MACROECONOMIC AND GOVERNMENT POLICY VARIABLE IMPACTS ON AN IMPORT DEMAND SYSTEM

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DEDICATION

TO MY LATE MOTHER

CHANG BONG HEE

WHOM I LOVE AND MISS MOST

The world is simply empty without you, mother. Nothing can compensate me for the loss of you. It was truly the happiest time of my life when you were with me. Since you left me, I have been full of beautiful memories for the past decades. I am unable to express myself how much I love you and I miss you. Now I realize that you are always alive with me, and this encourages me to be ready to take off for the new beginning.

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CHAPTER I

INTRODUCTION

Global issues in food and agriculture bring the interrelated problems of food production, population growth, economic growth, and security of food supplies through international trade. The ability of agricultural production to match growing demand depends upon the economic environment in the producing area and the nature of the domestic and international marketing system through which agricultural products pass on their way to consumers. Government also plays a role to influence each stage of this interconnected process from production, marketing, storage, and international trade through final consumption.

The U.S. dollar devaluations and the world food crisis in the early 1970's, with the subsequent expansion of world agricultural markets, sparked a renewed interest in empirical research on international agricultural trade.

Countries in the world become increasingly interdependent as international trade increases, and discussions at the GATT to resolve international trade disputes is an indicator of the importance of international trade. As one of the major agricultural exporters, U.S. agricultural programs were designed to raise farm incomes primarily through price supports in an early period when trade was not important for U.S. agriculture. U.S. agricultural policy now affects the international market in a major way.

Under this situation, we need to consider some important issues such as growth rates of production and disappearance, government support to encourage production, the level of investment in agriculture, inventory management, efficiency of the marketing system, agricultural protection and structural adjustment against international competition, and the role of agricultural trade in economic development. These issues must be considered within the context of interdependent international markets.

Government plays an important role in such an interdependent world. A government policy decision should depend on economic growth, the degree of self-sufficiency, and the economic health of production and consumption sectors in the importing country. Agricultural and food policy is thus constrained by national goals, resource endowments, and foreign interference. Policy makers and analysts should understand how the international environment influences domestic food supply and demand, and how to measure the impact of a domestic policy change on agricultural trade.

An Overview of Korean Agricultural Conflicts

While Korea has made remarkable economic progress for the past 30 years, substantial changes in industrial structure have accompanied these changes. Among those, an increasing income disparity between farm and nonfarm sectors caused massive out-migration from rural areas, which resulted in labor shortages in rural areas and rapid increase in rural wage rates.

Increasing income not only changed traditional food consumption patterns but also rapidly increased the consumption of high quality income elastic food. At the same time, increasing production costs and labor shortages contributed to reduced agricultural production and caused a considerable decrease in food self-sufficiency. As a result, the excess demand placed pressure on the need for imports of less costly foreign agricultural products, which in turn, depressed the price of domestically produced agricultural products, and discouraged costly domestic production. Korea had to learn how to match the rapidly increasing demand for food more efficiently with limited available resources.

A costly food security program with a high degree of self-sufficiency and cheaper food supply through imports could be pursued to protect both domestic producers and consumers. A more realistic and efficient government strategy should be designed for a tolerable level of protection.

Under these circumstances, it is important to understand the economic interactions that exist in the marketing channel for imports through domestic disappearance.

Transition of the Food Consumption Structure

Food consumption patterns depend upon a number of factors. In addition to the traditional factors suggested by economic theory such as income, cross price relationships between food products, and consumer preferences and tastes, additional factors to change food consumption pattern such as nutritional variables, health knowledge, government policy, availability of new food products, and foreign exchange reserves emerged. Rapid urbanization also contributed to shifting the pattern. Changes in the food consumption pattern also include consumer shifts in favor of income elastic commodities such as dairy products, fruits and vegetables. The limits of this study restrict it to grain commodities.

Rice has traditionally been the most important major food grain in Korea. It has been gradually substituted by other foods as income has risen, and per capita consumption of rice has declined. More efficient production plus the gradual decline of consumption resulted in rice production around the self-sufficiency level. These trends are summarized in Table 1.7. Per capita rice consumption has declined since the early 1980's.

A notable change in food consumption patterns can be found in grain consumption. Barley was the main staple food next to rice until the mid 1970's, then suddenly it dropped as shown in Table 1.7. Per capita annual barley consumption achieved a high of 40 kg in 1974. It began a rapid downward trend and finally reached 1.5 kg in 1992. Government programs also contributed to reducing barley consumption by lifting the regulations in 1977 imposed on rice and barley consumption, which had been designated a mix of 75 percent rice and 25 percent barley or other grains at commercial serving places. Decreasing consumption of rice and barley implies increasing consumption of other foods.

Wheat demand continuously increased for the last two decades and annual demand in 1992 was 2.9 times of that of 1970. At the same time, domestic production substantially dropped during the same period because of the relatively unfavorable cultivating conditions in Korea. From Table 1.5, self-sufficiency ratios for wheat of 15.4 percent in 1970 became 0.02 percent in 1992. The excess demand was filled with a rapid increase in imports. Wheat gradually replaced barley as the main food grain next to rice. This important grain is now entirely dependent on foreign supply. Wheat is also used in processing, seeding, and feeding. As illustrated by Table 1.2, feed use of wheat sharply increased since 1984.

Corn demand has greatly increased for the last two decades. Demand for corn in 1992 was 18.6 times that of 1970 (Table 1.3). The self-sufficiency level continued to drop from 18.9 percent in 1970 to 1.2 percent in 1992 (Table 1.5). In accord with this, imports substantially expanded 22.5 times for the same period, and Korean corn supplies almost entirely depended on the international market. Corn is mainly used for feed, and partly for processing.

Soybeans are important sources as food and feed. Feed use of soybeans began to exceed the total of all other uses by the early 1980's. Imports in 1992 were 36 times that of 1970 (Table 1.4). As shown in Table 1.5, the level of self-sufficiency dropped from 86.1 percent in 1970 to 12.2 percent in 1992.

Heavy usage of corn and soybeans for feed suggest an increasing demand for meat. Per capita annual meat consumption increased from 5.2 kg in 1970 to 23.9 kg in 1992. The number of live cattle, hogs, and chickens also increased. These trends are summarized in Table 1.8.

Objectives of the Study

Industrialization has made a rapid structural transformation in the Korean agricultural sector since 1970. The agricultural sector has experienced a drastic decrease in food self-sufficiency. Food security became an increasing matter of concern in Korea. High prices are necessary for producers to have an incentive to increase production, but such prices may lie beyond the ranges that consumers, especially the poor, are willing to pay. Korean agricultural policy in the 1990's needs to focus on how to provide a stable food supply to consumers at a reasonably low price while maintaining an adequate level of self-sufficiency in food and protecting the farm sector. Since these goals may not be mutually compatible, some difficult choices may face Korean agricultural policy makers.

Trade liberalization is expected to accelerate the inflow of foreign grains. A potential risk exists in heavy reliance on the international market for food supplies. A perfectly elastic supply is commonly and implicitly assumed in most small country studies. However, uncertainty in the price and quantity supplied permeates the world grain market. Foreign exchange availability is another constraint. A reasonable degree of self-sufficiency for major grains is thus one of the main goals of agricultural policymakers in Korea.

The system of markets such as production, stocks, imports, and disappearance should be organized to provide an adequate food supply to all segments of the population, even under adverse conditions. The objective of the study is to investigate the economic forces that prevail in the marketing channel of imports, stocks through disappearance to supply for the three most important imported grains, which are wheat, corn, and soybeans in Korea.

To explain those economic relationships, we first set up equations for the flow of each commodity. Any single equation estimation procedure, even for one commodity, tends to yield inefficient parameter estimates even if they yield consistent parameter estimates. The inefficiency arises from two sources. First, all available information in the description of the system of equations is not used in estimation. Second, single equation estimation does not account for the possible correlations in error terms across equations. The loss of efficiency can be solved by estimating a system of equations. A a system of equations for the three levels of markets, which are imports, stock, and disappearance, are constructed for each commodity.

The first objective is to determine whether the model as one system captures enough information to explain the international and domestic marketing situations of those three commodities in Korea.

Increasing income raised demand for grains and expanded the cost of those imported. Total Gross Domestic Product (GDP) increased at the annual average rate of 9.36 percent in the 1970's 8.2 percent in the 1980's, and 7.5 percent from 1990 to 1992 as shown in Table 1.7. The total cost of wheat, corn, and soybean imports increased 5.6, 72.3 and 114.1 times in nominal dollar terms, respectively, from 1970 to 1992 (Table 1.5). Thus the exchange rate is another variable to be considered. Exchange rate movements are important factors in determining the level of international trade. An adverse movement in the exchange rate means an increasing cost of imports and may reduce foreign exchange availability.

The United States dollar has been used as a foreign exchange variable in most of the statistical data and empirical analysis available for Korea. Under increasing intercountry dependency today, the traditional bilateral exchange rate may be inappropriate for trade analysis. Special Drawing Rights (won per SDR) are used as the exchange rate variable in order to consider the multilateral effect on the international market. In addition, government policy variables are also included to capture their effects on grain flows.

The second objective of the study is to analyze own, cross, and lagged effects between variables included and check whether they are consistent with actual market situations. The effects of selected macroeconomic and government policy variables are of particular interest. The economic impacts may suggest important policy implications. Elasticity analysis may provide additional quantitative information to both traders and policy makers. Whether the macroeconomic and government policy variables are capable of reflecting enough information and presenting useful knowledge and propositions is a major concern of the study.

Stocks are an important factor, but often overlooked, as a major contributor to price responsiveness. Stocks of wheat and corn are a small part of imports, but they are larger than domestic production in Korea. Stock policy and price policy are related, so a single general model is unlikely to explain stock-price relationships. Stock adjustment is a policy instrument, and food security stocks are held as protection against variable domestic prices and import costs. For this reason stock equations are separately included in the model system.

The third objective is to examine stock effects on imports and responsiveness to movements of potentially important variables such as price, disappearance, and government policy variables.

Finally, data for some potentially important variables was not available. Proxy variables for those unavailable were used to compensate the effects of missing variables.

The last objective is to evaluate and validate the performance of the model.

Organization of the Study

The rest of the study consists of five chapters. In Chapter II, a review of related empirical work is presented. This chapter contains two parts, the first covers the effects of foreign exchange and other macroeconomic variables on agricultural trade, and the second deals with various import demand modeling issues. Chapter III presents relevant theories for the development of the model. Chapter IV describes the methodology for the analysis. Details on data adjustments and methods for the estimation of the model are presented. In Chapter V, empirical results are examined and interpreted. Chapter VI, finally, concludes the study. The summary, conclusions, policy and further research implications are presented based upon the results of the study.

Table 1.1. Macroeconomic Data.

	Population (1000 (persons)	GDP (billion wons in 1985 price)	CPI (Korea) (1985=100)	CPI (US) (1985=100)	Tax (%)	SDR (won/SDR)	Interstate (% per annum)
1969	31,540		13.6	34.1		288.16	22.8
1970	32,241	24,584	15.7	36.1	14.6	310.56	22.8
1971	32,883	26,844	17.8	37.6	14.7	348.18	20.4
1972	33,505	28,440	19.9	38.9	12.7	426.57	12.0
1973	34,103	32,542	20.6	41.3	12.5	474.85	12.0
1974	34,692	35,117	25.6	45.8	14.3	486.43	15.0
1975	35,281	37,621	32.0	50.0	15.5	587.65	15.0
1976	35,849	42,471	36.9	52.9	16.9	558.79	16.2
1977	36,412	46,749	40.7	56.3	17.0	565.08	14.4
1978	36,969	51,289	46.6	60.6	17.3	605.97	18.6
1979	37,534	55,182	55.1	67.5	17.9	625.33	18.6
1980	38,124	53,989	70.9	76.6	18.4	790.59	19.5
1981	38,723	57,615	86.1	84.5	18.8	803.04	16.2
1982	39,326	61,821	92.2	89.7	19.5	807.12	8.0
1983	39,929	69,101	95.4	92.6	20.0	829.27	8.0
1984	40,513	75,606	97.6	96.6	19.2	826.13	9.2
1985	40,806	80,847	100.0	100.0	19.0	883.37	10.0
1986	41,184	90,868	102.8	101.9	17.5	1034.10	10.0
1987	41,575	101,804	105.9	105.7	17.7	1063.64	10.0
1988	41,975	113,492	113.5	109.9	18.2	983.03	10.0
1989	42,380	120,477	119.9	115.2	18.9	860.65	10.0
1990	42,869	131,503	130.2	121.4	19.7	960.26	10.0
1991	43,268	142,633	142.8	126.6	19.1	1053.73	10.0
1992	43,663	149,463	151.7	130.4	19.9	1108.61	10.0

Source: IMF, Statistical Year Book 1993, International Financial Statistics.

Table 1.2. Demand and Supply Transition: Wheat, 1000 MT.

Year	Supply	Carry -in	Produc -tion	Import	Demand	Food	Process -ing	Seed	Feed	Others	Carry- out
1970	1,759	286	219	1,254	1,421						338
1971	1,918	338	196	1,384	1,656						262
1972	2,189	262	149	1,778	2,033						156
1973	2,028	156	100	1,772	1,896						132
1974	1,633	132	74	1,427	1,497						136
1975	1,817	136	97	1,584	1,704						113
1976	2,052	113	82	1,857	1,816						236
1977	2,260	236	45	1,979	1,981						279
1978	1,902	279	36	1,587	1,691	1,412	237	3	20	19	211
1979	1,905	211	42	1,652	1,741	1,437	263	4	20	17	164
1980	2,066	164	92	1,810	1,924	897	931	5	7	84	142
1981	2,294	142	57	2,095	2,098	988	1,075	3	7	25	196
1982	2,202	196	66	1,940	1,950	932	981	3	6	28	252
1983	2,228	252	115	1,861	1,924	926	982	4	6	6	403
1984	2,969	304	17	2,648	2,720	1,023	997	1	702	17	249
1985	3,256	249	11	2,996	2,988	1,005	1,031	1	932	19	268
1986	3,716	268	5	3,443	3,315	972	1,046	0	1,276	21	401
1987	4,628	401	4	4,223	4,129	1,078	1,011	0	2,015	25	499
1988	4,744	499	2	4,243	4,198	1,047	1,115	0	2,010	26	546
1989	2,839	546	1	2,292	2,602	1,053	1,010	0	525	14	237
1990	2,477	237	1	2,239	2,005	903	992	0	98	12	472
1991	4,922	472	1	4,449	4,228	985	925	0	2,291	27	694
1992	4,551	694	1	3,851	4,056	1,015	944	0	2,074	25	495

Source: Ministry of Agriculture Forestry and Fisheries. Dept. of Grain Policy, Grain Policy Data 1988.4 and 1993.6.

Table 1.3. Demand and Supply Transition: Corn, 1000 MT.

Year	Supply	Carry -in	Produc -tion	Import	Demand	Food	Process -ing	Seed	Feed	Others	Carry- out
1970	379	32	63	284	333						46
1971	429	46	68	315	365						64
1972	550	64	64	422	465						85
1973	595	85	54	456	437						158
1974	792	158	61	573	594						198
1975	788	198	58	532	697						91
1976	1,041	91	60	890	894						147
1977	1,601	147	84	1,370	1,353						248
1978	2,152	248	113	1,791	1,890	19	346	2	1,508	15	262
1979	3,243	262	100	2,881	2,914	19	419	2	2,451	23	329
1980	2,712	329	149	2,234	2,517	85	380	1	1,967	84	195
1981	2,704	195	154	2,355	2,533	82	411	1	1,990	49	171
1982	3,130	171	145	2,814	2,930	89	492	1	2,301	47	200
1983	4,484	200	117	4,167	4,228	52	667	1	3,491	17	256
1984	3,580	256	101	3,233	3,305	43	707	1	2,569	-15	275
1985	3,443	275	133	3,035	3,245	67	810	1	2,389	-22	198
1986	4,027	198	132	3,697	3,749	56	946	1	2,743	3	278
1987	5,183	278	113	4,792	4,654	49	1,192	1	3,376	36	529
1988	5,892	529	127	5,236	4,971	48	1,239	1	3,651	32	921
1989	6,555	921	106	5,528	5,983	29	1,388	1	4,550	5	572
1990	6,891	572	121	6,198	6,425	3	1,466	1	4,949	6	466
1991	6,027	466	120	5,441	5,561	0	1,579	1	3,935	6	466
1992	6,927	466	75	6,386	6,209	0	1,642	1	4,524	42	718

Source: Ministry of Agriculture Forestry and Fisheries. Dept. of Grain Policy, Grain Policy Data, 1988.4 and 1993.6.

Table 1.4. Demand and Supply Transition: Soybeans, 1000 MT.

Year	Supply	Carry -in	Produc -tion	Import	Demand	Food	Process -ing	Seed	Feed	Others	Carry- out
1970	272	7	229	36	266						6
1971	299	6	232	61	281						18
1972	271	18	222	31	261						10
1973	307	10	224	73	298						9
1974	321	9	246	66	291						30
1975	410	30	319	61	372						38
1976	468	38	311	119	418						50
1977	496	50	295	151	437						59
1978	601	59	319	223	538	105	221	20	173	19	63
1979	778	63	293	422	675	105	237	22	291	20	103
1980	777	103	257	417	733	95	209	9	333	87	44
1981	789	44	216	529	727	100	219	10	388	10	62
1982	855	62	257	536	792	126	209	10	431	16	63
1983	1,034	63	233	724	907	112	217	10	552	16	127
1984	1,047	127	226	694	960	110	226	10	582	32	87
1985	1,226	87	254	885	1,130	99	282	8	725	16	96
1986	1,274	96	234	944	1,247	96	274	7	860	10	27
1987	1,357	27	199	1,313	1,225	76	251	11	861	26	132
1988	1,465	132	203	1,130	1,298	72	275	7	918	26	167
1989	1,338	167	239	932	1,232	102	265	8	830	27	106
1990	1,450	106	252	1,092	1,254	84	271	8	866	25	196
1991	1,312	196	233	883	1,202	91	269	6	865	31	110
1992	1,597	110	183	1,304	1,503	92	265	5	1,115	26	94

Source: Ministry of Agriculture Forestry and Fisheries. Dept. of Grain Policy, Grain Policy Data, 1988.4 and 1993.6.

Table 1.5. Self-Sufficiency and Amount Imported.

	Self-Sufficiency (%)			Amount Imported (1000 U.S. dollar)		
	Wheat	Corn	Soybeans	Wheat	Corn	Soybeans
1969				103,931	11,357	2,886
1970	15.4	18.9	86.1	88,317	20,429	4,380
1971	11.8	18.6	82.6	83,567	22,749	7,503
1972	7.3	13.8	85.1	106,991	25,472	4,449
1973	5.3	12.4	75.2	190,356	45,781	16,482
1974	4.9	10.3	84.5	318,940	82,682	19,966
1975	5.7	8.3	85.8	316,653	85,593	14,621
1976	4.5	6.7	74.4	287,211	116,922	31,989
1977	2.3	6.2	67.5	256,303	162,818	43,897
1978	2.1	6.0	59.3	196,730	209,480	59,909
1979	2.4	3.4	43.4	279,120	370,480	131,558
1980	4.8	5.9	35.1	342,178	301,088	123,309
1981	2.7	6.1	29.7	429,248	424,148	183,614
1982	3.4	4.9	32.4	351,170	396,253	147,550
1983	6.0	2.8	25.7	333,204	585,530	191,005
1984	0.6	3.1	23.5	428,671	522,052	218,415
1985	0.4	4.1	22.5	448,227	396,702	225,703
1986	0.2	3.5	18.8	437,947	388,388	213,680
1987	0.1	2.4	16.2	433.891	428,337	244,529
1988	0.1	2.6	15.6	538,437	585,424	312,849
1989	0.1	1.8	19.4	433,283	778,967	298,749
1990	0.05	1.9	20.1	395,409	837,536	288,731
1991	0.02	2.2	19.4	551,597	682,341	242,157
1992	0.02	1.2	12.2	580,313	821,123	329,190

Source: Ministry of Agriculture Forestry and Fisheries. Dept. of Grain Policy, Grain Policy Data, 1988.4 and 1993.6.

Table 1.6. Government Purchase Price.

	Wheat won/76.5 kg	Corn won/75 kg	Soybeans won/75 kg
1970	2,573	2,625	5,060
1971	3,268	3,284	6,327
1972	4,248	3,710	8,750
1973	4,673	4,081	9,625
1974	6,074	5,655	13,331
1975	7,417	6,995	16,490
1976	8,863	8,324	19,624
1977	10,901	10,950	24,380
1978	14,191	12,640	28,130
1979	16,868	13,275	32,350
1980	20,247	15,300	40,500
1981	22,784	17,475	52,160
1982	25,908	18,750	55,970
1983	25,908	18,750	55,970
1984	----	19,313	57,675
1985	----	20,288	60,563
1986	----	21,510	64,200
1987	----	24,520	76,900
1988	----	27,975	84,600
1989	----	31,050	93,075
1990	----	31,050	93,075
1991	----	32,606	97,725
1992	----	34,125	102,375

Source: Ministry of Agriculture Forestry and Fisheries. Dept. of Grain Policy, Grain Policy Data (1993.6).

Table 1.7. Rice, Barley: Supply and Consumption.

	Rice				Barley			
	Production (1000 MT)	Import (1000 MT)	Per Capita Consumption (kg)	Self-Sufficiency (%)	Production (1000 MT)	Import (1000 MT)	Per Capita Consumption (kg)	Self-Sufficiency (%)
1970	4,090	541	136.4	93.1	1,591	—	37.3	106.3
1971	3,939	907	134.8	82.5	1,510	—	36.8	91.8
1972	3,997	584	134.5	91.6	1,600	254	37.5	93.2
1973	3,957	437	129.4	92.1	1,443	350	39.3	82.9
1974	4,212	206	127.8	90.8	1,388	299	39.9	78.4
1975	4,445	481	123.6	94.6	1,700	354	36.3	92.0
1976	4,669	168	120.1	100.5	1,759	—	34.7	97.9
1977	5,215	—	126.4	103.4	814	322	28.5	53.4
1978	6,006	—	134.7	103.8	1,348	—	18.1	119.9
1979	5,797	501	135.6	85.7	1,508	—	14.1	117.3
1980	5,136	580	132.4	95.1	811	—	13.9	57.6
1981	3,550	2245	131.4	66.2	859	—	16.0	72.7
1982	5,063	269	130.0	93.7	749	—	13.8	85.9
1983	5,175	216	129.5	97.6	815	—	9.5	129.0
1984	5,404	—	130.1	97.6	804	—	6.2	97.5
1985	5,682	—	128.1	103.3	571	—	4.6	63.7
1986	5,626	—	127.7	96.9	453	—	3.6	82.4
1987	5,607	—	126.2	99.8	516	—	2.7	97.2
1988	5,493	—	122.2	97.9	561	—	2.0	119.4
1989	6,053	—	121.4	108.1	516	48	1.8	114.2
1990	5,898	—	119.6	108.3	416	64	1.6	97.4
1991	5,606	—	116.3	102.3	340	76	1.6	74.3
1992	5,384	—	112.9	97.5	315	134	1.5	83.3

Source: Ministry of Agriculture Forestry and Fisheries. Dept of Grain Policy, Grain Policy Data, 1988.4 and 1993.6.

Table 1.8. Meat Source.

	Per Capita Meat Consumption (kg)	Meat Cattle (1000 Heads)	Milk Cattle (1000 Heads)	Hog (1000 Heads)	Chicken (1000 Heads)
1970	5.2	1,286	24	1,126	23,633
1971	5.2	1,250	30	1,333	25,903
1972	5.5	1,338	36	1,248	24,537
1973	5.5	1,493	52	1,595	23,701
1974	5.8	1,785	73	1,818	18,814
1975	6.4	1,556	86	1,247	20,939
1976	6.8	1,463	90	1,953	26,325
1977	8.1	1,508	109	1,482	30,224
1978	10.1	1,651	136	1,719	40,753
1979	11.3	1,599	163	2,843	41,120
1980	11.3	1,427	180	1,784	40,130
1981	10.2	1,312	194	1,832	42,999
1982	11.2	1,526	228	2,183	46,592
1983	13.3	1,940	275	3,649	49,239
1984	13.9	2,318	334	2,958	46,483
1985	14.4	2,553	390	2,853	51,081
1986	14.3	2,370	437	3,347	56,095
1987	15.7	1,923	463	4,281	59,324
1988	17.0	1,559	480	4,852	58,467
1989	18.2	1,536	515	4,801	61,689
1990	19.9	1,622	504	4,528	74,463
1991	21.8	1,773	496	5,046	74,855
1992	23.9	2,019	508	5,463	73,324

Source: Ministry of Agriculture Forestry and Fisheries. Dept of Grain Policy, Grain Policy Data, 1993.

CHAPTER II

LITERATURE REVIEW

Chapter II consists of two major parts. Part one reviews exchange rate issues and part two reviews import demand issues in an agricultural trade framework.

I. Exchange Rate Issues in Agricultural Trade

Since the initial Nixon devaluation of the U.S. dollar in 1971, and the following devaluation and eventual floating of the dollar in 1973, a lot of attention has been directed at the effect of these changes on the agricultural sector. The impact should be observed through an adjustment in the agricultural sector. Many agricultural economists question the effectiveness of the exchange rate as an economic policy tool. Exchange rate problems first came into question in the agricultural field right after the first two consecutive dollar devaluations.

Issues and Structural Effect

Schuh (1974) has argued that previous studies of trade neglected the important role and effect of exchange rate devaluation and that these would bring important structural changes for U.S. agriculture and economy.

Without any empirical evidence and data under the new conditions at that time, the major issues under consideration were:

The consequence of an over-valued exchange rate on the agricultural sector in the post World War II period, especially "income share" problems.

