also present six regional soybean acreage functions, using the deflated net returns from soybeans, corn, cotton, oats, and rice to predict the level of acreage response. They also implicitly assume an adaptive expectations approach by including lagged acreage in the equation. They estimate that a 50 cent decline in bean prices will reduce total acreage by 2.23 million, and a 30 cent rise in the corn price will lower acreage planted to soybeans by 2.6 million acres. Likewise, they figure that an increase in soybean and corn expected yields by ten bushels per acre will result in 702,000 more and 2.2 million acres less, respectively. Finally, they assume an increase in energy costs which would translate into a cost increase of $1.50/acre for soybeans and $2.85 for corn. The end result from this would be a net rise in bean acreage by 104,000 acres.

The model used in this study can be divided into two sections. The first part has a national focus and is similar to previous models in its examination of beans, meal, and oil with respect to their three distinct means of disposition: domestic disappearance, exports, and the demand for inventories. The second part concentrates on the Iowa market. By linking Iowa to the national model, we can generate an Iowa acreage response equation, determine soybean disposition within Iowa, and compute measures of net farm income from soybean farming.

Table 2.1 lists all 23 of the interrelated behavioral equations and market clearing identities for each commodity, where Appendices A and B contain the variable definitions and the actual data used in the model.

The following section explains each of the equations of the theoretical model and the reasons for the selection of the included elements.

U.S. Soybean Acreage

Equation (2.1) is a national acreage response function and is similar in form to that of Fryar and Hoskin (1981). Soybean acreage planted in the next year is thought to be influenced by the current profitability of soybeans, as well as the major rivals for farmland, corn, and cotton. The net returns from these crops are computed to be the current season average price received by farmers times the most

Table 2.1. Structure of the U.S. model[a]

SOYSAE = f(DSNRE1, DCORNRE, DCTNRE, CORPE1/SOYPE1, CORPD1/CORPF, $SOYSAE_{-1}$)	(2.1)
SOYSC = f(VLOM, SOYPM, CVSOY)	(2.2)
SOYHC = f(SOYPM/GNPD, SOYSC + SOYMX, SOYSPE, SOYHG, $SOYHC_{-1}$, CORPF/GNPD)	(2.3)
SOYPF = f(SOYPM, DUM72, D74)	(2.4)
SOMDDT = f(SOMPM, CORPF, LIVIF1, HPAUTST, FEEDHPS, D74, D79)	(2.5)
SOODDT = f(SOOPM/GNPD, LOG(CEN1/GNPD), COODD + FAODD + PAODD, BUTTLD, D76)	(2.6)
SOOHC = f(SOOPM/GNPD, SOOSP, SOOHCC + SOOPL, SOYSPE, $SOOHC_{-1}$, D80)	(2.7)
SOOXTOT = f(SOOPM/SDR, SOOPL, IRESDEV, $OESOYX_{-1}$)	(2.8)
SOYXTOT = f(SOYPM/SDR, VALOM/SDR, CORNXPS, LIVEPUJ1)	(2.9)
SOMXTOT = f(RSOMCOR, SHIFT79, FIMPW, LIVEPUJ1)	(2.10)
SOOPL = f(SOOPM, SOOSP)	(2.11)
SOYSPE = SOYSPE * SOYSAE * 0.98	(2.12)
SOYSC = SOYSP + $SOYHC_{-1}$ + $SOYHCC_{-1}$ - SOYMX - SOYHC - SOYDV	(2.13)
SOYMX = SOYXTOT + SOYXSC - (SOYMXBR-SOYMXBRS1) * 0.0367	(2.14)
SOMSP = SOYSC * SOMSC * 50	(2.15)
SOOSP = SOYSC * SOOSC * 100	(2.16)
SOMDDT = SOMSP + $SOMHT_{-1}$ - SOMMXES - SOMHT	(2.17)
SOMMXES = SOYXTOT - 1.1023 * SOMMXBR1	(2.18)
SOODDT = SOOSP + $SOOHC_{-1}$ + $SOOHCC_{-1}$ - SOOXES - SOOPL - SOOHC - SOOHCC	(2.19)
SOYHT = SOYHC + SOYHG	(2.20)
SOYCM = (SOMSC * SOMPM)/20 + (SOOSC * SOOPM) - SOYPM	(2.21)
SOOXPL = SOOXES + SOOPL	(2.22)
SOOXTOT = SOOXES + SOOXF	(2.23)

[a]Variable definitions in Appendix A.

recent three-year average yield, less the variable costs of production, and deflated by a general price index for that crop year. Policy variables are included to account for the effects of relative changes in the corn to soybean support prices, and a ratio of corn diversion payments to the corn price received by farmers. Increases in either ratio are expected to reduce soybean acreage planted. Lagged acreage acts as a method of incorporating technological inertia and trend into the function.

Crushing Demand

Equation (2.2) enumerates those factors considered to be important in the demand for the domestic crushing of soybeans. Since crush demand is derived from the demand for oil and meal, a weighted average of the value of the two products per bushel is calculated. The wholesale soybean price is the input cost to the processor, and an increase will reduce the margin and the quantity crushed. A physical constraint on the level of production in the short run is specified through the crushing capacity of U.S. mills.

U.S. Soybean Stocks

The components of demand for commercial stocks plus stocks under government loan are shown in equation (2.3). A rise in the deflated wholesale price for soybeans is expected to induce more supplies for current use and a smaller placement into inventories. Likewise, a drop in the bean price relative to the oil price should increase carryover stocks that will be later converted to oil and meal. The amount crushed plus bean exports provide a measure of the current demand, and stocks demand can be considered as a kind of residual demand. With an expected bean production variable, we can test whether speculation about bean prices plays a significant part in the decision to hold or release stocks. Government-owned stocks may counteract this same speculative activity by reducing the potential price volatility resulting from a shortfall in soybean production. We utilize lagged stocks as a proxy for long-term trend and as a fixed capital constraint for storage facilities. A deflated corn price variable is included to account for the substitution between the two crops as competition for storage space would decrease as the returns to corn increased. It is hypothesized that at harvest a relatively stronger corn price would reduce corn stocks and make it possible to withhold soybeans from immediate marketing.

U.S. Soybean Price Transmission

The season average price received by farmers is positively linked to the wholesale bean price in equation (2.4). Since farmers respond to the farm price in their acreage decisions and demand for soybean crush depends on the wholesale price, such a function is necessary to connect the two sectors in the model. Dummy variables are also included here for 1972 and 1974 to explain the sharp fluctuations in price during the marketing year.

Domestic Soybean Meal Demand

The function for soymeal disappearance is presented in equation (2.5). The quantity of meal demanded is largely determined by consumption in the livestock and poultry sectors. As a primary feed source, the corn price is negatively correlated to consumption of meal, which is used as a high-protein feed supplement. The soymeal price has the same inverse relationship. Consumption of high-protein feeds excluding fish and soymeal can be adequate substitutes for soymeal use. An index of livestock prices directly reflects the demand for fed cattle, hogs, and poultry, which in turn affects meal disappearance. We include a measure of livestock population for similar reasons.

Domestic Soybean Oil Demand

The domestic disappearance of oil depends inversely on the deflated oil price, along with the consumption of competing fats and oils. Among those considered here for the substitution effect are butter and lard, and cottonseed and palm oils. The income effect is captured by using the logarithm of real consumption expenditures on nondurable goods and services. This implies that as real income increases, the percentage change in oil consumption is positive, but decreasing. In order to improve the fit of the equation, a dummy variable for the year 1976 was also included. This function is symbolized in equation (2.6).

U.S. Soybean Oil Stocks Demand

The criteria for holding commercial oil inventories is closely related with the decision to hold bean stocks. Therefore, equation (2.7) resembles (2.3), having real oil price and expected soybean production affecting the level of speculative inventory holding. The current level of oil production requires a corresponding amount of stocks in order to meet current demand. The sum of CCC-owned oil stocks and donations to foreign countries under the P.L. 480 program is assumed to exert an offsetting impact on privately-held stocks. And, in order to incorporate a Nerlovian-type distributed lag for the adaptation between actual and desired stocks, we add stocks from the preceding period to the function.

Oil Exports Demand

Commercial shipments of soybean oil are specified in equation (2.8). Competing sources of soyoil from Argentina and Brazil are also included in the total. The level of world soyoil exports is not greatly affected by price, that is, it is very price inelastic. For the stronger income effect, we use the amount of international currency reserves held by nonpetroleum exporting, developing countries. This seems to be a better indicator of the importing country's (such as India and Iran) ability to pay. Another postulation is that concessions for soybean oil made under P.L. 480 will partially displace commercial exports. One can consider the oil equivalent of the last year's bean exports to be a perfect substitute for soyoil purchases, so a negative coefficient is expected for this variable.

Soybean Exports Demand

Equation (2.9) is a demand function for total world soybean exports. This includes shipments by the U.S., Brazil, and Argentina to the world, but excluding the U.S.S.R. and China. Since Western Europe and Japan currently account for about two-thirds of the world's imports of soybeans, we will focus on the factors of greater relevance to these developed nations.

The U.S. soybean price has been adjusted here for changes in the exchange rate of the dollar as denominated by the SDR rate, which is a market basket of currencies from the five most important exporting nations. Imported beans are crushed to meet the feed supplement requirements of the receiving nations, so having a measure of swine and poultry production in the European community and Japan ought to be a significant explanatory variable. Other demand shifters include: a weighted average of the value of U.S. corn and E.C. threshold prices for corn, and a value of soybean oil and meal component, adjusted for exchange.

Soybean Meal Exports

As in (2.9), the Common Market and Japan currently import approximately one-half of the world's soymeal exports. Equation (2.10) enumerates those factors deemed to be important. We use a ratio of the U.S. soymeal price adjusted for international exchange over a weighted average of world corn prices. This serves as a measure of the relative substitutability between meal and corn. In addition to these prices, there is the price of another major high-protein substitute, fish meal. The consolidation of the scale of hog and poultry production in the E.C. and Japan points out the derived nature of meal demand. And, lastly, for an unexplained reason, exports rose sharply from 1979 through 1982. So, an intercept shift is used to account for this phenomenon.

The remaining equations of the national block, (2.12)-(2.23), are identities defining the price relationships, physical transformations, and production disposition of all the product markets. It should also be noted that soybean meal stocks are considered exogenous in this model. Due to the perishable nature of meal, stocks are insignificant in size.

P.L. 480 Exports

An additional innovation to this analysis is an attempt to endogenize the level of soybean oil exports under the Public Law 480 program into the model. The underlying assumption for this is that government officials make their decisions with respect to current market conditions. Hence, one may expect that donations would increase when oil demand is weak and oil price relatively low, and vice versa. And, since the program is intended to reduce surplus oil supplies gone unsold in commercial markets, a positive correlation between U.S. oil production and P.L. 480 exports would be anticipated.

CHAPTER 3. IOWA SUBMODEL SPECIFICATION

Although several studies have looked at acreage response on a regional basis, none have attempted to recursively connect a major soybean producing state, such as Iowa, to a simultaneous national model. The purpose of this study is to further disaggregate to a state level and, hopefully, to get more reliable parameter estimates for the forecasting of the production decisions of Iowa farmers. It is far easier to maintain the assumption of homogeneity among Iowa farmers than it is for a much broader national average with respect to their planting decisions because of their similar circumstances with regard to weather conditions, output prices, and input costs, which vary considerably with geography. It also may be of some interest to trace through the disposition of soybeans within Iowa. What conditions will bring about greater inventory holding, or intra-state processing, or net exports to other states and nations? This model also seeks to examine the issue of how Iowa aggregate net farm income derived from soybeans has changed in the past, how it compares with other crops, and how it may be expected to fluctuate given shifts in certain important macroeconomic relationships.

The Iowa submodel contains 13 equations, some estimating demand and supply functions, others connecting the Iowa block recursively to the national model. The following section presents a discussion of each function from Table 3.1 (see Appendix A for the variable definitions). Figure 3.1 gives a schematic presentation of the relationships in the model.

Table 3.1. Structure of the Iowa submodel[a]

IASOYSAE =	f(IASNR, IACNR, CORPD1/IACORPF, CORPE1/IASOYPL1, $IASOYSAE_{-1}$	(3.1)
IASOYHC =	f(IASOYPF, IACORPF, IASOYSP, SOYHG, $IASOYHC_{-1}$)	(3.2)
IASOYSC =	f(IASOYPF, VALOM, $IASOYSC_{-1}$)	(3.3)
IASOYPF =	0.99 * SOYPF	(3.4)
IACORPF =	1.004 * CORPF	(3.5)
IASOYPL1 =	0.995 * SOYPE1	(3.6)
IASOYSD =	IASOYSP - IASOYUF	(3.7)
IASOYNX =	IASOYSD - IASOYSC	(3.8)
IASOYVS =	IASOYSD * IASOYPF	(3.9)
IASOYEXP =	SYVC * $IASOYSAE_{-1}$	(3.10)
IASOYNFI =	IASOYVS - IASOYEXP	(3.11)
IASOMSP =	IASOMSC * IASOYSC * 50	(3.12)
IASOOSP =	IASOOSC * IASOYSC * 100	(3.13)

[a]Variable definitions in Appendix A.

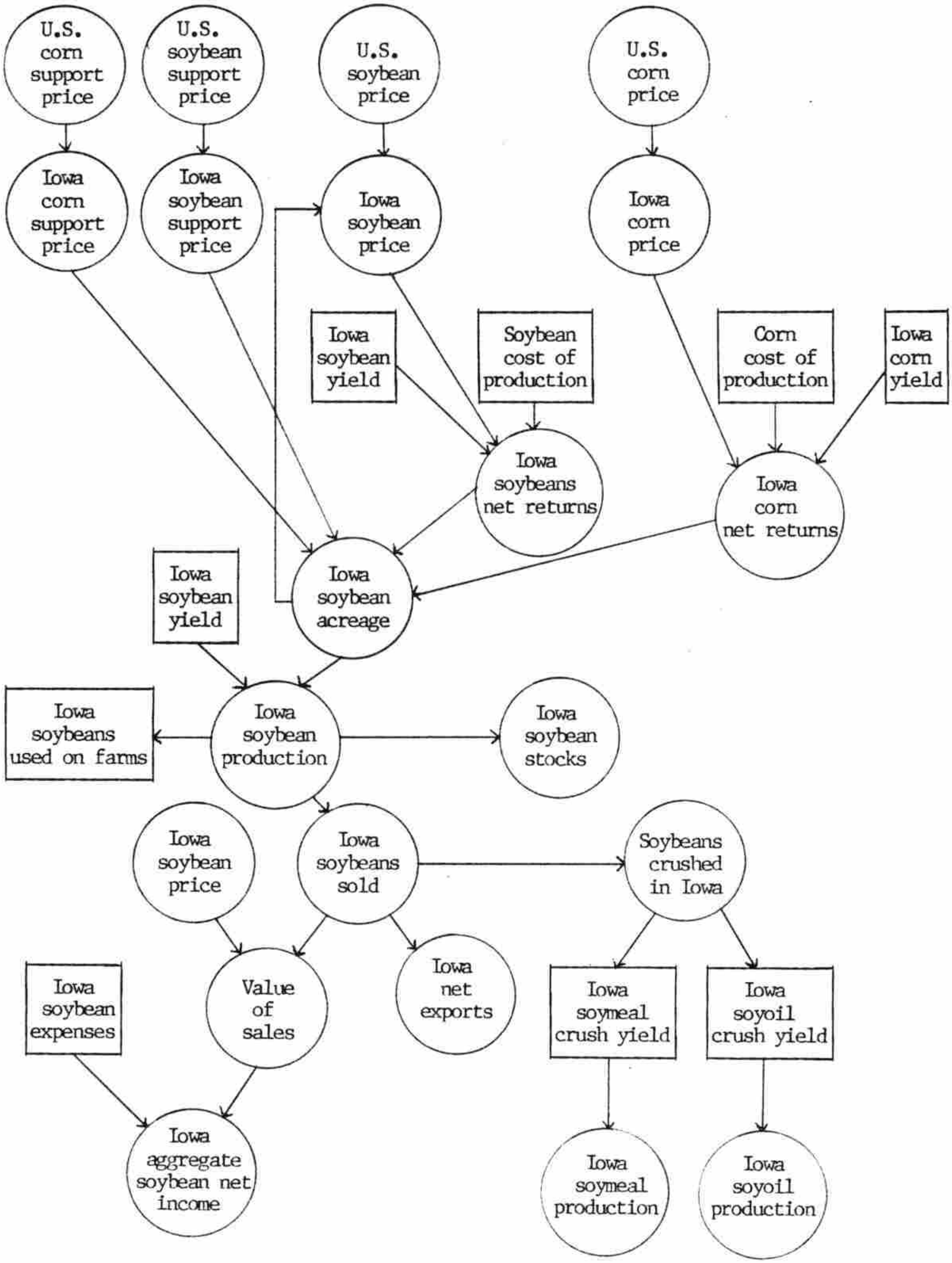

Figure 3.1. Flow chart of the Iowa submodel

Iowa Soybean Acreage

The first equation of the Iowa sector is shown by (3.1), which estimates the expected planted soybean acreage in Iowa. It is similar in nature to the U.S. equation, but uses Iowa prices and expected yields instead. The constituents of this equation are: the deflated net returns from both soybeans and corn, a ratio of corn to soybean support prices, a ratio of U.S. diversion payment to Iowa corn price, lagged acreage, and a dummy variable for 1972 to account for the large upward shift in that year.

Iowa Soybean Stocks

Equation (3.2) presents the factors thought to determine the amount of total stocks (including government-owned stocks held in Iowa). Soybean price is expected to be negatively correlated to stocks as farmers generally try to hold onto their supplies, speculating that their future returns will improve. Positive influences include: the Iowa corn price, since inventory holders will sell corn given a price rise and free up limited storage space; current soybean production in the state; total U.S. government stocks; and the previous period's carryover. It was not possible to separate stocks held in Iowa into privately held and government owned. The data were simply unavailable.

Iowa Crushing Demand

We may also be interested in the crushing industry within Iowa. This subject is examined in equation (3.3). The soybean price received by farmers is expected to have a depressing effect on crush since it is a cost to the firm. But, the value of oil and meal component represents the revenue received by the crusher and has a positive sign attached to it. As a proxy for trend and physical capacity constraints, crush in the previous year is included as an explanatory variable. Measures of the production of soybean meal and oil within Iowa are generated by equations (3.12) and (3.13), respectively.

Price Linkages

The bridge between the Iowa sector and the national sector comes through the price linkages in equations (3.4)-(3.6). The Iowa market prices for soybeans and corn are expressed as a proportion of the U.S. season average price which has been endogenously determined from the national model. Likewise, the Iowa support price for soybeans has been defined as a fixed percentage of the national effective support price. This rather simple approach assumes that prices are formed outside the state, i.e., Iowa is a price taker. This is not an unreasonable premise considering the international scope of the soybean trade.

Iowa Net Farm Income

The contribution from sales of soybeans to Iowa net farm income is estimated by equations (3.7)-(3.11). From the total production, we subtract the amount used on Iowa farms for purposes of seed and feed for livestock and get the quantity marketed. These sales can be broken down further into the portion crushed within the state, and that part that is exported to other states and countries for utilization. The model uses value of sales, i.e., quantity sold times season average price, as its estimate of gross cash receipts. The correlation between the two is quite close, and we lose little predictive ability by using value of sales. On the cost of production side, total expenses from soybean production are approximated by multiplying the national average variable cost of soybeans per acre times the Iowa planted acreage. The data on actual expenses do not exist, but the variable cost appears to be substantially correlated with changes in more broadly based price indices, such as the producer price index. Finally, the proxy for net income from soybeans is merely the difference between value of sales and total expenses.