The graphical demonstration of the issues using a model of induced technical change.

The analysis of the distribution of benefits from the technical change between consumers and producers.

The prospect of structural change for U.S. agriculture and the economy after the devaluation and the impact of the movement to flexible exchange rates.

Schuh's view was that the relatively high levels of unemployment during the 1950's and the over-valued exchange rate was a double squeeze on agriculture and brought balance of payments problems. The overvalued U.S. dollar up to the late 1960's and policies to overcome this aggravated U.S. agriculture and culminated in a high balance of payments deficit in 1971.

By applying the model of induced technical change, Schuh demonstrates that the consequences of an over-valued exchange rate on the agricultural sector resulted in shifting an important share of the benefits of technical change to the consumer and provides a characterization of the changed structural environment of agriculture after the devaluation.

The prospect is that the sizable devaluations and the movement toward flexible exchange rates would constitute important structural changes for U.S. agriculture and the general economy. Since the devaluation makes imports more expensive domestically, the increased price for imported competing foreign agricultural products would make domestic suppliers more competitive and attract more resources into the agricultural sector, so the effect of the devaluation would spread throughout the agricultural sector.

One aspect under the new situation is that the U.S. would be closer to realizing its true comparative advantage and capitalizing on the investments in science and technology, which would lead to a redistribution of income, at least for a while, and favorable terms of trade for agriculture.

In this study, Schuh finally argues that the exchange rate is an important variable that could affect the production, technological change, and the distribution of benefits between U.S. consumers and producers, and ultimately between the U.S. economy and the world.

Effects of Exchange Rate on Agricultural Trade

Theoretical Concept

Dutton and Grennes (1988) present an analytical and theoretical framework for the effect of exchange rate changes on the volume of trade and prices. Their paper analyzes the main issues related to trade elasticities, surveys the earlier work, and provides some new empirical results on the effect of exchange rates.

The demand for a commodity may also depend on prices of non-agricultural commodities, financial assets, factors of production, and foreign variables, besides the price effect of close substitutes. Even though data are available for these variables, statistical problems (like multicollinearity) makes precise estimation of parameters difficult. Since empirical models omit some potentially relevant markets, the importance of omitting cross-commodity effects raises the question of what depends upon the magnitudes of relevant cross-price elasticities of demand and supply.

However, it is sometimes possible to obtain information about the importance of cross-commodity effects within the agricultural sector by comparing the simulation results of a given model when cross-commodity effects are zero with those when they take on plausible non-zero values. Thus, Dutton and Grennes present an example from the work by Longmire and Morey ("Strong Dollar Dampens Demand for U.S. Farm Exports", ERS-USDA Foreign Agricultural Economic Report, No. 193, December 1983), which shows the effects of currency appreciation on the prices and volume of exports of wheat, corn, and soybeans.

As Table 2.1 provides, the introduction of consensus cross-price elasticities of demand and supply has a greater effect on exports than on domestic prices. The average price response is hardly affected, but the substitutability among commodities makes the price response more uniform, and all changes in export volume become smaller.

Currency aggregation or the aggregate exchange rate problem in trade models is also mentioned. Either a single representative currency or some computed weighted average is used to represent the aggregate exchange rate, but a problem arises when the difference in bilateral changes are large. The experience of the floating dollar since 1980 is a good example of the significance of currency aggregation. In fact, on average, the dollar appreciated until March 1985 and depreciated since then, but the changes were quite uneven across countries. They say an optimal set of weights must be determined for various currencies if currencies are aggregated since different weighing schemes have produced significantly different results. In other words, it is different whether the dollar depreciated only against traditional importers of U.S. goods, or simultaneously against

Table 2.1. Effects on Prices and Quantities (Percent Change) of a 10 Percent Real Appreciation.

Price or quantity	Zero cross commodity effects	Consensus cross-commodity effects
Wheat price	-10	-7
Corn price	-7	-7
Soybean price	-5	-6
Wheat exports	-7	-3
Corn exports	-13	-2
Soybean exports	-9	-3

Consensus Elasticities of Demand

Elasticity with respect to price of:	Wheat	Corn	Soybeans
Wheat	-0.20	0.05	0.05
Corn	0.05	-0.40	0.10
Soybeans	0.05	0.10	-0.40

Consensus Elasticities of Supply

Elasticity with respect to price of:	Wheat	Corn	Soybeans
Wheat	0.40	-0.15	-0.05
Corn	-0.15	0.40	0.30
Soybeans	-0.05	-0.30	0.40

Source: Longmire, Jim and Art Morey, Strong Dollar Dampens Demand for U.S. Farm Exports, ERS-USDA Foreign Agricultural Economic Report. No. 193, December, 1983. Dutton and Grennes (1988): p.30-31.

importers and competing exporting countries.

The results of a three region model constructed by Krissoff and Morely ("The Dollar Turnaround and U.S. Agricultural Exports" USDA-ERS Staff Report No. AGES 861128. December 1986) to show the difference between two kinds of currency changes for the volume of U.S. exports of wheat, corn, soybeans and their prices are presented in the Table 2.2.

Table 2.2 presents the results of a simulation in which U.S. wheat price rises by 6.5 percent and wheat exports rise by 5.2 percent when the dollar depreciates by 10 percent against the importing country only. In a uniform 10 percent depreciation against both exporting and importing countries, the wheat price rises by 8.9 percent and exports rise by 7.7 percent. According to the table, uniform exchange rate changes against all currencies magnifies the effects on prices and exports of all three commodities.

An appropriate exchange rate measure must convert money rates into some real rate measure to determine the relationship between exchange rates and trade. The multitude of bilateral exchange rates should be converted into an effective exchange rate index, so separate effects of exchange rates on the volume and value of trade, and foreign and domestic prices should be determined.

It is suggested that nominal exchange rate indices must be adjusted for inflation to determine their effect on relative prices and the volume of trade. They provide a method of adjusting for inflation which depends upon the inflation differentials for the countries being studied. Let the purchasing power parity real exchange rate be expressed as:

Table 2.2. Simulated Effect of 10 Percent Real Depreciation of Dollar (Percent Changes).

	Against imports only	Against exports only	Against all currencies
Wheat price	6.5	2.1	8.9
Corn price	5.5	2.3	8.0
Soybean price	5.2	1.7	7.1
Wheat exports	5.2	1.5	7.7
Corn exports	8.1	3.6	12.2
Soybean exports	2.9	0.8	3.7

Source: Krissoff, Barry and Art Morey, The Dollar Turnaround and U.S. Agricultural Exports, USDA-ERS Staff Report #AGES 861128, December, 1986. Dutton and Greenes (1988): p.8.

$$E_R = \frac{EP^*}{P}$$

where E is the nominal exchange rate, and P and P^* are the aggregate domestic and foreign price levels. For the expression as price changes:

$$\frac{dE_R}{E_R} = \frac{dE}{E} - \left[\frac{dP}{P} - \frac{dP^*}{P^*}\right]$$

which means that the real rate equals the nominal rate minus the inflation differential.

For the relationship between exchange rates and prices, empirical results generally support the proposition that the percentage change in prices does not exceed the percentage change in the exchange rate. The exception frequently cited is a study by Chambers and Just (1981). They present:

$$\frac{dP_x}{P_x} = \frac{dE}{E} + \frac{dP_x^*}{P_x^*}$$

where P_x is a domestic currency price of exports. The equation means the percentage change in the domestic currency price can be inferred from the price change in the foreign currency.

Exchange Rate Treatment and Its Impact on Trade

Chambers and Just (1979) criticized that the most common specification of the trade or demand and supply equations in empirical work was unnecessarily and overly restrictive and might bias the resulting analysis.

Alternative Approaches. Having reviewed various contradictory results from empirical work on the effects of exchange rate changes on the agricultural sector, Chambers and Just consider alternative specifications of the exchange rate in excess demand functions and suggest several less restrictive specifications for empirical research.

An alternative approach suggested with regard to exchange rate flexibility is to make explicit assumptions about the separability of utility functions underlying the import demand equations which leads a two-stage budgeting process by consumers. In the first stage, consumers split total expenditure into group expenditures, then in the second stage, consumers split group expenditures into individual commodity expenditures.

Since demand functions derived from this process depend upon the prices of other commodities within the group, price vectors for other groups, and total income, this leads to a significant reduction in the number of parameters to be estimated while not restricting exchange rate and own price movements to have the same effect on excess demand for imports. This argument could apply to the supply side as well.

Separate price indices are calculated for each group, but standard price indices are not appropriate because the standard baskets of goods used in calculating indices are not delineated along the lines of traded and nontraded goods.

Another alternative is to treat the exchange rate as a price index for all other traded goods. When all other individual price movements are not important in the overall indices for both of traded and nontraded commodities, this approach would simplify to using only two variables - own price and exchange rate.

Another alternative is to include the exchange rate directly in import equations as a separate regressor to allow for the differential effects of the fluctuations of exchange rate and price. Alternatively, a weighted exchange rate may be included as a separate regressor in the equation.

Unlike the alternatives described above, it is also suggested to inflate the income term in the excess demand or import function. However, this is appropriate only when all commodities are traded and homogeneity conditions for excess demand function hold, otherwise some bias may be introduced if there are nontraded commodities.

Impact of Exchange Rate Changes. By introducing a more general model of excess demand and supply, Chambers and Just (1979) assert that the response of both price and quantity traded to exchange rate changes can be greater than the overly restrictive models suggested.

The standard theoretical model used to examine the impact of exchange rate changes on the agricultural commodity market could be expressed in terms of the framework of excess supply and demand.

$$D_i = f(r_i) \quad S_i = g(p_i) \quad D_i = S_i = Q_i$$

where D_i and r_i are the excess demand for commodity i and market price in the importing country, respectively, S_i and p_i are the excess supply of commodity i and market price, respectively, in the exporting country. Q_i is the quantity of commodity i traded. With the assumption of zero transportation costs and no barriers to trade, one price holds at equilibrium. $r_i = p_i e$, where e is the exchange rate evaluated in terms of units of the importer's currency per unit of exporter's currency.

On the other hand, the excess demand function specified above is derived under the assumption of zero cross-price elasticities between the traded agricultural commodity and all other commodities for which prices are not constant. The model may be respecified as:

$$D_i = f(r, M) \quad S_i = g(P)$$

where r is a vector containing the price of all m commodities in the importing country, M is income, and P is a vector containing the prices of all m commodities in the exporting country. Assuming, for simplicity, that all commodities are traded and no barriers or distortions exist in trade, the price at equilibrium for all commodities is $r = p_i e$.

Since supply and demand interactions lead to income elasticities as well as cross-price elasticities in importing and exporting countries, by differentiating the above equilibrium condition with the assumption $dM = 0$, it is possible to obtain an exchange rate elasticity, cross-price elasticities of demand, exchange rate elasticities of cross prices, and cross-price elasticities of supply.

It is emphasized that more generality is attained by including a separate exchange rate variable, or a weighted price index of other traded goods, in the regression equation. Price indices more appropriate for international trade research are greatly needed, whose weightings pertain to internal decisions in the importing countries.

In addition to their study in 1979, Chambers and Just (1980) consider the possibility of determining the total impact of an exchange change. The applicability of the assumption of zero cross price elasticities between the traded agricultural commodity and all other goods for which prices are not constant is questioned.

In other words, is it proper to force the export price of grains and changes in the exchange rate to have the same relative effect on excess demand in the importing country? Specifically, a certain percentage change in a country's U.S. dollar price and an equal percentage change in the U.S. price of a specific commodity may not have the same effect on that country's demand for the U.S. commodity unless that commodity is the only commodity traded between both countries. A change in the exchange rate can have more far-reaching effects than a change in U.S. grain prices because of implications for trade in all other goods (and the related impacts). This means that the full impact of exchange rates that can enter through all cross-price elasticities should be considered.

They demonstrate:

A utility function $U = U(Q_{11}, Q_{12},..Q_{1m}, Q_{21}...Q_{n1},..Q_{nm})$ where Q_{ij} is good j of commodity group i and has price P_{ij}. The maximization problem is to maximize U subject to $\sum_{i=1}^{n} \sum_{j=1}^{m} P_{ij} Q_{ij} = m,$ where m represents total income. By applying the concept of separability, the first stage is to maximize

$$U^* = U(Q_1, Q_2,...Q_n) \text{ subject to } \sum_{i=1}^{n} P_i Q_i = m$$

where P_i is a price index and Q_i is a quantity index for group i. The group demand equations may be written as:

(1) $Q_i = Q_i(P_1, \ldots, P_n, m)$.

Given this allocation and expenditure m_i,

(2) $m_i = P_i Q_i(P_1, .., P_n, m)$ on group i.

The second stage is the within-group allocation and maximization of $U^i = U^i(Q_{i1}, ..Q_{im})$ subject to $\sum_{j=1}^{m} P_{ij} Q_{ij} = m_i.$ The within-group demand equations may be written as:

(3) $Q_{ij} = Q_{ij}(P_{i1}, ..P_{im}, m_i)$,

or substituting (2) into (3),

(4) $Q_{ij} = Q^*_{ij}(P_{i1}, ..P_{im}, P_1 -- P_{i-1}, P_{i+1} --- P_n, m)$. The total impact of an exchange rate change may be obtained by differentiation (4). So,

$$\frac{dQ_{ij}}{de} = \sum_{j^1=1}^{m} \frac{\partial Q_{ij^1}}{\partial P_{ij^1}} \frac{\partial P_{ij^1}}{\partial e} + \sum_{j^1=1}^{n} \frac{\partial Q_{ij}}{\partial P_k} \frac{\partial P_k}{\partial e} + \frac{\partial m}{\partial e}$$

Equation (4) is a somewhat reduced form of a complex system, but the result includes the effects of exchange rates on prices as shown.

Effects of Macroeconomic Variables

Exchange Rate and Other Macro Variables. Johnson, Grennes, and Thursby (1977) attempted to test the hypothesis that dollar devaluations in the early 1970's were responsible for an important part of the increase in agricultural prices in 1973-1974. The exchange rate and other explanatory variables - tariffs, export taxes, and transport costs - that could also affect agricultural prices are considered and their relative importance is compared in this study.

With the dollar devaluation, all major importers and exporters adopted insulating policies to protect consumers from increasing prices. The question is how much of the observed increase in domestic prices was attributable to dollar devaluation and how much to other variables. Other relevant variables were the tariff policy of EEC, trade controls by Canada, Australia, and Japan, and ocean freight rates. Since wheat is the most important agricultural product exported by the U.S., U.S. wheat prices for the year of highest prices (1973-1974) are examined.

A trade model that allows isolation of the separate effects of those variables on the U.S. price of wheat is developed. This model distinguishes wheat by the country of origin, thus allowing a consuming region to distinguish among various exporters' wheat and to simultaneously purchase wheat from all regions at different prices.

The model is formulated as a short-run forecasting model, leaving the supply side exogenous, and is composed of three sets of equations as follows:

(a) a set of demand equations:

$Q_{ij} = f(P_{ij}^{D}, Z_i)$, where Q_{ij} and P_{ij}^{D} are quantities consumed and consumer prices in country i of wheat originating in country j, and Z_i is an exogenous demand shifter for country i.

(b) a set of price relations:

$P_{ij}^{D} = rP_j^{s} + t_{ij}$, where P_j^{s} is the supply price of country j, t_{ij}'s are exogenous shifters that affect the difference between the origin price and the ultimate consumer prices, and r is the exchange rate between i and j.

(c) a set of market clearing equations:

$W_{1j}Q_{1j} + W_{2j}Q_{2j} + \ldots + W_{nj}Q_{nj} = S_j$, where W_{ij} is the fraction of country j's exports that go to country i and $\sum_i W_{ij} = 1$, and s_j is the exogenous supply in j.

Their model consists of six endogenous countries and an exogenous rest of the world.

The main framework could be thought as XY = A, where X is a matrix of demand parameters, and weights that appear as coefficients on endogenous variables. A is a vector of exogenous shifters, demand, supply, and trade shifters which include transport costs, trade controls, exchange rates, and Y is the solution vector of endogenous variables. The inverse of X necessary for the solution is considered as a matrix of impact multipliers, where each element in the inverse is a partial derivative of an element in Y with respect to an element in A. Once X^{-1} is known, the direct impact on any endogenous variable from a policy change appearing in A would be found from the appropriate element in X^{-1}.

Because of the large increase of price of wheat in 1973-74 accompanied by many policy changes, the impacts are distinguished with the model described above. Johnson, Greenes and Thursby have found that foreign commercial policy was more important for the U.S. domestic price and continued distortion in U.S. shipping policy was as important as the dollar devaluation.

The dollar depreciation with the rapid expansion of U.S. agricultural exports which occurred in the 1970's has caused economists to propose that a strong correlation exists between exchange rates and agricultural trade.

Collins, Meyers, and Bredahl (1980) have set up a hypothesis to determine whether there is a relationship between domestic prices of agricultural products and the relative value of the dollar, and examined the effects of recent changes in exchange rates.

In their study, it is argued that the analysis should incorporate relative rates of inflation and exchange rate changes to understand the relationship between exchange rates and commodity prices, (i.e. exchange rate effects that include relative inflation rates). In addition, since the dollar depreciates against the currencies of many countries while simultaneously appreciating against those of others, and many countries import a different bundle of agricultural products from the U.S., a single exchange rate measure such as the SDR may not be expected to serve well for all commodities, so their analytical framework incorporates multiple exchange rate changes, rates of inflation and trade restrictions to examine the impact of multilateral exchange rate changes on U.S. prices of major agricultural commodities.

A theoretical model is presented to analyze short-run U.S. commodity price changes caused by both nominal exchange rate changes and exchange rate changes adjusted for differential inflation rates. Annual changes in U.S. prices of wheat, corn, soybeans, and cotton due to exchange rate changes and inflation rates of major noncentral countries are calculated. These changes are compared with observed price changes to find exchange rate impacts on U.S. agriculture.

The model begins with the specification of each country's demand and supply functions, then the condition is imposed that U.S. export supply equals the demand for U.S. exports, and is followed by the expression of the nominal internal price in each country, which is a function of the U.S. price and the value of each country's currency per U.S. dollar. Total differentials of these equations are used for the analysis.

To determine the impacts of exchange rates on U.S. prices, internal and world market prices are linked for 37 selected major trading partners, so three kinds of policy scenarios are analyzed. These are the free trade policy, nominal price insulation policies and real price insulation policies.

Exchange rate effects are clear and significant, but exchange rate effects on real U.S. commodity prices are the greatest as nominal price insulation policies become prevalent.

The strength of the model lies in the simultaneous consideration of prices, consumption and production levels, and exchange rates for major trading countries. However, the model is a partial-equilibrium elasticity approach. It is not possible to examine cross price effects. Assumed elasticities and computed exchange rates may raise issues of suitability.

Macroeconomic Shocks and Structural Adjustment. Adelman and Robinson (1988) have performed policy experiments to analyze the impact of swings in macro variables on the structure of relative prices, production, trade, income, and demand with a computable general equilibrium model of the U.S. economy, which is designed to focus on foreign trade issues, incorporating sector demand elasticities for imports and supply elasticities for exports.

The macro policy mix in the 1980's has led to a revaluation of the dollar which reduced agricultural exports, and shifted incentives from exporting to importing. However, the macroeconomic success of controlling inflation was a significant benefit to the economy.

The model is developed for the analysis of trade policy issues whose equations describe supply and demand behavior across markets. The model is composed of three agricultural sectors, five industrial sectors, and two service sectors.

The model focuses on flow equilibria and incorporates major aggregate macroeconomic balances excluding asset or money markets such as:

$$Z = SH + SG + F \qquad SG = T - G \qquad F = M - E$$

where Z is aggregate investment, SH is total private savings, SG is government savings, F is foreign savings, T is total government revenue, G is government expenditure, M is aggregate imports, and E is aggregate exports.

Domestic prices of imports and exports are related to world prices by the equations:

$$PE = (1 + TE)EXR \bullet PWE \qquad PM = (1 + TM)EXR \bullet PWM$$

where TE and TM are export subsidies and import tariffs. EXR is the exchange rate, and PWE and PWM are the world prices of exports and imports.

Using base-year data for 1982, with a social accounting matrix for the U.S.

economy in 1982, a 1982 solution is determined and used to generate a solution for 1986.

In analyzing the economic impact of macroeconomic shocks observed in the 1980's, a set of three policy experiments is considered. First, foreign preliminary savings vary; second, vary government deficits; and third, a combination of the two.

In the first experiment, the same balance of trade surplus as in 1980 with no reliance on foreign borrowing to finance the deficit is assumed. The experiment is modelled by changing the exogenous balance of trade in goods and services to achieve the same trade balance in 1986 as obtained in 1980. The experiment indicates that the exchange rate appreciation induced by foreign financing of the budget deficit has caused a dramatic increase in agricultural imports with a large decrease in agricultural exports.

In the second experiment, the assumption is that the increase in government expenditures is financed by increasing taxes without generating a budget deficit. It is modelled by increasing the exogenous tax rates to achieve about the same total government deficit in 1986 as obtained in 1980. The experiment restores the exchange rate, agricultural terms of trade and agricultural incomes to their 1986 values.

In the third experiment, the above two experiments are combined under the assumption that both foreign borrowing and the budget deficit remain at 1980 levels. The experiment suggests that the effects of the macro policies of the Reagan Administration have been dominated by imported capital from abroad and the effect on the U.S. economy has been a major revaluation of the real exchange rate.

In summary, the authors reveal the importance of general equilibrium linkages for a macro shock through the economy, while illustrating the potentially misleading impact of a partial-equilibrium analysis that isolates the impacts of those shocks on a single sector.

Alternative Measure of the Exchange Rate

Choice Among Exchange Rate Indices

Dutton and Grennes (1987) have analyzed alternative measures of multilateral exchange rate changes appropriate for agricultural trade. Their study is based on the point that even though exports and prices of U.S. agricultural products respond to changes in the prices of the U.S. dollar, U.S. agriculture is also affected by many other factors.

They argue that the exchange rate changes relevant for agricultural trade is important and that its measurement affects the economic interpretation of estimated parameters, exchange rate elasticities, and predictions. Thus more precise quantitative measures are pursued to provide additional knowledge of these relationships and the behavior of alternative measures based on total trade and agricultural trade.

Choice problems are followed in defining an effective exchange rate index. Two major choice problems in this study are the choice of weights and the determination of a mathematical form for the index.

There are several available total trade-weighted effective exchange rate indices: a) Federal Reserve Board's (FRB) trade-weighted dollar; b) the value of the dollar in Special Drawing Rights (SDR); and c) Multilateral Exchange Rate Model (MERM). Those are converted into real form by using real exchange rates for individual countries, adjusting with consumer prices reported by the IMF. The exception is the Morgan Guaranty Trust (MGT) index which is published in both nominal and real form.

A real exchange rate index between the base period and period t is obtained by adjusting the nominal rate index for changes in relative price levels, so an effective exchange rate is a weighted average of rates between the home currency and more than one foreign currency.

Comparing these real effective exchange rates, they have found substantial differences among the indices, which could lead to different economic conclusions.

On the other hand, for an agricultural trade-weighted effective exchange rate, they use USDA agricultural trade-weighted dollar indices. Four new indices are computed for the 38 chief customers of U.S. agricultural products using the USDA weights for the base period 1976-8 by varying mathematical forms, while two new series are constructed for the same countries by varying the weights. No major divergences are found in each group when exchange rates are expressed in real terms.

Trade shares, which are bilateral and global weight indices for total agricultural trade, are also analyzed as another source of variation in weights. Two new agricultural trade indices are calculated based on global market share for each major crop and on each exporter's share of global agricultural exports, respectively, then compared with the USDA index which uses bilateral export weights. It is found that the USDA index is sensitive to the choice between bilateral and global weights.

The guidelines for the choice among alternative exchange rate measures may be generalized as:

1. a real exchange rate is preferred;
2. geometrical forms have advantages over arithmetic forms;
3. weights should reflect the importance of all major market participants, and

4. weights from a more recent period are desirable.

Trade-Weight Exchange Rate Indices

Henneberry, Henneberry, and Tweeten (1987) provide three different methodologies to calculate a trade-weighted foreign exchange rate representing six flows of U.S. export commodities, which are total exports, all nonagricultural exports, all agricultural exports, and wheat, corn, and soybeans.

In their study, they argue that measurement and interpretation of the dollar price movement must be done with caution. Indices of nominal and real exchange rates for the U.S. dollar relative to the basket of major U.S. customers' currencies are computed for the above six flows of U.S. export commodities. Exchange rates in terms of competing exporters' currencies for wheat, corn, and soybeans are also calculated.

The difference between indices calculated in this work and others lies in the focus on currencies important for trade in specific agricultural commodities so the exchange rate movement these new indices measure would be more appropriate for a specific agricultural commodity.

Trade flow study three indexing formulas (Paasche, Laspeyres, and the Fisher Ideal) are applied to calculate the new indices of trade-weighted foreign exchange rates.

Impact of dollar appreciation is found to be considerably different for each commodity and for agricultural and nonagricultural exports, depending upon the choice of indices and the choice of time periods for the same indices.

Another important factor determining the level of U.S. exports is the value of the U.S. dollar in terms of the currencies of competing exporters. Nominal and real trade-weighted U.S. dollar foreign exchange rates are calculated in terms of the currencies of major U.S. competitors for wheat, corn, and soybeans with the Laspayres formula for the same 10 year period. Substantial appreciation of the U.S. dollar in both nominal and real terms in relation to other competitors' currencies in the early 1980's, and dollar appreciation in nominal terms but depreciation in real terms against other currencies in 1970's are found.

Since a large number of trading partners and large differences in relative trade flows between agricultural and nonagricultural export markets are involved, the authors suggest that movements in the value of the currency must be measured by appropriately weighted indices reflecting the composition of trading partners in specific commodity markets. Agricultural and nonagricultural markets are separated from total U.S. trade flows to compute foreign exchange rate indices in this study. In addition, the trade flows for wheat, corn, and soybeans are utilized to measure the dollar appreciation within the agricultural export market.

This study shows the significance of the methodology used to compute trade-weighted foreign exchange rates. It is concluded that the theoretically superior index under conditions of a varying export basket is the Fisher Ideal Index, which is the geometric mean of Paasche and Laspeyres indices.

II. Issues of Import Demand Models

In this section, the specification of the model, the impact of macro variables on import demand, and approaches to analyze the import demand model will be reviewed.

Functional Form and Model Choice

Functional Form

Murray and Ginman (1976) offered an alternative specification of the functional form of the import demand model. Their application of the traditional import demand equations on Canadian import demand raised serious objections to accepting the traditional import demand model. They argued that the traditional log-linear model used in presenting the estimates of import price and income elasticities was incorrectly specified, thus different functional forms could lead to different estimates of demand elasticities.

The traditional model, which is a function of the import price (index), price (index) of domestically produced substitutes, and real income, is consistent with the classical theory of demand equations. They note that the traditional model includes the price incentives of consumers to shift between imports and domestic substitutes while tending to neglect non-traded items. A new equation is estimated for the U.S. in log-linear form using real income and including the domestic price index of nontraded goods:

$$Q = f(y, P_m, P_d, P_{nt})$$

where

y is real GNP;

P_m is the import price index;

P_d is the domestic price index of traded goods; and

P_{nt} is the domestic price index of nontraded goods.

The result indicates that this equation is reasonable and consistent with theoretical expectations. The real income elasticity and import price elasticity are approximately one, which is lower than in the traditional equation but more consistent.

The implication of this paper is that the relative price specification of the traditional import demand model may be inappropriate for estimating and the new estimates are more reasonable and consistent with theoretical expectations.

Muti (1977) tested several specifications of demand equations for both import and competing domestic goods, using annual data for the period 1958-1972, to allow more direct consideration of the substitutability between the two goods.

Using same variables for each equation in double log form, the model begins with:

$$L_nM = \propto_0 + \propto_1 L_nY + \propto_2 L_nP_m + \propto_3 L_nP + \propto_4 L_nP_r \quad (1)$$

$$L_nD = \beta_0 + \beta_1 L_nY + \beta_2 L_nP_m + \beta_3 L_nP + \beta_4 L_nP_r$$

where M and D are quantities of imports and competing domestic production sold in the U.S., respectively. Y is money income. P_m is the dollar price of imports, P is the price of competing domestic goods, and P_r is the price of all other goods.

This procedure implies that import from all sources and all other prices can be treated as an aggregate. The first part of the test is to see if consumers exhibit no money illusion. If no money illusion, $\propto_1 + \propto_2 + \propto_3 + \propto_4 = 0$ and $\beta_1 + \beta_2 + \beta_3 + \beta_4 = 0$ will hold, then (1) reduces to:

$$L_nM = \propto_0 + \propto_1 L_n(Y/P_r) + \propto_2 L_n(P_m/P_r) + \propto_3 L_n(P/P_r) \quad (2)$$

$$L_nD = \beta_0 + \beta_1 L_n(Y/P_r) + \beta_2 L_n(P_m/P_r) + \beta_3 L_n(P/P_r)$$

The constraint can be tested from the estimates of equation (1).

In addition to no money illusion, the second part of the relationship is to see if the pure substitution effect for both goods with respect to the bundle of all other goods equals zero. If so, $\alpha_2 = -\alpha_3$ and $\beta_2 = -\beta_3$. Equation (1) reduces to:

$$L_nM = \alpha_0 + \alpha_1 L_n(Y/P_r) + \alpha_2 L_n(P_m/P)$$

$$L_nD = \beta_0 + \beta_1 L_n(Y/P_r) + \beta_2 L_n(P_m/P)$$

The substitution constraint can be tested from the estimates of (1) or (2).

The third part is to estimate the elasticity of substitution between imports and competing domestic goods. If equation D is subtracted from equation M in (1) and no money illusion constraint is imposed, the resulting expression is:

$$L_n(M/D) = (\alpha_0 - \beta_0) + (\alpha_1 - \beta_1)L_nY + (\alpha_3 - \beta_3)L_n(P/P_m) + (\alpha_4 - \beta_4)L_nP_r \quad (3)$$

If $\alpha_1 = \beta_1$ and $\alpha_4 = \beta_4$, the equation reduces to:

$$L_n(M/D) = (\alpha_0 - \beta_0) + (\alpha_3 - \beta_3)L_n(P/P_m)$$

where $(\alpha_3 - \beta_3)$ is the elasticity of substitution and the constraint can be tested from estimates of equation (3).

The estimation for eight industries is performed by ordinary least squares using annual data for the period 1958-1972. The test of constraint sets for each industry is done using an F statistic. These constraints indicate whether the estimates from alternative functional forms are consistent with the structural relationships suggested by consumer demand theory.

The results of no money illusion constraint are rather mixed. For the zero pure substitution constraint, the null hypothesis is rejected for only two, which indicates that the demand equation should be specified in a more general form. For the elasticity of substitution test, the null hypothesis is rejected for six of eight industries, which suggests that trade research based on elasticity of substitution estimates should be taken skeptically. As a result, he concludes that more general functional forms may be appropriate.

Model Choice

Since price and income elasticities of demand and supply for imports and exports vary by commodity, country, and time period, estimates often vary even when commodities are narrowly defined. There are differences in modelling by differences in commodity substitutability and by those in commodity use (as final consumption or as inputs). Different behavioral models could lead to the same estimating equation for trade flows.

Thursby and Thursby (1988) surveyed recent works on specification, estimation, and evaluation of trade equations and elasticities. They claim that any hope of obtaining a consensus of parameter values from trade equations depends on taking a different approach, which involves using as much information as possible.

Their purpose is not to choose and defend any particular model, rather to provide an example of the use of statistical technique in the choice of more proper models.

Using annual data for 1960-1985 and ordinary least squares, they first get 32 single equation specifications of U.S. wheat exports to Japan. Then they apply non-nested tests procedures and specification searches to choose appropriate models from these competing models.

For the eight accepted models, it is shown that each of the price and income elasticities vary but within a narrow range for each. Thus they demonstrate that the non-nested procedure rejects the models whose price and income elasticities are outliers.

Inflationary Effect

The question about the assumption of zero homogeneity i.e., that inflation has no effect on import demand functions is reviewed in this section.

External Inflation

Henry (1976) conducted an economic analysis to investigate the response of U.S. exports to Ghana and Nigeria to rate of inflation that prevailed in the U.S. from 1967 to 1976. Since rapid U.S. inflation may deteriorate their terms of trade and eventually hinder their economic development as importers of a wide variety of goods and services from the U.S., he hypothesizes that the U.S. rate of inflation significantly affected the level of U.S. exports to those two countries and therefore accounted for a considerable proportion of the variation in imports over the period.

Two models are used to explain the variation of imports. For the first model, the real value of imports of each country in year t is taken to be a multiplicative function of the rate of inflation, real gross domestic product, and the real value of financial reserves. For the second model, real values of imports is a multiplicative function of the rate of inflation, real net long term capital inflows, and real exports.

Two kinds of inflation rates are included in each equation, which are measured by a one-year rate of change of producer prices, $\frac{\Delta P_t}{P_t}$, and a two-year moving sum rate of change of prices, $\frac{\Delta P_t}{P_t} + \frac{\Delta P_{t-1}}{P_{t-1}}$. Transforming these equations into linear by double log transformation, those are estimated by ordinary least squares for the period of 1967-1976.

It is found that the U.S. inflation rate significantly affects the import demand but its effect on imports is relatively small. Henry notes that the elasticities estimated by ordinary least squares using time series data are subject to a downward bias. An attempt is made to make adjustment for such bias. Keeping the estimated elasticities within lower bounds, he adjusts the estimates of the elasticity with respect to inflation by adding two and three standard errors to the least squares estimates. The upper bound measures are still less than unity. However, when only the two-year moving sum rate of price change is used as the measure of inflation for Nigeria, there is a relatively large increase in the elasticity when adjusted upwards by three standard errors, and then it looks quite consistent with economic theory.

In this analysis, all data are measured in real 1973 dollars, U.S. imports of two countries are deflated by the U.S. export price index, gross domestic product is deflated with the consumer price index, exports and reserves are deflated with the U.S. export price index, and the U.S. rate of inflation is measured by changes in the U.S. producer price index.

Test for the Impact of Inflation

Arnade and Dixit (1989) developed a method to test whether proportionate change in prices and income influenced import demands.

Several import demand equations for agricultural products were specified. A test for whether or not imposing zero homogeneity on these equations could significantly reduce the equations fit was conducted. They imposed zero homogeneity on these equations and used this restriction to test for the correct index with which to deflate prices and income.

Imports are defined as the excess of domestic demand over supply, in which all variables are deflated by the consumer price index. A log-linear import demand function is obtained as:

$$L_n(I_m) = b_0 + b_1 L_n(Y) + b_2 L_n(P_1) + b_3 L_n(P_2) + b_4 L_n(S) - (b_1 + b_2 + b_3)\, L_n(CPI)$$

where

I_m is imports of a good;

Y is income;

P_i is nominal domestic prices;

S is domestic supply; and

CPI is a consumer price index.

The restriction on parameters for the test is: if the coefficient of CPI is a_1, estimating the above equation and testing whether $a_1 = -(b_1 + b_2 + b_3)$ is equivalent to testing whether the sum of the price and income elasticities equals zero. When CPI is dropped from the equation, estimating the new equation and testing whether $b_1 + b_2 + b_3 = 0$ is equivalent to testing whether the import demand function is homogeneous of degree zero.

Wheat and soybean import demand equations for five countries with diverse inflation rates are estimated using ordinary least squares with data covering the late 1960's to the early 1980's. Each is estimated twice, with and without homogeneity restrictions. The null hypothesis that the homogeneity restriction does not significantly reduce the fit of the equation is tested by an F static. Each country equation is specified twice, with and without CPI.

The homogeneity issue is followed by the choice of price index issue. They only test to examine if CPI should be used as a normalizing variable in an import demand function which is restricted to be zero homogeneity in income and prices. Thus the above equation is estimated with the restriction $a_1 = -(b_1 + b_2 + b_3)$ and tested against the two restrictions $a_1 = -(b_1 + b_2 + b_3)$, $a_1 = 0 = -(b_1 + b_2 + b_3)$.

The import demand equation with CPI against that without CPI is tested by using an F statistic. The null hypothesis for the test is that the former does not provide a significantly better fit than the latter.

Some evidence was found that inflation influences import demand. The results indicate that the CPI index should be included in the model, either as a deflator or as an exogenous variable, if zero homogeneity is imposed on import demand functions. However, which price index is the most appropriate is not tested in this work, only the CPI.

Single Equation Method

Some studies in this section contain several equations. When each single equation explains import demand for the commodity in the study, it is included in this section.

Multiple Regression Models

Interperiod Comparison. Salas (1982) investigated the changing structure of Mexican private sector imports for the period of 1961-1977, and 1961-1979. Mexico's total exports dramatically increased in 1977, 1978, and 1979, which was matched by a corresponding acceleration of imports, particularly in 1978 and 1979, years of economic recovery.

His objective is to determine the possibility of a structural break in the import demand function for the periods 1961-1977 and 1978-1979, and to determine if the income and price elasticities have changed or if other exogenous parameters have contributed to the acceleration in private sector imports. He tries to identify a structural change and to find its probable cause to explain the acceleration of imports in 1978-1979.

Maximizing a utility function with respect to income and prices, the basic form of the import demand equation is $M = f(Q, P^M, P^D)$, where M is import demand in real terms, Q is real national income or some proxy variable, P^M is price of imported goods, and P^D is price of domestic goods that are potential import substitutes. Additional variables that can contribute to an improvement of the model are also considered.

The data used here are disaggregated, which means that import demand functions for three kinds of goods: capital, intermediate, and consumption goods are estimated for both periods. The null hypothesis of no structural change within the period being analyzed is tested using Chow's F test for each commodity category. As a result, the evidence that the acceleration of imports is associated with more liberal Mexican trade policies is found.

Relative Price Approach. Hamilton (1980) examined the relationship between the volume of Swedish imports, relative prices, and economic activity at a disaggregated level. All commodity groups for which data are available are included in this study.

They calculate two indices in order to arrive at the Swedish relative price, an import price index and a domestic production price index. Imports are calculated in volume terms, and import values are deflated by the calculated import price indices for each commodity group. Twenty five commodity groups for 1960-1975 are included for the analysis.

The model has the form $Q_{mi} = f(P_{di}, P_{mi}, A_i)$ where Q_{mi} is the volume of imports, P_{di} is the unit price of the domestic nonperfect substitute, P_{mi} is the unit price of the imported commodity i, and A_i is a variable reflecting the level of economic activity in the economy. When estimating import demand relationships, the function above is expressed:

$$\left[\frac{M_i}{P_{mi}}\right]_{to} = \pi^1 + \alpha^1_{to}\left[\frac{P_{mi}}{P_{di}}\right]_{to} + \alpha^1_{tl}\left[\frac{P_{mi}}{P_{di}}\right]_{tl} + \beta^1_{to}A_i$$

or

$$L_n\left[\frac{M_i}{P_{mi}}\right]_{to} = L_n\pi^2 + \alpha^2_{to}L_n\left[\frac{P_{mi}}{P_{di}}\right]_{to} + \alpha^2_{tl}L_n\left[\frac{P_{mi}}{P_{di}}\right]_{tl} + \beta^2_{to}L_nA_i$$

where M_i is the value of imports of commodity i, π is a constant, α_{to} and α_{tl} are the price coefficients in the current and preceding years respectively, and β_{to} is the activity variable coefficient.

The domestically produced part of the home demand for commodity i is used as the activity variable. This variable is a proxy for expenditure on commodity i.

Both functional forms are employed for estimation and compared. Elasticities for the linear form are computed using 1968 (midpoint) levels of the variables. It is found that price elasticities of commodities produced within the same industry and between commodity groups are significantly different in several cases.

Weighting the commodity groups by import volumes in 1968, an overall import price elasticity is calculated, and this figure is compared with import price elasticities for

Sweden and other countries previously estimated. The results indicate that the Swedish economy is comparatively sensitive to changes in relative price on the import side.

Melo and Vogt (1984) have estimated real income and relative price elasticities of demand for Venezuelan imports with disaggregated annual data over the period 1962-1979. The import demand function estimated is:

$$L_n M_{it}^d = \alpha_{oi} + \alpha_{1t} L_n (\frac{PM_i}{PD_i})_t + \alpha_{2t} L_n Y_t + \alpha_{3t} D_{it} + U_{it}$$

where M_i^d is the quantity demand of the ith import commodity, PM_i is the price of the commodity, PD_i is the price of the domestic substitute, Y is real gross domestic product, and U_i is a random disturbance. α_{1i} is the relative price elasticity of demand for commodity i, and α_{2i} is the real income elasticity.

A dummy variable D_i is included as a proxy for the increase in permanent income during 1974-1979 due to a significant increase in the market value of Venezuela's oil reserves. $D_i = 0$ for 1962-1973 and $D_i = 1$ for 1974-1979. Five categories of imports, which comprise 92 percent of total Venezuelan imports, are analyzed in this study. These individual and total import equations are estimated, and the results are reasonable.

The aggregation bias, which results from the use of direct estimates of the income and relative price elasticities of demand for total imports, instead of estimates derived from the estimates of the elasticities of the disaggregated import demand function is calculated. Comparing with the study by Khan (Khan, M.S. "The Structure and Behavior of Imports of Venezuela", Review of Economics and Statistics, May 1975 p221-224), they find that the direction of the aggregation bias is the same as in his study but the size is greater for the relative price elasticity and smaller for the income elasticity.

In comparison to Khan's estimates of price and income elasticities for the period of 1953-1972, their estimates for the period of 1962-1979 are generally greater. These greater price elasticities suggest that the economy of Venezuela has made progress in developing industries which produce substitutes for imports.

Unobservable Variables. Islam (1978) has demonstrated a way of handling unobservable variables in analyzing import demand. He has derived an import demand based on the hypothetical theory that a significant proportion of government interference in rice importing is motivated by a desire to conserve foreign reserves.

He divides rice imports for a typical Asian country into desired imports and government/determined imports. The theory is that actual imports equal desired imports when the country is not experiencing foreign exchange shortages, while actual imports are below the desired level and dominated by government-determined imports when the country is under foreign exchange shortages.

Desired imports at time t are obtained by the difference between the desired level of rice consumption and production at time t. Since desired consumption is not directly observable, it is measured indirectly by projecting consumption from a base period using observable variables thought to affect desired consumption. In addition, government determined imports are handled by assuming that the imports respond to desired imports and the foreign currency import price of rice.

Kim (1986) attempted to incorporate the quantitative effects of pricing policies by an importing country in an econometric model. This study models government intervention that distorts consumer and producer prices and foreign exchange allocations, and how to obtain consistent estimates of an import demand equation with 10 years or less of annual time series data (1973-1982), which is less than the number of predetermined variables.

This work examines the effects of Mexican government price policies and financial constraints on grain import demand. Government policy variables that affect import demand are identified, then incorporated into a social utility maximization framework. This model is applied to Mexico's import demand for corn.

Since domestic Mexican consumer and producer prices are set by the government, and are insulated from international prices during this time period, the size of government expenditures for subsidies, their allocation among consumers and producers, and the foreign exchange allotment are key government policy variables, so are incorporated into the model estimation.

Mexico was a corn exporter until 1972. The twelve predetermined variables influencing corn imports exceed the annual time series available, so ordinary least squares cannot be applied. The instrumental variable approach associated with canonical correlation is applied to increase degrees of freedom. An index variate of a predetermined monetary variable is derived with the data for the period 1973-1982. The quantity of net corn imports is then regressed with other predetermined variables and the index variate.

Simultaneous Relationship Analysis

Aggregate Analysis. Goldstein and Khan (1977) criticized the implicit assumption of infinite supply price elasticity for exports and imports facing any individual country. They argued that this assumption carried less intuitive appeal when applied to the supply of exports of an individual country. In other words, it is unlikely that an increase in world demand for a country's exports can be satisfied without any increase in the price of its exports unless idle capacity exists in the export sector.

In this study, an explicit account of the simultaneous relationship between the quantity of exports and prices (usually ignored in previous studies) is conducted by specifying models of export demand and supply and by simultaneously estimating those.

The primary purpose of this work is to investigate the price responsiveness of both export demand and export supply by using quarterly data on the aggregate exports of eight industrial countries for 1955-1970.

Two kinds of relatively simple models of export demand and supply are each simultaneously estimated. The first model, called an equilibrium model, makes the assumption of no lags in the system so that the adjustment of export quantities and prices to their respective equilibrium is instantaneous. The second model, called a disequilibrium model, allows for the possibility of adjustment with some delay.

Both models are estimated by a Full-Information Maximum Likelihood estimator, which requires specification of the complete model and utilizes all a priori restrictions on the system to estimate the coefficients simultaneously by maximizing the likelihood function of the model. It is not clear from the results which model is better.

The empirical results generally suggest that estimates of demand/price elasticities for exports can be quite different when export supply relationships are explicitly taken into account. In addition, the adjustment of exports to changes in the independent variables is neither instantaneous nor very long.

Arize and Afifi (1987) have specified and estimated aggregate import demand functions for thirty developing countries with annual data for the period of 1960-1982. They claim that simultaneous relationships between the quantity of imports and their price have been ignored, so consideration of this simultaneity is made by specifying models of import demand. Then these models are simultaneously estimated on annual data for thirty countries.

Their formulation of an aggregate import demand equation relates the real quantity of imports demanded by country i to the ratio of import prices to domestic prices, by assuming substitutability between imports and domestic goods, and to domestic real income. Price and relative price elasticities can be derived.

Four log-linear variants of the equation are estimated for each country as:

a. $$M_{it} = M_{it}\left(TY_{it},\ CY_{it},\ P_{it}^{m},\ P_{it}^{d}\right)$$

b. $$M_{it} = M_{it}'\left(TY_{it},\ CY_{it},\ P_{it}^{m},\ P_{it}^{d},\ M_{it-1}\right)$$

c. $$M_{it} = M_{it}''\left(TY_{it},\ CY_{it},\ P_{it}\right)$$

d. $$M_{it} = \bar{M}_{it}\ (TY_{it},\ CY_{it},\ P_{it},\ M_{it-1})$$

where M_i is the real quantity of imports of country i, P_i is the ratio of the unit value of imports (P^m) of country i to the domestic price level (P^d) of country i, Y_i is the real gross domestic product of country i, TY_i is trend level of real income, and (Y_i is the ratio of current real income (Y) to the trend value).

Equations a and c are equilibrium demand equations, while b and d are disequilibrium demand equations. The lagged dependent variables in b and d imply a partial adjustment process, so long-run and short-run price elasticities can be calculated here. The exchange variable is excluded in their specifications since they have found its nonsignificant effects from some previous studies for developing countries.

Two stage least squares are used in estimating the models to minimize the problem of simultaneity bias. Stability tests are applied to examine whether the country's import demand relationship has shifted during the estimation period. In this test, if the coefficients are thought to be unstable, they are treated as linear functions of time. The test adds variables to the basic equation and the coefficients on these variables are then jointly tested for significance by using an F test.

Following the estimation, statistically unstable equations are excluded, and the more appropriate model for each country is selected. Then statistical criteria are used to choose a final equation for each country.

The empirical results show that the long-run estimated price elasticity is greater than or equal to 1, which implies a fairly large response of imports to changes in import or relative price, and the duration of the adjustment of import volumes to changes in the explanatory variables does not seem to be long.

Disaggregate Analysis. Kargbo (1992) has applied a two-stage least square procedure to evaluate the effects of exchange rate movements on the import demand for meat in Sierra Leone. The analysis is based on an import demand model that treats imports as demand-determined and also determined by the availability of foreign exchange. The simultaneous equation approach is appropriate because meat imports are jointly determined by both demand factors and foreign exchange availability.

The unit values of imported meat and fish are used as proxies for prices, real per capita GNP is used as a proxy for total expenditure by an individual for the estimation. The real exchange rate is defined as the relative price of tradables with respect to nontradables, which is RER = $EP_T(1+t)/P_N$, where E is the bilateral nominal exchange rate expressed in domestic currency units per U.S. dollar. P_T is the U.S. wholesale price index and is used as the price deflator for the dollar. P_N is the GDP deflator of Sierra Leone and the price deflator for the domestic currency. T is the average tax rate. The estimating equation for meat has the following form.

$$L_nM_t^* = \beta_0 + \beta_1 L_n PMEAT + \beta_2 L_n INC + \beta_3 L_n RER + \beta_4 L_n DOMPR$$
$$+ \beta_5 L_n PSUB + \beta_6 L_n TREST + e_t$$

where

M_t^*	is the per capital quantity of meat imported;
PMEAT	is the real price of meat in leones/kg;
PSUB	is real price of substitutes or complements in leones/kg;
INC	is per capita income in real terms;
RER	is the real exchange rate'
DOMPR	is the per capita domestic meat production; and
TREST	is the ratio of GNP over the sum of total exports and imports.

TREST is an indicator of trade policy restrictions such as quotas and tariffs by the government to conserve foreign exchange and encourage domestic meat production.

Empirical results are obtained through both the two stage least squares and ordinary least squares methods for the period of 1965-1987. The results indicate that real exchange rates, income, trade restrictions, domestic production and prices of meat and competing products are the key determinants of import demand response for meat and have more significant effects than pricing policies. A depreciation in the real exchange rate has a depressing effect on meat imports. Import restrictions implemented by the government are found to dampen the transmission mechanism of relative prices.

System of Equations Method

Mixed Estimation

Leong and Elterich (1985) developed a theoretical framework to explain the interrelationships that characterize the Japanese broiler market. Three behavioral equations and two identities were constructed to estimate Japanese per capita demand, import demand, and the domestic supply function in Japan over the period from January 1974 to February 1982 with monthly data.

Monthly data for the income variable was not available, so quarterly GNP data was transformed into monthly data by choosing a correlation coefficient of GNP with the general index of industrial production, 0.91, to derive weights to split the quarterly data, then used the resulting weighted monthly GNP values in the analysis.

Ordinary least squares is used to estimate the parameters of the per capita demand and supply equations, while two stage least squares is used to estimate the import demand equation. The estimated results using a double-log functional form indicate that broilers are a superior income elastic good and that macro variables such as the exchange rate and GNP play a significant role in determining the import demand for American broilers. In addition, the elastic nature of import demand for American broilers suggests a good prospect for American producers.

Simulations with the use of changes in the value of selected independent variables that would have a policy impact on the dependent variables are conducted. An assumed and persistent percentage change in one of the independent variables is entered into each equation, and the difference between the observed value and simulated value of the dependent variable is computed.

For the simulation of the import demand for American broilers, the simulation on the exchange rate shows the most impressive results. A 25 percent decrease in the yen-to-dollar exchange rate results in a five-fold increase in imports over 13 months.

Dzata and Henneberry (1993) investigated the economic forces that influence Mexico's import demand for live cattle and sorghum. A simultaneous model of four equations is constructed and estimated for imports of Mexican live cattle in which the major variables affecting import demand can be determined and evaluated.

With annual calendar data for the period of 1970-1990, a model of four behavioral equations and four identities, which is composed of five endogenous and six exogenous variables, is developed, then two-stage least squares is utilized for the estimation of this model.

The approach is to separate import demand into demand from the U.S. as an endogenous variable and to include the demand from the rest of the world an exogenous variable. It is found that Mexican cattle imports from the rest of the world could reduce the import demand for U.S. cattle, and that a cattle production increase in Mexico could substantially increase the import demand for U.S. sorghum.