CHAPTER 4. STATISTICAL MODEL

The following section discusses the assumptions and method of parameter estimation and simulation for this soybean model. The empirical work here concerns the sample period from 1961 to 1982. This time span is considered recent enough to be relevant, sufficiently long for us to have confidence in the statistical results, and displays substantial variation in the data to test the validity of the theoretical model. All of the annual data used in this paper are presented in Appendix B.

Assumptions of the Model

The regressions performed here follow the form of the classical linear regression model, for which the structural form can be briefly denoted in matrix form by:

$$Y\Gamma + XB = U \qquad (5.1)$$

where Y = T x M matrix of endogenous variables,

X = T x K matrix of predetermined variables,

U = T x M matrix of error terms,

B = K x M matrix of predetermined variable coefficients, and

= M x M invertible matrix of endogenous variable coefficients.

We can reformulate this system into a reduced form model by premultiplying (5.1) by Γ^{-1}, getting

$$Y + XB\Gamma^{-1} = \Gamma^{-1}U \tag{5.2}$$

and rewriting,

$$Y = X\Pi + V \tag{5.3}$$

where $\Pi = -B\Gamma^{-1}$ and $V = U\Gamma^{-1}$

The coefficients for the reduced form can be estimated using the ordinary least squares estimator, or

$$\Pi = (X'X)^{-1}X'Y \tag{5.4}$$

The underlying assumptions for the equations of the entire model are as follows:

1. Each function has a random error term with a normal distribution and expected value of zero, $E(U) = 0$.
2. the variance of the eror term is constant over all observations, i.e., the functions are homoscedastic, $E(U'U) = \sigma^2 In$.
3. The values of the error terms between two observations are considered independent, or have zero covariance.
4. The disturbance terms are uncorrelated with any of the regressors, $E(X'U) = 0$.
5. We have included only the relevant independent variables, which are nonrandom and measured without error.
6. The matrix of independent variables is of full rank, that is, there are no exact linear combinations between the variables.

7. The errors across equations are uncorrelated, $E(U_i'U_j) = 0$. If this is not the case, 2SLS is inefficient and the three-stage least square estimator has the smallest variance.
8. All equations are identified, or the number of basic endogenous variables included as regressors cannot be greater than the number of excluded exogenous variables plus any additional endogenous variables for each structural equation. Since the equations of this model are overidentified, the use of two-stage least squares makes for the proper number of instrumental variables for nine unique solution sets.
9. The number of instruments used in the first stage of two-stage least squares is assumed to be sufficient to insure identification and reduce the variance of the estimate, but less than the number of observations. Otherwise, the 2SLS estimator is really OLS, and, hence, inconsistent.

Estimation Procedure

The model is block recursive in structure. That is, the equations for the national block for beans, meal, and oil are solved simultaneously, and from which we can then derive solutions for the equations of the Iowa submodel. Use of ordinary least squares (OLS) for the national model would be inappropriate, because the simultaneous nature of the system would make OLS estimates biased and inconsistent. But, since the Iowa sector is recursive, it is justifiable to use least squares for these equations. To avoid simultaneous equations bias, the choice was made to estimate the parameters by means of nonlinear two-stage least squares (N2SLS). This procedure uses all available information and produces asymptotically unbiased parameter values, although it is less well known how the small sample properties of N2SLS compare to OLS. Some studies suggest N2SLS is better, and is less susceptible to problems such as multicollinearity. I have used the technique of principal components to provide us with an adequate, although arbitrary, number of instrumental variables, since there are more predetermined variables than there are observations. The principal components are chosen to maximize their correlation with the endogenous variables and, hence, reduce the correlation between exogenous variables and the error terms. This is the first stage of two-stage least squares, from which the instruments are then regressed using OLS.

The nonlinear estimation is performed using the Gauss-Newton method algorithm. This is an iterative linearization approach, where the nonlinear regression equation is given initial parameter values (from OLS) and repeatedly regressed until the coefficients converge, or do not vary significantly from their previous values. We then can proceed to make use of these parameters for both static simulation, employing the actual data for prediction, and for dynamic simulation, where the computed values are inserted into the equations. These estimates can then be compared to the time paths of simulations where key exogenous variables have been changed. Some of the multipliers of special interest for the soybean product markets are: the corn price, the general price level, the exchange rate, soybean yield, and government support prices.

Testing Assumptions of the Statistical Model

One of the necessary tests of the model's assumptions is for the presence of autocorrelation. If successive values of the disturbance term are positively or negatively correlated, as they may be over time, this would mean that our least squares estimators do not have minimum variance. Considering the temporal nature of the data, it would not be improbable to experience some difficulty here with this problem.

In order to detect the presence of serially correlated errors, the Durbin-Watson d-statistic has been computed and reported for each of the applicable equations. This test establishes intervals where an extreme value for the d-statistic suggests nonindependence of the error terms. The Durbin-Watson statistic is merely the sum of the squared differences in successive error terms divided by the sum of squared errors, or

$$d = \frac{\sum_{t=2}^{N} (U_t - U_{t-1})^2}{\sum_{t+1}^{N} U_t^2}.$$

As the number of observations increases to infinity, d approaches two. So, a Durbin-Watson value within fixed bounds about two would allow us to fail to reject the hypothesis of no serial correlation.

However, this test is inappropriate for the case of lagged dependent variables used as independent variables. This is the nature of several of the equations of this paper. Use of the Durbin-Watson statistic when a lagged dependent variable is used means that the test is less powerful and is biased towards two, hence, a conclusion of no serial correlation. Alternative tests such as the Durbin h may be used instead. The h-statistic is asymptotically, normally distributed with zero mean and unit variance, and is valid even for equations with lags of dependent variables that exceed one period. The h statistic is defined as

$$h = (1 - \frac{d}{2}) \left[\frac{N}{1 - N[Var(\beta)]}\right]^{1/2} .$$

This test breaks down if the number of observations times the variance of the coefficient of the lagged dependent variable is greater than one. In the event of this happening, we may employ another procedure where we regress the OLS residuals on the lagged residuals and observe whether the coefficient form this regression is significantly different from zero.

Validation of the Simulation Model

The preliminary specification of the model has been based upon the results of individual OLS regressions. Variables considered to have some explanatory effect were used and evaluated with respect to their level of significance (t-value), coefficient of determination (R^2), mean square error (MSE), and Durbin-Watson statistic (d). We should also examine how well the multi-equation model performs overall. A number of criteria have been developed to gauge the ability of the simultaneous equations model to track the historical data.

The root mean squared error (RMSE) is the average deviation of the simulated from actual values over time, or

$$RMSE = \left[\frac{1}{N} \sum_{t=1}^{N} (Y_t^s - Y_t^a)^2 \right]^{1/2} .$$

Since the value of RMSE is dependent upon the units used for the variable, a more informative approach is the root mean squared percent error (percent RMSE). This statistic states the deviation in a proportional form, making it easier to compare results between variables, or

$$\% \ RMSE = \left[\frac{1}{N} \sum_{t=1}^{N} \frac{(Y_t^s - Y_t^a)}{Y_t^a}^2 \right]^{1/2} .$$

So, a value close to zero for root mean squared percent error would be highly desirable.

Theil's inequality coefficient U presents us with another method to analyze the validity of the model's structure. The root mean squared error has been standardized so that the inequality coefficient lies between zero and unity, where a score of zero means all of the simulated values equal the actual, and a value of one means the simulated values are always the opposite sign of the actual observations. The inequality coefficient can be expressed as

$$U = \frac{\left[\frac{1}{N} \sum_{t=1}^{N} (Y_t^s - Y_t^a)^2 \right]^{1/2}}{\left[\frac{1}{N} \sum_{t=1}^{N} (Y_t^s)^2 \right]^{1/2} + \left[\frac{1}{N} \sum_{t=1}^{N} (Y_t^a)^2 \right]^{1/2}} .$$

This expression can in turn be split into three parts. They are defined as follows:

1. A proportion accounted by bias, which is the difference between the means of the actual and forecast values, or

$$U^M = \frac{(\overline{Y}^s - \overline{Y}^a)^2}{\frac{1}{N}\sum_{t=1}^{N}(Y_t^s - Y_t^a)^2}.$$

This is a measure of systematic error, and we would like it to be as small as possible.

2. A variance component contrasts the variability of the simulated values with the fluctuations of the actual data. This proportion is denoted by

$$U^s = \frac{(\sigma_s - \sigma_a)^2}{\frac{1}{N}\sum_{t=1}^{N}(Y_t^s - Y_t^a)^2}.$$

This component gives us an idea of how well the model predicts turning points. It also should be close to zero.

3. An unsystematic error component represents the randomness of the errors after the first two inequality proportions have been accounted for. It can be denoted by

$$U^c = \frac{2(1-\rho)\sigma_s\sigma_a}{\frac{1}{N}\Sigma(Y_t^s - Y_t^a)^2}$$

where ρ is the correlation coefficient and σ_s and σ_a are the standard deviations for the simulated and actual values, respectively. Hopefully, U^c will account for most of the simulation error.

CHAPTER 5. ESTIMATION AND VALIDATION OF RESULTS

In this chapter, the estimated coefficients from the system are presented in Table 5.1, as well as measures of their statistical significance and a simulation of the historical data. The equations from Chapters 2 and 3 have been calculated by nonlinear two-stage least squares. The parameters derived from this procedure are then used to make a base simulation. The t-statistics are placed in parentheses below their coefficients, and elasticities at the mean are put into brackets. The results of the OLS regressions for the Iowa sector are similarly listed in Table 5.2. The variable definitions are in Appendix A.

Evaluation of the Estimated Equations

Overall, the model produces statistically significant relationships and reasonable signs and sizes of the coefficients. The price elasticities are generally close to values found by previous studies, and support some conclusions others have made with regard to the relative sizes of elasticities of domestic, export, and inventory demands for beans, meal, and oil. Tests of the null hypothesis of no autocorrelation were either inconclusive or a failure to reject, except in the case of the Iowa soybean crushing equation. Since this equation is not a central issue of this study, the problem will be ignored here.

The acreage equations for the U.S. and Iowa suggest that Iowa farmers are less price responsive than all farmers on average. An increase in soybean net returns of ten percent will induce a positive 1.7

Table 5.1. Coefficients for the U.S. model[a]

	R^2	D.W.
U.S. soybean acreage		
(1) SOYSAE = 9.08 + 0.283 DSNRE1 - 0.137 DCORNRE - 0.072 DCTNRE - 9.60 $\frac{\text{CORPE1}}{\text{SOYPE1}}$		
(3.49) (8.81)** (-7.48)** (-5.28)** (-2.00)		
[0.35] [-0.16] [-0.09] [-0.08]		
-11.27 $\frac{\text{CORPD1}}{\text{CORPF}}$ + 0.857 SOYSAE_{-1}	0.992	2.10
(-3.04)* (22.01)**	h = -0.004	
[-0.03] [0.83]		
U.S. soybean crushing[b]		
(2) SOYSC = 80.0 - 316.1 SOYPM + 280.3 VALOM + 0.779 CVSOY	0.993	1.39
(1.98) (-4.35)** (4.13)** (9.31)**		
[-1.94] [1.82] [1.00]		
U.S. soybean stocks		
(3) SOYHC = -120.0 - 26.0 $\frac{\text{SOYPM}}{\text{GNPD}}$ + 0.218 SOYSCMX - 0.074 SOYSPE - 0.159 SOYHG		
(-2.18)(-1.70) (5.36)** (-1.54) (-1.25)		
[-0.75] [1.99] [-0.74] [-0.04]		
+ 0.326 SOYHC_{-1} + 99.97 $\frac{\text{CORPF}}{\text{GNPD}}$	0.921	1.62
(2.28)* (2.82)*		
[0.29] [1.13]		
U.S. soybean price linkage		
(4) SOYPF = -0.073 + 0.964 SOYPM - 1.55 DUM72 + 0.616 D74	0.997	1.68
(-1.08) (68.9)** (-12.3)** (4.86)**		
[1.03]		

*Significant at a five percent level.

**Significant at a one percent level.

[a]Variable definitions in Appendix A.

[b]For regression on residuals, $\hat{\varepsilon}_t = \alpha + \rho^*\hat{\varepsilon}_{t-1} + \beta^* y_{t-1} + \gamma^* x_t$, the t-value for ρ^* is 0.98, hence autocorrelation is not present.

[c]For regression on residuals, $\hat{\varepsilon}_t = \alpha + \rho^*\hat{\varepsilon}_{t-1} + \beta^* y_{t-1} + \gamma^* x_t$, the t-value for ρ^* in -0.09, hence autocorrelation is not present.

Table 5.1. continued

	R^2	D.W.
U.S. soybean meal disappearance		
(5) SOMDDT = -3,988 - 23.2 SOMPM + 1,097.9 CORPF + 4,293.7 LIVIF1 + 140.2 HPAUTST (-0.960) (-3.48)** (2.31)* (4.09)** (4.81)** [-0.22] [0.15] [0.50] [1.45] - 1.19 FEEDHPS - 2,412.8 D74 + 2,223.4 D79 (-3.70)** (-2.38)* (3.15)** [0.59]	0.975	1.36
U.S. soybean oil disappearance		
(6) SOODDT = -24,305.2 - 72.94 $\frac{SOOPM}{GNPD}$ + 5,878.8 LOG ($\frac{CEN1}{GNPD}$) - 0.781 FATOIL - 1.56 BUTTLD (-2.66)(-3.56)** (5.24)** (-2.41)** (-3.33)** [-0.16] [5.73] [-0.18] [-0.72] - 706.2 D76 (-2.73)**	0.780	2.38
U.S. soybean oil stocks[c]		
(7) SOOHC = 579.6 - 17.3 $\frac{SOOPM}{GNPD}$ + 0.160 SOOSP - 0.513 SOOHCPL - 0.578 SOYSPE (1.54)(-1.52) (6.05)** (-1.89) (-3.68)** [-0.32] [1.68] [-0.37] [1.01] + 0.247 $SOOHC_{-1}$ + 704.1 D80 (1.79) (4.58)** [0.24]	0.886	1.94
World soybean exports		
(8) SOYXTOT = -439.1 - 179.5 $\frac{SOYPM}{SDR}$ + 150.3 $\frac{VALOM}{SDR}$ + 2.81 CORNXPS + 591.7 LIVEPUJ1 (-9.67) (-2.76)* (2.55)* (1.83) (5.70) [-1.44] [1.28] [0.48] [1.55]	0.966	2.35

Table 5.1. continued

Equation	R^2	D.W.
World soybean meal exports		
(9) SOMXTOT = -3,973.1 - 4,655.1 RSOMCOR + 4,360.2 SHIFT79 + 20.94 FIMPW (-1.75) (-2.72)* (5.22)** (2.82)* [-0.74] [0.66] + 8,706LIVEPUJ1 (6.27)** [1.47]	0.980	1.38
World soybean oil exports		
(10) SOOXTOT = 804.5 - 25.1 $\frac{\text{SOOPM}}{\text{SDR}}$ - 0.817 SOOPL + 0.106 IRESDEV - 0.174 OESOYX_{-1} (0.95)(-0.589) (-0.921) (9.69)** (-1.42) [-0.15] [-0.18] [1.36] [-0.35]	0.977	1.81
P.L. 480 exports		
(11) SOOPL = 693.8 - 27.8 SOOPM + 0.04 SOOSP (8.62)(-6.52) (3.01) [-0.85] [0.59]	0.715	1.61

Table 5.2. Estimated equations for Iowa[a]

<u>Iowa soybean acreage</u>

$$(1)\ \text{IASOYSAE} = \underset{(1.11)}{0.24} + \underset{\substack{(4.44)^{**} \\ [0.17]}}{0.013}\ \text{IASNR} - \underset{\substack{(-5.77)^{**} \\ [-0.11]}}{0.010}\ \text{IACNR} - \underset{\substack{(-1.62) \\ [-0.08]}}{1.07}\ \frac{\text{CORPE1}}{\text{IASOYPL1}} + \underset{\substack{(27.66)^{**} \\ [0.97]}}{1.01}\ \text{IASOYSAE}_{-1} + \underset{(4.65)^{**}}{1.16}\ \text{DUM72}$$

$R^2 = 0.988$, D.W. = 1.99, h = 0.053

<u>Iowa soybean stocks[b]</u>

$$(2)\ \text{IASOYHC} = \underset{(-3.63)}{-30.6} - \underset{\substack{(-1.99) \\ [-0.76]}}{7.94}\ \text{IASOYPF} + \underset{\substack{(3.23)^{**} \\ [1.20]}}{30.83}\ \text{IACORPF} + \underset{\substack{(2.71)^{*} \\ [0.92]}}{0.205}\ \text{IASOYSPE}_{-1} + \underset{\substack{(6.40)^{**} \\ [0.21]}}{0.323}\ \text{SOYHG} + \underset{\substack{(0.94) \\ [0.09]}}{0.105}\ \text{IASOYHC}_{-1}$$

$R^2 = 0.894$, D.W. = 1.15

<u>Iowa soybean crush[c]</u>

$$(3)\ \text{IASOYSC} = \underset{(0.53)}{5.12} - \underset{\substack{(-1.53) \\ [-0.37]}}{10.19}\text{IA SOYPF} + \underset{\substack{(2.04)^{*} \\ [0.45]}}{10.99}\ \text{VALOM} + \underset{\substack{(6.18)^{**} \\ [0.88]}}{0.917}\ \text{IASOYSC}_{-1}$$

$R^2 = 0.905$, D.W. = 2.32

<u>Iowa price linkages</u>

$$(4)\ \text{IASOYPF} = \underset{(0.69)}{0.05} + \underset{(61.7)^{**}}{0.987}\ \text{SOYPF}$$

$R^2 = 0.995$, D.W. = 1.64

$$(5)\ \text{IACORPF} = \underset{(-1.45)}{-0.04} + \underset{(70.9)^{**}}{1.002}\ \text{CORPF}$$

$R^2 = 0.996$, D.W. = 2.08

$$(6)\ \text{IASOYPL} = \underset{(-0.16)}{-0.01} + \underset{(88.7)^{**}}{0.994}\ \text{SOYPE}$$

$R^2 = 0.998$, D.W. = 2.10

*Significant at a five percent level.

**Significant at a one percent level.

[a] Variable definitions in Appendix A.

[b] t-value of ρ^* is -0.78, hence we conclude no autocorrelation is present.

[c] t-value of ρ^* is 2.29, hence we can conclude autocorrelation is a problem.

percent change in acreage planted in Iowa, whereas nationally a 3.5 percent acreage increase would occur, assuming all other effects are held constant. Notice also that for the Iowa equation the corn diversion variable was omitted, since a negative coefficient could not be achieved for that equation.

Iowa crushing firms also appear to be less influenced by changes in their input and output prices than the U.S. industry as a whole. Iowa crushers respond to a ten percent increase in the value of oil and meal by crushing an additional 4.5 percent, compared to 18.2 percent expansion by the industry. The two-stage least squares estimates were used in place of the nonlinear parameters in this case, as the price elasticities from the nonlinear approach were unreasonably low.

The effect of soybean prices on Iowa and national inventory holdings seems to be roughly comparable. However, the price elasticities are considerably more inelastic than estimates achieved in other studies, such as the elasticity of -2.29 found by Meyers and Hacklander (1979). This result may impair the model's forecasting precision, and the discrepancy may be due to the different periods covered by the studies and the use of a corn price effect.