Block Recursive System

Chambers and Just (1981) used an econometric model of a system of equations to examine the effects of exchange rate fluctuations on U.S. wheat, corn, and soybean markets. Their primary concerns were the effect of the U.S. dollar devaluation in the early 1970's. They attempted to develop a model which contained exchange rate adjustments and reflected exchange rate effects on the domestic sector as well as the foreign sector of U.S. agriculture. They argued that most modeling efforts thus far had been static in nature thus incapable of portraying dynamic adjustment to a fluctuation in exchange rates.

One objective of this study is to investigate this dynamic effect in an empirical model and to identify the major dynamic characteristics of the adjustment process through dynamic multiplier analysis.

A seemingly recursive form of the econometric model, which consists of fifteen equations including three identities, is formulated to explain disappearance, inventories, exports, and production for wheat, corn, and soybeans, and estimated as a single system by three-stage least squares with quarterly data over 1969I - 1977II. Unlike in other empirical studies, SDR per dollar, used as a proxy for the exchange rate, is used in nominal terms, while other price variables are deflated by the wholesale price index.

They also report the three stage-least squares, reduced form estimates for the model, whose coefficients present a more accurate picture of the total effects of predetermined variables. The model is then used to generate dynamic and long-run multipliers to examine the time path of adjustment to fluctuations in the exchange rate. It is found that exports and agricultural prices appear to be relatively more sensitive to the fluctuation in the exchange rate. The short-run effects in prices and exports are found to be more dramatic.

Kondoh and Lin (1991) developed a system of equations to analyze the competitiveness of U.S. soybeans on the Japanese market and the potential of expanding

U.S. soybean exports to Japan.

Thirty nine disaggregated structural equations for the period of 1978-1988 are specified and estimated by two-stage least squares to examine Japanese food and non-food soybean consumption. The model includes the production of soybeans in China, Japan, the U.S., other exporting countries and the importation and disappearance of soybeans and soybean products in Japan and the U.S.

Their model is a block recursive type including five blocks. Four of those are concerned with soybean production in Japan, the U.S., China, and other exporting countries while the last one is concerned with the supply of and demand for soybeans, soybean oil, and/or soybean meal in the countries involved.

The soybean import function in Japan is also disaggregated by three sources of supply, which are the U.S., China, and other exporting countries. Estimated short-run and long-run elasticities of current endogenous variables with respect to exogenous variables are evaluated at the average level of related variables based upon the estimated reduced form equations.

The main concerns are the competitive relationships among soybeans from different sources for Japanese consumption and the potential for expanding exports of U.S. soybeans to Japan. U.S. soybeans would be capable of competing well in both short-run and long-run, while other exporters have greater ability to compete when the U.S. dollar depreciates. Supplying more food quality soybeans to Japan may expand the export of U.S. soybeans. The rapid growth of Japanese swine and poultry industry under government protective policies is considered another positive factor for the U.S. soybean industry.

Summary

The preceding presentation provided various methodologies for analyzing import demand. Since Schuh (1974) raised exchange rate issues for the agricultural sector, many theoretical and empirical studies have followed. Those studies were divided into two parts.

In the first part, the effects of exchange rates on agricultural trade and an alternative measure of exchange rate were investigated. Chambers and Just (1979) emphasized alternative approaches to the exchange rate in agricultural trade models and demonstrated the impacts of exchange rate changes on every price in the economy by applying a stage analysis of group demand equations.

In addition to the exchange rate, Johnson, Grennes, and Thursby (1977) added other macro variables in the trade model and linked U.S. and foreign markets. Adelman and Robinson (1988) further developed the model to analyze the impact of the changes in macro variables on the structure of the U.S. economy in the context of a computable general equilibrium framework.

Henneberry, Henneberry, and Tweeten (1987) stressed the importance of real exchange rates and demonstrated the significance of the methodology to compute trade-weighted exchange rate indices. Dutton and Green analyzed alternative measures of multilateral exchange rate changes appropriate for agricultural trade (1987), and presented a theoretical framework for the effect of exchange rate changes on volume of trade and prices (1988). The main issues related to trade elasticities were also analyzed.

In the second part, methodologies of modeling import demand were presented. Murray and Ginman (1976), and Muti (1977) offered alternative specifications of import demand models. Thursby and Thursby (1988) used statistical techniques to select more appropriate models.

The inflationary effect on import demand was also studied. Henry (1976) surveyed the effect of inflation in a large exporting country on the import demand of two small countries, while Arnade and Dixit (1989) examined the basic economic assumption of zero homogeneity of import demand.

A variety of econometric handling methods used in the estimations of models were considered. Salas (1982) compared two models with different estimation periods to investigate the changing structure of Mexican private sector imports. Hamilton (1980), and Melo and Vogt (1984) used relative prices of imports and domestic substitutes. Relative price elasticities of demand for imports were carefully examined.

Islam (1978) and Kim (1986) demonstrated ways of handling unobservable variables in their models. Islam divided rice imports into desired and government-determined imports. An unobservable variable of desired consumption was measured indirectly by projecting consumption from a base period using observable variables. On the other hand, Kim employed the Canonical Regression Instrument variable approach in estimating the quantitative effects of pricing policies. The degree of price insulation varies among countries and across commodities depending on government price policies.

The simultaneous relationship approach was explicitly accounted by Goldstein and Kahn (1977), Arize and Afifi (1987), and Kargbo (1992). Based on aggregate analysis, Goldstein and Kahn, and Arize and Afifi employed the models with lags and the models without lags, then checked the trade elasticities and the adjustment of trade to changes in the independent variables.

The system of equation approaches were adopted by Chambers and Just (1981), Leong and Elterich (1985), Kondoh and Lin (1991), and Dzata and Henneberry (1993), Leong and Elterich showed the simulation effects of the exchange rate and a policy variable on import demand. Dzata and Henneberry separated import demand into demand from the U.S. as an endogenous variable and included demand from the rest of the world as exogenous variable. Chambers and Just, and Koudoh and Lin applied block recursive system methods. The former demonstrated the dynamic effects in the model and the major dynamic characteristics of the adjustment process through dynamic multiplier analysis, while the latter provided highly disaggregated analysis.

CHAPTER III

THEORY

Chapter III presents the analytical basis for the study of import demand system. Theoretical issues are discussed in various frameworks.

The first section of this chapter discusses the theory of demand, and is extended to derive excess demand as the import demand in the second section. In the third part, the theory of trade is analyzed. In the fourth part, foreign exchange issues, as a key variable, are carefully examined in the various models. The fifth part provides a more detailed analysis of trade theory in the traditional macroeconomic context. The sixth part examines the effect of government intervention on international markets, and the stock effect is analyzed in the last part.

Theory of Demand

Basic economic theory assumes that an individual consumer allocates income among different commodities to maximize his or her own utility U subject to a budget constraint. Under the assumption of nonsatiation, the individual spends all income on goods q_1, q_2, q_n, so

Maximize $U(q_1, q_2, \ldots q_n)$

$$\text{subject to} \quad \sum_{i=1}^{n} P_i q_i = Y$$

The necessary first order condition is that the first partials of the lagrangian equal zero:

$$L = U(q_i \cdot \; . \; . q_m) + \lambda \left[Y - \sum_{i=1}^{n} P_i \, q_i \right]$$

where λ is the lagrange multiplier. The consequence of this behavior becomes

$$L_i = U_i - \lambda P_i = 0$$

$$L_\lambda = Y - \sum_{i=1}^{n} P_i q_i = 0$$

where $U_i = \dfrac{\partial U}{\partial q_i}$

By simultaneously solving the n + 1 partial derivatives for q_i, we obtain the ordinary demand function for each q_i as function of own and other prices and income.

The sufficient second order condition for this constrained maximization is that the bordered Hessian determinant of the second partials of L,

$$D_A = \left| \bar{H}_A \right| = \begin{bmatrix} L_{11} & L_{12} \ldots L_{1\lambda} \\ L_{21} & L_{22} \ldots L_{2\lambda} \\ \cdot & \\ \cdot & \\ \cdot & \\ L_{\lambda 1} & L_{\lambda 2} \ldots -L_{\lambda\lambda} \end{bmatrix} = \begin{bmatrix} U_{11} & U_{12} \ldots -P_1 \\ U_{21} & U_{22} \ldots -P_2 \\ \cdot & \\ \cdot & \\ \cdot & \\ -P_1 & -P_2 \ldots 0 \end{bmatrix}$$

be negative definite.

The relationship of the demand for q_i with P_i, P_j and Y is determined by the signs of the first order partial derivatives with respect to P_i, P_j and Y. Good i is a gross substitute of good j if the cross price elasticity of demand for good i with respect to the price of good j is positive, that is $\epsilon_{ij} = \partial q_i / \partial P_j \cdot P_j / q_i > 0$, while good j is a gross substitute of good i if $\partial q_j / \partial P_i > 0$. On the other hand, if the cross price elasticity is negative, both goods are gross complements.

Thus if $\epsilon_{ij} < 0$ and $\epsilon_{ji} > 0$, good i is a gross complement of good j, and good j is a gross substitute of good i. Good i is a normal good if $\partial q_i/\partial Y > 0$.

An important point is that the demand curve is independent of any monotonic transformation of the utility function. Let a monotonic transformation of the above utility function be $Z(q_1, q_2, \ldots q_n) = F[U(q_1, q_2, \ldots q_n)]$, where $F'(U) > 0$.

From the first order necessary conditions above and replacing $U(q_1, q_2, \ldots q_n)$ by $Z(q_1, q_2, \ldots q_n) = F[U(q_1, q_2, \ldots q_n)]$, we get

$$\frac{U_i}{U_j} = \frac{P_i}{P_j} = \frac{Z_i}{Z_j}, \text{ since } Z_i = F'(U)U_i,$$

$$\frac{Z_i}{Z_j} = \frac{F'U_i}{F'U_j} = \frac{U_i}{U_j} = \frac{P_i}{P_j},$$

which means nothing is changed by the transformation of U.

Using the product and chain rule from $Z_i = F'(U)U_i$, and assuming two goods for simplicity, we generalize Z_{ij} as $Z_{ij} = F'U_{ij} + F''U_iU_j$. Then the second order sufficient condition for $Z(q_i, \ldots q_n)$ is

$$D_B = \left|\bar{H}_B\right| = \begin{bmatrix} Z_{11} & Z_{12} & -P_1 \\ Z_{21} & Z_{22} & -P_2 \\ -P_1 & -P_2 & 0 \end{bmatrix} = \begin{bmatrix} F'U_{11} + F''U_1^2 & F'U_{12} + F''U_1U_2 & -P_1 \\ F'U_{21} + F''U_1U_2 & F'U_{22} + F''U_2^2 & -P_2 \\ -P_1 & -P_2 & 0 \end{bmatrix}$$

which should be negative definite.

Since $P_i = U_i/\lambda$ from the original first order conditions,

$$D_B = \frac{1}{\lambda}\begin{bmatrix} F'U_{11} + F''U_1^2 & F'U_{12} + F''U_1U_2 & -P_1 \\ F'U_{21} + F''U_1U_2 & F'U_{22} + F''U_2^2 & -P_2 \\ -U_1 & -U_2 & 0 \end{bmatrix}$$

Multiplying the last row by $F''U_2$ and then adding to the second row,

$F'' \, U_1 U_2$ *and* $F'' \, U_2^2$ is eliminated in the second row without changing the value of the determinant. Again, multiplying the last row by $F'' \, U_1$, then adding it to the first row, we also eliminate $F'' \, U_1^2$ *and* $F'' \, U_1 U_2$. If we reassemble the last row prices,

$$D_B = \begin{bmatrix} F'U_{11} & F'U_{12} & -P_1 \\ F'U_{21} & F'U_{22} & -P_2 \\ -P_1 & -P_2 & 0 \end{bmatrix} = (F')^2 \begin{bmatrix} U_{11} & U_{12} & \frac{-P_1}{F'} \\ U_{21} & U_{22} & \frac{-P_2}{F'} \\ -P_1 & -P_2 & 0 \end{bmatrix} = F' \begin{bmatrix} U_{11} & U_{12} & -P_1 \\ U_{21} & U_{22} & -P_2 \\ -P_1 & -P_2 & 0 \end{bmatrix}$$

$= F'D_A$ is obtained.

Since D_A and D_B have the same sign with $F' > 0$, $Z(q_1, q_2) = F[U(q_1, q_2)]$ achieves a maximum whenever $U(q_1, q_2)$ does. Hence, the demand curve is unaffected by any monotonic transformation of the utility function.

The market demand function for good k is represented as $Q_K = \sum_{i=1}^{n} q_{ik}$ $i = 1, 2, \ldots n$ which is the horizontal aggregation of individual demand curves.

Theory of Excess Demand

Several methods of specifying an import demand function exist. If we follow the most commonly held theoretical viewpoint, while assuming that an excess demand function is equivalent to an import demand function, it begins with a derivation of an ordinary domestic demand function from utility maximization with respect to income as described earlier.

An individual domestic demand function for good i can be theoretically written as $D_i = Q_i(P_1, P_2, \ldots P_n, Y)$ where P_n is nth good and Y is income. Since the demand function is viewed as being homogeneous of degree zero, it is common practice in estimating domestic demand equations to normalize on the appropriate price index and write the demand in real variables as:

$$D_i = Q_i \left[\frac{P_1}{d}, \frac{P_2}{d} \cdot \cdot \frac{P_n}{d}, \frac{Y}{d} \right]$$

where d is a deflator. Alternatively, Arnade and Dixit (1989) suggest that the function can be normalized on the price of a substitute or a complement, which could be written as:

$$Q_i \left[\frac{P_1}{P_2} \cdot \cdot \cdot \frac{Y}{P_2} \right].$$

After obtaining the domestic demand functions, we now define imports as the excess of domestic demand over supply. An import demand for a good i in real terms is

$$M_i = D_i - S_i = Q_i \left(\frac{P_1}{d}, \frac{P_2}{d}, \cdot \cdot \cdot \frac{Y}{d}\right) - S_i\left(\frac{P_1}{d}, \cdot \cdot \cdot \frac{W_j}{d}\right)$$

where M_i is the import of a good i, S_i is the supply of the good, and W_j is the jth factor cost. The supply function is derived from profit maximizing procedures and is also assumed to have zero homogeneity. This import demand equation is also homogeneous of degree zero in prices and income. The supply is often assumed to be fixed in the short run so that this supply function could be replaced by a fixed level.

Theory of Trade in Basic Framework

As we have seen above, the theoretical model of import demand is based on the concept of excess demand and excess supply. If a country's production of a certain good is less than their total requirement for consumption or if the country has no domestic production of the good, excess demand exists at a given price and the demand could be satisfied by importing the good from the countries with excess supplies at an equilibrium price, where excess demand equals excess supply.

In order to discuss the theoretical trade equation, it may be useful to think in the following context. A country's net trade for a certain commodity can be represented by:

$$N = D(P^d, Y) - S(P^s, W)$$

where N is the net trade of a country, P_s is a vector of supply prices, W is a vector of factor costs, P^d is a vector of consumer prices, and Y is income in the country.

If $N > 0$, the country is a net importer of the commodity and the equation can be used to describe demand for imports of the commodity. Then the country faces export supply given by $\sum_j N_j$, where j is the exporting country index. $\Sigma N = 0$ in equilibrium for any commodity. The equation can represent excess demand for either a single commodity or aggregate commodity trade.

Trade models are broadly classified into perfect substitutes and imperfect substitutes.

Perfect Substitutes Model

This is the usual representation of trade models in which imports and goods domestically produced are perfect substitutes for each other. It allows one to calculate trade elasticities from domestic demand and supply elasticities. Differentiating N (with assumptions of no domestic policies) so $P_i^d = P_i^s$, we can express a country's price elasticity of demand for imports of a commodity as

$$n^d = (S/N)\ (dL_nS/dL_nP) - (D/N)\ (dL_nD/dL_nP)$$

Similar expressions can be derived for income elasticities of demand for imports when commodities are perfect substitutes, so we may choose to use domestic elasticity estimates to compute trade elasticities or estimate them directly.

The perfect substitutability can be explained by a basic graphical illustration. Suppose we have two trading partners of the exporting country and the importing country for a specific commodity, and there is an absence of transfer costs, trade barriers between them and domestic pricing policies.

In Figure (3.1), when there is no trade, country E produces and sells Q_E^o at the price of P_E^o per unit, while country I produces and sells Q_I^o at the price of P_I^o per unit. When both countries open their markets, excess supply (ES) and excess demand (ED) functions are created from exporting and importing countries, respectively, in the world market. The ED is the import demand function for country I, which is a horizontal subtraction of the supply function from its demand function. The ES is analogously derived from supply and demand functions in country E.

Domestic demand (D_E) equals domestic supply (S_E) at A_E in E, so ES equals zero as indicated by A_W in the world market. At the price of P_E^1, ES equals $\left(Q_E^1 - Q_E^2\right)$ in E and Q_W in W. At B_I in country I, domestic demand and supply are equal and ED is zero as indicated by B_W in W. At the price of P_I^1, the country consumes Q_I^1 and produces Q_I^2, domestically. ED is $\left(Q_I^1 - Q_I^2\right)$ which is equivalent to Q_w. The world

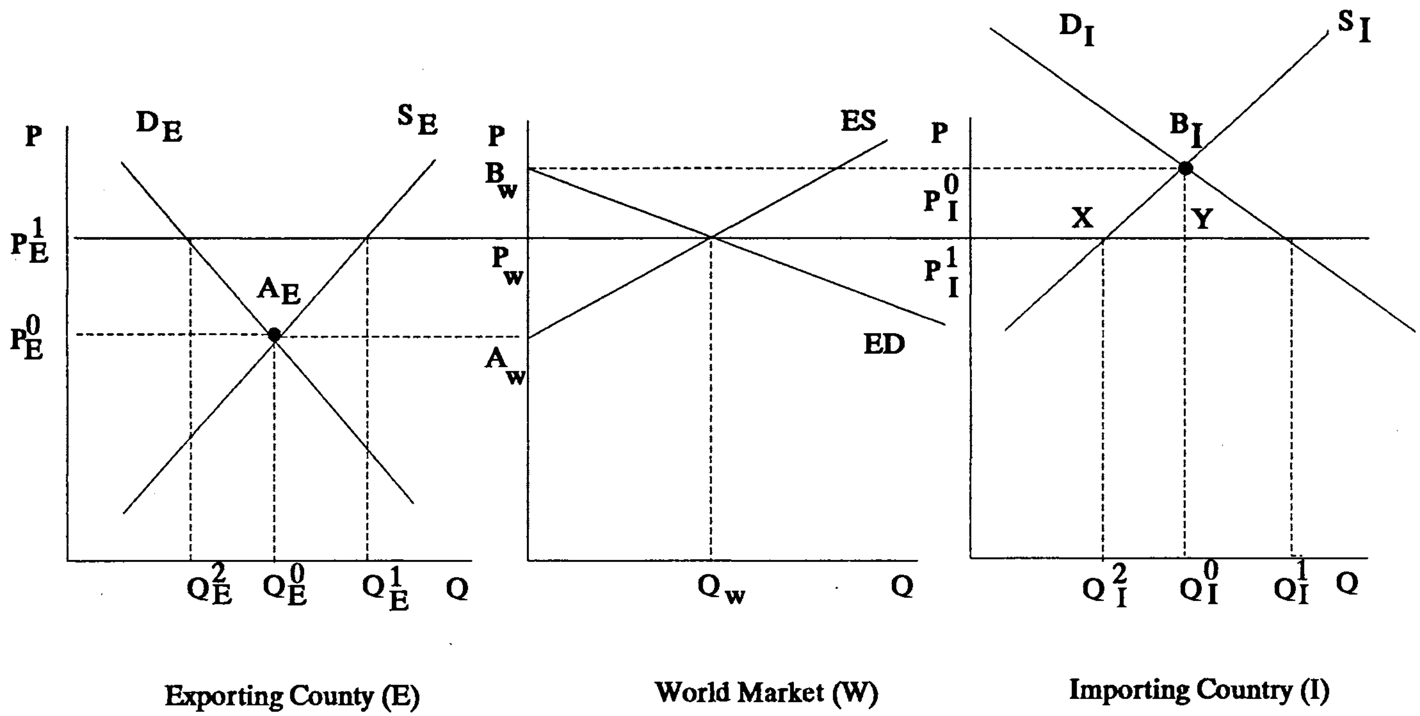

Figure 3.1. Excess Demand and Supply for Trade.

price P_W and its quantity traded Q_W are determined by the intersection of ED and ES.

By opening trade, the importing country has more consumption and less production at an adjusted lower price. Resources used to produce this comparatively disadvantageous commodity can be switched to a more efficient product. As a result, consumer surplus improves as much as X and Y, but producer surplus loses as much as X. The net gain is Y, thus this analysis explains the advantages of free trade.

The interdependency of trading partners can be further explored by using the preceding model. Any shift in domestic supply or demand shifts either ES or ED, and transmit its impact to the world market.

Suppose demand for the commodity shifts up from D_I^1 *to* D_I^2 in the importing country as a result of an increase in consumer income as in Figure 3.2. This leads to a shift of ED from ED_1 to ED_2. Price and quantity imported rise as the arrows indicate. In this case, the net gain depends upon the elasticity of domestic demand in country I. We next consider another transmission effect from the exporting country.

Suppose unfavorable weather condition or increasing factor costs in the exporting country E shifts its supply curve upward from S_E^1 *to* S_E^2.

Shifts in the exporting country's supply function is transmitted to the world market as a shift of ES from ES_1 to ES_2. The direction of the resulting change is indicated by arrows, and the level of imports is determined by the increased world price.

An import demand function may be derived mathematically. Since import demand is the excess of domestic demand over supply as described earlier, we could express it as:

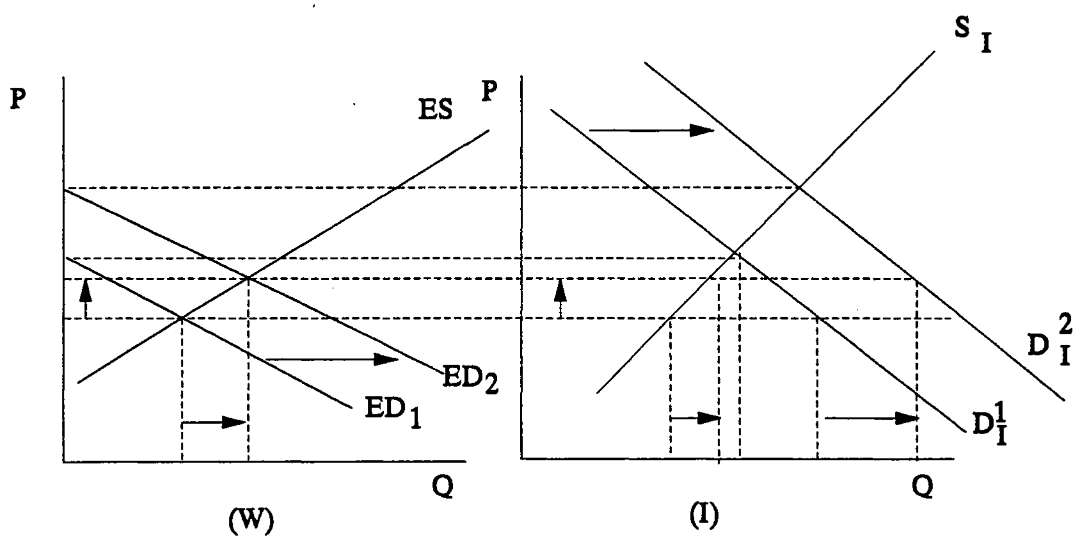

Figure 3.2. Transmission Effect from Importing Country.

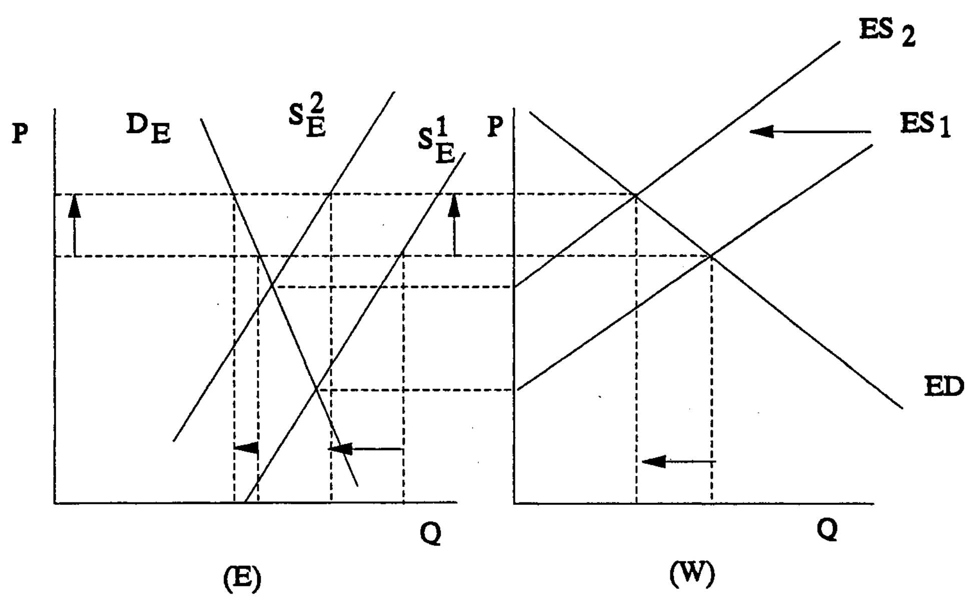

Figure 3.3. Transmission Effect from Exporting Country.