The price linkages between U.S. farm and wholesale levels and Iowa farm and U.S. farm prices have strong statistical relationships between them evidenced by the very high correlation coefficients and parameter values of near unity.

The domestic meal demand function gives results remarkably similar to that of Meyers and Hacklander (hereafter M&H) and Vandenborre (1966).

Their respective estimates of -0.21 and -0.28 concur with the meal price elasticity computed in this model.

U.S. soybean oil disappearance is predicted to decrease 1.6 percent for every ten percent increase in the real oil price, which is considerably smaller than Vandenborre's -4.5 percent, but larger than the -0.6 percent of M&H. The real income effect for this equation is much stronger than the latter study's income elasticity of 1.10.

The major determinant of changes in oil stocks is the level of oil production, with a positive elasticity of 1.60. The real oil price elasticity is smaller, being -0.32 here and -0.39 in the M&H study.

World soybean exports are quite sensitive to price shifts in soybeans and soybean products as well as corn prices. The evidence from equation (8) in Table 5.1 implies that given all other things equal, a ten percent increase in currency adjusted bean price will reduce exports 14.4 percent. Baumes and Meyers (1980) have a similar total bean export equation, but find a higher -19.9 percent effect.

World demand for soymeal exports can be seen to depend substantially on the livestock production of the developed nations of Europe and Japan. The model also reports an elasticity of -0.74 for the ratio of soymeal price to the average world corn price. This tends to support the assertion that export demand is less inelastic than domestic demand.

The price elasticity of demand for oil exports is rather small at -0.15 and not significant at a five percent level, and would indicate that exports are no more price responsive than domestic demand. The coefficient on P.L. 480 exports implies a substantial tradeoff between donations and commercial exports. The international reserves of developing countries variable is somewhat crude, but appears to be an important factor.

Equation (11) in Table 5.1 does surprisingly well in predicting P.L. 480 exports using just soybean oil prices and production. As expected, a ten percent rise in soybean oil prices would reduce the amount donated by 8.5 percent.

Table 5.3 lists the statistics of fit from the basic dynamic simulation. All of the root mean square percent error terms are less than one, except for the crushing margin and oil exports. The individual endogenous variables track the historical data quite well using this model, or at least better than one might predict by a random guess. Figures 5.1-5.6 give a visual depiction of how well certain important endogenous variables such as bean, meal, and oil prices compare to their simulated values. As you can seen, some variations arise between the years 1979 and 1981.

Table 5.4 presents Theil's inequality coefficients and their decomposition into the three components of bias, variance, and covariance. Fortunately, all of the variables have relatively small measures of systematic error or bias. However, the crushing margin still does not appear to do as well, as witnessed by the large accuracy indicator. This may render some of our results less accurate than desired.

Table 5.3. Statistics of fit

Variable	N	RMS error	RMS % error
IASOYEXP	22	11.7204	0.0331907
IASOYSD	22	8.44123	0.0399334
IASOYPL1	22	0.0528146	0.0215382
IACORPF	22	0.0452635	0.0248977
DCTNRE	22	0.000062723	9.576E-07
DCORNRE	22	0	0
SOMSP	22	960.451	0.0477022
SOMPM	22	19.216	0.123241
SOMXTOT	22	741.316	0.211658
SOYPM	22	0.855979	0.17311
SOYHC	22	49.682	0.629899
SOOXES	22	308.446	1.7536
SOYXTOT	22	39.6948	0.108657
SOODDT	22	252.971	0.0501198
SOYPF	22	0.799394	0.172601
SOMDDT	22	601.839	0.0456167
SOYSC	22	40.6291	0.0478721
SOYSPE	22	95.8063	0.07329
SOYHT	22	49.4854	0.340397
SOYMX	22	39.6844	0.110638
SOMMXES	22	741.318	0.234907
SOOXTOT	22	308.446	0.422423
DSNRE1	22	16.1554	0.287342
SOOSP	22	450.039	0.0489314
SOOHC	22	154.739	0.206719
SOOPL	22	182.086	0.421505
SOOPM	22	4.97965	0.312266
SOYSAE	22	3.57341	0.0740883
IASOYPF	22	0.805753	0.171277
SOOXPL	22	303.635	0.223161
OESOYX	22	432.74	0.108657
SOYCM	22	0.162837	0.9618
IASOYSC	22	14.7295	0.12941
IASOYVS	22	185.788	0.148334
IASOOSP	22	164.534	0.12941
IASOMSP	22	368.939	0.12941
IASOYHC	22	13.5371	0.58774
IASOYNX	22	16.9313	0.274728
IASOYSAE	22	0.222713	0.03448
IASOYNFI	22	193.191	0.227731
IASOYSPE	22	8.4463	0.039313