$M_i = D_i(P_i^d, P_1, \ldots, P_n, Y, V^d) - S_i(P_i^s, C_1, \ldots C_m, V^s)$ where M_i is imports of commodity i, P_i^d is the consumer price of commodity i, P_i^s is the domestic supply price of i, other p's are prices of substitutes and complements, Y is income, and c's are factor prices. V^d and V^s represent demand and supply shifters respectively. Again assuming no transfer costs and no trade restrictions and no domestic pricing policies, $P_i^d = P_i^s = P_w$, which, in turn means that the import demand function for a good i may be specified as:

$$M_i = D_i(P_w, P_1, \ldots, P_n, Y, V^d) - S_i(P_w, C_1, \ldots, C_m, V^s)$$

For example, suppose the domestic demand function is $D_i = a_0 - a_1P_w - a_2P_c + a_3P_s + a_4Y$ and the domestic supply function is:

$$S_i = b_0 + b_1P_w - b_2C_j$$

where P_s and P_c are the prices of substitutes and complements respectively, and a and b are non-negative. Then the import demand function becomes:

$$\begin{aligned} M_i &= D_i - S_i \\ &= (a_0 - a_1P_w - a_2P_c + a_3P_s + a_4Y) - (b_0 + b_1P_w - b_2C_j) \\ &= (a_0 - b_0) - (a_1 + b_1)\, P_w - a_2P_c + a_3P_s + a_4Y + b_2C_j \\ &= r_0 - r_1P_w - r_2P_c + r_3P_s + r_4Y + r_5C_j \end{aligned}$$

where $r_0 = a_0 - b_0$, $r_1 = a_1 + b_1$, $r_2 = a_2$, $r_3 = a_3$, $r_4 = a_4$, and $r_5 = b_2$

<u>Imperfect Substitutes Model</u>

This model is based on the assumption that consumers perceive domestically produced goods and imported goods as heterogeneous products. When internationally traded goods are not close substitutes for domestically produced goods, it is conventional to drop the representation of trade equations as the excess between domestic demand and supply. Demand for imports is typically expressed as a function of a price vector and income of the importing country in this case. A simple example for a commodity is:

$$M = f(P_m, P_d, Y)$$

where M is import demand, P_m denotes price of imports, P_d denotes the price of domestically produced goods, and Y is income.

Thursby and Thursby (1988) explain that the demand function above is often presumed to be derived from utility maximization but studies rarely mention how the exact functions estimated are derived and, as a result, the demand functions may be inconsistent with the presumed theory. One example is that the log-linear form of demand is popular since the estimated coefficients are interpreted as elasticities, but it is not derivable from constrained utility maximization.

Supply is usually assumed to be infinitely elastic, however some studies have emphasized that supply capacity is not infinite and specify supply as a function of an appropriate price vector and other activity variables.

The case of imperfect substitutability may also be mathematically illustrated. Let a consumer utility function and income be $U(M_m\ q_m^d, q_i)$ and $Y = P_{wm}M_m + P_m^d q_m^d + \sum_{i=1}^{n} P_i q_i,$ where M_m is the quantity of imported good m, P_{wm} is the price of m, P_m^d is the price of domestically produced good m, q_m^d is the quantity of domestically demanded good m, P_i and q_i are the price and quantity of substitutes and complements respectively, and Y is consumer income. By setting up the Lagrange function, constrained maximization is achieved as:

$$L = U(M_m, q_m^d, q_i) + \lambda(Y - P_{wm}M_m - P_m^d q_m^d - \sum_{i=1}^{n} P_i q_i)$$

Let the first order partials be zero,

$$\frac{\partial L}{\partial M_m} = f_{Mm} - \lambda P_{wm} = 0$$

$$\frac{\partial L}{\partial q_m^d} = f_{q_m^d} - \lambda P_m^d = 0$$

$$\frac{\partial L}{\partial q_i} = f_i - \lambda P_i = 0 \qquad i = 1,2,\ldots n$$

$$\frac{\partial L}{\partial \lambda} = Y - P_{wm}M_m - P_m^d q_m^d - \sum_{i=1}^{n} P_i q_i = 0 \qquad i=1,2,\ldots n$$

and solving these simultaneously, import demand for good m is obtained as $M_m = Q_m(P_{wm}, P_m^d, P_i, Y)$.

We can also graphically illustrate this. Because imported and domestically produced goods are heterogeneous, it can be assumed that the imported commodity is not domestically produced.

In this case, the import demand for a certain commodity is equivalent to domestic demand and is a function of the world price and domestic demand shifting variables, thus ED shifts only if a shift in the domestic demand occurs. The arrows in Figure (3.4) indicate the changes after D^1 shifts to D^2 in the importing country.

Model with no Domestic Production

Since no domestic supply exists in this case, a graphical illustration is identical to the case of imperfect substitutability. The import demand is a function of the world price and other domestic demand variables, and is represented as

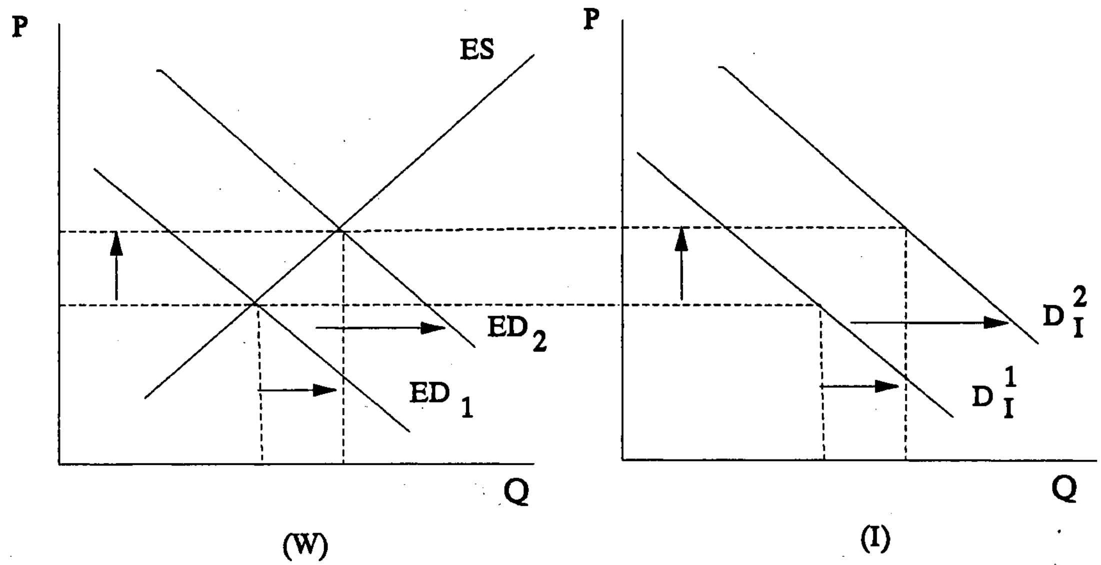

Figure 3.4. Import Demand Shift under Imperfect Substitutability.

$M_m = Q_m(P_{wm},P_i,Y,V^d)$.

Theory of Foreign Exchange

Foreign exchange is the general term applied to foreign money. Foreign exchange held by the central bank is called official reserves. Importers create a demand for foreign exchange, while exporters earn foreign exchange and thereby add to the supply of foreign exchange. A country's reserves consist of financial assets such as holdings of gold, convertible foreign currencies, and credit with the IMF. The total reserves of all countries are usually described as international liquidity.

The prices at which currencies trade for each other in foreign exchange markets are the exchange rates. The price of a specific currency in terms of the other is a bilateral exchange rate and in terms of an average of other currencies is a multilateral exchange rate. The current price of a specific foreign currency is the spot rate, whereas the rate at which the currency can be currently purchased for future delivery is the forward rate.

Nominal and Real Exchange Rates

The exchange rate is the amount of domestic currency needed to purchase a unit of foreign currency, so we can write,

Korean wons = E x (U.S. dollars)

where E is the price of dollars. In the long run, there is the expectation that trade will be balanced and the value of exports equals that of imports. In this case, both currencies are split into price and quantity components and $P_Kq_K = EP_{US}q_{US}$ where q_K and qUS are

Korean and U.S. exports respectively, and P_K and P_{US} are the prices of the respective exports. Rearranging the above relationship to $q_K/q_{US} = EP_{US}/P_K$, we obtain the real terms of trade which means that q_K units of Korean exports will purchase q_{US} units of U.S. goods. If a larger volume of domestically produced goods is needed to obtain a given quantity of foreign goods, the terms of trade is deteriorated, which means an increased ratio q_k/q_{US}.

The price of foreign currency in terms of domestic currency, E, is called the nominal exchange rate. If the real terms of trade equals the product of the exchange rate and the ratio of foreign to domestic prices, it is called the real exchange rate. The real exchange rate measures the competitiveness of a country in international trade. A rise in the price of foreign exchange makes domestic goods more attractive to foreign buyers. The same thing happens if P_{US}/P_K rises, which means there is inflation abroad relative to the domestic price movement.

Using the definition of the real exchange rate to compute percentage changes, we have

$$\Delta q_K/q_K - \Delta q_{US}/q_{US} = \Delta E/E + \Delta P_{US}/P_{US} - \Delta P_k/P_k$$

The theory of exchange rate determination holds that the real exchange rate will not change in the long run by competitive forces, then there is no change on the left-hand side of the equation. So the equation becomes $\Delta E/E = \Delta P_k/P_k - \Delta P_{US}/P_{US}$. The theory implies that the nominal exchange rate must reflect relative domestic-foreign inflation rates. In other words, the nominal exchange rate will rise at a rate equal to the difference between the domestic and foreign rates of inflation. Hence, we can say that a major determinant of the nominal exchange rate in the longer run is the rate of domestic inflation relative to foreign inflation.

Exchange Rate and Elasticity of Imports

To examine the relationship between imports and foreign exchange. Let

$$M^{*} = MP_f \tag{3.1}$$

where M* is the value of imports denominated in foreign currency, M is the physical volume of imports, and P_f is the foreign price of imports. Also, let P be domestic price of imports, and $P = EP_f$.

Imports are demanded by the home country, so the elasticity of demand for imports must be defined in terms of home prices. The elasticity of demand for imports with respect to price is given by

$$n_d = \frac{-dM/M}{dP/P}$$

Imports are supplied by foreign exporters, so the elasticity of supply of imports must be stated in terms of foreign prices, then the elasticity of supply of imports is defined as

$$n_s = \frac{dM/M}{dP_f/P_f}$$

From (3.1)

$$dM^{*}/M^{*} = dM/M + dP_f/P_f \text{ and from } P = EP_f,\ dP/P = dE/E + dP_f/P_f \tag{3.2}$$

using (3.2) and the definition of elasticity, elasticities can be expressed in foreign prices as

$$n_d = \frac{-dM/M}{dP_f/P_f - dE/E} \qquad n_s = \frac{dM/M}{dP_f/P_f}$$

solving these for dM/M and dP_f/P_f provides

$$\frac{dM}{M} = \frac{-n_s n_d}{n_d + n_s} \frac{dE}{E} < o$$

$$\frac{dP_f}{P_f} = \frac{-n_d}{n_d + n_s} \frac{dE}{E} < o \tag{3.3}$$

The equations mean that both the physical volume of imports and the foreign price of imports decline if dE/E > o, which means the price of foreign exchange rises, so the value of imports must decline. The rising price of foreign exchange raises the domestic price of the imports and reduces the quantity of imports purchased. Exports face a decline in demand, so the foreign price decreases. As quantity and foreign price decline, the quantity of foreign exchange demanded also drops. If we plug the results in (3.3) into (3.2), it yields

$$\frac{dM^*}{M^*} = \frac{-n_d\,(1+n_s)}{n_d + n_s} \frac{dE}{E} < o$$

which means that the elasticity of the value of imports with respect to the exchange rate is negative, so the value of imports and the demand for foreign exchange decrease as price of foreign exchange rises.

<u>Exchange Rate and Policy Variables</u>

The flexible exchange rate period that began in 1973 has been characterized by the tendency for exchange rates to overshoot; that is, the exchange rate appears to go too far in the right direction and then reverses itself. We can examine the relationships between exchange rate and government variables by using the body of macroeconomic theory that explains exchange rates.

Let the flexible exchange model be

$$Y = C(Y) + I(i) + G + X(e) + eM(Y, e)$$

$$M_s = L(Y, i)$$

$$O = X(e) - eM(Y, e) + K(i)$$

In the first equation, Y is equilibrium national income, C is consumption, I is investment, G is government spending, X is export, M is import, and i is interest rate. In the second equation, M_s is money supply, and the equation defines monetary equilibrium. In the third equation, K is the net inflow of capital, so the equation states equilibrium in the balance of payments when net exports plus the net inflow of capital equal zero. Since the imports variable is expressed in foreign currency, it is necessary to multiply the foreign exchange value of imports by e, the price of foreign exchange, to convert the imports into a domestic currency equivalent.

Total differentiation of the above equations to apply comparative statics gives

$$dY = C_y\, dY + I_i\, di + dG + X_e\, de - eM_y\, dY - M(Y, e)de - eMe\, de$$

$$dM_s = L_y\, dY + L_i\, di$$

$$O = X_e\, de - eM_y\, dy - M(Y, e)de - eMe\, de + K_i\, di$$

Moving all exogenous variables to the right hand sides, the equations become

$$(1 - Cy + eM_y)dY - I_i\, di - [Xe - M(Y, e) - eM_e]\, de \qquad = dG$$

$$L_y\, dY + L_i\, di \qquad = dM_s$$

$$eM_y\, dY - K_i\, di - [X_e - M(Y, e) - eM_e]\, de \qquad = O$$

Assuming that initially all prices and the exchange rate equal 1, and let

$$S_y = 1 - C_y \text{ and}$$

$$A = X_e - M(Y, e) - eM_e = X_e - M(Y, e) - M_e,$$

the equations become

$$(S_y + M_y)dY - I_i\, di - A de = dG$$

$$L_y\, dY + L_i\, di = dM_s$$

$$M_y\, dY - K_i\, di - A de = O$$

Let $B = -A(L_i S_y - L_y K_i + L_y I_i)$, then inversion of the coefficient matrix gives

$$\begin{bmatrix} dY \\ di \\ de \end{bmatrix} = \begin{bmatrix} \frac{AL_i}{B} & \frac{-A(I_i-K_i)}{B} & \frac{AL_i}{B} \\ \frac{AL_y}{B} & \frac{-AS_y}{B} & \frac{-AL_y}{B} \\ \frac{-(L_yK_i+L_iM_y)}{B} & \frac{K_i(S_y+M_y)-I_iM_y}{B} & \frac{-L_i(S_y+M_y)+L_yI_i}{B} \end{bmatrix} X \begin{bmatrix} dG \\ dM_s \\ O \end{bmatrix}$$

The change in the exchange rate is given as:

$$\frac{de}{dG} = \frac{-(L_yK_i + L_iM_y)}{B} = \frac{-(L_yK_i + L_iM_y)}{-A(L_iS_y - L_yK_i + I_iL_y)}$$

$$\frac{de}{dM_s} = \frac{K_i(S_y+M_y)-I_iM_y}{B} = \frac{K_i(S_y+M_y)-I_iM_y}{-A(L_iS_y-L_yK_i+I_iL_y)}$$

Thus the directions between e and G, and e and M_s depend on the sign of A.

Exchange Rate in a Commodity Model

Theoretical considerations of commodity model could be helpful to understand the relationships between exchange rates and other variables. Choosing one among alternative exchange rate measures is particularly relevant to the study of agricultural trade. Dutton and Grennes (1988) have offered a basic framework to understand the relationships.

To illustrate the effect of an exchange rate, we again employ a simple two country model as we have analyzed in the basic theory of trade. Let foreign demand for a country's agricultural exports take the following form:

$$X = f_1\ (P_A^*,\ P_o^*,\ P_N^*,\ Y^*)$$

where

P_A^* is price of an agricultural export commodity;

P_o^* is price of other tradable commodity;

P_N^* is price of foreign nontradable commodity; and

Y^* is income of foreign currency.

All variables are expressed in foreign currency. This demand equation is an excess demand which is homogeneous of degree zero in prices and income. This characteristic allows multiplication by a common factor. Thus we can multiply all of them by the nominal exchange rate expressed in domestic currency per unit of foreign currency.

The demand function with the variables expressed in domestic currency is

$$X = f_2\ (P_A,\ P_o,\ P_N,\ Y)$$

Neither of the two functions contain the exchange rate because it disappears due to zero homogeneity of demand in the transformation of prices and income from foreign to domestic currency.

Applying zero homogeneity again to deflate the variables with the domestic price level, we have

$$X = f_2\left[\frac{P_A}{P}\ \frac{P_o}{P}\ \frac{P_N}{P}\ \frac{Y}{P}\right] = f(P_A',\ \ P_o',\ \ P_N',\ \ Y') \tag{3.4}$$

where P_A', P_o', P_N' *and* Y' are real values. The exchange rate does not appear explicitly since the nominal exchange rate does not play a role in the function if prices and income are expressed in the same currency as the zero homogeneity property of demand implies. Many studies have used the real exchange rate in equations like (3.4). The real exchange rate is usually defined as

$$E_R = \frac{EP_R^*}{P}$$

where P_R^* and P are nominal price levels abroad and at home, and measured in foreign and domestic currency, respectively. This can also be written

$$E_R = \frac{P_R}{P} = P_R' \tag{3.5}$$

where P_R and P are in nominal domestic currency, and P_R' is the deflated by the domestic price level. Let a fixed weight price index for the rest of the world be defined as

$$P_R^* = \alpha_A P_A'^* + \alpha_o P_o'^* + \alpha_N P_N'^*$$

where α_i is the expenditure share of good i. If we convert this to domestic currency and deflate by the domestic price level. We have

$$P_R' = \alpha_A P_A' + \alpha_o P_o' + \alpha_N P_N' \tag{3.6}$$

using (3.5) and expressing for P_N' results in

$$P_N' = \frac{E_R - \alpha_A P_A' - \alpha_o P_o'}{\alpha_N}$$

substituting this into (3.4) produces

$$X = f\left[P_A',\ P_o', \frac{E_R - \alpha_A P_A' - \alpha_o P_o'}{\alpha_N},\ Y'\right] \tag{3.7}$$

This demand is now expressed as a function of the real exchange rate.

If we go a step further to examine the effect of X with respect to prices and the exchange rate:

$$X_E = \frac{f_N}{\alpha_N} \qquad X_A = f_A - \alpha_A X_E \qquad X_o = f_o - \alpha_o X_E$$

X_i is the partial derivative of the demand with respect to price i, and f_i is the partial of f with respect to price *i*. For example

$$X_A = \frac{\partial X}{\partial P_A'} \; and \; f_N = \frac{\partial f}{\partial P_N'}$$

The coefficient of the real exchange rate carries the effect of the foreign non-traded commodity price and inversely relates to the share of good N in the foreign economy. The own price effect of the traded agricultural good declines if $X_E > 0$. The real exchange rate serves to represent the price level of the alternative good in the foreign economy.

Other specifications of the estimated equation are possible as we see from (3.6) and (3.7). We can also enter real income in terms of foreign currency, then equation (3.7) becomes

$$X = f\left[P_A',\, P_o',\, \frac{E_R - \alpha_A P_A' - \alpha_o P_o'}{\alpha_N},\, E_R\, Y'^*\right]$$

where Y'^* is real income in foreign currency. We obtain

$$X_E = \frac{f_N}{\alpha_N} + f_y\, Y'^*,$$

which means the real exchange rate coefficient reflects a foreign commodity price effect as well as an income component.

The above model indicates that the exchange rate should be real. Using a nominal rate in such an equation may lead to a mismeasurement and a bias in the coefficient.

Dutton and Grennes (1988) say that the exchange rate used in studies is generally an index of exchange rates with a set of other countries. Many possible mathematical forms for such an index exist, but theory does not provide any ground to choose one form over another.

Theory of Trade in a Conventional Macroeconomic Framework

Theory of Trade can be analyzed in the traditional macroeconomic framework. Dernburg (1989) provides the foundation of the analysis. We again assume two economies: country one and country two. The respective equilibrium conditions are

$$Y_1 = C_1 + I_1 + G_1 + (X_1 - M_1)$$

$$Y_2 = C_2 + I_2 + G_2 + (X_2 - M_2)$$

where Y, C, I, G, X, and M are equilibrium income, consumption, government spending, exports, and imports, respectively, in each country. M_2 is country two's imports and thus country one's exports. Likewise, M_1 is country one's imports and country two's exports. We can rewrite equations:

$$Y_1 = C_1 + I_1 + G_1 + (M_2 - M_1) \qquad (3.8)$$

$$Y_2 = C_2 + I_2 + G_2 + (M_1 - M_2)$$

and define the respective consumption and import functions as

$$C_1 = C_1^* + (1-S_1)\, Y_1 \qquad C_2 = C_2^* + (1-S_2)\, Y_2$$

$$M_1 = M_1^* + m_1\, Y_1 \qquad M_2 = M_2^* + m_2\, Y_2$$

where S_i and m_i are the marginal propensity to save and import in each country. Substituting these functions into (3.8). We get the set of simultaneous equations.

$$(S_1 + m_1)\, Y_1 - m_2\, Y_2 = C_1^* + I_1 + G_1 + M_2^* - M_1^* = E_1 \tag{3.9}$$

$$-m_1\, Y_1 + (S_2 + m_2)\, Y_2 = C_2^* + I_2 + G_2 + M_1^* - M_2^* = E_2$$

where E_1 and E_2 are the sums of autonomous expenditure components. From the equations (3.9), we get equilibrium solutions for Y_1 and Y_2 if we let

$$Y_1 = \frac{S_2 + m_2}{H} E_1 + \frac{m_2}{H} E_2 \tag{3.10}$$

$$Y_2 = \frac{m_1}{H} E_1 + \frac{S_1 + m_1}{H} E_2$$

where $(S_1 + m_1)(S_2 + m_2) - m_1 m_2 = H > 0$ for positive parameters values.

For a change in autonomous expenditure in country one, the respective multipliers are

$$\frac{\Delta Y_1}{\Delta E_1} = \frac{S_2 + m_2}{H} \qquad \frac{\Delta Y_2}{\Delta E_1} = \frac{m_1}{H} \tag{3.11}$$

and for the same thing in country two.

$$\frac{\Delta Y_1}{\Delta E_2} = \frac{m_2}{H} \qquad \frac{\Delta Y_2}{\Delta E_2} = \frac{S_1 + m_1}{H} \tag{3.12}$$

Since the common denominator is positive for positive values of the parameters, each country enjoys an increase in income if $dE_1 > 0$ as we see from (3.11). A rise in Y_1 increases imports of country one, and increases exports and Y_2 in country two. As E_1 increases, the rise in income is greater in country one since $S_2 + m_2 > m_1$. The country in which autonomous expenditure changes enjoys the greater rise in income. The same logic prevails for country two as shown in (3.12).

We next analyze the effect of ΔE_1 on the net trade of the respective countries. Country one's net exports are $NX_1 = M_2 - M_1$, and its change is $\Delta NX_1 = \Delta M_2 - \Delta M_1$. From the import functions, we obtain $\Delta M_1 = m_1 \Delta Y_1$ and $\Delta M_2 = m_2 \Delta Y_2$. From (3.11).

$$\Delta Y_1 = \frac{\Delta E_1 (S_2 + m_2)}{H} \qquad \Delta Y_2 = \frac{\Delta E_1 \, m_1}{H}$$

thus

$$\Delta NX_1 = \Delta M_2 - \Delta M_1 = m_2 \Delta Y_2 - m_1 \Delta Y_1$$

$$= m_2 \frac{\Delta E_1 \, m_1}{H} - m_1 \frac{\Delta E_1 (S_2 + m_2)}{H}$$

$$= \Delta E_1 \frac{m_1 \, m_2 - (S_2 + m_2) \, m_1}{H}$$

$$\frac{\Delta NX_1}{\Delta E_1} = \frac{-m_1 S_2}{H} < 0 \qquad (3.13.1)$$

Using the same procedure for ΔNX_2 *gives* $\dfrac{\Delta NX_2}{\Delta E_1} = \dfrac{m_1 S_2}{H} > 0$ (3.13.2)

As we see (3.13), ΔE_1 and net exports of country one move in the opposite direction, whereas ΔE_1 and that of country two move in same direction. This increase in net exports of country two raised its income level even though there is no increase in its own autonomous expenditure.

However, there would be no change in net exports if the marginal propensity to save in country two is zero as we see (3.13). If $S_2 = 0$ the multiplier in country one reduces to $\dfrac{\Delta Y_1}{\Delta E_1} = \dfrac{1}{S_1}$ from (3.11), which means that country one's income rises by the reciprocal of its marginal propensity to save. Since $\Delta NX_1 = 0$ in this case, the adjustment of trade balance is complete.

The effects of an autonomous shift in exports or imports can also be analyzed. Suppose there is a change in tastes and preferences which cause consumers in country one to switch from domestic goods to those from country two. This means $\Delta M_1^* = -\Delta E_1$ for country one, and $\Delta M_1^* = \Delta E_2$ for country two. From (3.10).

$$\begin{aligned} \Delta Y_1 &= \frac{S_2 + m_2}{H} \Delta E_1 + \frac{m_2}{H} \Delta E_2 \\ &= -\Delta M_1^* \frac{S_2 + m_2}{H} + M_1^* \frac{m_2}{H} \\ &= \frac{-S_2}{H} \Delta M_1^* < 0 \quad \textit{and} \end{aligned} \tag{3.14}$$

$$\Delta Y_2 = \frac{S_1}{H} \Delta M_1^* > 0$$

Income in country one decreases as imports rise. While income in the other country increases as exports rise.

The change in net exports in country one is $\Delta NX_1 = \Delta M_2 - \Delta M_1$. $\Delta M_2 = m_2 \Delta Y_2$ *and* $\Delta M_1 = \Delta M_1^* + m_1 \Delta Y_1$ from the import functions. Then

$$\begin{aligned} \Delta NX_1 &= m_2 \Delta Y_2 - \Delta M_1^* - m_1 \Delta Y_1 \\ &= m_2 \frac{S_1}{H} \Delta M_1^* - \Delta M_1^* + m_1 \frac{S_2}{H} \Delta M_1^* \end{aligned}$$

from (3.14). The first term is the change in country one's exports and is positive since Y_2 rises. The second term itself is the positive autonomous change in imports. The third term is the induced change in imports and is negative since Y_1 declines. Factoring out the equation with ΔM_1^*, we have

$$\Delta NX_1 = \Delta M_1^* \left[\frac{m_2S_1 + m_1S_2}{H} - 1\right],$$

which is negative since $\frac{m_2S_1 + m_1S_2}{H}$ is a positive function. It implies that net exports in country one still decline even if the induced effects on exports and imports work to offset the effect of the autonomous change.

The preceding analysis can be extended for more country care. If there are no countries, the information we need is basically the same as in the two country case. However, each marginal propensity to import must be divided into separate marginal propensities to import. For example, $m_1 = m_{21} + m_{31} + \ldots + m_{n1}$ where m_1 is country one's overall marginal propensity to import, M_{21} is the marginal propensity to import from country two, and m_{31} is that from country three, and so on.

From the equilibrium condition with consumption and import functions, equilibrium income for country one is

$$Y_1 = (1 - S_1 - m_1)Y_1 + m_{12} Y_2 + m_{13} Y_3 + \ldots + m_{1n} Y_n + E_1$$

where the first term on the right hand side is the induced component of country one's consumption and imports. The second term is the induced components of country one's exports to country two. The third term is same but to country three, and the last term is the sum of country one's autonomous expenditure components. Rearranging the above equation for E_1 for country one, and applying the same logic to other countries, the complete model can be written as

$$(S_1 + m_1)Y_1 - m_{12} Y_2 - m_{13} Y_3 \ldots - m_{1n} Y_n = E_1$$

$$- m_{21} Y_1 + (S_2 + m_2)Y_2 - m_{23} Y_3 \ldots - m_{2n} Y_n = E_2$$

$$- m_{31} Y_1 - m_{32} Y_2 + (S_3 + m_3) Y_3 \ldots - m_{3n} Y_n = E_3$$

$$\vdots \quad \vdots \quad \vdots \quad \vdots \quad \vdots \quad \vdots \quad \vdots$$

$$- m_{n1} Y_1 - m_{n2} Y_2 + \ldots\ldots + (S_n + m_n) Y_n = E_n$$

These equations can be solved for the equilibrium value of each Y as a function of E's.

$$Y_1 = K_{11} E_1 + K_{12} E_2 + K_{13} E_3 + \ldots$$

$$Y_2 = K_{21} E_1 + K_{22} E_2 + K_{23} E_3 + \ldots$$

$$Y_3 = K_{31} E_1 + K_{32} E_2 + K_{33} E_3 + \ldots$$

$$\vdots \quad \vdots \quad \vdots \quad \vdots \quad \vdots \quad \vdots$$

$$Y_n = K_{n1} E_1 + K_{n2} E_2 + K_{n3} E_3 + \ldots$$

where k's are the various multipliers. K_{11} is the change in Y_1 due to a one dollar increase in E_1. This increase in E_1 changes Y_2 by K_{21}, Y_3 by K_{31} and Y_n by K_{n1}. Likewise, K_{12} measures the effect on Y_1 from a change in E_2 and K_{13} measures the effect on Y_1 from a change in E_3 and so on.

The above illustration shows the basic principle for the n country case, and the system is more complex than the single country case as we have seen. The computation for an entire matrix of multipliers is beyond the scope of the study.

Impacts of Domestic Policy on the International Market

The theory chapter to date has assumed no government intervention in the domestic agricultural sector. Government intervenes in the agricultural sector for a variety of reasons such as producer price and income enhancement, consumer price subsidization, taxation, and income transfers. These interventions alter the country's position and condition in the world market.

Policy makers can use various intervention instruments such as subsidies to increase demand, subsidies on inputs, direct transfer payments to producers, and a government commitment to buy commodities at a price above the prevailing free-trade price. There are some trade policy tools available, but only the import tax, import subsidy, and import quota will be analyzed. The following assumptions are held for the discussion:

a. perfect competition in product and factor markets.

b. homogeneous imported goods and perfect substitutes for domestically produced goods.

c. first round analysis of a specific policy not accompanied by retaliation from other countries.

. partial and static equilibrium analysis.

e. constant marginal utility of money. In other words, one dollar gain to consumers exactly offsets one dollar loss to producers or government.

Henneberry and Henneberry provide an analytical tool for international trade policy. In this analysis, it is crucial to differentiate between a small and large country. Small and large in this context do not refer to macroeconomic factors such as population, geographic size, or gross national product of the country. It refers to the relative size of the country in the market for the commodity analyzed.

A small country's imports are so small relative to the volume of world trade that it does not affect the world price of the commodity by the policies it adopts. Conversely, a large country's policies have an influence on the world price. The induced change in the world price level makes it important to differentiate between large and small country policy impacts. It is possible for a specific country to be large with respect to one commodity and small with respect to another because large and small refer only to a particular commodity. Theoretically, large country status could be relevant in some years but not in others as the level of production varies over time and across regions.

Import Tax: Small Country

As the country imposes an import tax (tariff) of T on the commodity, the price, which is faced by producers and consumers in the country, rises from P_w to P_w + T and imports decline from Q_1Q_1' to Q_2Q_2'. In Figure 3.5, P_w is the world price faced by domestic producers and consumers before the tax is imposed, where P_w + T is the new price after the tax.

The welfare analysis is:

Consumer surplus loss:	-a -b -c -d
Producer surplus gain:	+a
Government revenue gain:	+c
Net social welfare loss:	-b -d

Import Tax: Large Country

In Figure 3.6, P_w' is a reduced world price as a result of reduced world demand from a tariff, P_w' + T is the price faced by domestic consumers and producers with a tariff. As the country imposes a tariff, imports to this country decline from Q_1Q_1' *to* Q_2Q_2', which leads to a decrease in world demand and a fall in world price from P_w to P_w' because this is a large country.

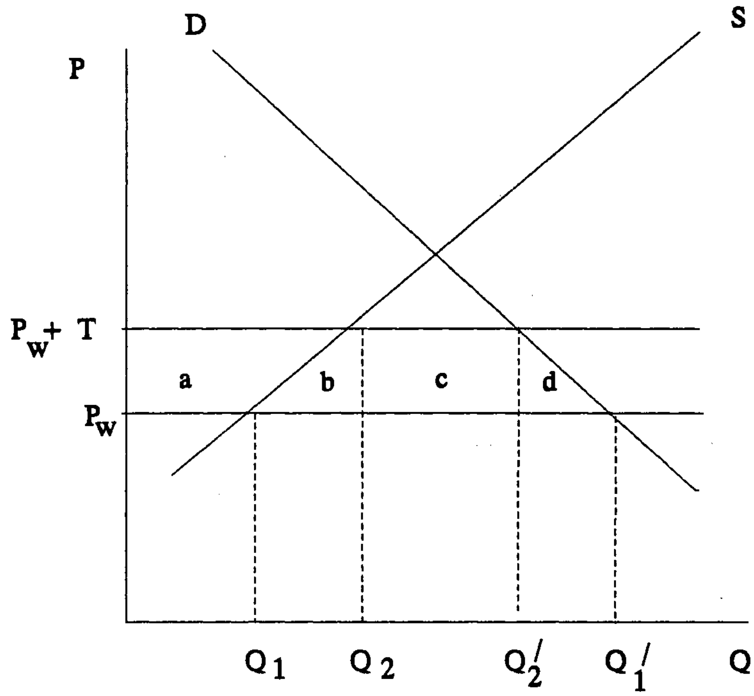

Figure 3.5. Welfare Analysis of an Import Tax: Small Country.

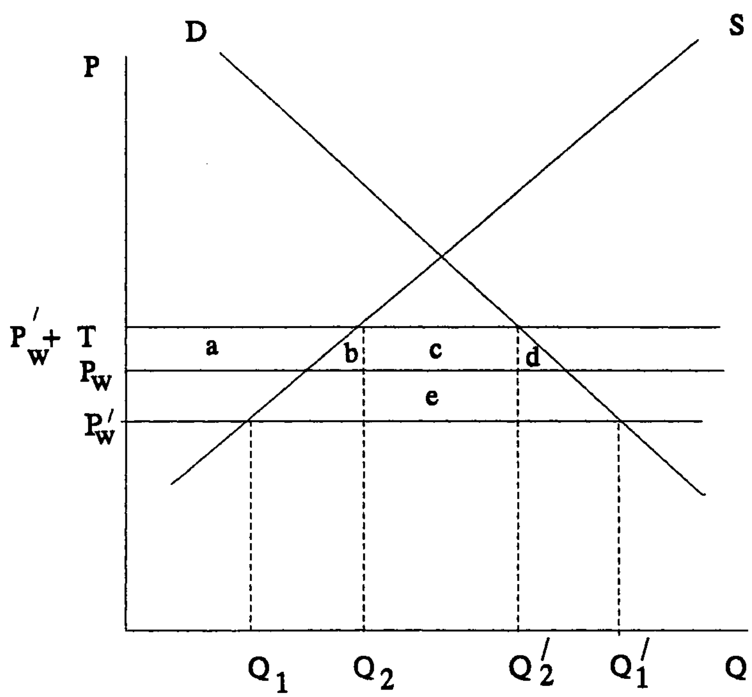

Figure 3.6. Welfare Analysis of an Import Tax: Large Country.

The welfare analysis is:

Consumer surplus loss:	-a -b -c -d
Producer surplus gain:	+a
Government revenue gain:	+c +e
Net Social welfare loss or gain:	+e -b -d

The country gains from imposing a tariff when e > b + d, while loses when e < b + d, which depends on the elasticities of domestic demand and supply. The optimum tariff is the tariff which maximizes the area e -(b + d).

Import Subsidy: Small Country

P_w - S is the price faced by domestic producers and consumers after the subsidy in Figure 3.7. After the country places a subsidy, P_w declines to P_w - S, which leads to an increase in imports from Q_1Q_1' *to* Q_2Q_2'.

The welfare analysis is:

Consumer surplus gain:	+a +b +c +d +e
Producer surplus loss:	-a -b
Government revenue loss:	-b -c -d -e -f
Net social welfare Loss:	-b -f

Import Subsidy: Large Country

After the large country places an import subsidy S on the commodity in Figure 3.8, imports by the country increase, which leads to increases in world demand and world price from P_w to the new world price P_w'. The price faced by domestic producers

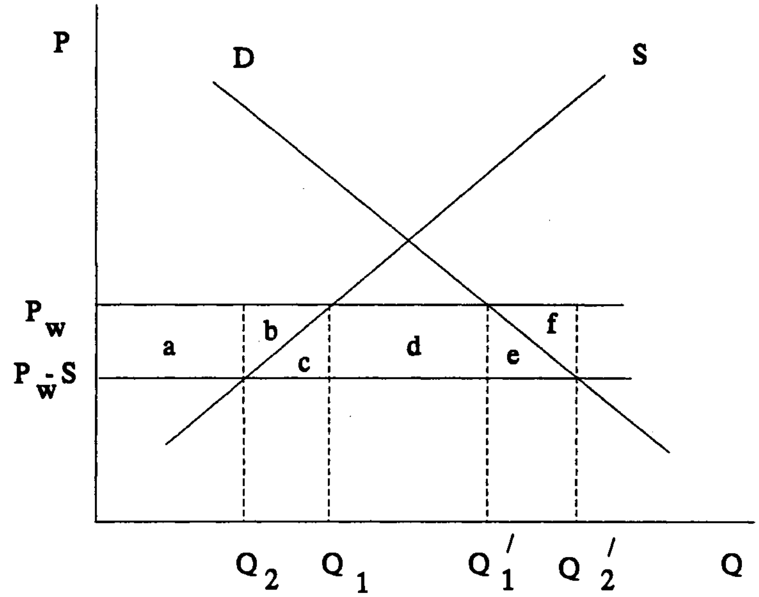

Figure 3.7. Welfare Analysis of an Import Subsidy: Small Country.

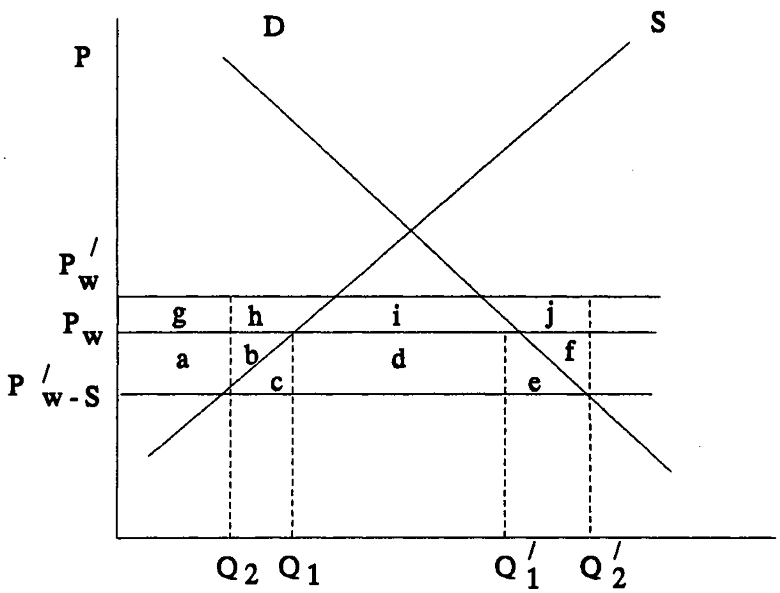

Figure 3.8. Welfare Analysis of an Import Subsidy: Large Country.

producers and consumers is $P_w' - S$.

The welfare analysis is:

Consumer surplus gain:	+a +b +c +d +e
Producer surplus loss:	-a -b
Government revenue loss:	-b -c -d -e -f -h -i -j
Net social welfare loss:	-b -f -h -i -j

Import Quota: Small Country

In Figure 3.9, the domestic price P_d is equal to world price P_w before the quota. P_d' is the domestic price after the quota, SS is the original supply curve, and $SXYS'$ is the supply curve faced by domestic producers and consumers with the quota. Q_1Q_2 is the quantity of the import quota. When a quota of Q_1Q_2 is placed on imports, the domestic price rises from P_d to P_d' and domestic production increases from Q_1 to $Q_1 + Q_3 - Q_2$.

The welfare analysis is:

Consumer surplus loss:	-a -b -c -d
Producer surplus gain:	+a
Government revenue gain:	+b
Net social welfare loss:	-c -d

Import Quota: Large Country

When a quota of Q_1Q_2 is placed on imports by the large country, world demand declines and world price falls from P_w to P_w' in Figure 3.10. A quota reduces the supply in the large country and this causes a rise in the domestic price from P_d to

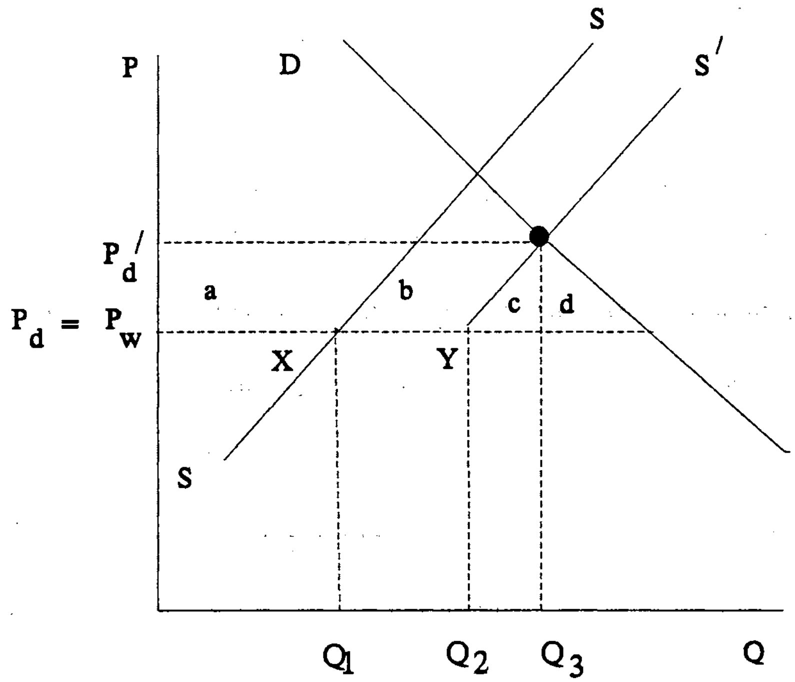

Figure 3.9. Welfare Analysis of an Import Quota: Small Country.

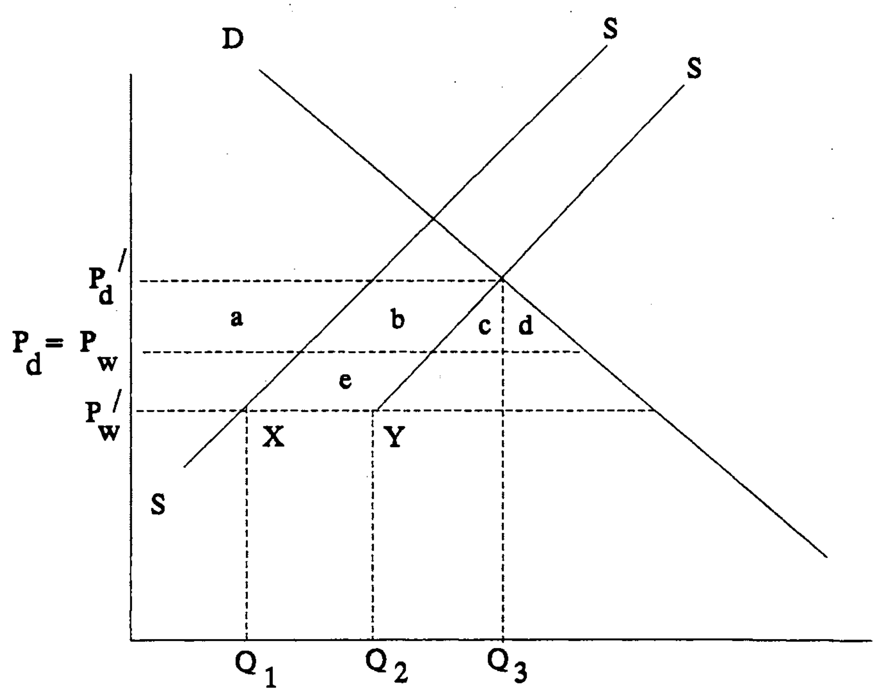

Figure 3.10. Welfare Analysis of an Import Quota: Large Country.

P_d' where the demand curve and new supply curve $SXYS'$ meet.

The welfare analysis is:

Consumer surplus loss:	-a -b -c -d
Producer surplus gain:	+a
Government revenue gain:	+b +e
Net social welfare loss or gain:	+e - (c + d)

The country has a net social welfare gain if e > (c + d), or loss if e < (c + d), thus the optimum import quota is the one that maximizes e -(c + d).

If we compare the preceding three policies, a tariff is the policy to reduce the quantity of imports by increasing domestic production and reducing domestic consumption, an import subsidy is designed to increase consumer welfare by reducing prices and increasing imports, and an import quota is the policy to increase the welfare of domestic producers.

The Theory of Carry-Over

Our analysis has not considered any stock effect and simply assumed that markets clear in one period without storage from one time period to another. Inventory plays an important role in the process of distributing instability and reducing the impacts of supply or demand shocks in the agricultural sector. McCalla and Josling (1985) provided a theoretical background. To incorporate stocks in the trade model, we begin with the equilibrium of world trade:

$$S_w = D_w$$

where S_w and D_w are total world supply and demand, respectively. For any one country, supply and demand can differ by the amount traded:

$$S_1 + M_1 = D_1 + X_1$$

where M_1 is imports into country one and X_1 is exports from country one. This equation means total availability equals total disappearance of the commodity studied. The market clearing conditions for the countries trading with each other:

$$S_1 - D_1 = X_1 - M_1 = M_2 - X_2 = D_2 - S_2$$

Let country one be a net exporter and country two be a net importer, then define X_1 and M_2 as net exports an imports, respectively, for convenience.

$$S_1 - D_1 = X_1 = M_2 = D_2 - S_2$$

Next, we add two more variables:

STI: stocks carried-in from previous periods.

STO: stocks carried-out to the next period.

Thus the identities become

$$S_w + STI_w = D_w + STO_w$$

$$S_1 + STI_1 - D_1 - STO_1 = X_1 = M2 = D_2 + STO_2 - S_2 - STI_2$$

Let ST = STO - STI as the increase in stocks, we have

$$S_w = D_w + ST_w$$

$$S_1 - D_1 - ST_1 = X_1 = M_2 = D_2 - S_2 + ST_2.$$

In general, STO is negatively related to the current price, so the lower the price is, the more likely it can be sold later at a profit. We write

$$STO = STO\ (P, \ldots)$$

Since STI is exogenous, we have

$ST = STO\ (P,\ldots) - STI = ST\ (P,\ldots)$

When there is no stock effect, we can write X_1 and M_2 as functions of price:

$X_1 = X_1\ (P,\ldots) = S_1\ (P,\ldots) - D_1\ (P,\ldots)$

$M_2 = M_2\ (P,\ldots) = {}_2\ (P,\ldots) - S_2\ (P,\ldots)$

If any disturbance occurs, price changes are necessary to restore the system to balance, so we can establish the sensitivity of quantities to price changes.

$$\frac{dX_1}{dP} = \frac{dS_1}{dP} - \frac{dD_1}{dP}$$

$$\frac{dM_2}{dP} = \frac{dD_2}{dP} - \frac{dS_2}{dP}$$

When we have stocks, we can add this variable to the X and M equations.

$$X_1 = X_1\ (P,\ldots) = S_1\ (P,\ldots) - D_1\ (P,\ldots) - ST_1\ (P,\ldots) \qquad (3.15)$$

$$M_2 = M_2\ (P,\ldots) = D_2\ (P,\ldots) - S_2\ (P,\ldots) + ST_2\ (P,\ldots)$$

The corresponding sensitivity of quantities leads to the new definition of the trade elasticities including a stock effect.

$$E_{X_1,P} = E_{S_1,P}\left[\frac{S_1}{X_1}\right] - E_{D_1,P}\left[\frac{D_1}{X_1}\right] - E_{ST_1,P}\left[\frac{ST_1}{X_1}\right]$$

$$E_{M_2,P} = E_{M_2,P}\left[\frac{D_2}{M_2}\right] - E_{S_2,P}\left[\frac{S_2}{M_2}\right] - D_{ST_2,P}\left[\frac{ST_2}{M_2}\right]$$

Carry-in can be added to the current supply and carry-out to current demand. Then excess demand and supply curves are the difference between these stock adjusted functions. The slope of the above STO function in the exporting country adds to the slope of X_1, and the slope of the STO function in the importing country increases the slope of M_2. This is an additional effect to the price response in trade volumes, which could reduce an instability in international trade as we see (3.15). $X_1 = S_1 - D_1 - ST_1$ an $M_2 = D_2 - S_2 + ST_2$ are more price responsive than $X_1 = S_1 - D_1$ and $M_2 = D_2 - S_2$. This means the set of stock inclusive excess demand and supply curves are more elastic or flatter than the stock exclusive set.

If carry-out function responds to world prices, a trading country, whether it is an exporting or an importing country, adjusts its stocks for an adequate supply. Private stocks are usually more responsive to domestic price signals while government stocks are more likely to be world price sensitive. Stock policies are designated to react to the fluctuations in domestic production. However, private stockholders may have little incentive to react to domestic production if prices are fixed or supported within narrow bands whereas the government may well engage in price stabilizing behavior by varying stocks.

Summary

This chapter presented the economic theory behind international trade. Since import demand is typically assumed to be equivalent to an excess demand function, both theories of demand and excess demand were discussed. The rest of the chapter then consisted of five sections.

The theory of trade in a basic framework was presented next. Three basic models, the perfect substitutes model, imperfect substitutes model, and model without domestic production, were separately discussed.

The theory of foreign exchange followed as the next section. Nominal and real exchange rates were discussed first, then the relationship between exchange rates and the elasticity of imports showed that the elasticity of the value of imports with respect to exchange rate was negative. The value of imports and demand for foreign exchange declined as the exchange rate increased. The interrelationships between the exchange rate and policy variables were also analyzed. This section concludes with exchange rates in a commodity model, which showed that the real exchange rate reflected foreign commodity price effects.

The next section dealt with the theory of trade in a traditional macroeconomic framework. It showed the responses of income, consumption, and imports and exports when trade opened between two and n countries.

The following section was about the impacts of government intervention on the domestic agricultural sector on the international market. The net social welfare effect was analyzed for each government intervention policy.

In the final section, the theory of stocks was discussed. It was demonstrated that the stock effect could reduce an instability in international trade and stock inclusive excess demand and excess supply were more elastic than the non-stock inclusive functions.

CHAPTER IV

DATA AND METHODOLOGY

Chapter IV presents the model and the data used for the empirical analysis. The model is developed based on the theory which is presented in Chapter III. The structure of the model, data and study period, formulation of the model, and estimation of the model are presented in this chapter.

Structure of the Model

The empirical estimation of an international commodity trade model begins with the model specification. The specification includes methodological issues such as selection of an appropriate model, choice of variables and the functional form of the model.

Model Specification

The model is composed of a set of three equations, which are import, stock, and disappearance equations for each of the three commodities, to reflect the information available in the import demand system for those commodities.

This model is more aggregate than other models of agricultural trade. For example, many empirical trade models separate grains into food and feed use. Imported and domestically produced grains can also be separately studied. Trade studies can differentiate exports or imports by country of shipping or destination. Further partition is possible for stocks into government held and privately held stocks. However, our interest is not on each particular component of the market but on the effects of fluctuations in macroeconomic and policy variables on the import demand system for the selected commodities.