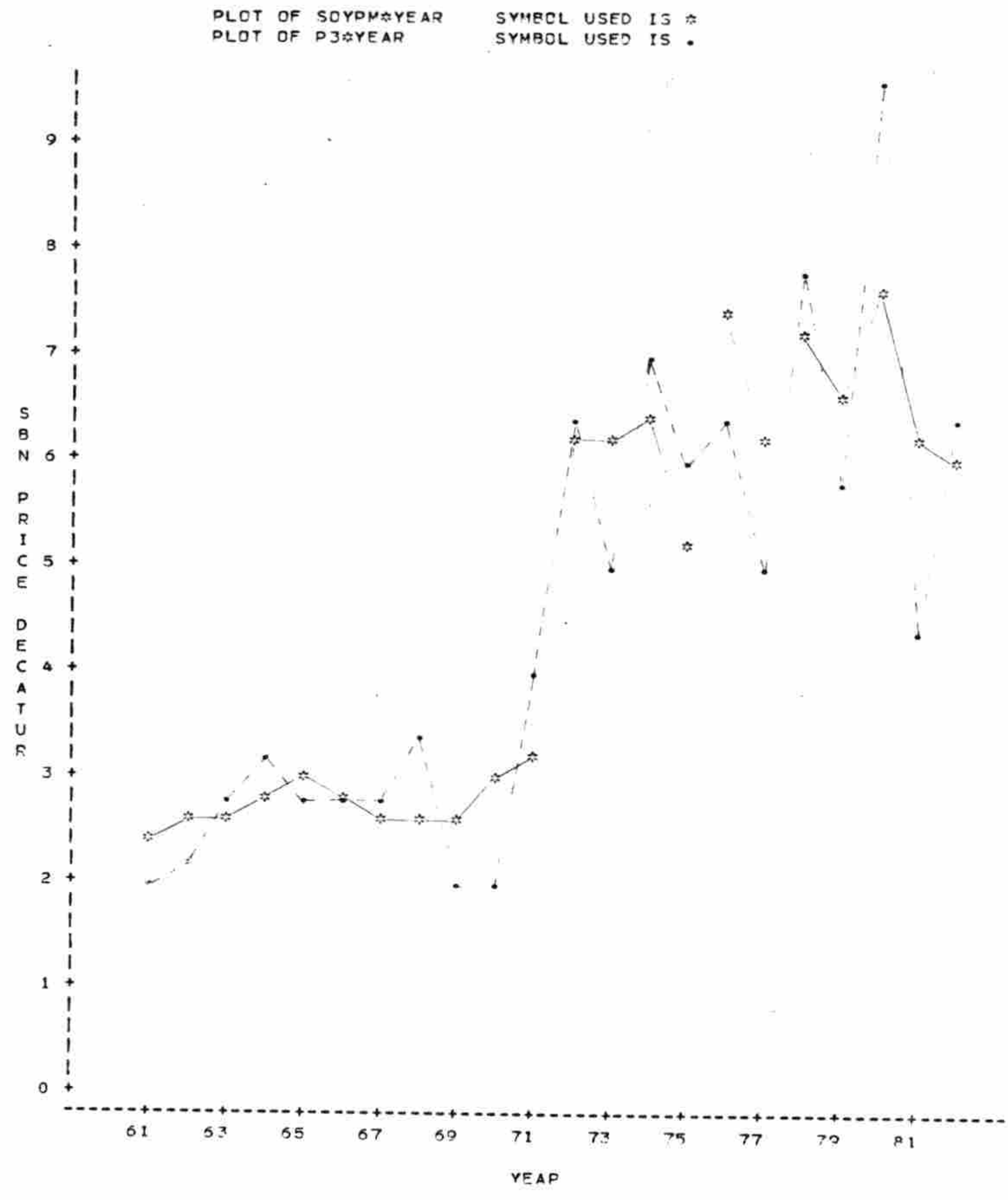

Figure 5.1. Plot of predicted vs. actual wholesale soybean price

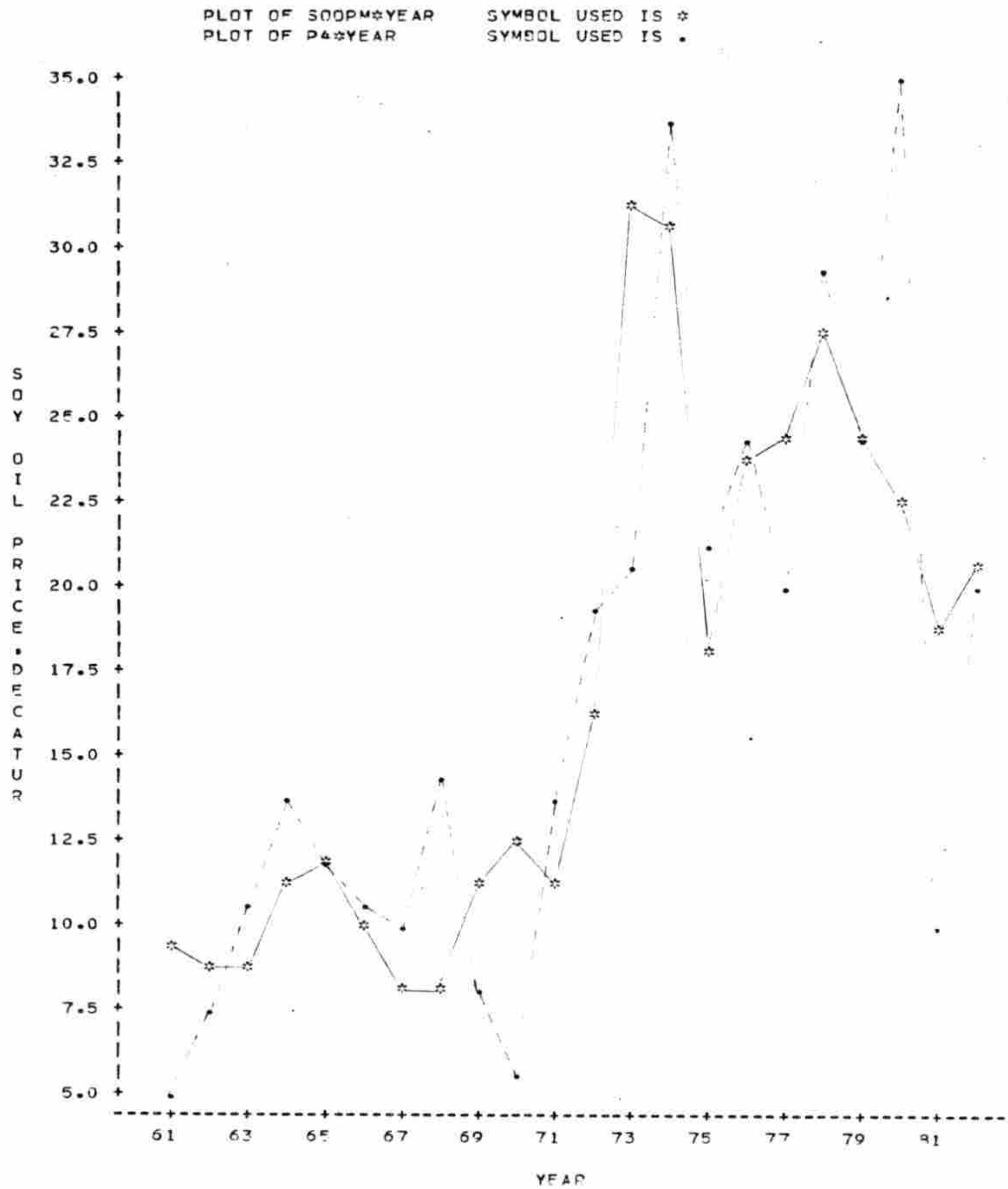

Figure 5.2. Plot of predicted vs. actual soybean oil price

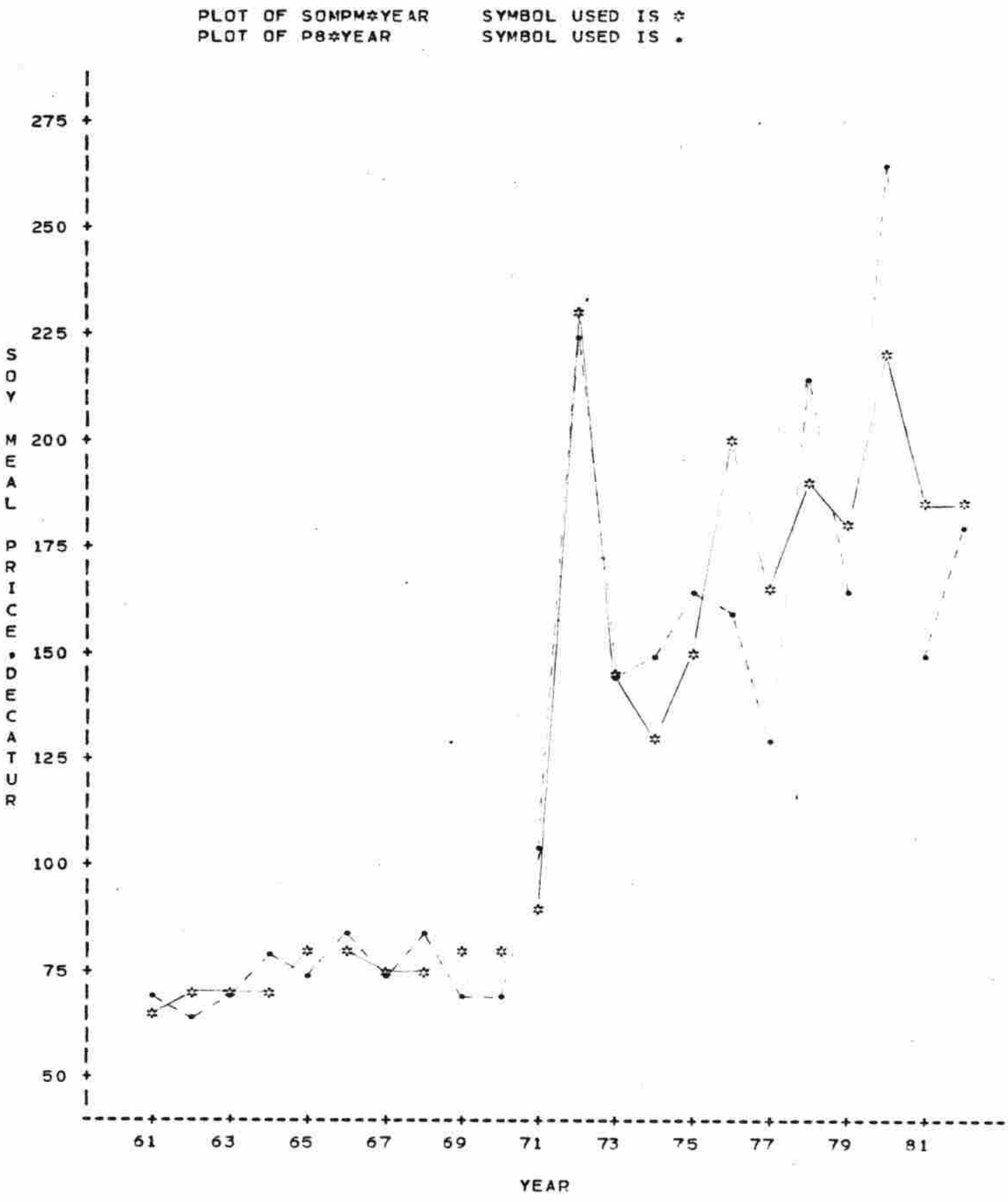

Figure 5.3. Plot of predicted vs. actual soybean meal price

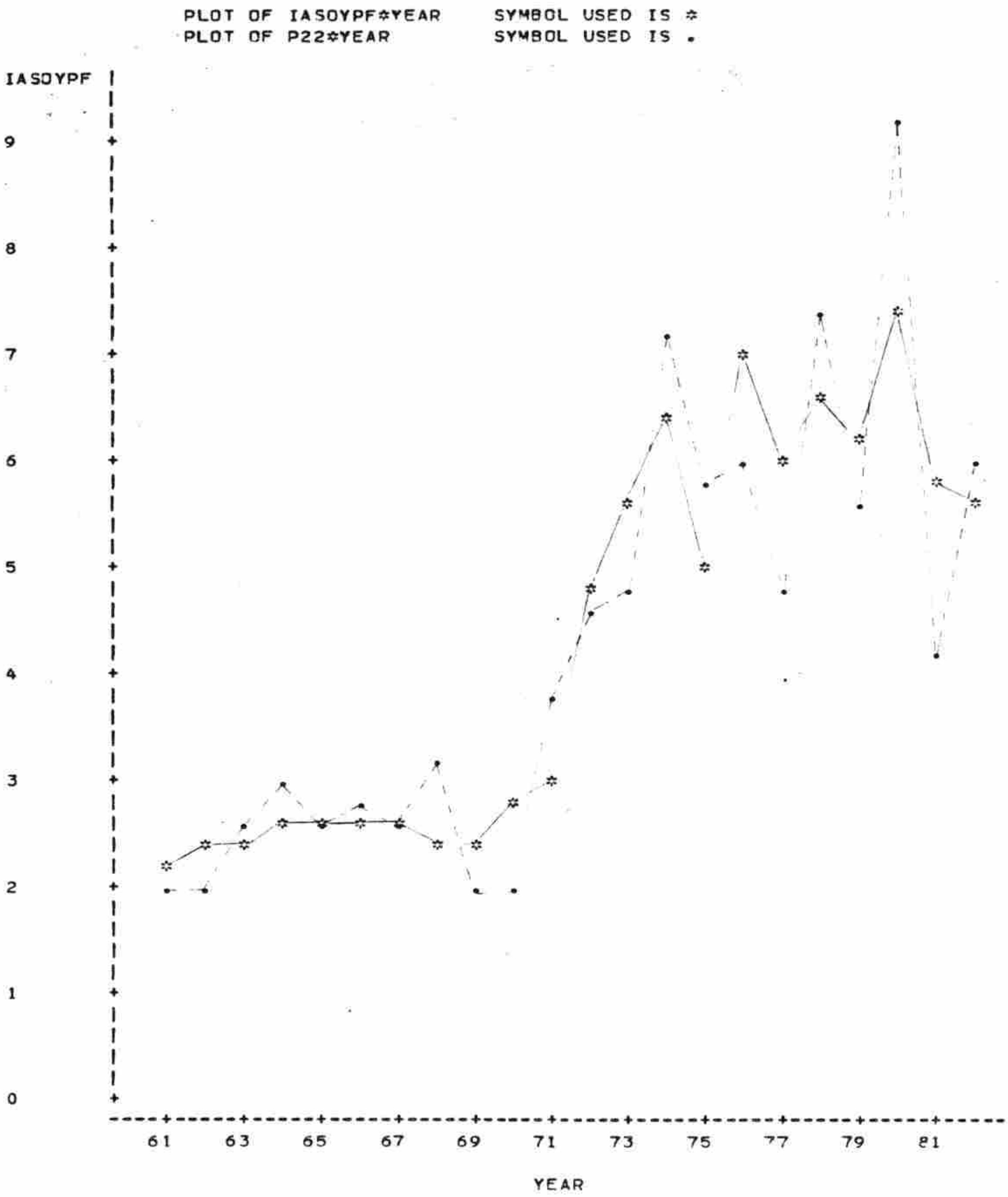

Figure 5.4. Plot of predicted vs. actual Iowa soybean price

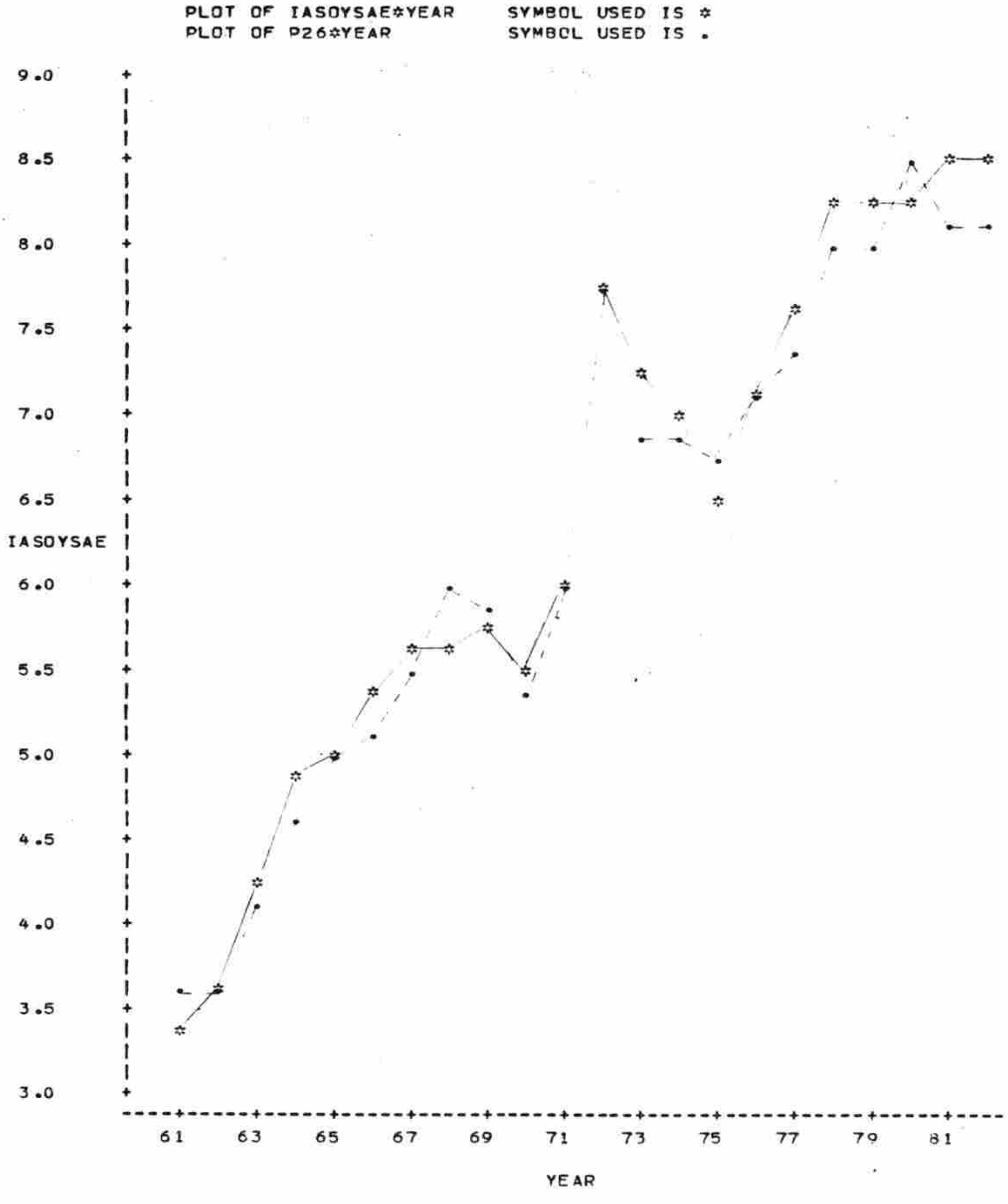

Figure 5.5. Plot of predicted vs. actual Iowa soybean acreage

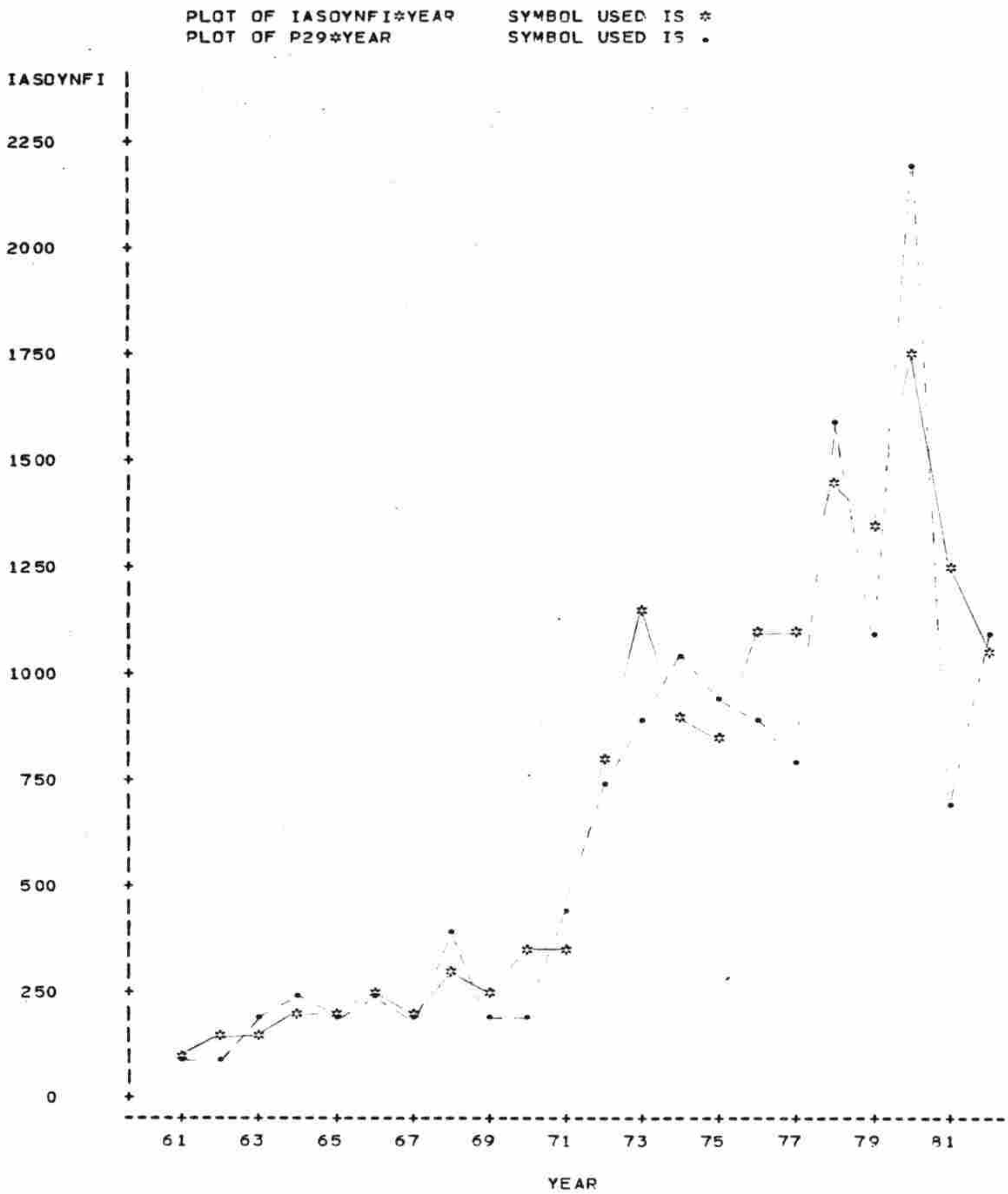

Figure 5.6. Plot of predicted vs. actual net farm income

Table 5.4. Theil's forecast error measures

Variable	N	Relative change MSE	Decomposition			
			Bias (UM)	Regress. (UR)	Disturb. (UD)	Accuracy (U1)
IASOYEXP	22	0.00127923	0.05	0.00	0.95	0.0001
IASOYSD	22	0.00171197	0.21	0.01	0.77	0.0002
IASOYPL1	22	0.000463296	0.00	0.04	0.96	0.0066
IACORPF	22	0.0010342	0.01	0.31	0.69	0.0169
DCTNRE	22	3.965E-13	0.05	0.00	0.95	0.0000
SOMSP	22	0.00246861	0.00	0.36	0.64	0.0000
SOMPM	22	0.017598	0.00	0.11	0.89	0.0010
SOMXTOT	22	0.114673	0.05	0.57	0.38	0.0000
SOYPM	22	0.0324	0.00	0.43	0.57	0.0362
SOYHC	22	0.460346	0.04	0.64	0.32	0.0040
SOOXES	22	2.40533	0.01	0.34	0.65	0.0015
SOYXTOT	22	0.0145841	0.01	0.31	0.68	0.0002
SOODDT	22	0.00286238	0.00	0.34	0.66	0.0000
SOYPF	22	0.0326844	0.00	0.50	0.50	0.0386
SOMDDT	22	0.00225035	0.00	0.19	0.81	0.0000
SOYSC	22	0.00249637	0.00	0.35	0.65	0.0001
SOYSPE	22	0.00551636	0.00	0.26	0.74	0.0001
SOYHT	22	0.188657	0.00	0.28	0.72	0.0022
SOYMX	22	0.0157384	0.01	0.38	0.61	0.0002
SOMMXES	22	0.125203	0.05	0.56	0.40	0.0001
SOOXTOT	22	0.124542	0.04	0.17	0.78	0.0001
DSNRE1	22	0.0843704	0.00	0.50	0.50	0.0044
SOOSP	22	0.00256174	0.00	0.24	0.76	0.0000
SOOHC	22	0.0776043	0.00	0.05	0.95	0.0003
SOOPL	22	0.140254	0.00	0.52	0.48	0.0006
SOOPM	22	0.111391	0.00	0.48	0.51	0.0181
SOYSAE	22	0.00566309	0.01	0.48	0.51	0.0015
IASOYPF	22	0.0326245	0.00	0.49	0.51	0.0386
SOOXPL	22	0.0610615	0.00	0.15	0.84	0.0002
OESOYX	22	0.0147132	0.01	0.34	0.65	0.0000
SOYCM	22	1.96051	0.02	0.00	0.97	3.5676
IASOYSC	22	0.0158124	0.11	0.37	0.52	0.0010
IASOYVS	22	0.029447	0.03	0.23	0.74	0.0001
IASOOSP	22	0.0191726	0.11	0.54	0.36	0.0001
IASOMSP	22	0.0188707	0.10	0.50	0.40	0.0000
IASOYHC	22	0.636237	0.00	0.07	0.93	0.0145
IASOYNX	22	0.046678	0.24	0.01	0.76	0.0024
IASOYSAE	22	0.00127152	0.06	0.02	0.92	0.0055
IASOYNFI	22	0.0756513	0.02	0.26	0.72	0.0003
IASOYSPE	22	0.00165524	0.22	0.00	0.78	0.0002

CHAPTER 6. IMPACT ANALYSIS

Using the results of the system's parameters from Chapter 5, we can now shock the model and determine the consequences of shifts in major exogenous variables. The shocks will be considered to be a constant yearly absolute or percentage increase, beginning in 1976 and until 1980. This time period should be able to tell us the year by year impact on prices, acreage, and production for the three commodities for both the U.S. as a whole and Iowa by itself. Comparative statics is used to analyze the impact of these shifts in relation to the base, or equilibrium, solution. Since the model is nonlinear, linear combinations of the impact size are not valid and will not give necessarily comparable results. The impact may also depend on the time frame of the results. The impact may also depend on the time frame of the base simulation. The impact multipliers for 11 cases are presented in the tables of this chapter, with a brief discussion of each below.

Case 1: Corn Price

The chain of events for a ten cent rise in the corn price goes as follows. First, domestic demand for meal increases, but is more than offset by the rise in meal price. And, although the demand for domestic crush is stronger, a lesser quantity of beans is processed in order to satisfy expansion of foreign exports and inventories. The cutback in meal and oil production reduces exports, stocks, and consumption of both commodities. In Iowa, we find a reduction in bean acreage and production in spite of a rise in soybean price. The corn price increase more than offsets this, and the net effect is a substitution towards corn production in Iowa. The value of the soybean crop is enchanced, and net farm income rises by $26-37 million. It should be remembered that this is only the impact on soybean income. The effect on income from corn is not included in this model. Table 6.1 has the consequences of the corn price effect, and Figure 6.1 has been included to facilitate the conceptual understanding of the model's adjustment.

Case 2: Corn Diversion Payments

Government policy can exert substantial change on farmers' production decisions. A paid diversion program awards cash payments of so many cents per bushel to those farmers who voluntarily withdraw land from production of a commodity. We analyze here the effect of a ten cent per bushel increase in a corn diversion program. The consequent reduction in corn acreage cuts corn production and pushes the price up. Previous work by Baumes and Meyers (1980) calculates an increase of 47 cents in the corn price resulting from a ten cent rise in diversion payments. This estimate is implemented into the present model, with the results presented in Table 6.2.

Since the rise in corn price does not take effect until the anticipated rise in corn production is realized, the first year impact is due solely to the influence of the diversion payment on soybean acreage planted. The expected decline in soybean production increases the amount held in bean and oil inventories. There is a tradeoff at the expense of

Table 6.1. Reduced form impact multipliers of the model (sector: component: unit: +10¢/bu. corn price)

	Year 1	Year 2	Year 3	Year 4	Year 5
Soybeans:					
Supply (mil. bu.)	0	7.2	5.1	3.8	3.4
Domestic crush (mil. bu.)	-4.4	-1.5	-2.6	-3.0	-2.9
Comm. exports (mil. bu.)	1.6	2.8	2.0	1.8	1.9
Comm. stocks (mil. bu.)	2.8	5.9	5.7	5.1	4.4
$Acreage_{t+1}$ (1000 acres)	144.5	-27.1	-60.8	-65.3	-38.2
Margin (¢/bu.)	0.8	1.0	1.0	1.0	1.2
Price (¢/bu.)	18.5	12.1	15.2	16.1	17.5
Meal:					
Supply (1000 tons)	-103.0	-37.4	-62.9	-72.9	-68.9
U.S. consumption (1000 tons)	-27.9	11.3	-9.8	-8.8	-24.7
Comm. exports (1000 tons)	-75.2	-48.7	-53.1	-64.1	-44.2
Price ($/ton)	5.93	4.25	5.16	5.11	5.8
Oil:					
Supply (mil. lbs.)	-48.0	-25.5	-32.6	-35.2	-34.1
U.S. consumption (mil. lbs.)	-26.1	-12.6	-15.8	-18.2	-17.1
Comm. exports (mil. lbs.)	2.2	-1.9	-3.3	-1.3	-1.3
P.L. 480 exports (mil. lbs.)	-15.7	-7.7	-10.9	-13.4	-13.7
Stocks (mil. lbs.)	-8.3	-3.4	-2.6	-2.3	-2.0
Price (¢/lb.)	0.50	0.25	0.35	0.43	0.45
Iowa beans:					
Iowa production (mil. bu.)	0	-0.4	-1.4	-2.2	-3.0
Iowa crush (mil. bu.)	0.3	0.5	0.8	1.0	1.2
Iowa stocks (mil. bu.)	1.7	2.3	1.9	1.6	1.3
Iowa net exports (mil. bu.)	-0.3	-0.9	-2.2	-3.2	-4.3
Iowa acreage (1000 acres)	-11.7	-38.3	-58.8	-80.3	-99.6
Iowa net income (mil. bu.)	34.9	26.6	29.8	37.0	26.4
Iowa meal production (1000 tons)	7.7	11.2	18.3	23.9	30.0
Iowa oil production (mil. lbs.)	3.7	5.3	7.8	9.8	14.7

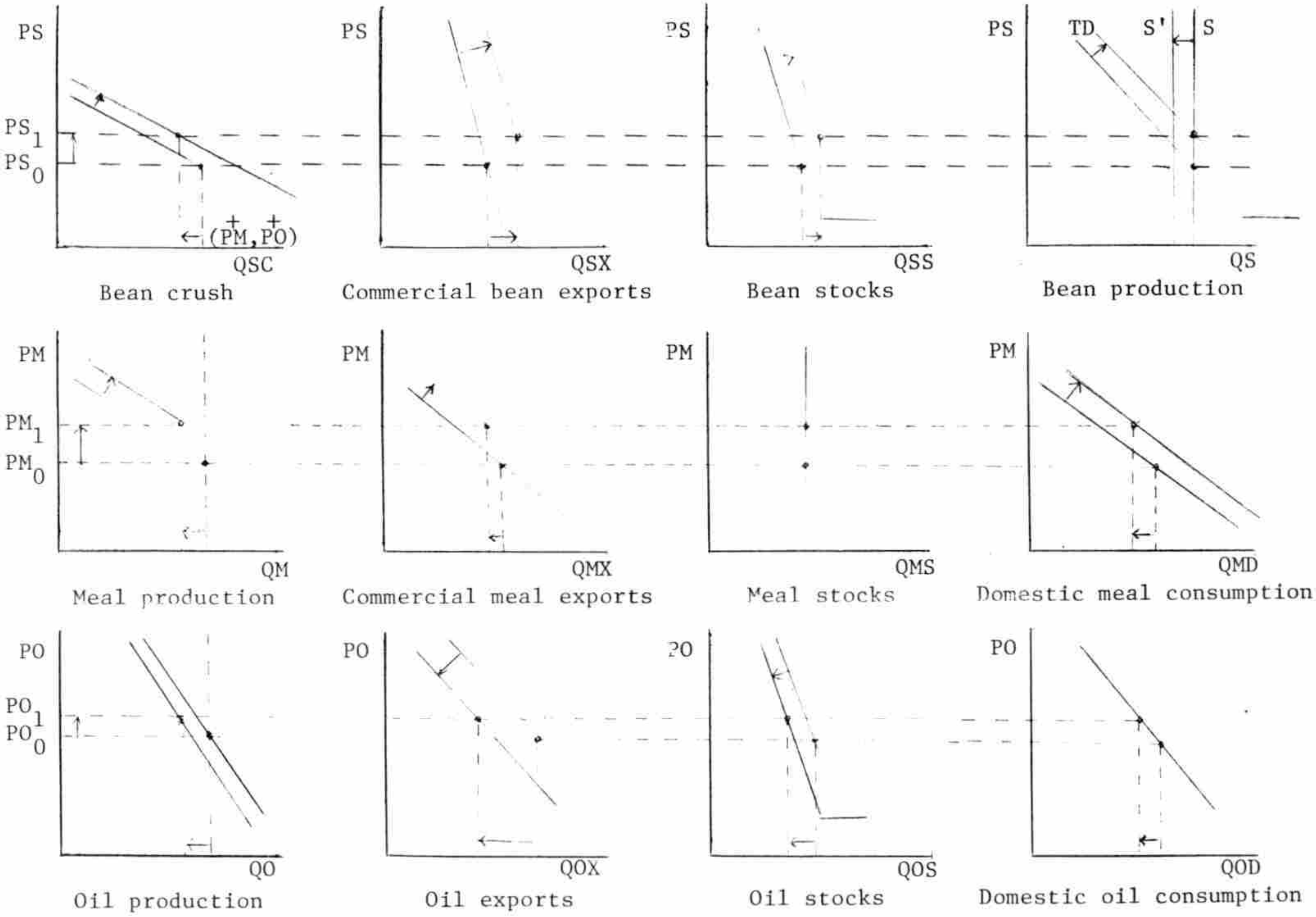

Figure 6.1. Graphical representation of the model's response to higher corn price

Table 6.2. Reduced form impact multipliers of the model (sector: component: unit: +10¢/bu. corn diversion payment, +47¢)

	Year 1	Year 2	Year 3	Year 4	Year 5
Soybeans:					
Supply (mil. bu.)	0	-12.7	23.3	15.2	11.2
Domestic crush (mil. bu.)	-0.3	-26.0	-10.9	-15.4	-16.3
U.S. exports (mil. bu.)	-0.3	3.7	10.5	7.5	6.5
Stocks (mil. bu.)	0.6	9.6	23.7	23.1	21.0
$Acreage_{t+1}$ (1000 acres)	-442.3	453.3	-279.8	-399.5	-438.3
Price (Decatur) (¢/bu.)	1.6	100.4	68.3	81.1	83.2
Margin (¢/bu.)	0.1	3.6	4.9	4.9	4.8
Meal:					
Supply (1000 tons)	-6.6	-611.4	-261.0	-369.7	-392.3
U.S. consumption (1000 tons)	-2.4	-187.5	-11.8	-81.7	-71.0
Comm. exports (1000 tons)	-4.2	-423.9	-272.8	-288.0	-321.3
Price ($/ton)	0.10	30.32	21.73	25.76	25.30
Oil:					
Supply (mil. lbs.)	-3.1	-276.5	-160.3	-186.7	-188.9
U.S. consumption (mil. lbs.)	-7.0	-156.0	-89.4	-98.5	-102.4
Comm. exports (mil. lbs.)	0.3	14.2	2.1	-7.1	-0.6
P.L. 480 exports (mil. lbs.)	-3.8	-94.8	-56.7	-68.4	-76.3
Stocks (mil. lbs.)	7.5	-39.9	-16.3	-12.7	-9.6
Price (¢/lb.)	0.13	3.0	1.9	2.2	2.5
Iowa beans:					
Iowa production (mil. bu.)	0	0.1	0.3	3.9	6.4
Iowa crush (mil. bu.)	0.03	1.7	2.8	4.0	5.1
Iowa stocks (mil. bu.)	-0.1	6.9	10.0	8.6	7.5
Iowa net exports (mil. bu.)	-0.03	-1.6	-3.1	-7.9	-11.5
Iowa acreage (1000 acres)	4.4	-12.3	-106.2	-176.4	-257.0
Iowa net income (mil. bu.)	3.0	195.6	163.1	173.9	219.1
Iowa meal production (1000 tons)	0.7	39.4	59.0	95.3	123.6
Iowa oil production (mil. lbs.)	0.3	19.1	27.7	40.4	51.6

bean exports and crush, which lowers meal and oil production and elevates their respective prices. Net income in Iowa rises by $3 million in the first year.

The subsequent years include the 47 cents rise in corn prices, as well. This is by far the more dominant force in the market, and intensifies the magnitude of the multipliers. Iowa net farm income now jumps by $163-219 million. The effect of the diversion payment by itself (ignoring the impact of an inevitably higher corn price) would elevate net income by $30-50 million in the subsequent years.

Case 3: Corn Loan Rate

We can also look at the consequences of raising the support price for corn on the soybean sector. Assuming that the market price is above the loan rate, we can expect an increase in the supply and a corresponding fall in the corn price received by farmers. Baumes and Meyers (1980) have computed a drop in that price by five cents a bushel for a ten cent increase in the support price. However, in the instance that the market price for corn has fallen to equal the corn price support, the increase in the support price would also raise the price received by farmers by the same amount. The outcomes from both situations are detailed in Tables 6.3a and 6.3b, respectively. Like the diversion payment, the corn price effect is not felt until the following year, and generally overwhelms the loan rate. The initial response is diagrammed in Figure 6.1.

The first year impact is the same for both situations, but have the opposite results in the next years. The expected drop in soybean

Table 6.3a. Reduced form impact multipliers of the model (sector: component: unit: +10¢ corn loan rate, -5¢ corn price)

	Year 1	Year 2	Year 3	Year 4	Year 5
Soybeans:					
Supply (mil. bu.)	0	-6.6	-7.4	-6.2	-4.9
Domestic crush (mil. bu.)	-0.15	-0.6	-0.5	0.0	0.5
U.S. exports (mil. bu.)	-0.15	-2.7	-2.4	-1.9	-1.7
Comm. stocks (mil. bu.)	0.3	-3.3	-4.6	-4.4	-3.7
$Acreage_{t+1}$ (1000 acres)	-231.4	-139.0	-50.8	-25.9	-62.0
Price (Decatur) (¢/bu.)	0.8	-2.7	-1.8	-3.7	-4.6
Margin (¢/bu.)	0.1	-0.6	-0.4	-0.5	-0.4
Meal:					
Supply (1000 tons)	-3.4	-15.5	-11.8	-0.4	12.3
U.S. consumption (1000 tons)	-1.2	-10.9	-18.2	-8.1	-6.3
Comm. exports (1000 tons)	-2.2	-4.6	6.5	7.7	18.6
Price ($/ton)	0.05	-1.90	-1.58	-2.02	-2.09
Oil:					
Supply (mil. lbs.)	-1.6	-2.9	-5.6	0.4	5.2
U.S. consumption (mil. lbs.)	-3.7	-3.8	-6.0	-2.2	0.7
Comm. exports (mil. lbs.)	0.1	1.0	6.0	4.8	3.1
P.L. 480 exports (mil. lbs.)	-2.0	-2.9	-4.2	-1.9	0.1
Stocks (mil. lbs.)	3.9	2.8	1.5	1.2	2.3
Price (¢/lb.)	0.1	0.1	0.1	0.1	0.0
Iowa beans:					
Iowa production (mil. bu.)	0	-1.0	-1.1	-1.0	-1.1
Iowa crush (mil. bu.)	0.02	-0.1	-0.2	-0.2	-0.3
Iowa stocks (mil. bu.)	-0.1	-1.6	-1.8	-1.7	-1.6
Iowa net exports (mil. bu.)	-0.02	-0.9	-0.9	-0.8	-0.8
Iowa acreage (1000 acres)	-28.5	-28.5	-28.1	-29.4	-32.3
Iowa net income (mil. bu.)	1.6	-5.8	-10.4	-10.3	-26.0
Iowa meal production (1000 tons)	0.4	-2.6	-3.0	-5.5	-7.5
Iowa oil production (mil. lbs.)	0.2	-1.2	-1.5	-2.4	-2.7

Table 6.3b. Reduced form impact multipliers of the model (sector: component: unit: +10¢ corn loan rate, +10¢ corn price)

	Year 1	Year 2	Year 3	Year 4	Year 5
Soybeans:					
Supply (mil. bu.)	0	-6.6	3.2	1.4	0.8
Domestic crush (mil. bu.)	-0.15	-7.2	-2.8	-3.9	-4.0
U.S. exports (mil. bu.)	-0.15	-0.3	1.8	1.2	1.0
Comm. stocks (mil. bu.)	0.3	0.9	4.2	4.2	3.9
$Acreage_{t+1}$ (1000 acres)	-231.4	76.4	-90.8	-117.5	-160.9
Price (Decatur) (¢/bu.)	0.8	25.0	16.3	19.1	19.5
Margin (¢/bu.)	0.1	0.6	1.1	1.0	1.0
Meal:					
Supply (1000 tons)	-3.4	-170.2	-68.3	-94.6	-97.3
U.S. consumption (1000 tons)	-1.2	-52.3	-1.2	-22.5	-19.2
Comm. exports (1000 tons)	-2.2	-118.3	-67.1	-72.1	-78.1
Price ($/ton)	0.05	6.99	4.78	5.70	5.56
Oil:					
Supply (mil. lbs.)	-1.6	-74.9	-41.1	-47.0	-46.5
U.S. consumption (mil. lbs.)	-3.7	-43.1	-25.0	-26.0	-26.6
Comm. exports (mil. lbs.)	0.1	4.2	3.3	-0.1	1.2
P.L. 480 exports (mil. lbs.)	-2.0	-26.5	-15.9	-18.2	-20.0
Stocks (mil. lbs.)	3.9	-9.6	-3.6	-2.7	-1.1
Price (¢/lb.)	0.1	0.8	0.5	0.6	0.7
Iowa beans:					
Iowa production (mil. bu.)	0	-1.0	-1.7	-3.1	-4.4
Iowa crush (mil. bu.)	0.02	0.4	0.6	0.9	1.2
Iowa stocks (mil. bu.)	-0.1	1.0	1.6	1.2	0.8
Iowa net exports (mil. bu.)	-0.02	-1.4	-2.3	-4.1	-5.6
Iowa acreage (1000 acres)	-28.5	-46.0	-85.6	-117.8	-152.8
Iowa net income (mil. bu.)	1.6	46.6	29.6	34.5	29.7
Iowa meal production (1000 tons)	0.4	9.0	13.8	21.9	28.3
Iowa oil production (mil. lbs.)	0.2	4.4	6.4	9.3	12.0

production promotes a buildup of oil and bean stocks. The overall decline in demand for soybeans is further reinforced by the dip in the corn price. This lowers prices so that Iowa acreage, production, and net income are down, also. The reverse occurs when the government attempts to lift the price floor when market conditions for corn are depressed. Exports and inventories of soybeans show some growth as acreage and production tail off, therefore, bean prices improve. Aggregate net farm income in Iowa receives a boost of $30-47 million, in contrast to the approximately $30 million loss when corn market prices are above the support.

Case 4: Soybean Loan Rate

We can also explore the aftermath of a decision to raise the price support for soybeans. Table 6.4 is the culmination of a ten cent per bushel increase in the loan rate. It is assumed that the free market price is well above the price floor set by the government.

At first we notice that raising the support induces additional area to be planted to soybeans. The larger expected volume prompts a disposal of current inventories of beans and oil. As crushing rises due to lower bean prices, the production of oil and meal increase. Domestic meal consumption expands by 1-13 thousand tons because of a declining price of 3-58 cents per ton. Oil consumption is similarly affected, and net exports of oil increase mainly because of concessionary sales.

Marginal increases of 16-36 thousand ares of soybeans occur in Iowa. It appears that only in one year out of five is there a production

Table 6.4. Reduced form impact multipliers of the model (sector: component: unit: +10¢/bu. soybean loan rate, SOYPF > SOYPE

	Year 1	Year 2	Year 3	Year 4	Year 5
Soybeans:					
Supply (mil. bu.)	0	3.7	1.7	1.7	1.3
Domestic crush (mil. bu.)	0.1	1.5	0.5	0.6	0.4
U.S. exports (mil. bu.)	0.1	1.1	0.4	0.4	0.3
Comm. stocks (mil. bu.)	-0.2	1.1	0.8	0.7	0.5
$Acreage_{t+1}$ (1000 acres)	128.6	19.4	29.6	22.9	46.0
Price (Decatur) (¢/bu.)	-0.5	-3.5	-1.8	-1.8	-1.5
Margin (¢/bu.)	0.0	0.1	-0.1	0.0	0.0
Meal:					
Supply (1000 tons)	1.9	37.0	11.9	14.7	10.5
U.S. consumption (1000 tons)	0.7	13.5	4.8	5.9	4.5
Comm. exports (1000 tons)	1.2	23.6	7.1	8.9	6.0
Price ($/ton)	-0.03	-0.58	-0.21	-0.25	-0.19
Oil:					
Supply (mil. lbs.)	0.9	14.8	6.5	6.7	4.9
U.S. consumption (mil. lbs.)	2.0	9.1	5.5	4.6	3.7
Comm. exports (mil. lbs.)	-0.1	-1.1	-2.6	-1.4	-1.1
P.L. 480 exports (mil. lbs.)	1.1	5.8	3.6	3.3	2.9
Stocks (mil. lbs.)	-2.2	1.0	0.1	0.1	-0.6
Price (¢/lb.)	-0.04	-0.18	-0.12	-0.11	-0.10
Iowa beans:					
Iowa production (mil. bu.)	0	0.6	0.6	0.9	1.1
Iowa crush (mil. bu.)	-0.01	-0.03	-0.05	-0.07	-0.09
Iowa stocks (mil. bu.)	0.03	0.4	0.3	0.3	0.4
Iowa net exports (mil. bu.)	0.01	0.6	0.7	1.0	1.2
Iowa acreage (1000 acres)	16.4	17.4	24.1	29.1	35.8
Iowa net income (mil. bu.)	-0.9	-6.3	-0.7	-1.8	4.1
Iowa meal production (1000 tons)	-0.2	-0.7	-1.3	-1.7	-2.1
Iowa oil production (mil. lbs.)	-0.1	-0.3	-0.5	-0.7	-1.0

increase sufficient to offset the lower soybean price, therefore, aggregate net returns from soybeans fall by \$1-6 million.

Case 5: Government Owned Soybean Stocks

One of the implications of soybean price support activity is an accumulation of stocks by the CCC during periods of weak market demand. Baumes and Meyers (1980) have obtained an 18 cent rise in the corn price for a 100 million bushel addition to CCC owned inventories, which is incorporated into the multipliers of Table 6.5.

A large quantity of government owned soybeans overhanging the market has a stifling effect on the level of commercially held stocks, but is mitigated by the higher corn price. The net effect suggests that of the 100 million bushel reduction in supply, 80 percent comes equally from crush and private stocks, with the remaining 20 million from exports. The price per bushel goes up by almost a dollar. Production of meal and oil also declines, which leads to higher prices of about \$23/ton for meal and 4¢/pound for oil. When the price that Iowa farmers receive goes up by 94 cents, their net cash receipts are \$186 million higher than it would have been.

It should be kept in mind that these government stocks should be disposed of eventually. Impacts of the opposite sign of the results from Table 6.5 should then be witnessed. The rationale behind price support activity is that there ought to be a net gain to society by preventing price from reaching an equilibrium below the support level. This model

Table 6.5. Reduced form impact multipliers of the model (sector: component: unit: +100 mil. bu., CCC owned soybean stocks, +18¢ corn price,

	Year 1	Year 2	Year 3	Year 4	Year 5
Soybeans:					
Supply (mil. bu.)	-100.0	67.1	-17.8	-25.4	-15.3
Domestic crush (mil. bu.)	-40.2	32.9	-10.2	-9.6	-3.9
U.S. exports (mil. bu.)	-17.6	28.2	1.0	0.5	4.2
Comm. stocks (mil. bu.)	-42.1	6.0	-8.7	-16.3	-15.7
$Acreage_{t+1}$ (1000 acres)	3642	-813.0	-530.4	37.9	-33.9
Price (Decatur) (¢/bu.)	98.7	-47.6	32.1	39.6	29.2
Margin (¢/bu.)	-1.8	5.7	0.5	1.6	2.3
Meal:					
Supply (1000 tons)	-941.7	794.3	-242.9	-231.7	-93.4
U.S. consumption (1000 tons)	-329.7	341.1	-71.4	-57.5	-31.6
Comm. exports (1000 tons)	-612.0	453.3	-171.5	-174.2	-61.8
Price ($/ton)	22.37	-6.18	11.59	11.00	9.89
Oil:					
Supply (mil. lbs.)	-438.6	365.1	-112.8	-103.6	-43.1
U.S. consumption (mil. lbs.)	-211.5	120.2	-20.0	-56.8	-27.8
Comm. exports (mil. lbs.)	19.2	15.8	-49.2	6.2	1.9
P.L. 480 exports (mil. lbs.)	-129.1	82.2	-16.8	-41.9	-22.0
Stocks (mil. lbs.)	-117.2	29.6	2.8	-8.5	-3.7
Price (¢/lb.)	4.0	-2.4	0.4	1.4	0.7
Iowa beans:					
Iowa production (mil. bu.)	0	5.6	-3.0	-3.9	-4.4
Iowa crush (mil. bu.)	1.1	1.1	1.4	1.9	2.4
Iowa stocks (mil. bu.)	30.4	45.8	39.6	38.2	38.8
Iowa net exports (mil. bu.)	-1.1	4.5	-4.4	-5.8	-6.7
Iowa acreage (1000 acres)	161.0	-80.8	-105.1	-115.7	-155.9
Iowa net income (mil. bu.)	186.3	-93.8	62.6	95.8	48.9
Iowa meal production (1000 tons)	25.0	23.4	34.4	47.0	57.5
Iowa oil production (mil. lbs.)	12.1	11.1	14.6	19.4	28.1

provides a way of testing whether price stabilization leads to higher net incomes for Iowa's farmers over the long run.

Case 6: Expected Soybean Yield

Suppose that we have exceptional growing conditions for soybeans that are isolated to the state of Iowa. Since Iowa is the source of approximately one-fifth of the nation's output, it is assumed that a five bushel per acre gain in productivity in Iowa will raise the U.S. average yield by one bushel per acre (see Table 6.6).

As Iowa's farmland becomes more productive relative to other parts of the country, we see that farmers would exploit their comparative advantage by planting more ares to soybeans. Although price is falling due to increased supply, net return from sobyeans in Iowa is rising due to the more than compensating yield improvement. And other areas of the country respond by reducing soybean acreage in order to plant something else. The expansion in supply makes beans more available for crush, export, and inventories, and satisfies a greater amount of meal and oil demand.

Case 7: General Price Level

We suspend the usual assumption of money neutrality in this case, that is, an equal rise in prices acorss the economy will not affect relative demand for any commodity. It is assumed that there is a rise in the general price level, denoted by the GNP deflator. It is also held that the variable costs of production for soybeans, corn, and cotton also

Table 6.6. Reduced form impact multipliers of the model (sector: component: unit: +5 bu./acre Iowa yield, + 1 bu./acre U.S. yield

	Year 1	Year 2	Year 3	Year 4	Year 5
Soybeans:					
Supply (mil. bu.)	0	80.8	11.5	32.8	22.1
Domestic crush (mil. bu.)	1.8	33.1	0.5	12.8	7.6
U.S. exports (mil. bu.)	1.8	22.7	1.8	8.1	6.1
Comm. stocks (mil. bu.)	-3.6	25.1	9.2	11.9	8.4
Acreage_{t+1} (1000 acres)	865.3	-2378	-1394	-2031	-1490
Price (Decatur) (¢/bu.)	-10.1	-74.4	-14.0	-34.2	-26.9
Margin (¢/bu.)	-0.6	2.3	-1.6	0.2	-0.7
Meal:					
Supply (1000 tons)	42.0	799.1	12.2	308.5	181.0
U.S. consumption (1000 tons)	15.1	290.5	4.9	123.2	77.4
Comm. exports (1000 tons)	26.9	508.6	7.3	185.3	103.6
Price ($/ton)	-0.65	-12.52	-0.21	-5.31	-3.33
Oil:					
Supply (mil. lbs.)	19.6	319.7	43.5	129.7	86.3
U.S. consumption (mil. lbs.)	44.5	186.5	62.1	81.9	68.3
Comm. exports (mil. lbs.)	-1.7	-24.1	-48.5	-14.9	-21.7
P.L. 480 exports (mil. lbs.)	24.3	119.5	38.2	59.9	53.1
Stocks (mil. lbs.)	-47.6	37.8	-8.3	2.8	-13.3
Price (¢/lb.)	-0.8	-3.8	-1.4	-2.0	-1.8
Iowa beans:					
Iowa production (mil. bu.)	0	46.1	47.0	62.0	66.5
Iowa crush (mil. bu.)	-0.2	-0.7	-0.9	-1.2	-1.5
Iowa stocks (mil. bu.)	0.8	15.2	12.3	16.6	17.4
Iowa net exports (mil. bu.)	0.2	46.8	47.9	63.2	68.0
Iowa acreage (1000 acres)	289.6	268.3	538.9	641.2	898.6
Iowa net income (mil. bu.)	-19.0	6.4	303.4	180.8	495.4
Iowa meal production (1000 tons)	-4.4	-13.9	-21.9	-29.6	-36.2
Iowa oil production (mil. lbs.)	-2.1	-6.6	-9.3	-12.2	-17.7

rise at the same rate, which is ten percent a year. Table 6.7 records the outcome of the simulation when some prices adjust with a lag. The price of oil falls because of the drop in domestic demand. Since real consumer income is highly elastic in comparison to previous studies, the oil price effect may be overstated.