Once a model has been chosen to represent the trade channel, the choice of appropriate variables for the model becomes the next issue. Economic theory with distinguishing features of the agricultural sector offers the guideline in the selection process. For example, one of the main problems in specifying an import function for direct estimation is deciding which price variables to include to capture the direct price response and substitution relationships.

The production of wheat, corn, and soybeans in Korea are very small. Production of wheat and corn has continued to drop for past twenty years and current productions is negligible. Self-sufficiency ratios for wheat and corn are currently about 0.02 percent and 1.2 percent, respectively. Self-sufficiency in soybeans has been domestically reduced from almost self-sufficient level to slightly more than 10 percent of that.

Since domestic production is presumed to have only minor effects in each commodity market, it does not seem to be reasonable to include production equations in the system. Hence, we do not specify equations for production and, instead, we include the annual production level of each commodity as an exogenous variable in an appropriate equation. It is common to formulate production as fixed within a year.

In the import equation, own import price, exchange rate, and income level are considered prime variables. Carry-over from the last year is assumed to influence the level of imports. Since the feed use of grain has been sharply increased through the years, a meat consumption variable is included as a proxy to capture this effect.

Interest in the effect of exchange rates on agricultural trade has been stimulated. Exchange rate analysis relying on a bilateral exchange rate may be misleading. The dollar can depreciate against the currencies of many developed countries while appreciating against those of many less developed countries. Since different countries trade different commodities, a bilateral exchange rate such as Korean won per U.S. dollar may not serve very well for all commodities. Instead, we need to consider a multilateral exchange rate.

Several aggregate effective exchange rates are available. The Federal Reserve Board's (FRB) trade-weighted dollar, which is computed as the inverse of a geometric average of rates expressed as dollars per unit of foreign currency, uses global weights involving trade of the Group of Ten plus Switzerland. Special Drawing Rights (SDR) is a fixed-weight arithmetic index of currencies from five most important trading countries. The Morgan Guaranty Trust (MGT) index uses bilateral weights based on the trade of fifteen industrial countries. The International Monetary Fund (IMF) publishes a geometric index based on its multilateral exchange rate model. Available exchange rate indices relatively weight industrialized countries.

According to Henneberry, Henneberry and Tweeten (1987, p. 191), the exchange rate movements most of the available exchange rate indices measure may not be appropriate for an agricultural commodity. Trade flows of some agricultural commodities are skewed toward the developing countries. Because we intend to explain agricultural imports, weights based on agricultural trade might be more appropriate than weights based on total trade. The USDA publishes an agricultural trade-weighted dollar exchange rate in its Agricultural Outlook. They are in both nominal and real form with bilateral export weights based on the shares of thirty-eight customer countries for U.S. agricultural exports. The weights reflect the importance of buyers of U.S. exports and the implicit assumption in the choice of weights is that the main competitors are producers in the importing country. Major competing agricultural exporters with the U.S. are assigned small or zero weights.

While analyzing alternative measures of multilateral exchange rate changes appropriate for agricultural trade, Dutton and Grennes (1987, p. 440) found that the differences between indices using total trade weights and agricultural trade weights were not consistently greater than the differences among alternative agricultural trade weighted indices and the most sensitive factor in constructing the indices was the choice between bilateral and global agricultural trade weights.

Economic theory, in fact, implies that the real exchange rate is more appropriate for explaining trade than the nominal rate since the former rate represents only changes caused by fundamental economic forces after adjusting for the effects of inflation. A nominal exchange rate index would give the misleading impression that countries with the highest inflation rates would gain a competitive advantage since their currencies would depreciate the fastest. Dutton and Grennes (1988, p. 104) states that it has not been easy to explain the behavior of the real exchange rate but there is some evidence that it has been more volatile during the floating exchange rate period.

Many studies have attempted to measure the effects of exchange rate fluctuations on prices and trade, but the results have been mixed. Dutton and Grennes (1988, p. 118) again mention that empirical results confirmed the importance of relative prices and income on trade but it is difficult to separate the effects of prices and exchange rates.

Isolating the impact of the exchange rate is complicated by the problem of choosing an exchange rate index. The possible endogeneity of the exchange rate may make it difficult to estimate a consistent relationship between exchange rates and trade. Macroeconomic shocks should ideally be controlled along with the exchange rate in an import equation. On the other hand, Chambers and Just (1979, p. 33) criticized the specifications of the exchange rate variable in many empirical agricultural trade studies, and argued that only deflating own price by the exchange rate in a trade equation could cause a significantly wrong estimation of the exchange rate effect, since an economic agent might respond differently to exchange rate adjustments from market price movements. It seems to be appropriate to include the exchange rate directly in an import equation to allow for the differential effects of exchange rate and price fluctuations. Deflated price cannot be used to represent both effects if there are differential adjustments to price and exchange rate movements. Thus it may be justified to include an exchange rate term as a separate regressor in the model.

Some empirical studies actually applied the principle to U.S. grain export markets by including the exchange rate as a separate regressor and found that the exchange rate was an important factor affecting the level of exports. Chambers and Just (1981) used a nominal exchange rate to explain U.S. exports of agricultural commodities. Considering the interdependency of the world today and the effectiveness of the multilateral exchange rate, the SDR may be appropriate for our study where the valuation basket consists of the currencies of the five members having the largest exports of goods and services during the period 1985-1989. Hence, we select the SDR as an exchange rate variable as Chambers and Just did and the import equation is somewhat different from the usual grain import modeling in treating the exchange rate variable.

For the price variables in our model, import prices are used as proxies to serve to capture their own effects and cross effects because appropriate domestic price data are not available. Gross Domestic Product (GDP) is included as the income variable instead of GNP because GDP accounts for pure domestic product and is expected to serve better than GNP in our model

In the wheat import equation, domestic production is included to catch the constantly negative relationship between declining productions and increasing imports. In the corn import equation, a soybean price variable is included to reflect the cross price effect of the potential competing good. The government purchase price is also included to examine the effect of the government purchase program and the relationship between this policy variable and imports. In the soybean import equation, the government purchase price of soybean is included for the same reason.

Stock adjustments affect trade flows and pose econometric difficulties for estimation of price elasticities. Private stocks may be held as working inventories or for speculative gains whereas public stocks are held to complement domestic policies. Private stocks which are held to meet policy requirements may behave as public ones. For the purpose of our analysis, we would not differentiate both. It simplifies our study and does not detract much from reality. Stocks may depend on import price and other factors that determine the costs and benefits of holding stocks such as interest rates, storage cost, or supply-demand conditions. Carry-in stocks from the previous period and current disappearances are expected to influence current stocks. Since data on storage cost is not available, we use domestic production and interest rates, when necessary, to serve as proxies.

The domestic price of a commodity could be staged within a reasonable range through inventory adjustment. Inventory level of a commodity adjusts as the domestic price of the commodity changes. Import price could serve this role. Since government purchase is an important variable to influence the level of stock, the policy variables are included in corn and soybean stock equations. The government has dropped the wheat purchase program since 1984, thus we include the dummy variable to see the effect in the wheat stock equation. Stock equations thus can be separated. Direct estimation of those is then feasible, and elasticities with respect to prices, disappearances, and government policy variables can be calculated.

Demand for each commodity has drastically increased for the period of study -- 2.9 times for wheat, 18.7 times for corn, and 5.7 times for soybeans, while population increased only 1.35 times. There is a clear increasing trend with the increase in income, thus, in the disappearance equations, a GDP variable is included. A meat consumption variable is included to capture the effects of substitution or feed use of grains. Since price variables are supposed to be influential variables in the disappearance of the commodities, import prices are used as proxies for domestic prices. Domestic production is also included when necessary. Wheat is an important food grain, so a tax variable is included to see the effect in food consumption of wheat.

Economic Model

Based on the above discussion, the relevant variables and relationships are specified in a model consisting of nine behavioral equations. The preliminary model is specified as:

1. Import Equations

WI = f(GDP, FE, WIP, WP, MC, LWS)

CI = f(GDP, FE, CIP, MC, SIP, GCPP, LCS)

SI = f(GDP, FE, SIP, MC, GSPP, LSS)

2. Stock Equations

WS = f(WIP, WD, WP, DW)

CS = f(CIP, CD, GCPP)

SS = f(SIP, SD, SP, GSPP, INT)

3. Disappearance Equations

WD = f(WIP, GDP, T, MC, WP)

CD = f(CIP, GDP, WIP, MC)

SD = f(SIP, GDP, CIP, MC, SP)

where

WI: wheat import, 1000 MT

CI: corn import, 1000 MT

SI: soybean import, 1000 MT

WS: wheat stock, 1000 MT

CS: corn stock, 1000 MT

SS: soybean stock, 1000 MT

WD: wheat disappearance, 1000 MT

CD: corn disappearance, 1000 MT

SD: soybean disappearance, 1000 MT

LWS: wheat stock lagged one period, 1000 MT

LCS: corn stock lagged one period, 1000 MT

LSS: soybean stock lagged one period, 1000 MT

GDP: gross domestic product in billion Korean wons

FE: Korean won per SDR, period average

WP: volume of wheat production, 1000 MT

SP: volume of soybean production, 1000 MT

MC: volume of meat consumption, 1000 MT

WIP: wheat import price, U.S. dollars per metric ton

CIP: corn import price, U.S. dollars per metric ton

SIP: soybean import price, U.S. dollars per metric ton

GCPP: government corn purchase price, Korean won per 75 kg

GSPP: government soybean purchase price, Korean won per 75 kg

DW: dummy variable for government wheat purchases

0 for 1970-1983, 1 for 1984-1992

INT: nominal interest rate, percent (%) per annum

T: nominal tax rate, percent (%)

Data and Study Period

Data sources and handling methods are discussed in this section. International Financial Statistics (IFS) from the IMF defines GDP as the sum of final expenditures: exports of goods and services, imports of those, private consumption, government consumption, gross fixed capital formation, and increase/decrease (-) in stocks. The difference between GDP and GNP is net factor income/payments (-) abroad. Gross Domestic Product (GDP) values used in our study are 1985 constant prices in billions of Korean wons.

The value of the SDR, which is our exchange rate variable, has been determined daily by the IMF on the basis of a weighted basket of currencies since July 1, 1974. Before that time, the value of the SDR was based on the U.S. dollar only: the SDR was U.S. $1 till December 17, 1971. Then the value continued to evolve up to SDR 1 = U.S. $1.20635 from February 12, 1973 through June 30, 1974. To derived the value of the SDR, the currencies of the basket are valued at their market exchange rates for the U.S. dollar, and the U.S. dollar equivalents of each of the currencies are summed to yield the rate of the SDR in terms of the U.S. dollar.

The number and weights of currencies in the SDR basket have changed over time while the calculating method of the U.S. dollar/SDR exchange rate remains the same. The rates for the SDR in terms of other currencies are derived from the market exchange rates of those currencies for the U.S. dollar and the U.S. dollar rate for the SDR. From January 1, 1991, the SDR basket consists of the currencies of the five countries who have the largest exports of goods and services during the period of 1985-1989. The weights, which are U.S. dollar - 40 percent, German mark - 21 percent, Japanese yen -

17 percent, French franc - 11 percent, and British pound - 11 percent, reflect the relative importance of those five currencies in international trade and finance.

We have obtained the time series data of annual average won/SDR rates for the period 1970-1990. However, IFS has no longer issued annual average rates from the 1991 yearbook. Thus we take the averages from quarterly end of period data for the rest of the period (1991 and 1992).

Interest rates available for the entire study period are discount rate/bank rate at which the monetary authorities lend or discount eligible paper for deposit money banks and deposit rates which usually include rates offered to resident customers for demand, time, and savings deposits. The former series is typically cited on an end of period basis, and the latter series is percent per annum. We use deposit rates for the interest rate variable.

For the estimation of the model, all quantity variables are converted into per capita basis, and all price variables are expressed in real terms. Import, stock, disappearance, income, production, and consumption variables are divided by the relevant population level for each year.

As indicated earlier, real prices, after eliminating money illusions, are more relevant to examine the fundamental effects of the economic variables, so we need to deflate all price variables with appropriate price indices. A price index of a commodity is a ratio of its price in one period to its price in the base period, and an aggregate price index is designed to indicate the movement of aggregate prices over time. The compilation of a price index is a complex procedure that cannot constitute a completely accurate indicator of change in price for all commodities for all regions and the population. Each price index tends to emphasize price changes that affect particular sections of the population, thus affect one field more than another.

A change in the price index is a change in the aggregate and this aggregate price measure is a weighted average to reflect the relative importance of movements of the components which is a fixed basket of goods and services. The U.N. guidelines suggest the weights of a price index be updated at least once every five years.

The producer price index is designed to measure the price received by producer. The wholesale price index is designed to track changes in prices of items at the level of their first important commercial transaction and reflects changes in prices of commodities at various stages of production and distribution. The consumer price index (CPI) is intended to reflect changes in the cost of obtaining a basket of goods and services by an average consumer and is widely used as an indicator of inflation.

At the lower stage of processing, many of the commodities covered by producer and wholesale price indices are not affected so much by quality changes as are consumer goods and services.

The IMF Bureau of Statistics has found that the CPI methodology is established and known to national compilers and that greater methodological variability hampers the international comparability of inflation rates based on other price indices. Accordingly, the IMF uses the CPI as an indicator of inflation in a statistical survey. We, therefore, regard the CPI as an indicator of inflation and employ it as a deflator.

The price variables expressed in Korean won are government purchase prices of corn and soybeans. They are deflated by the Korean CPI (1985 = 100). The price variables expressed in U.S. dollars are import prices of all three commodities. They are deflated by the U.S. CPI (1985 = 100).

The data for population, tax rates, meat consumption, production, imports, disappearance, stocks, import prices and government purchase prices are taken from Grain Policy Data, 1988 and 1993, and Agriculture, Forestry and Fisheries Major Statistics 1987 and 1993 by the Department of Agriculture, Forestry and Fisheries in Korea. Some 1992 data are temporary estimations. The data for GDP, SDR, CPI's and interest rates are from various issues of IFS yearbooks by the IMF. The study period covers the period from 1970 to 1992 using annual time series data.

Formation of the Model

Modeling System of Simultaneous Equations

In a simultaneous equation model, the behavior of the variables is jointly determined, and several endogenous variables are simultaneously determined, by an interrelated series of equations. A model of nine behavioral equations and three identities are developed for this study and estimated simultaneously to provide greater estimation efficiency.

Our model is formulated in a block recursive equation system in which a group of equations can be broken up into blocks of equations in such a way that equations across blocks are recursive. Knowledge of the endogenous variables in the first block allows the determination of the endogenous variables in the second block, then that in the third block. Thus disappearance of a commodity helps to determine the stock of the commodity, and then the stock partially determines the import level of the commodity in our model. The model is a completely interdependent system since it is not possible to solve for any single endogenous variable without simultaneously solving all equations.

Each functional relationship is assumed to be linear and a one period autoregressive term is included in each equation. The inclusion of the lagged endogenous variables implies a partial adjustment process. That is, the change in an endogenous variable is related to the difference between the value of the variable in period t and the value realized in period t-1. Thus the formulation is able to capture the delayed response. An adjustment of the coefficient of the autoregressive term provides a simple means of changing the dynamic response of the endogenous variable, and is another method by which trend effects and built-in dynamic adjustments can be modified. In addition, the existence of lags in the reactions of economic agents leads us to believe that all variables to be explained with a proper time frame could be seen as a function of predetermined variables which include lagged endogenous variables.

In our model, endogenous variables, which are determined in the system, include import, stock, and disappearance of each commodity. Exogenous variables, predetermined outside the system, cover all other variables. Korea has been one of the major customers for foreign agricultural products and could affect inventory levels of some traded agricultural commodities, however it is not yet big enough to influence the prices of commodities determined in the world market. The import price of each commodity is regarded as an exogenous variable. All lagged endogenous variables are currently predetermined variables and included in exogenous variables. Hence the model includes nine endogenous variables and twenty-two exogenous variables.

Identification

Identification is a prior step to model estimation. The identification problem arises since different sets of structural coefficients may be compatible with the same set of data.

By the identification problem we mean whether or not the estimates of a structural equation can be obtained. If this can be done, the equation under consideration is identified. If this cannot be done, the equation is under identified or unidentified. When an equation is identified, it is said to be exactly identified if unique values of the parameters can be obtained, or it is said to be over identified if more than one value can be obtained for some of the parameters of the equations.

A useful rule for identification is the order condition, which states that if an equation is to be identified, the number of predetermined variables excluded from the equation must be greater than or equal to the number of included endogenous variables minus one. In other words, a necessary condition for an equation to be identified is that the number of all variables excluded from the equation be greater than or equal to the number of endogenous variables in the model system minus one.

However, the problem with the order condition is that it is not a sufficient condition, which means that it is possible for the equation to be unidentified. When the order condition is satisfied for identification, there is a possibility that it will fail on occasion. The condition that includes sufficient as well as necessary conditions for identification is quite difficult since it involves the rank conditions.

To understand the conditions, let

G = number of endogenous variables in the system

g = number of endogenous variables in a given equation

K = number of exogenous variables in the system

k = number of exogenous variables in a given equation.

The necessary condition for the identification of an equation is (G-g) + (K - k) $\geq$ G - 1, which leads to K - k $\geq$ g - 1. This means that for an equation to be identified it is required that the number of predetermined variables excluded from the equation must be at least as large as the number of endogenous variables included less one.

The sufficient or rank condition for identification states that in a model containing G equations in G endogenous variables, an equation is identified if at least one non-zero determinant of order (G - 1)(G - 1) can be constructed from the coefficients of both endogenous and exogenous variables excluded from the particular equation but included in the other equations in the system.

To check the rank condition, let the equation exclude some variables. For this equation to be identified, we have to obtain at least one non-zero determinant of order (G - 1)(G - 1) from the coefficients of the variables excluded from this equation but included in other equations. To get the determinant, we first obtain the relevant matrix of coefficients of excluded variables included in the other equations. Let the matrix be A. If the determinant of A, $|A|$, is singular, the rank of A, R(A), is less than G - 1, and the equation does not satisfy the rank condition and thus is not identified. If R(A) = G - 1, the equation is identified.

Hence the identification problem can be summarized as follows:

If K - k > g - 1 and R(A) = G - 1, the equation is over identified.

If K - k = g - 1 and R(A) = G - 1, the equation is exactly identified.

If $K - k \geq g - 1$, and $R(A) < G - 1$, the equation is under identified.

If $K - k < g - 1$, the structural equation is unidentified.

By applying the necessary and sufficient conditions, our model of over identified equations to be estimated is described in the next section.

Statistical Model

The appropriate explanatory variables included in the model depends on the nature of the actual markets under consideration and the purpose of the study, based on economic theory.

Most of the important variables are included in the model, but data for some potentially important variables are not available and we thus use commonly accepted proxy variables. Data unavailability is relatively serious in the stock equations.

The economic model is modified and respecified below for statistical estimation.

1. Import Equations

$$PWI_t = a_1 + b_{11}PGDP_t + b_{12}FE_t + b_{13}UWIP_t + b_{14}PMC_t + b_{15}PWP_t + b_{16}PWS_{t-1} + b_{17}PWI_{t-1}$$

$$PCI_t = a_2 + b_{21}PGDP_t + b_{22}FE_t + b_{23}UCIP_t + b_{24}USIP_t + b_{25}PMC_t + b_{26}KGCPP_t + b_{27}PCS_{t-1} + b_{28}PCI_{t-1}$$

$$PSI_t = a_3 + b_{31}PGDP_t + b_{32}FE_t + b_{33}USIP_t + b_{34}PMC_t + b_{35}KGSPP_t + b_{36}PSS_{t-1} + b_{37}PSI_{t-1}$$

2. Stock Equations

$$PWS_t = a_4 + b_{41}UWIP_t + b_{42}PWD_t + b_{43}PWP_t + b_{44}DW_t + b_{45}PWS_{t-1}$$

$$PCS_t = a_5 + b_{51}UCIP_t + b_{52}KGCPP_t + b_{53}PCD_t + b_{54}PCS_{t-1}$$

$PSS_t = a_6 + b_{61}USIP_t + b_{62}KGSPP_t + b_{63}PSD_t + b_{64}PSP_t + b_{65}INTt +$

$b_{66}PSS_{t-1}$

3. Disappearance Equations

$PWD_t = a_7 + b_{71}PGDP_t + b_{72}UWIP_t + b_{73}PMC_t + b_{74}PWPt + b_{75}T_t +$

$b_{76}PWD_{t-1}$

$PCD_t = a_8 + b_{81}PGDP_t + b_{82}UCIP_t + b_{83}UWIP_t + b_{84}PMC_t + b_{85}PCD_{t-1}$

$PSD_t = a_9 + b_{91}PGDP_t + b_{92}USIP_t + b_{93}PMC_t + b_{94}UCIP_t + b_{95}PSP_t +$

$+ b_{96}PSD_{t-1}$

4. Identities

$PWP_t + PWI_t + PWS_{t-1} = PWD_t + PWS_t$

$PCP_t + PCI_t + PCS_{t-1} = PCD_t + PCS_t$

$PSP_t + PSI_t + PSS_{t-1} = PSD_t + PSS_t$

where

Endogenous variables

$PWI_t =$ per capita wheat imports, Kg

$PCI_t =$ per capita corn imports, Kg

$PSI_t =$ per capita soybean imports, Kg

$PWS_t =$ per capita wheat stocks, Kg

$PCS_t =$ per capital corn stocks, Kg

$PSS_t =$ per capita soybean stocks, Kg

$PWD_t =$ per capita wheat disappearance, Kg

$PCD_t =$ per capita corn disappearance, Kg

$PSD_t =$ per capita soybean disappearance, Kg

Exogenous variables

$PGDP_t$	=	per capita GDP, 1000 Korean won in 1985 prices
FE_t	=	nominal Korean won per SDR, period average
$UWIP_t$	=	wheat import price (U.S. dollar per metric ton) deflated by U.S. CPI (1985=100)
$UCIP_t$	=	corn import price (U.S. dollar per metric ton) deflated by U.S. CPI (1985=100)
$USIP_t$	=	soybean import price (U.S. Dollar per metric ton) deflated by U.S. CPI (1985=100)
$KGCPP_t$	=	government corn purchase price (1000 Korean won per 75 Kg, 2nd class) deflated by Korean CPI (1985=100)
$KGSPP_t$	=	government soybean purchase price (1000 Korean won per 75 Kg, 2nd class) deflated by Korean CPI (1985=100)
PWP_t	=	per capita wheat production, Kg
PSP_t	=	per capita soybean production, Kg
PMC_t	=	per capita meat consumption, Kg
INT_t	=	interest rate, percent per annum
T_t	=	tax rate, percent
DW	=	dummy variable for government wheat purchases, 0 for 1970-1983, one for 1984-1992, and

PWI_{t-1}, PCI_{t-1}, PSI_{t-1}, PWS_{t-1}, PCS_{t-1}, PSS_{t-1}, PWD_{t-1}, PCD_{t-1}, PSD_{t-1}, are the same as in endogenous variables but lagged one period.

A model of nine behavioral equations and three identities are now ready to be estimated.

Estimation of the Model

The efficiency of parameter estimates can be improved using system estimation methods as mentioned earlier. Three-stage least squares (3SLS) is utilized to estimate our model as a single system because of the likelihood of cross-block correlation of disturbances.

In the first stage, the reduced form of the system of equations is estimated and the fitted values of the endogenous variables are used to get two-stage least squares (2SLS) estimates of all the equations in the model. In the second stage, residuals of each equation are used to estimate the cross-equation variance and covariances after the 2SLS estimates have been obtained. In the third stage, generalized least squares (GLS) parameter estimates are obtained. Thus 3SLS involves the application of GLS estimation to the system of equations, each of which has first been estimated by 2SLS. The 3SLS yields more efficient estimates than 2SLS since it considers cross-equation correlation after 2SLS.

Annual data of nine endogenous and twenty-two exogenous variables for the period 1970-1992 are employed for the estimation by applying 3SLS, and the empirical results are shown in the next chapter. The results of our study and the performance of our model will be evaluated by ex-post simulation analysis. The differences between the actual historical movements of the variables in interest and simulated movements of those from the estimation will be analyzed.

Summary

In this chapter, the first part dealt with the structure of the model. The model specification and a preliminary model were presented. The selection of the variables for the model was discussed based on economic theory. Detailed discussion of the variables, data handling and sources were presented in the second part. The third part was mainly about model building. The methodology for the study was also discussed. The model system was respecified for estimation. The estimation technique employed presented in the last part.

CHAPTER V

EMPIRICAL RESULTS

In this chapter, we discuss the empirical results from the estimation of the model. Each of the nine estimated equations is examined in the first part, followed by elasticity analysis in the second part. Finally, performance of the model is evaluated.

Appropriate estimation procedures for our study are 2SLS, 3SLS, and a seemingly unrelated equation model. The problem is that seemingly unrelated equation estimation is appropriate when none of the endogenous variables appears on the right hand side of any equation in the model. Each of the stock equations in our model has a corresponding disappearance, which is an endogenous variable, on the right hand side.

We have applied the remaining two alternative estimation methods and found that 3SLS outperformed 2SLS. Hence, the results from 3SLS estimation only are reported and analyzed in this chapter.

Econometric Analysis

The estimated equations are presented below with t-ratios in parentheses.