Case 8: Exchange Rates

A depreciation in the value of the dollar would now be of considerable interest to people with a stake in the soybean market. The export demand for soybeans, as well as meal and oil, is being curtailed by the current strnegth in our currency relative to the rest of the world. If that strength receded by, say, ten cents/SDR, how would the cheaper prices to foreigners affect trade and, ultimately, the domestic markets? The impacts of such a devaluation are shown in Table 6.8.

Exports of soybeans climb by about 2-6 million bushels, which come out of compensating reduction in crush for the first year and out of a supply expansion after that. Higher meal exports are balanced by less domestic consumption and more production. The meal price fluctuates up or down with regard to this change in output. There is a net income in soy oil exports. When the oil price changes, this brings about a substitution between commercial and P.L. 480 exports. The net increase is from 35-50 million pounds.

Iowa experiences growth in acreage and production of soybeans, which translates into a $25-63 million profit from devaluation, depending on the extent to which increased soybean production pressures soybean prices downward.

Table 6.7. Reduced form impact multipliers of the model (sector: component: unit: +10% general price level, corn, soybean, cotton production costs

	Year 1	Year 2	Year 3	Year 4	Year 5
Soybeans:					
Supply (mil. bu.)	0	-51.5	-44.8	-54.2	-31.8
Domestic crush (mil. bu.)	-6.9	-29.2	-24.5	-26.6	-17.4
U.S. exports (mil. bu.)	0.3	-12.9	-10.5	-11.6	-6.2
Comm. stocks (mil. bu.)	6.7	-9.5	-9.8	-16.0	-8.2
$Acreage_{t+1}$ (1000 acres)	-1942	-1203	-1406	-611.3	-1512
Price (Decatur) (¢/bu.)	-32.8	6.2	9.9	1.1	-9.8
Margin (¢/bu.)	-6.7	-9.6	-7.5	-9.3	-7.5
Meal:					
Supply (1000 tons)	-162.0	-704.4	-585.8	-642.1	-414.4
U.S. consumption (1000 tons)	-58.2	-256.1	-236.1	-256.5	-177.1
Comm. exports (1000 tons)	-103.8	-448.3	-349.7	-385.6	-237.2
Price ($/ton)	2.51	11.04	10.18	11.06	7.63
Oil:					
Supply (mil. lbs.)	-75.5	-281.1	-273.9	-279.0	-216.3
U.S. consumption (mil. lbs.)	-228.2	-345.5	-353.3	-350.4	-323.0
Comm. exports (mil. lbs.)	-2.5	3.9	27.2	18.1	21.4
P.L. 480 exports (mil. lbs.)	112.6	62.3	44.0	78.6	82.0
Stocks (mil. lbs.)	42.7	-1.9	8.2	-25.2	3.2
Price (¢/lb.)	-4.2	-2.7	-2.0	-3.2	-3.2
Iowa beans:					
Iowa production (mil. bu.)	0	-5.0	-5.6	-7.5	-7.3
Iowa crush (mil. bu.)	-1.1	-1.9	-2.4	-3.3	-3.9
Iowa stocks (mil. bu.)	2.5	-1.2	-2.0	-1.8	-0.9
Iowa net exports (mil. bu.)	1.1	-3.0	-3.2	-4.2	-3.4
Iowa acreage (1000 acres)	-143.5	-152.2	-203.1	-194.2	-269.8
Iowa net income (mil. bu.)	-92.3	-39.4	-50.1	-74.3	-139.9
Iowa meal production (1000 tons)	-25.2	-40.4	-57.9	-79.8	-94.7
Iowa oil production (mil. lbs.)	-12.2	-19.2	-24.6	-32.8	-46.3

Table 6.8. Reduced form impact multipliers of the model (sector: component: unit: +10¢/SDR exchange rate

	Year 1	Year 2	Year 3	Year 4	Year 5
Soybeans:					
Supply (mil. bu.)	0	20.3	5.0	14.8	-2.2
Domestic crush (mil. bu.)	-0.5	10.3	2.4	10.0	-1.2
U.S. exports (mil. bu.)	4.4	5.7	2.7	0.01	1.9
Comm. stocks (mil. bu.)	-3.9	4.4	-0.1	4.8	-2.9
Acreage_{t+1} (1000 acres)	807.8	19.8	471.7	-271.0	716.6
Price (Decatur) (¢/bu.)	15.6	-12.7	9.3	-14.0	22.5
Margin (¢/bu.)	1.8	2.0	2.0	2.0	2.5
Meal:					
Supply (1000 tons)	-12.2	247.9	56.7	242.4	-28.3
U.S. consumption (1000 tons)	-118.1	7.5	-121.2	13.2	-157.9
Comm. exports (1000 tons)	105.9	240.4	-177.8	229.2	129.6
Price ($/ton)	5.09	-0.32	5.22	-0.57	6.80
Oil:					
Supply (mil. lbs.)	-5.7	100.1	36.2	105.5	1.1
U.S. consumption (mil. lbs.)	-26.7	44.2	4.9	41.8	-30.4
Comm. exports (mil. lbs.)	49.2	16.6	30.1	17.5	60.5
P.L. 480 exports (mil. lbs.)	-14.3	29.4	4.1	32.1	-22.7
Stocks (mil. lbs.)	-13.9	9.9	-2.9	14.1	-6.4
Price (¢/lb.)	0.51	-0.89	-0.11	-1.0	0.8
Iowa beans:					
Iowa production (mil. bu.)	0	1.5	0.3	1.2	-0.1
Iowa crush (mil. bu.)	0.4	0.5	0.8	0.7	1.2
Iowa stocks (mil. bu.)	-1.2	1.2	-0.5	1.3	-1.6
Iowa net exports (mil. bu.)	-0.4	1.0	-0.5	0.5	-1.3
Iowa acreage (1000 acres)	43.4	7.9	32.9	3.4	51.9
Iowa net income (mil. bu.)	29.5	-22.3	25.8	-32.9	63.1
Iowa meal production (1000 tons)	9.4	9.7	18.1	17.4	28.7
Iowa oil production (mil. lbs.)	4.6	4.6	7.7	7.2	14.0

Case 9: Foreign Livestock Production

The scale of the pork and poultry sectors in Western Europe and Japan has a substantial influence on the amount of soybeans and soybean meal exported to those countries. The ramifications of a 500 million pound increase in pork production and a 200 million pound rise in poultry output are roughly comparable, with the impact multipliers listed in Tables 6.9a and 6.9b, respectively.

Both factors shift the soybean export demand curve outward. This supply comes at the expense of crush and stocks in the first year, so meal and oil production fall and their prices increase. However, acreage and production begin to expand enough so that crush and stocks climb in the later years. Since these countries import much of their soybean oil needs through the purchase of soybeans, oil exports are hurt. Oil price begins to fall, which in turn promotes more domestic consumption.

The response to these circumstances in Iowa is very similar. More acreage is planted, and more soybeans are produced for crushing into meal and for export. The 27 cent per bushel jump in the wholesale bean price means an extra $51 million to Iowa farmers.

Case 10: High Protein Animal Units

A greater population of animals on high protein feed will have an important influence on the soymeal market. As shown in Table 6.10, domestic meal demand requires 1.3-1.5 million tons more in order to satisfy a ten percent increase in the number of livestock. Exports fall and meal price advances by $20-31 per ton.

Table 6.9a. Reduced form impact multipliers of the model (sector: component: unit: +500 mil. lbs. pork production in EC and Japan

	Year 1	Year 2	Year 3	Year 4	Year 5
Soybeans:					
Supply (mil. bu.)	0	35.2	29.3	28.3	23.8
Domestic crush (mil. bu.)	-8.9	6.1	1.7	1.4	-0.5
U.S. exports (mil. bu.)	15.6	25.2	22.7	22.0	21.1
Comm. stocks (mil. bu.)	-6.7	3.9	4.8	5.0	3.2
$Acreage_{t+1}$ (1000 acres)	1398	865.5	744.7	727.6	902.0
Price (Decatur) (¢/bu.)	27.0	-6.3	0.1	1.8	6.6
Margin (¢/bu.)	0.3	1.4	0.6	0.7	0.7
Meal:					
Supply (1000 tons)	-207.5	147.8	40.3	33.4	-11.8
U.S. consumption (1000 tons)	-189.7	-62.8	-112.9	-114.7	-142.1
Comm. exports (1000 tons)	-17.9	210.6	153.3	148.1	130.2
Price ($/ton)	8.18	2.71	4.87	4.94	6.12
Oil:					
Supply (mil. lbs.)	-96.7	31.5	1.9	-3.6	-22.6
U.S. consumption (mil. lbs.)	-39.6	51.0	44.9	36.3	25.4
Comm. exports (mil. lbs.)	4.1	-34.2	-52.6	-47.4	-42.5
P.L. 480 exports (mil. lbs.)	-24.8	31.4	28.2	24.7	18.3
Stocks (mil. lbs.)	-36.4	-16.8	-18.5	-17.1	-23.8
Price (¢/lb.)	0.8	-1.0	-1.0	-0.9	-0.7
Iowa beans:					
Iowa production (mil. bu.)	0	2.6	2.1	2.2	2.4
Iowa crush (mil. bu.)	0.4	0.5	0.5	0.5	0.7
Iowa stocks (mil. bu.)	-2.1	0.8	0.5	0.4	0.03
Iowa net exports (mil. bu.)	-0.4	2.2	1.6	1.6	1.8
Iowa acreage (1000 acres)	75.2	58.2	58.9	64.4	81.3
Iowa net income (mil. bu.)	51.0	-5.9	13.3	13.0	37.6
Iowa meal production (1000 tons)	9.0	9.4	12.0	13.0	15.9
Iowa oil production (mil. lbs.)	4.4	4.5	5.1	5.4	7.8

Table 6.9b. Reduced form impact multipliers of the model (sector: component: unit: +200 mil. lbs. poultry production in EC and Japan

	Year 1	Year 2	Year 3	Year 4	Year 5
Soybeans:					
Supply (mil. bu.)	0	38.0	31.6	30.6	25.7
Domestic crush (mil. bu.)	-9.6	6.6	1.8	1.5	-0.5
U.S. exports (mil. bu.)	16.8	27.2	24.5	23.7	22.8
Comm. stocks (mil. bu.)	-7.3	4.2	5.2	5.4	3.5
$Acreage_{t+1}$ (1000 acres)	1511	935.4	804.9	786.4	974.9
Price (Decatur) (¢/bu.)	29.2	-6.8	0.1	2.0	7.1
Margin (¢/bu.)	0.3	1.5	0.7	0.8	0.7
Meal:					
Supply (1000 tons)	-224.3	159.7	43.6	36.1	-12.8
U.S. consumption (1000 tons)	-205.0	-67.9	-122.0	-124.0	-153.5
Comm. exports (1000 tons)	-19.3	227.6	165.6	160.1	140.8
Price ($/ton)	8.84	2.93	5.26	5.34	6.62
Oil:					
Supply (mil. lbs.)	-104.5	34.1	2.1	-3.9	-24.4
U.S. consumption (mil. lbs.)	-42.8	55.2	48.5	39.2	27.5
Comm. exports (mil. lbs.)	4.4	-36.9	-56.9	-51.3	-45.9
P.L. 480 exports (mil. lbs.)	-26.8	33.9	30.5	26.7	19.8
Stocks (mil. lbs.)	-39.3	-18.1	-20.0	-18.5	-25.8
Price (¢/lb.)	0.8	-1.1	-1.1	-0.9	-0.7
Iowa beans:					
Iowa production (mil. bu.)	0	2.8	2.3	2.3	2.6
Iowa crush (mil. bu.)	0.4	0.5	0.5	0.6	0.7
Iowa stocks (mil. bu.)	-2.2	0.9	0.6	0.4	0.04
Iowa net exports (mil. bu.)	-0.4	2.3	1.8	1.8	1.9
Iowa acreage (1000 acres)	81.3	62.9	63.7	70.0	87.8
Iowa net income (mil. bu.)	55.1	-2.0	17.9	18.2	45.7
Iowa meal production (1000 tons)	9.8	10.1	12.9	14.1	17.2
Iowa oil production (mil. lbs.)	4.7	4.8	5.5	5.8	8.4

Table 6.10. Reduced form impact multipliers of the model (sector: component: unit: +10% high protein animal units

	Year 1	Year 2	Year 3	Year 4	Year 5
Soybeans:					
Supply (mil. bu.)	0	51.5	43.4	47.1	35.1
Domestic crush (mil. bu.)	8.2	31.1	25.7	28.0	22.0
U.S. exports (mil. bu.)	1.6	14.8	11.4	10.4	9.0
Comm. stocks (mil. bu.)	-9.8	5.6	6.2	8.7	4.1
$Acreage_{t+1}$ (1000 acres)	2044	1288	1297	1020	1534
Price (Decatur) (¢/bu.)	39.5	-8.8	3.9	-1.9	15.7
Margin (¢/bu.)	8.0	10.0	9.7	9.8	9.9
Meal:					
Supply (1000 tons)	192.0	751.6	615.0	677.3	525.4
U.S. consumption (1000 tons)	1310.3	1546.0	1539.0	1543.0	1487.1
Comm. exports (1000 tons)	-1118.4	-794.5	-924.0	-865.7	-961.7
Price ($/ton)	27.02	19.56	26.88	24.82	30.95
Oil:					
Supply (mil. lbs.)	89.4	319.9	295.2	305.6	249.1
U.S. consumption (mil. lbs.)	75.9	205.1	207.5	201.7	167.5
Comm. exports (mil. lbs.)	-4.7	-23.9	-53.2	-49.0	-36.5
P.L. 480 exports (mil. lbs.)	43.7	129.1	138.3	146.1	131.7
Stocks (mil. lbs.)	-25.5	9.6	2.7	6.8	-13.5
Price (¢/lb.)	-1.4	-4.1	-4.6	-4.8	-4.4
Iowa beans:					
Iowa production (mil. bu.)	0	3.8	3.2	3.6	3.5
Iowa crush (mil. bu.)	1.5	2.4	3.4	4.0	5.0
Iowa stocks (mil. bu.)	-3.0	1.1	0.5	0.9	-0.4
Iowa net exports (mil. bu.)	-1.5	1.4	-0.2	-0.4	-1.5
Iowa acreage (1000 acres)	110.0	86.3	97.7	93.7	133.2
Iowa net income (mil. bu.)	74.6	-7.7	29.6	7.6	72.2
Iowa meal production (1000 tons)	34.2	49.6	80.6	97.4	121.6
Iowa oil production (mil. lbs.)	16.6	23.6	34.2	40.1	59.5

The crushing industry becomes much more profitable in spite of a 40 cent/bushel rise in wholesale bean prices because of the 8-10 cent widening of the margin. A shrinking of stocks supplies the necessary quantity in the initial period, whereas the soybean price fosters more acreage and production in the following periods. The oil sector now becomes burdened with abundant supplies and oil prices go down by 1-5 cents per pound. This encourages U.S. soy oil consumption by 75-200 million pounds. Since soybean exports to developed countries are rising, we experience a decline in the amount of commercially exported oil, which is disposed of through the P.L. 480 program.

Iowa is a major producer of livestock for the nation, so it is not surprising to discover that more of the soybean crop is being crushed for use in the state. Net income to soybean producers is estimated to be $75 million higher.

Case 11: Competing Oils Consumption

Table 6.11 illustrates how an increase in the consumption of butter and lard, cottonseed, palm, and other oils by 100 million pounds would reduce domestic soy oil consumption by about 38-58 million pounds, and thus cut the oil price by about a half cent per pound. This in turn reduces the demand for soybeans, which reduces bean price, crush, meal and oil production, and acreage planted in the next year. Iowa's acreage and production of beans, meal, and oil similarly fall, and Iowa net farm income from soybeans declines by about 11 million dollars in the first year.

Table 6.11. Reduced form impact multipliers of the model (sector: component: unit: +100 mil. lbs. competing oil consumption

	Year 1	Year 2	Year 3	Year 4	Year 5
Soybeans:					
Supply (mil. bu.)	0	-7.6	-6.7	-6.1	-5.7
Domestic crush (mil. bu.)	-1.4	-4.8	-4.0	-3.6	-3.5
U.S. exports (mil. bu.)	-0.03	-2.1	-1.5	-1.5	-1.4
Comm. stocks (mil. bu.)	1.5	-0.8	-1.1	-1.0	-0.8
$Acreage_{t+1}$ (1000 acres)	-30.5	-20.0	-15.7	-18.2	-20.5
Price (Decatur) (¢/bu.)	-5.9	1.2	0.3	-1.0	-1.1
Margin (¢/bu.)	-1.3	-1.5	-1.4	-1.4	-1.4
Meal:					
Supply (1000 tons)	-33.5	-114.9	-94.7	-87.5	-84.7
U.S. consumption (1000 tons)	-12.0	-41.8	-38.2	-35.0	-36.2
Comm. exports (1000 tons)	-21.5	-73.1	-56.5	-52.5	-48.5
Price ($/ton)	0.52	1.80	1.65	1.51	1.56
Oil:					
Supply (mil. lbs.)	-15.6	-51.0	-48.6	-45.1	-45.6
U.S. consumption (mil. lbs.)	-37.7	-57.0	-57.5	-54.7	-56.3
Comm. exports (mil. lbs.)	-0.4	0.8	4.0	2.3	2.9
P.L. 480 exports (mil. lbs.)	20.7	9.7	10.8	14.0	14.3
Stocks (mil. lbs.)	1.8	-4.6	-6.0	-6.6	-6.6
Price (¢/lb.)	-0.77	-0.43	-0.45	-0.56	-0.57
Iowa beans:					
Iowa production (mil. bu.)	0	-0.57	-0.48	-0.46	-0.58
Iowa crush (mil. bu.)	-0.20	-0.34	-0.44	-0.58	-0.69
Iowa stocks (mil. bu.)	0.45	-0.16	-0.14	-0.04	-0.04
Iowa net exports (mil. bu.)	0.20	-0.23	-0.04	0.12	0.12
Iowa acreage (1000 acres)	-16.4	-13.3	-12.7	-15.3	-18.3
Iowa net income (mil. bu.)	-11.1	0.7	-2.3	-4.4	-7.7
Iowa meal production (1000 tons)	-4.7	-7.0	-10.6	-14.1	-16.8
Iowa oil production (mil. lbs.)	-2.3	-3.3	-4.5	-5.8	-8.2

Summary

Although it is doubtless that many improvements can be made to this model, the results conform to theoretical expectations and the magnitudes of the impacts seem plausible. We can compare the multipliers of Table 6.1 with those obtained by Meyers and Hacklander (1979) for a ten cent rise in corn price.

In the latter study, soybean price experiences a 10-15 cent rise, and acreage declines by 700 thousand after the first year and rises 100 thousand in the next year. Bean exports grow by 3.6 million bushels, fed mostly by a drop in domestic stocks. Downward shifts in meal and oil supplies are relatively small in the first period, but drop even further in the succeeding year by 150 thousand tons and 60 million pounds, respectively. These result in meal and oil price impacts of a positive \$3.8-4.4 per ton and 0.2-0.5 cents per pound.

The discrepancies appear to rise out of differences in the price elasticities. Meyers and Hacklander have more elastic demands for bean stocks and bean exports and less elastic crush demand than found in this study.

Further extensions of this paper could be made which would produce even better insights of the effects on Iowa net farm income. It would be quite reasonable to augment this model with an international feed grains sector and even a domestic livestock section. The interrelated markets among soybeans, corn, and livestock production in Iowa could be examined for their contributions to net income, as well.

BIBLIOGRAPHY

Baumes, H., and W. Meyers. "The Crops Model: Structural Equations, Definitions, and Selected Impact Multipliers." NED Staff Report. USDA, ESCS, Washington, D.C., March 1980.

Brown, W. "Soybeans: Acreage Response to Price and Farm Program Changes." USDA, ERS #473, July 1971.

Evans, R., and D. Kenyon. "Regional Soybean Acreage Response Analysis and Projections for 1974." USDA, ERS, Fats and Oils Situation, FOS-272 (April 1974): 33-39.

Fryar, E., and R. Hoskin. "Regional Soybean Acreage Response." USDA, ERS, Fats and Oils Situation, FOS-302 (February 1981): 21-23.

Golden, R. "The Demand and Price Structure for Oil and Meal." In World Soybean Research. Proceedings of the World Soybean Research Conference, University of Illinois at Urbana-Champaign, Interstate Printers and Publishers, Inc., Danville, Illinois, 1976.

Heady, E., and V. Rao. "Acreage Response and Production Supply Functions for Soybeans." Iowa State University Research Bulletin #555, 1965.

Houck, J., and J. Mann. "An Analysis of Domestic and Foreign Demand for U.S. Soybeans and Soybean Products." University of Minnesota, Department of Agriculture and Applied Economics, Technical Bulletin #256, 1968.

Houck, J., and A. Subotnik. "The U.S. Supply of Soybeans: Regional Acreage Functions." Agric. Econ. Res. 21(4) (October 1969):99-108.

Houck, J., M. Ryan, and A. Subotnik. Soybeans and their Products. Minneapolis, Minn.: University of Minnesota Press, 1972.

Houck, J., M. Abel, M. Ryan, P. Gallagher, R. Hoffman, and J. Penn. "Analyzing the Impact of Government Programs on Crop Acreage." USDA, Technical Bulletin #1548, 1976.

Huyser, W. "A Regional Analysis of Trade Policies Affecting the Soybean and Soymeal Market." Unpublished Ph.D. Dissertation. Iowa State University, Ames, Iowa, 1983.

Langley, J. "Regional Acreage Response Functions for Major U.S. Field Crops: Estimation and Policy Implications." Unpublished Ph.D. Dissertation. Iowa State University, 1983.

Matthews, J. "Conditional Market Forecasts and Implications for the U.S. Soybean Economy." USDA, ERS, Fats and Oils Situation, FOS-268 (July 1973): 17-25.

Matthews, J., A. Womack, and R. Hoffman. "Formulation of Market Forecasts for the U.S. Soybean Economy with an Econometric Model." USDA, ERS, Fats and Oils Situation, FOS-260 (November 1971): 26-31.

Meyers, W., and D. Hacklander. "An Econometric Approach to Analysis of Soybean and Soybean Product Markets." NED Staff Report. USDA, ESCS, Washington, D.C., June 1979.

Pindyck, R., and D. Rubinfeld. Econometric Models and Economic Forecasts. Second ed. New York: McGraw-Hill, 1981.

SAS. SAS/ETS User's Guide. Cary, North Carolina: SAS Institute, Inc., 1980.

Schaller and Dean. "Predicting Regional Crop Production." USDA Technical Bulletin 1329, April 1965.

U.S. Department of Agriculture. "Statistics on Oilseeds and Related Data, 1965-1982." USDA, ERS, Statistical Bulletin 695, 1983.

Vandenborre, R. "Demand Analysis of the Markets for Soybean Oil and Soybean Meal." Journal of Farm Economics (1966): 924-934.

Vandenborre, R. "An Econometric Analysis of the Markets for Soybean Oil and Soybean Meal." University of Illinois Agricultural Experiment Station, Technical Bulletin 723, 1967.

Wisner, R., and C. Chase. "World Food Trade and U.S. Agriculture, 1960-82." World Food Institute, Iowa State University, Ames, Iowa, August 1983.

Womack, A., S. Johnson, W. Meyers, J. Matthews, and R. Young. "Impact Multipliers of the Crops: An Application for Corn, Soybeans, and Wheat." Conference on Applied Commodity Price Analysis and Forecasting, Iowa State University, October, 1981.

Wonnacott, R., and T. Wonnacott. Econometrics. Second ed. New York: John Wiley and Sons, 1979.

APPENDIX A

Variable Definitions and Sources

Endogenous variables

DCORNRE: Deflated net returns from corn, $/acre (computed [CORPF * (CORSYGRE$_{-1}$ + CORSYGRE$_{-2}$ + CORSYGRE$_{-3}$)/3 - CORVC]/GNPD)

DCTNRE: Deflated net returns from cotton, $/acre (computed [COLFAU * (COLSYE$_{-1}$ + COLSYE$_{-2}$ + COLSYE$_{-3}$)/3] - CTVC]/GNPD)

DSNRE1: Deflated net returns from soybeans, $/acre (computed [SOYPF * (SOYSYE$_{-1}$ + SOYSYE$_{-2}$ + SOYSYE$_{-3}$)/3 - SYVC]/GNPD)

OESOYX: Oil equivalent of total world soybean exports, million lbs. (computed SOYXTOT * SOOSC * 100)

SOMDDT: Soybean meal domestic disappearance, 1,000 tons: Fats & Oils Situation

SOMMXES: Soymeal exports, excluding shipments to U.S. territories, crop year, 1,000 tons: Fats & Oils Situation

SOMPM: Soybean meal price, 44 percent protein, Decatur, crop year average, $/ton: Fats & Oils Situation

SOMXTOT: Soybean meal, total world exports, million lbs. (computed SOMMXES + SOMMXBR1 * 1.1023)

SOMSP: Soybean meal, U.S. production, crop year, 1,000 tons: Fats & Oils Situation

SOODDT: Soybean oil domestic disappearance, million lbs.: Fats & Oils Situation

SOOHC: Soybean oil, ending commercial stocks, million lbs.: Fats & Oils Situation

SOOPM: Soybean oil season average price, Decatur, ¢/lb.: Fats & Oils Situation

SOOSP: Soybean oil total U.S. production, October year, million lbs.: Fats & Oils Situation

SOOXES: Soybean oil, U.S. exports excluding shipments to U.S. territories and P.L. 480, million lbs. (computed SOOXPL - SOOPL)

SOOXPL: Soybean oil, U.S. exports, commercial plus P.L. 480, million lbs.: Fats & Oils Situation

SOYHT: Soybeans, ending total stocks, August 31, million bu.: Fats & Oils Situation

SOYHC: Soybeans, ending commercial stocks, million bu.: Fats & Oils Situation

SOYCM: Soybean crushing margin, $/bu. (computed SOMSC * SOMPM/20) + (SOOSC * SOOPM) - SOYPM)

SOYMX: Soybeans, U.S. exports, crop year, million bu.: Fats & Oils Situation

SOYPF: Soybeans season average price received by farmers, $/bu.: Fats & Oils Situation

SOYPM: Soybeans, season average wholesale price, #1 yellow, $/bu.: Fats & Oils Situation

SOYSAE: Soybean acreage planted, million acres: Crop Production

SOYSC: Soybeans, total crushed, September year, million bu.: Fats & Oils Situation

SOYSCMX: Soybeans, crushed plus exports, million bu. (computed SOYSC + SOYMX)

SOYSPE: Soybeans, total production, million bu.: Fats & Oils Situation

SOYXTOT: Soybeans, total world exprots, million bu. (computed SOYMX - SOYXSC + 0.0367 * (SOYMXBR1 - SOYXBRS1))

IACORNYE: Iowa corn yield, bu./acre: Crop Production

IACORPF: Iowa corn price, season average paid to farmers, $/bu.: Agricultural Prices

IACNR: Iowa corn net returns, deflated $/bu. (computed $[IACORPF * (IACORNYE_{-1} + IACORNYE_{-2} + IACORNYE_{-3})/3 - CORVC]/GNPD)$

IASOYEXP: Iowa aggregate soybean production, million dollars (computed SYVC * IASOYSA)

IASOYNFI: Iowa net farm income from soybeans, million dollars (computed IASOYVS - IASOYEXP)

IASOYNX: Iowa net exports of soybeans, million bu. (computed IASOYSD - IASOYSC)

IASOYSD: Iowa soybeans sold, million bu.: Agricultural Statistics

IASOYVS: Iowa soybeans, value of sales, million dollars (computed IASOYSD * IASOYPF)

IASOMSP: Iowa soymeal production, thousand tons: Oilseed Crushings

IASOOSP: Iowa soyoil production, million lbs.: Oilseed Crushings

IASOYHC: Soybeans, total stocks in Iowa t year's end, 1,000 bu.: Grain Stocks

IASNR: Iowa soybean met returns, deflated \$/bu. (computed [IASOYPF * ($IASOYSYE_{-1}$ + $IASOYSYE_{-2}$ + $IASOYSYE_{-3}$)/3 - SYVC]/GNPD)

IASOYPF: Season average price received by farmers in Iowa for soybeans, \$/bu.: Agricultural Prices

IASOYPL1: Iowa expected soybean loan rate, \$/bu.: ASCS data

IASOYSAE: Iowa acreage planted, million acres: Crop Production

IASOYSC: Soybeans crushed in Iowa mills, 1,000 bushels, Dept. Commerce: Oilseed Crushings

IASOYSPE: Soybeans, total production in Iowa, crop year, 1,000 bushels: Crop Production

VALOM: Value of oil and meal, \$/bu. (computed (SOMPM/20) * SOMSC + (SOOPM * SOOSC) - SOYPM)

Exogenous variables

BUTTLD: Butter and lard, U.S. domestic disappearance, October year, million lbs.: Fats and Oils Situation

CEN1: Personal consumption expenditures on nondurable goods and services, billion \$: Economic Indicators

CHISPEC1: Poultry production in European community, calendar year, 1,000 metric tons: Foreign Agricultural Circular

COLFAU: Cotton, American upland, price received by farmers, August year, ¢/lb.: Agricultural Prices

COLSYE: Cotton yield, expected lb./acre: Crop Production

COODD: Cottonseed oil, domestic disappearance, October year, million lbs.: Fats & Oils Situation

CORNXPS: Weighted world corn price, \$/bu. (computed, (19.27) * CORPF/SDR) + 0.47 * CORPA)

CORPA: EC threshold price for corn, weighted average of countries: Marches Agricoles

CORPD1: Expected effective diversion payment, corn (including support payment), \$/bushel (computed)

CORPE1: Corn, expected effective price support, \$/bu. (computed)

CORPF: Corn, season average price received by farmers, \$/bu.: Agricultural Prices

CORSYGRE: Corn yield, expected bu./acre, October year: Crop Production

CORVC: Corn, variable costs of production, \$/acre: USDA-ESS Costs of Producing Selected Crops in the United States

CTVC: Cotton, variable costs of production, \$/acre: USDA-ESS Costs of Producing Selected Crops in the United States

D74: Dummy variable, D74 = 1 in 1974, Ø elsewhere

D76: Dummy variable, D76 = 1 in 1976, Ø elsewhere

D80: Dummy variable, D80 = 1 in 1980, Ø elsewhere

DUM72: Dummy variable, DUM72 = 1 in 1972, Ø elsewhere

FAOOD: Fats and oils disappearance less soy, cotton, palm, butter, and lard, October year, million lbs.: Fats & Oils Situation

FATOIL: Total oil disappearance, mil. lbs. (computed, COODD + FAODD + PAODD)

FEEDHPS: U.S. feed, high protein consumption less fish and soy meal, October year, 1,000 tons: Fats & Oils Situation

CVSOY: Soybean crushing capacity, million bu.: Fats & Oils Situation

FIMPW: Fish meal price, CIF European ports, Peruvian and/or any origin \$/short ton: Foreign Agricultural Circular

GNPD: GNP deflator, October year, 1972 = 100: Economic Indicators

HOGJN1: Hog production in Japan, calendar year, 1,000 metric tons: Foreign Agricultural Circular

HOGSDEC1: Hog production in European Community, 1,000 m.t.: Foreign Agricultural Circular

HPAUTST: High protein animal units, calendar year (computed from Feed Situation)

LIVIF1: Livestock price index, calendar year, 1966 = 100 (computed)

LIVEPUJ1: Livestock production, 1,000 m.t. (computed .5 * (CHISPEC1 + POLJN)/2,513 + .5 * (HOGSDEC1 + HOGJN1)/6,790)

IACORNYE: Iowa corn yield, bu./acre, October year: Crop Production

IASOMSC: Iowa meal crushing yield, cwt./bu. (computed,

$$IASOMSC = \frac{IASOMSP}{IASOYSC * 50})$$

IASOOSC: Iowa oil crushing yield, cwt./bu. (computed,

$$IASOOSC = \frac{IASOOSP}{IASOYSC * 100})$$

IASOYSYE: Expected Iowa soybean yield, bu./acre: Crop Production

IASOYUF: Iowa soybeans used on farms, million bu., Agricultural Statistics

IRESDEV: International reserves of nonoil exporting developing countries, millions SDR: OSS data files

PAODD: Palm oil domestic disppearance, October year, million lbs.: Fats & Oils Situation

POLJN: Poultry production in Japan, calendar year, 1,000 m.t.: Foreign Agricultural Circular

RSOMCOR: Ratio of real meal price to world average corn price (computed, (1 - SOMECPC) (39.368 * CORPF)/SDR + SOMECPC * CORPA)

SDR: U.S. dollars per SDR, October basis, $/SDR: International Financial Statistics

SHIFT77: Dummy variable, SHIFT77 = 1 after 1977, Ø elsewhere

SMSMNE9: Soybean meal imported by EC, 1,000 m.t., Foreign Agricultural Circular

SOMECPC: Soybean meal imported by EC, percent of total exports (computed, SMSMNE9 * 1.1023/SOMXTOT)

SOMHT: Soymeal, end of year stocks, billion lbs.: Fats & Oils Statistics

SOMMXBR1: Soybean meal exports, Brazil and Argentina, calendar years, 1,000 m.t.: Foreign Agriculture Service data

SOMSC: Soybean meal computed crushing yield cwt./bu. (computed SOMSP/SOYSC * 50)

SOOHCC: Soybean oil ending stocks, CCC owned, million lbs., ASCS data

SOOHCPL: Soybean oil government stocks plus PL-480, million lbs. (computed, SOOHCC + SOOPL)

SOOPL: Soybean oil, PL-480, October year, million lbs. exported: Fats & Oils Situation

SOOSC: Soybean oil crushing yield, cwt./bu. (computed SOOSP/SOYSC * 100)

SOOTS: Soybean oil, total supply, million lbs. (computed, SOOSP + $SOOHC_{-1}$ + $SOOHCC_{-1}$)

SOOXF: Soybean oil, exports by foreign nations, million lbs.: Foreign Agricultural Circular

SOYCC: Soybeans, ending stocks, CCC owned, under loan and reseal, million bu.: Fats & Oils Situation

SOYDV: Soybeans, domestic feed, seed, and residual use, million bu.: Fats & Oils Situation

SOYHF: Soybeans, ending stocks under loan, million bu.: Fats & Oils Situation

SOYHG: Soybeans, ending stocks, CCC owned, million bu. (computed, SOYCC - SOYHF)

SOYMXBR1: Soybean exports by Brazil and Argentina, 1,000 m.t.: FAS data

SOYXBRS1: Soybean exports by Brazil and Argentina to the USSR and China, 1,000 m.t.: FAS data

SOYXSC: Soybeans, U.S. exports to the USSR and China, million bu., September year: Fats & Oils Situation

SOYSYE: Expected soybean yield per harvested acre, September year, bu./acre: Crop Production

SYVC: Soybeans, variable cost per acre, $/acre: USDA-ESS Costs of Producing Selected Crops in the U.S.

APPENDIX B

Table B.1. Exogenous variables

YEAR	BUTTLD	CEN1	CHISPEC1	COLFAU	COLSYE	COODD	CORNXPS
61	3363	308.5	1524	0.329	457	1352	57.694
62	3693	323.2	1702	0.319	517	1347	58.111
63	3763	344.1	1879	0.320	517	1407	59.106
64	3598	367.3	2009	0.296	527	1555	62.365
65	3399	397.1	2181	0.280	480	1590	62.208
66	3432	420.2	2216	0.206	447	1157	65.884
67	3573	456.4	2300	0.254	516	1090	63.166
68	3398	496.2	2453	0.220	434	1031	66.329
69	3075	536.5	2652	0.209	438	1052	68.539
70	3238	575.0	2760	0.219	438	890	72.678
71	3069	625.9	3020	0.281	507	834	66.571
72	2688	688.6	3192	0.273	520	980	75.936
73	2614	766.6	3148	0.444	441	991	92.864
74	2595	844.7	3134	0.427	453	622	105.822
75	2190	927.4	3348	0.499	465	451	106.975
76	2289	1026.2	3464	0.638	520	532	105.440
77	2527	1145.2	3591	0.521	420	683	104.892
78	2817	1293.7	3707	0.585	547	620	107.880
79	2975	1453.3	3884	0.633	404	659	113.658
80	2910	1613.7	4009	0.744	543	527	128.502
81	2843	1739.7	4032	0.544	590	680	126.264
82	2311	1876.1	4157	0.578	487	604	133.638

Table B.1. continued

YEAR	CORPA	CORPD1	CORPF1	CORPF	CORSYGRF	CORVC	CTVC	CVSDY
61	73.92	0.192	0.84	1.10	64.7	56.05	66.44	535
62	73.92	0.112	0.88	1.12	67.9	55.49	65.74	550
63	76.48	0.180	0.81	1.11	62.9	55.39	68.64	575
64	80.75	0.180	0.81	1.17	74.1	55.27	69.52	585
65	80.86	0.248	0.65	1.16	73.1	54.82	66.46	600
66	85.13	0.150	0.94	1.24	80.1	55.18	63.94	650
67	88.67	0.241	0.63	1.03	79.5	54.89	68.92	750
68	93.18	0.241	0.68	1.08	85.9	54.22	71.60	750
69	94.33	0.231	0.68	1.16	72.4	52.11	72.16	800
70	95.59	0.160	1.05	1.33	88.1	53.00	72.05	875
71	96.58	0.260	0.89	1.03	97.0	57.78	81.47	900
72	101.79	0.030	0.83	1.57	91.3	60.75	92.63	925
73	103.56	0.000	1.38	2.55	71.9	63.51	104.96	1000
74	115.35	0.000	1.38	3.02	86.3	88.43	128.05	1050
75	130.40	0.000	1.57	2.54	87.9	91.21	143.99	1100
76	142.20	0.000	2.00	2.15	90.8	93.49	156.14	1200
77	149.91	0.122	2.08	2.02	101.0	96.41	168.21	1250
78	152.16	0.051	2.18	2.25	109.7	98.39	172.03	1300
79	156.10	0.000	2.25	2.52	90.9	113.11	205.67	1350
80	159.40	0.000	2.40	3.11	109.8	136.51	219.38	1412
81	169.60	0.000	2.50	2.51	114.8	154.94	266.91	1470
82	174.90	1.350	2.60	2.65	80.5	157.93	306.95	1500

Table B.1. continued

YEAR	D72	D7274	D74	D76	D80	DUM72	FADDD	FATOIL	FEEDHPS
61	1	0	0	0	0	0	-213	1199	6928
62	1	0	0	0	0	0	138	1528	7032
63	1	0	0	0	0	0	354	1784	7407
64	1	0	0	0	0	0	59	1631	7251
65	1	0	0	0	0	0	334	1958	7189
66	1	0	0	0	0	0	511	1761	6765
67	1	0	0	0	0	0	500	1647	6783
68	1	0	0	0	0	0	244	1436	6809
69	1	0	0	0	0	0	411	1585	6149
70	1	0	0	0	0	0	494	1566	6394
71	1	0	0	0	0	0	619	1804	6544
72	0	1	0	0	0	1	792	2128	6352
73	0	0	0	0	0	0	443	1728	6159
74	0	-1	1	0	0	0	912	2226	5885
75	0	0	0	0	0	0	742	2076	5807
76	0	0	0	1	0	0	825	1968	5873
77	0	0	0	0	0	0	505	1555	6211
78	0	0	0	0	0	0	19	916	5922
79	0	0	0	0	0	0	-35	899	7036
80	0	0	0	0	1	0	-70	691	6900
81	0	0	0	0	0	0	-50	937	7000
82	0	0	0	0	0	0	-50	841	7300

Table B.1. continued

YEAR	FIMPW	GNPD	HOGJN1	HOGSDEC1	HPAUTST	LIVEPUJ1	LIVI
61	124.0	0.702	324	5508	131.61	0.75715	1.003
62	120.9	0.713	279	5159	133.99	0.76773	0.947
63	134.1	0.724	298	5799	130.21	0.85844	0.905
64	165.0	0.739	407	6145	125.34	0.92338	1.026
65	159.0	0.760	564	6023	132.95	0.95754	1.119
66	140.0	0.784	603	6187	136.57	1.00000	1.000
67	121.0	0.816	589	6554	136.52	1.05007	1.050
68	161.0	0.856	587	6533	134.07	1.09334	1.200
69	179.0	0.902	734	6958	145.83	1.19316	1.160
70	155.0	0.948	843	7474	142.95	1.27082	1.123
71	169.0	0.989	885	7604	140.32	1.35273	1.288
72	497.0	1.039	970	7611	138.91	1.40586	1.837
73	338.0	1.123	957	7862	134.68	1.42299	1.657
74	221.0	1.235	1039	7709	125.95	1.41816	1.872
75	341.0	1.308	1056	7848	136.58	1.48834	1.760
76	403.0	1.384	1039	8179	138.17	1.55165	1.750
77	372.0	1.474	1284	8605	142.64	1.64703	2.074
78	358.0	1.603	1430	9061	154.26	1.73075	2.307
79	366.0	1.742	1476	9141	151.13	1.78380	2.247
80	354.0	1.911	1396	9310	157.28	1.78558	2.333
81	375.0	2.047	1430	9265	152.24	1.79452	2.487
82	398.0	2.140	1465	9398	157.40	1.87454	2.368

Table B.1. continued

YEAR	IACORNYE	IASOMSC	IASOOSC	IASOYSYE	IASOYUF	IRESDEV
61	77.0	0.455771	0.101814	27.5	2.77	7653
62	80.0	0.431746	0.096166	30.5	2.80	8171
63	77.5	0.522838	0.114125	28.5	2.93	9308
64	82.0	0.452260	0.099545	26.0	3.10	9111
65	89.0	0.428985	0.093521	29.5	3.07	10345
66	88.5	0.457864	0.100873	27.5	3.23	11282
67	93.0	0.528339	0.117224	32.0	3.23	12002
68	99.0	0.487902	0.105748	32.5	2.81	14006
69	86.0	0.429980	0.094869	32.5	2.52	15361
70	102.0	0.439391	0.095014	32.5	2.24	16875
71	115.0	0.525657	0.117303	36.0	2.99	18412
72	107.0	0.417309	0.096711	34.0	3.39	26132
73	80.0	0.446402	0.098412	28.0	2.45	32307
74	90.0	0.568487	0.127418	34.0	2.38	32973
75	91.0	0.355228	0.078150	31.0	2.13	32288
76	86.0	0.463224	0.112325	35.5	2.40	42790
77	115.0	0.416374	0.098962	37.5	2.76	52795
78	127.0	0.475449	0.100981	37.5	2.55	61673
79	110.0	0.483031	0.099409	38.5	2.46	68703
80	127.0	0.483936	0.118395	40.5	2.58	71776
81	120.0	0.474862	0.118099	37.5	3.26	75304
82	87.0	0.474005	0.098740	34.0	3.11	73406

Table B.1. continued

YEAR	PADDD	POLJN	RSOMCOR	SDR	SHIFT77	SMSMNE9	SOMECPC
61	60	123	1.00094	1.000	0	638	0.660966
62	43	144	1.13293	1.000	0	885	0.631683
63	23	179	1.07058	1.000	0	928	0.690049
64	17	207	1.03521	1.000	0	1224	0.627034
65	34	244	1.25581	1.000	0	1392	0.546454
66	93	297	1.02831	1.000	0	1942	0.765950
67	57	334	1.06793	1.000	0	1873	0.653762
68	161	407	0.98590	1.000	0	1979	0.644311
69	122	498	1.08211	1.000	0	2334	0.550403
70	182	549	1.05063	1.000	0	2651	0.517178
71	351	637	1.08971	1.064	0	3313	0.668230
72	356	698	2.44096	1.166	0	3195	0.562734
73	294	740	1.35995	1.204	0	2198	0.295863
74	692	756	1.03565	1.221	0	2512	0.341767
75	883	837	1.25564	1.160	0	3019	0.345206
76	611	923	1.77661	1.162	0	3720	0.345183
77	357	1027	1.42702	1.224	1	3829	0.337543
78	277	1109	1.40327	1.291	1	5144	0.434476
79	275	1152	1.36305	1.305	1	5315	0.327745
80	234	1003	1.45652	1.211	1	5848	0.387557
81	307	1029	1.35372	1.125	1	6300	0.391525
82	287	1244	1.36930	1.075	1	6472	0.388726

Table B.1. continued

YEAR	SOOTS	SOOXF	SOYCC	SOYDV	SOYHF	SOYHG
61	5461.5	549	58.5	46.583	0.4	58.1
62	5569.2	199	4.8	48.272	2.2	2.6
63	5733.1	194	26.0	53.843	11.2	14.8
64	5724.0	233	0.0	47.367	0.0	0.0
65	6072.6	262	0.0	51.601	0.0	0.0
66	6535.2	287	33.9	52.989	21.5	12.4
67	6620.3	365	137.9	57.282	67.0	70.9
68	7059.3	272	316.8	53.745	41.9	274.9
69	8311.6	345	196.9	60.177	5.1	191.8
70	8805.4	311	11.4	64.227	3.0	8.4
71	8622.7	321	1.5	65.545	1.5	0.0
72	8286.0	739	0.2	81.695	0.2	0.0
73	9511.0	1045	0.8	75.500	0.3	0.0
74	8169.0	1273	0.4	77.087	0.4	0.0
75	10191.0	2041	0.0	71.340	0.0	0.0
75	9829.0	2284	0.0	76.310	0.0	0.0
77	11055.0	3188	0.0	81.870	0.0	0.0
78	12052.0	3217	12.1	98.440	12.1	0.0
79	12881.0	3353	42.0	81.000	42.0	0.0
80	12480.0	4957	56.5	99.000	56.5	0.0
81	12715.0	4607	86.6	89.000	83.9	2.7
82	13144.0	4863	161.2	86.000	140.3	20.9

Table B.1. continued

YEAR	SOYMXBR1	SOYXBRS1	SOYXSC	SOYSYE	SYVC
61	97	0	0.00	24.2	26.33
62	33	0	0.00	24.4	25.28
63	0	0	0.00	22.8	25.27
64	98	0	1.30	24.5	26.54
65	213	0	0.90	25.4	27.02
66	185	0	0.00	24.5	27.24
67	188	0	0.00	26.7	27.56
68	300	0	0.00	27.4	27.30
69	260	0	0.00	26.7	27.81
70	626	0	0.00	27.5	27.80
71	1430	2	0.00	27.8	30.77
72	3252	4	32.70	27.8	32.01
73	3460	0	28.40	23.7	41.02
74	3009	469	1.40	28.9	46.34
75	1940	1985	11.40	26.1	47.54
76	2791	1305	30.30	30.6	45.98
77	3212	929	20.25	29.9	52.82
78	3246	1862	35.91	32.2	56.53
79	3447	1095	44.14	26.4	63.89
80	1505	1154	13.00	30.1	72.50
81	2550	1201	25.00	31.9	81.62
82	3000	1250	7.00	25.0	82.35

Table B.2. Endogenous variables

YEAR	DCORNRE	DCTNRE	DSNPE1	IACORNYE	IACORPF	IACNR
61	9.055	115.472	26.686	77.0	1.09	25.741
62	17.366	107.788	29.351	80.0	1.09	32.244
63	23.149	113.223	56.162	77.5	1.05	35.891
64	28.383	104.996	71.981	82.0	1.12	43.676
65	32.116	104.254	47.910	89.0	1.13	46.568
66	40.384	51.923	41.498	88.5	1.17	53.233
67	28.370	66.404	46.124	93.0	1.01	39.798
68	34.523	39.077	70.984	99.0	1.07	49.367
69	47.469	27.898	18.260	86.0	1.11	57.289
70	55.300	30.880	11.330	102.0	1.25	66.280
71	31.268	41.692	79.505	116.0	1.04	42.177
72	71.230	31.976	101.204	107.0	1.65	102.454
73	152.654	99.608	75.091	80.0	2.58	192.333
74	140.490	65.502	116.181	90.0	2.97	171.287
75	91.769	69.729	90.692	91.0	2.50	106.746
76	59.886	96.007	67.595	86.0	2.05	61.315
77	55.647	55.307	74.901	115.0	1.99	54.749
78	69.485	63.596	96.776	127.0	2.17	70.383
79	80.454	52.048	32.638	110.0	2.42	86.956
80	92.176	63.123	144.782	127.0	3.15	121.973
81	51.178	1.955	-3.917	120.0	2.41	67.159
82	56.431	-5.057	47.652	87.0	2.65	73.561

Table B.2. continued

YEAR	IASOMSP	IASODSP	IASOYEXP	IASOYHC	IASOYHC	IASOYNFI	IASOYNX
61	1670.4	746.3	90.312	24.79	24.79	124.62	23.110
62	1758.0	787.6	89.212	3.84	3.84	125.20	18.695
63	1971.1	860.5	90.048	11.30	11.30	168.19	29.736
64	1840.7	810.3	106.493	9.30	9.30	190.29	29.874
65	1986.2	866.0	126.755	5.97	5.97	189.79	30.392
66	2229.8	982.5	138.177	31.54	31.54	251.29	52.718
67	2369.6	1051.5	141.576	58.66	58.66	204.88	43.309
68	2185.8	947.5	149.701	113.59	113.59	275.01	71.955
69	2137.0	943.0	170.490	86.26	86.26	255.51	86.924
70	2379.3	1029.0	163.451	18.95	18.95	355.52	79.202
71	2602.0	1161.3	161.186	12.87	12.87	369.73	57.627
72	2372.4	1099.6	191.863	11.03	11.03	814.11	67.034
73	2698.5	1189.8	322.128	36.95	36.95	1139.87	107.837
74	2873.7	1288.2	322.586	54.77	54.77	917.36	42.990
75	2419.1	1064.4	325.673	73.39	73.39	862.61	75.498
76	3117.5	1511.9	324.206	29.96	29.96	1088.77	59.168
77	3249.8	1544.8	372.582	46.23	46.23	1096.57	90.350
78	4022.3	1708.6	426.237	44.18	44.18	1433.42	112.339
79	4574.3	1882.8	523.471	66.51	66.51	1351.29	132.486
80	4205.4	2057.7	560.440	72.88	72.88	1731.33	111.043
81	3946.1	1962.8	724.320	78.10	78.10	1228.43	176.904
82	4325.3	1802.0	663.470	99.23	99.23	1025.56	123.285

Table B.2. continued

YEAR	IASOYPF	IASOYPL1	IASOYSAE	IASOYSC	IASOYSD	IASOYSPE	IASOYVS
61	2.28	2.21	3.42	73.3	94.270	93.64	179.37
62	2.33	2.21	3.59	81.9	92.305	109.04	178.28
63	2.44	2.21	4.27	75.4	103.581	121.24	279.76
64	2.57	2.21	4.86	81.4	108.970	126.10	365.99
65	2.61	2.47	5.01	92.6	116.460	147.38	311.13
66	2.69	2.47	5.36	97.4	143.418	144.27	356.62
67	2.50	2.47	5.58	89.7	135.213	177.95	357.87
68	2.44	2.47	5.63	89.6	169.155	177.13	534.61
69	2.36	2.21	5.71	99.4	192.737	184.60	331.53
70	2.82	2.21	5.52	108.3	185.024	178.75	270.94
71	3.07	2.21	5.05	99.0	163.854	216.00	658.99
72	4.74	2.21	7.70	113.7	208.073	260.10	1041.37
73	5.65	2.22	7.20	120.9	259.210	199.08	1171.20
74	6.36	2.22	7.00	101.1	188.637	236.98	1346.84
75	5.09	2.47	6.47	136.2	226.129	199.95	1395.57
76	7.05	3.47	7.10	134.6	207.250	251.34	1106.58
77	5.92	4.47	7.60	156.1	242.642	283.13	1382.60
78	6.64	4.47	8.20	169.2	274.546	306.38	2001.19
79	6.17	4.99	8.30	189.4	298.644	318.40	1167.35
80	7.39	4.98	8.20	173.8	288.679	326.00	3388.52
81	5.88	4.98	8.45	166.2	348.961	310.80	875.54
82	5.60	4.98	8.47	182.5	292.974	270.64	1824.08

Table B.2. continued

YEAR	OESOYX	SOMDDT	SOMMXES	SOMPM	SOMXTOT	SOMSP	SODDDT
61	1697.9	9262	1064	63.60	1064.0	10342	3540.0
62	1962.5	9586	1476	71.30	1544.3	11127	3623.6
63	2059.2	9168	1478	71.00	1482.4	10609	4058.5
64	2295.2	9266	2036	70.20	2151.7	11286	4086.0
65	2781.3	10271	2604	81.50	2807.9	12901	4712.0
66	2925.5	10821	2657	78.80	2794.8	13483	4865.0
67	2871.8	10753	2899	76.90	3158.0	13660	5125.0
68	3216.5	11525	3044	74.10	3385.7	14581	5786.0
69	4731.0	13581	4035	78.40	4674.3	17596	6357.0
70	4979.1	13467	4559	78.50	5650.3	18035	6292.0
71	5115.0	13173	3805	90.20	5465.1	17024	6482.0
72	5886.9	11973	4745	229.00	6258.5	16709	6704.0
73	6952.4	13802	5548	146.30	8189.1	19674	7281.0
74	5332.6	12552	4299	130.90	8101.9	16702	6580.0
75	6016.7	15612	5145	147.78	9640.2	20754	7964.0
76	6413.6	14056	4559	199.80	11879.4	18488	7511.0
77	8481.9	16276	6080	163.56	12504.2	22371	8273.0
78	8371.0	17720	6610	190.06	13050.7	24354	8941.0
79	9908.8	19214	7932	181.91	17875.8	27105	8981.0
80	7966.2	17591	6784	218.18	16633.1	24312	9115.0
81	10204.2	17714	6908	182.52	17737.0	24634	9535.0
82	10489.1	19306	7109	187.40	18352.5	26714	9858.0

Table B.2. continued

YEAR	SOOHC	SOOPM	SOOSP	SOOXES	SOYHT	SOYHC
61	478.2	9.5	4790	782	78.3	20.2
62	911.1	8.9	5091	661	46.0	43.4
63	578.0	8.5	4822	507	67.3	52.5
64	272.6	11.3	5146	737	29.7	29.7
65	459.2	11.8	5800	479	35.6	35.6
66	598.3	10.1	6076	283	90.1	77.7
67	528.3	8.4	6032	89	166.3	95.4
68	407.6	8.4	6531	79	326.8	51.9
69	540.4	11.2	7904	664	229.8	38.0
70	730.7	12.8	8265	900	98.8	90.4
71	785.0	11.3	7892	626	72.0	72.0
72	516.0	16.5	7501	623	59.6	59.6
73	794.0	31.5	8995	1201	170.8	171.6
74	561.0	30.7	7375	811	185.2	185.2
75	1251.0	18.3	9630	573	244.9	244.9
76	771.0	23.9	8578	1176	102.9	102.9
77	729.0	24.5	10288	1581	164.1	161.1
78	776.0	27.2	11323	1999	175.6	174.1
79	1210.0	24.3	12105	2173	358.5	358.8
80	1736.0	22.7	11270	1054	313.0	313.0
81	1103.0	19.0	10979	1535	254.5	251.8
82	1261.0	20.6	12041	1489	344.6	323.7

Table B.2. continued

YEAR	SOYCM	SOYMX	SOYPF	SOYPM	VALOM
61	0.167720	149.4	2.28	2.41	2.53332
62	0.140315	180.5	2.34	2.50	2.65101
63	0.070300	187.2	2.51	2.59	2.60070
64	0.052310	212.2	2.62	2.81	2.88414
65	0.320400	250.6	2.54	2.91	3.20595
66	0.139980	261.6	2.75	2.86	2.95836
67	0.094530	266.6	2.49	2.61	2.72973
68	0.149305	286.8	2.43	2.54	2.66337
69	0.538240	432.6	2.35	2.53	3.06768
70	0.255650	433.8	2.85	3.00	3.24285
71	0.120420	416.8	3.03	3.24	3.35814
72	0.807350	479.4	4.37	6.21	7.20930
73	0.817385	539.1	5.68	6.12	6.86931
74	0.018920	420.7	6.64	6.32	6.41793
75	0.318020	555.1	4.92	5.26	5.47879
76	-0.049580	554.1	6.81	7.33	7.31646
77	0.529474	700.5	5.88	6.14	6.52237
78	0.451634	739.2	6.66	7.11	7.44202
79	0.507526	875.2	6.28	6.51	6.93567
80	0.110593	724.3	7.57	7.59	7.62247
81	0.155228	929.1	6.05	6.24	6.37772
82	0.779850	905.0	5.65	6.01	6.66618