1. Import Equations

$$PWI_t = \underset{(1.896)}{27.821} + \underset{(3.092)}{37.141}\, PGDP_t + \underset{(5.581)}{0.0926}\, FE_t - \underset{(-1.991)}{0.0507}\, UWIP_t$$

$$- \underset{(-4.173)}{7.9627}\, PMC_t - \underset{(-1.547)}{2.0614}\, PWP_t + \underset{(3.156)}{2.3818}\, PWS_{t-1} - \underset{(-1.484)}{0.1834}\, PWI_{t-1}$$

$$R^2 = 0.8186$$

$$\begin{aligned} PCI_t = \; & \underset{(0.1706)}{2.9188} + \underset{(0.0081)}{0.0947}\, PGDP_t + \underset{(3.708)}{0.0495}\, FE_t - \underset{(3.339)}{0.1779}\, UCIP_t \\ & + \underset{(1.532)}{0.0407}\, USIP_t + \underset{(2.503)}{5.1149}\, PMC_t - \underset{(-1.165)}{0.8385}\, KGCPP_t \\ & + \underset{(2.63)}{1.4482}\, PCS_{t-1} - \underset{(-0.7257)}{0.1074}\, PCI_{t-1} \end{aligned}$$

$$R^2 = 0.9522$$

$$\begin{aligned} PSI_t = \; & \underset{(-2.9)}{5.7734} - \underset{(-3.644)}{7.0273}\, PGDP_t + \underset{(2.294)}{0.0069}\, FE_t - \underset{(-0.8826)}{0.0038}\, USIP_t \\ & + \underset{(5.746)}{1.8246}\, PMC_t + \underset{(1.355)}{0.0742}\, KGSPP_t - \underset{(-9.531)}{3.5514}\, PSS_{t-1} \\ & + \underset{(7.308)}{0.6594}\, PSI_{t-1} \end{aligned}$$

$$R^2 = 0.9867$$

2. Stock Equations

$$\begin{aligned} PWS_t = \; & \underset{(1.429)}{4.4095} - \underset{(-2.06)}{0.0136}\, UWIP_t + \underset{(2.279)}{0.0816}\, PWP_t + \underset{(1.271)}{0.4328}\, PWP_t \\ & + \underset{(1.12)}{1.8735}\, DW_t - \underset{(-0.4006)}{0.0726}\, PWS_{t-1} \end{aligned}$$

$$R^2 = 0.5789$$

$$\begin{aligned} PCS_t = \; & \underset{(-1.141)}{-5.9712} - \underset{(-1.4)}{0.0197}\, UCIP_t + \underset{(2.641)}{0.5919}\, KGCPP_t \\ & + \underset{(0.6547)}{0.0171}\, PCD_t + \underset{(2.129)}{0.3898}\, PCS_{t-1} \end{aligned}$$

$$R^2 = 0.7001$$

$$PSS_t = -1.8408 - 0.0021\ USIP_t + 0.0528\ KGSPP_t$$
(-1.175) (-1.066) (2.205)

$$+ 0.0296\ PSD_t + 0.167\ PSP_t - 0.0172\ INT_t - 0.0507\ PSS_{t-1}$$
(0.6265) (1.132) (-0.5482) (-0.3644)

$$R^2 = 0.6396$$

3. Disappearance Equations

$$PWD_t = 85.367 + 13.703\ PGDP_t - 0.0897\ UWIP_t - 1.5118\ PMC_t$$
(2.82) (0.8163) (-2.902) (-0.5661)

$$-3.3619\ PWP_t - 0.6543\ T_t + 0.0953\ PWD_{t-1}$$
(-1.972) (-0.4176) (0.6492)

$$R^2 = 0.6472$$

$$PCD_t = 16.582 + 7.3616\ PGDP_t - 0.2584\ UCIP_t + 0.1123\ UWIP_t$$
(1.129) (0.5462) (-3.321) (2.68)

$$+ 4.2381\ PMC_t + 0.1915\ PCD_{t-1}$$
(1.813) 1.491)

$$R^2 = 0.9528$$

$$PSD_t = -2.4039 - 6.0639\ PGDP_t - 0.0076\ USIP_t + 1.3518\ PMC_t$$
(-0.6613)(-2.889) (-1.43) (4.389)

$$+ 0.0117\ UCIP_t + 0.4767\ PSP_t + 0.7687\ PSD_{t-1}$$
(1.037) (1.311) (7.256)

$$R^2 = 0.9692$$

System $R^2 = 0.9993$

Five percent level of significance is used in this study.

The model as a whole generally fits well and achieves a reasonable level of statistical significance. The signs of coefficients for most of the variables are in accord with a priori expectations. Stock equations performed less satisfactory than the import and disappearance equations. This may be due to the lack of information in specifying the equations.

DW statistics for all equations lie within the reasonable range, and reveal no major problems in serial correlation. DW statistics may be not useful when one or more lagged endogenous variables are present since they are often close to 2 even when errors are serially correlated. When autocorrelation is present, a correction for serial correlation could be used to obtain consistent estimates of both the equation coefficients and the serial correlation coefficient, except for those equations which do not contain lagged dependent variables.

Pindyck and Rubinfeld (p. 421) state that the estimation technique for obtaining those consistent estimates cannot be applied for the equations which contain a lagged dependent variable even if serial correlation is present since the estimate of the serial correlation coefficient would be inconsistent for those equations.

If the error terms are serially correlated, the estimates of the coefficient of the lagged dependent variable will also be inconsistent. For this reason we could argue that it is not desirable to include lagged dependent variables in the equations. According to Pindyck and Rubinfeld, the lagged dependent variable sometimes provides the best means of imposing a lagged distribution on the equation, and this benefit may outweigh the associated statistical problems.

Import Equations

Wheat Imports

Wheat imports are a function of income level, foreign exchange, own import price, meat consumption level, domestic production and previous stock and import levels.

The value of R^2 reveals that 82 percent of the variation in wheat imports is explained by this equation. Per capita GDP, foreign exchange, import prices, per capita meat consumption, and lagged per capita wheat stocks are found to be significant to determine the level of wheat imports.

The coefficients of all variables included in the equation have the expected signs except foreign exchange and lagged per capita wheat stocks which move together with the level of wheat imports. Since our exchange rate variable is specified in nominal terms, a positive exchange rate coefficient on wheat imports is possible.

Wheat is an increasingly important food grain. As a potential competing food grain, we attempted to include the rice variable in import and disappearance equations for wheat, with expectations of a substitution effect. However, the inclusions hurt the statistical fit in repeated estimations, we thus eliminate the rice variables from our model. Wheat was considered a potential substitute of rice. As income level has increased, price effects of rice and wheat as competitors in consumption might have diminished. Consumer tastes and preferences may be a more important factor. Since wheat is a food necessity in Korea and a superior good as the strong positive income effect suggests, we may be able to interpret that it is always available so wheat imports have continued to increase with income even though its stock in the preceding period is large.

Domestic wheat production and imports show a clear negative relationship as they have for several years. Per capita GDP and wheat import prices have positive and negative signs, respectively, as economic theory suggests. Per capita meat consumption has a significantly negative effect on wheat imports and this negative cross effect clearly suggests their substitution relationship.

The effects of macroeconomic variables on wheat import demand are found to be significant. The relative sizes of the estimates imply that per capita GDP is not only a strong macroeconomic variable but also the most influential of all variables included in explaining per capita wheat imports.

Corn Imports

More than 95 percent of the variation in per capita corn imports is explained by the variables included in the equation. The equation has a better statistical fit than per capita wheat imports.

Corn import prices, per capita meat consumption, foreign exchange, and lagged per capita corn stocks are significant for per capita corn imports. All variables bear reasonable signs. Lagged per capita stocks has a positive sign, and is probably because corn is an important feed grain. The same principle, (as in the wheat case), may be applied to corn. Macroeconomic variables such as per capita GDP and exchange rates have positive signs but income the effect on corn imports is small and not significant. Significantly positive per capita meat consumption suggests the importance of corn in feed use and a complementary effect for both commodities.

Corn import prices and per capita corn imports have a strong negative relationship as we expect. A positive cross price effect for corn and soybeans implies that corn is a substitute for soybeans in imports. Current corn imports decline if the imports for the previous period were large, which is the same as in wheat imports.

Unlike the wheat import equation, we include a government policy variable to explain how it affects corn imports. It is found that imports tend to decline if the government purchase price of corn increases. The relationship is not statistically significant, however, it suggest that a government purchase program could influence the level of corn imports. If the purchase price increases by one unit, per capita corn imports decline by approximately 0.84 unit.

Soybean Imports

Most variables appear to be significant in the per capita soybean imports equation. The estimated result reveals that only own import price and government purchase price of soybeans have minor effects on soybean imports. Both macroeconomic variables are found to be significant. Per capita GDP appears to have an unusual effect on per capita soybean imports. A negative sign means that soybean imports decline as income rises, which is in contradiction to our expectation.

However, the negative sign for per capita GDP explains soybean imports. Demand for soybeans is largely a derived demand from beef, for example. As income goes up, demand for beef also goes up. Two alternatives are possible to satisfy the increasing demand for beef. The first one is increasing domestic production, which implies that the demand for soybean increases as income goes up, which in turn raises soybean imports. The problem is that a time lag exists between the production, planning and actual realization. Rapid growth in demand for beef and GATT/Trade negotiation might force Korea to increase direct beef imports. The second alternative suggests that the demand for soybeans and the income level moved in opposite directions. The strong positive income effect on per capita wheat imports, then positive but very weak income effect on per capita corn imports may, at least partially, support this interpretation. In addition, the strong and negative effect of lagged soybean stocks in the soybeans import equation may add support for this interpretation.

Unlike its effect on corn imports, a government policy variable has the same trend with soybean import levels even if it is not significant. This is probably because domestically produced and imported soybeans are different in usage, or the government program is not effective to reduce imports.

Stock Equations

Wheat Stocks

Per capita wheat stocks are poorly fitted in relative base. Fifty-eight percent of the variation in stocks can be explained by the variables. Some important explanatory variables unavailable to us may be missed in specification of the equation.

Lagged per capita wheat stock and the price variable reduce the stock accumulation, as we expect. If disappearance of wheat goes up, the level of stock increases to meet the demand. Domestic production has the same effect. However, the production and dummy variable for the government purchase program show positive effects but are not significant on the stock level. Price and per capita wheat disappearance variables are found to be significant for wheat stocks. The estimated coefficients imply that the government policy variable is the most effective on wheat stocks in relative size even if it is not statistically significant. Per capita wheat disappearance is found to be the most significant variable.

Corn Stocks

The per capita corn disappearance equation is not so effective. The government purchase price is found to have the strongest influence on the stock level. Our estimation shows that a one unit increase in the government purchase price brings approximately 0.60 units more corn to stocks. The price variable carries the expected sign but is not statistically significant. The per capita stock level declines if price goes up but is not sensitive to its movement.

Lagged per capita corn stocks have a positive and significant effect on the current stock level, which is the opposite of our expectation. Corn disappearance in 1992 is 25 times that of 1969. The self-sufficiency level has declined from 18.9 percent in 1970 to 1.2 percent in 1992. In 1992, the carry-out at the end of every year became over 22 times that of 1969. In the same year, the amount of imports in nominal terms became over 72 times the 1969 level. The importance of corn in Korean agriculture has increased greatly. Sharp increases are clear in every respect for the period of study. Hence we may interpret that corn should have reasonably large stocks.

Soybean Stocks

All variables carry the expected signs. The interest rate is included as a potential explanatory variable. Its effect on carrying the stock is not significant, although a negative relationship looks reasonable. The upward movement of price reduces the stock as expected. The positive effect of the government purchase price is as expected and is the only significant variable in the equation. Over 12 percent of soybean disappearance was still self-sufficiency in 1992, thus the policy variable is enough to be effective to change the level of per capita soybean stocks. Per capita disappearance and per capita domestic production have positive effects.

A potential problem may be found in this equation. Only one significant variable is not enough for an equation with R^2 of 0.64. The statistical soundness of the per capita soybean stock equation might be associated with a multicollinearity problem. We thus consider only the directional effects of the variables and are cautious about interpreting the magnitude of the effect of each variable.

Disappearance Equations

Wheat Disappearance

Per capita wheat disappearance is a function of two significant variables, price and per capita domestic production, and several nonsignificant variables, lagged per capita wheat disappearance, per capita GDP, the tax rate, and per capita meat consumption. Signs of the variables are consistent with priori expectations.

The positive sign of lagged per capita disappearance implies that the disappearance pattern continues in the current period. A one unit increase in the price variable brings a 0.09 unit reduction in per capita disappearance. Per capita meat consumption again reveals a substitution relationship between both commodities as in per capita wheat imports, but the relationship is much weaker this time.

A probable theoretical contradiction is found in per capita domestic wheat production, which is negatively related to per capita wheat disappearance. As per capita domestic production has declined, per capita wheat disappearance significantly has gone up. It is consistent with the reality for the study period.

Since wheat is an important food grain, a tax variable is included to determine the effect on wheat disappearance from the consumer side. Its sign is correct but the magnitude is not statistically significant.

Corn Disappearance

The signs on all variables that influence per capita corn disappearance are in accord with a priori expectations. The past disappearance trend continues in the present period. Per capita GDP contributes to increasing corn disappearance. A one unit increase in per capita meat consumption causes a more than four unit increase in per capita corn disappearance. The meat consumption variable is not significant, but suggests a complementary cross relationship between both commodities.

The price variables for corn and wheat are found to be significant. The own price effect states that a one unit increase in price brings slightly over a quarter unit reduction in corn disappearance. On the other hand, a one unit increase in wheat prices raises over one tenth unit of disappearance, which implies that wheat and corn are substitutes and that the cross price effect is significant.

Soybean Disappearance

Per capita soybean disappearance is another well estimated equation. All estimated coefficients influence per capita soybean disappearance with the expected signs. The coefficients of per capita GDP and per capita meat consumption are generally consistent with those in the per capita soybean import equation with respect to direction and magnitude. A one unit increase in per capita meat consumption has the effect of a

1.35 unit increase in per capita soybean disappearance, and this complementary relationship is strong. A one unit increase in per capita domestic soybean production causes almost a half unit increase in disappearance. The negative own price effect for disappearance is weak and nonsignificant. Both the own price and domestic production effect are insignificant.

The corn price variable is weakly but positively related to per capita soybean disappearance. This positive relationship suggests that corn and soybeans are substitutes even though the cross price effect is not strong.

Elasticity Analysis

Elasticities of the current endogenous variables are evaluated at the mean levels of the related variables. This analysis is conducted to analyze the responsiveness of current endogenous variables when there are shocks in related variables. It is clear that different elasticity estimates may occur in various empirical works because of differences in the behavioral models assumed. We also know that the same behavioral model can produce very different elasticity values when different measures of the variables are used.

<u>Imports</u>

Table 5.1. Estimated Elasticities of Commodity Imports.

PWI		PCI		PSI	
$PGDP_t$	1.0948	$PGDP_t$	0.0024	$PGDP_t$	-0.9293
FE_t	1.1361	FE_t	0.5294	FE_t	0.3790
$UWIP_t$	-0.1721	$UCIP_t$	-0.4461	$USIP_t$	-0.1008
PMC_t	-1.5809	$USIP_t$	0.2091	PMC_t	1.6251
PWP_t	-0.0597	PMC_t	0.8847	$KGSPP_t$	0.3234
PWS_{t-1}	0.2973	$KGCPP_t$	-0.2658	PSS_{t-1}	-0.4645
PWI_{t-1}	-0.1774	PCS_{t-1}	0.1419	PSI_{t-1}	0.5972
		PCI_{t-1}	-0.0979		

Source: Empirical Estimates.

For wheat imports, the estimated elasticity of -0.1721 indicates an inelastic response to imports prices of wheat, while wheat appears to be a superior commodity in imports with an income elasticity of 1.0948. Estimated elasticities of per capita wheat imports with respect to both macroeconomic variables of per capita GDP and foreign exchange are elastic (from Table 5.1). Thus per capita wheat imports are responsive to the movement of macroeconomic variables. However, we have to keep in mind that the effects of the exchange rate variable might be inflated since we have used nominal values for this variable. Per capita wheat imports are responsive to per capita meat consumption and their substitutional cross relationship is represented by an elasticity of -

1.5809. Table 5.1 indicates inelastic responses of wheat imports to other variables.

Per capita corn imports appears to be not responsive to the movements of all variables included. Only the meat consumption variable is relatively responsive. Own price elasticity (-0.4461) is larger than the cross price elasticity for soybeans (0.2091) in absolute size. The estimated elasticity of per capita corn imports with respect to the government purchase price is not responsive and is only -0.2658. This indicates that the government program is not effective. Corn imports are not very responsive to changes in macroeconomic variables. However, the foreign exchange effect (0.5294) is much more sensitive than the income effect (0.0024).

For soybean imports, most of the estimated elasticities are inelastic except per capita meat consumption. The cross elasticity of per capita soybean imports with respect to per capita meat consumption is 1.6251. Per capita soybean imports appear to be fairly responsive to the movements of macroeconomic variables, but still inelastic. Per capita GDP has a negative effect as we have seen before, and the income elasticity is close to one in absolute terms. The government soybean purchase price does not appear to be elastic.

<u>Stocks</u>

As illustrated by Table 5.2, stocks appear to have elastic responses to few variables. Only government policy elasticities for corn and soybean stocks are in the elastic range, and they are 1.7420 and 1.6783, respectively. Estimated elasticities of stocks with respect to corresponding price variables are close to each other and fairly

Table 5.2. Estimated Elasticities of Commodity Stocks.

PWS_t		PCS_t		PSS_t	
$UWIP_t$	-0.3649	$UCIP_t$	-0.4575	$USIP_t$	-0.4115
PWD_t	0.6620	$KGCPP_t$	1.7420	$KGSPP_t$	1.6783
PWP_t	0.0991	PCD_t	0.1627	PSD_t	0.3164
DW_t	0.0963	PCS_{t-1}	0.3547	PSP_t	0.5903
PWS_{t-1}	-0.0716			INT_t	-0.1246
				PSS_{t-1}	-0.0484

Source: Empirical Estimates.

responsive in an inelastic sense. Per capita disappearance elasticity of each stock is also small, but wheat disappearance elasticity is relatively large. Soybean stock responds to change in domestic production although in an inelastic sense, which means that per capita soybean stock increases 5.9 percent when per capita domestic soybean production increase 10 percent. On the other hand, domestic wheat production has a negligible effect on wheat stock. It is also found that soybean stock is not much responsive to interest rate.

<u>Disappearance</u>

As Table 5.3 shows, per capita disappearance for all commodities are found to be income and price inelastic. Per capita corn disappearance is relatively responsive to own price, and the estimated elasticity indicates that a 10 percent increase in price reduces 6.31 percent of corn disappearance. Soybean disappearance is least responsive to price changes.

Table 5.3. Estimated Elasticities of Commodity Disappearance.

PWD_t		PCD_t		PSD_t	
$PGDP_t$	0.3938	$PGDP_t$	0.1842	$PGDP_t$	-0.5479
$UWIP_t$	-0.2966	$UCIP_t$	-0.6310	$USIP_t$	-0.1376
PMC_t	-0.2926	$UWIP_t$	0.3232	PMC_t	0.8226
PWP_t	-0.0949	PMC_t	0.7142	$UCIP_t$	0.1031
T_t	-0.1839	PCD_{t-1}	0.1757	PSP_t	0.1578
PWD_{t-1}	0.0922			PSD_{t-1}	0.7243

Source: Empirical Estimates.

Wheat appears to be a superior good but its disappearance increases by 3.9 percent when per capita GDP rises by 10 percent. The cross effect between meat consumption and wheat disappearance is not found to be strong. Per capita wheat disappearance declines by 2.93 percent when meat consumption increases by 10 percent. Tax does not appear to be a sensitive variable to wheat disappearance, and disappearance decreases by approximately 0.18 percent as tax goes up by one percent.

The cross price elasticity of per capita corn disappearance with respect to changes in wheat prices is 0.3232, which indicates that the substitution effect is less than one-third when the wheat price moves. Per capita meat consumption is found to be the most sensitive of all variables in corn disappearance. The income elasticity is only 0.1842, which is less than half that of wheat disappearance.

In per capita soybean disappearance, the own price effect is the least in all commodity disappearances whereas the meat consumption effect is the largest in absolute terms. The estimated elasticity of per capita domestic soybean production is 0.1578, so the disappearance is not responsive to domestic production. The cross price elasticity of soybean disappearance with respect to corn prices is 0.1031, which indicates soybean disappearance is substituted by one-tenth when corn price rises.

Ex Post Simulation Analysis

In this section, we discuss the construction, evaluation, and analysis of the simultaneous equation simulation model. Even though individual equations may fit the historical data very well, simulation results may diverge from reality when they are combined to form a simultaneous equation model. When a simulation model is constructed, understanding the dynamic structure of the model system which results from combining the individual equations is involved. The process is not straightforward.

In a system of equations model, each individual equation may have a good statistical fit, but the model as a whole may be very poor in reproducing the historical data. On the contrary, the individual equations may have a poor statistical fit, but the model as a whole may reproduce the historical time series quite well. Thus is the concern with evaluating and validating a simultaneous equation simulation model.

Since we know the values for the parameters of the equations in the model, initial values and a time path are specified for the endogenous variables, then the simultaneous solution of equations provides time paths for each of the endogenous variables. The model is solved over the period of study to yield solutions for each of the endogenous variables with estimated parameters, initial values for the endogenous variables, and a given time series for the exogenous variables. By simulating the model during the period of study for which the historical data for all variables is available, we can compare the original data series with the simulated series for each endogenous variable and test the validity of the model.

Ex post simulation is useful for policy analysis. We may examine and compare what would have taken place as a result of alternative policies by changing parameter values or letting exogenous policy variables, (such as KGCPP, KGSPP, and DW in our study), follow different time paths. We can also analyze the economic consequences that might have resulted from changes in the levels of macroeconomic variables, (such as PGDP, FE, INT, and T). However, these analyses are beyond the scope of the current study.

In the multi-equation model, high statistical significance for some equations may be balanced against low statistical significance for other equations. It is not guaranteed that the model as a whole will reproduce the same data series closely when simulated even though all the individual equations fit the data well and are statistically significant. It is also possible that some of endogenous variables track the original series closely while others do not in an ex post simulation.

A criterion to be used to evaluate a simulation model is the fit of the individual variables in a simulation context. We will check whether or not the results of a simulation through our estimation period match the actual data closely, thus a historical simulation is performed to determine how closely individual variables track their corresponding data series to test the performance of the model.

The measures that are most often used are the root-mean-square (rms) simulation error and the rms percent error, which are used in our analysis. Each of them is a measure of the deviation of the simulated variable from its actual time path. Low root-mean-square simulation errors are only one desirable measure of simulation fit.

Another important criterion is how well the model simulates turning points in the historical data. One might prefer a model which duplicates sudden changes in the actual data despite a larger root-mean-square simulation error. If a simulated value moves upward from the preceding period to the current period when the actual data series goes down for the same period, we record it as a turning point missed. The ability of a simulation model to duplicate the directional changes in the actual data is an additional criterion for model evaluation. If the former criterion is a quantitative evaluation, the latter one is a qualitative evaluation. The quantitative and qualitative evaluations of the model's performance are summarized for each endogenous variable in Table 5.4.

In addition, the data series for each endogenous variable is reproduced from our model and compared with the historical series. The results are shown graphically in Figures (5.1) to (5.9), where actual and reproduced data series for each endogenous variable are plotted on the same set of axes. A simulated series for each endogenous variable begins with SI. For example, the simulated series of PWI is denoted SIPWI.

The model appears to be stable. No simulated series diverges more and more rapidly from the range of actual values. It is found that every reproduced series moves in the same characteristic way with the actual series.

From the figures, it is observed that the simulated series looks good enough to reproduce the general long-run behavior of the historical series. The simulated series closely tracks historical ones, although some short-run fluctuations in the actual series are not correctly reproduced, which we call turning points missed. Per capita wheat imports is the best in turning point accuracy, while per capita soybean stocks is the most missed. Twenty-three to twenty-four percent of the whole turning points are missed, however, most of those missed still closely reproduce the actual data. The rms and rms percent simulation errors support this. These errors are small enough to prove the good performance of the model.

Per capita soybean stocks, which has the most turning points missed, achieves the lowest rms simulation error. Per capita wheat imports, which has the best turning point accuracy, is sixth in rms error evaluation and second in rms percent error evaluation. Per capita soybean disappearance is the best in rms percent error evaluation. These illustrate that evaluation of the model by one criterion is not enough to judge its performance.

Summary

The empirical results from the estimation of the system of nine simultaneous equations are reported in this chapter. The model as a whole generally fits well and is found to be statistically sound. Each equation is carefully examined based on economic theory and appears to be consistent with priori expectations. Effects of macroeconomic and government policy variables are captured and suggest some policy implications. Cross effects between variables allow us to identify their substitutability or complementarity.

The effects of those variables become concrete through elasticity analysis. The value of each elasticity provides a clear picture of the magnitude each endogenous variable receives from the movement of each exogenous variable.

Finally, the evaluation of the performance of the model is presented. The data series of endogenous variables in the model is simulated and compared with the actual data series to check how closely our model reproduces the historical data series. Those results are evaluated by both quantitative and qualitative methods.

Table 5.4. Evaluation of the Simulation Performance.

	Imports			Stocks			Disappearance		
Year	PWI	PCI	PSI	PWS	PCS	PSS	PWD	PCD	PSD
1970-71				X				X	X
1971-72			X	X		X			
1972-73		X	X		X				X
1973-74		X	X	X					X
1974-75		X		X	X			X	
1975-76			X			X			
1976-77									
1977-78				X			X		
1978-79	X				X	X	X		
1979-80		X	X	X			X	X	
1980-81		X				X			
1981-82			X				X		
1982-83						X			
1983-84		X		X				X	
1984-85	X	X			X			X	
1985-86						X			
1986-87									X
1987-88				X		X			X
1988-89					X	X			X
1989-90						X			X
1990-91		X						X	X
1991-92					X		X		
Turning points missed	2	8	6	8	6	9	5	6	8
rms error	8.6593	10.0317	1.1635	2.3303	2.642	0.9747	11.1249	9.9757	2.2073
rms percent error	0.1464	0.2669	0.3907	0.3738	0.3083	1.3063	0.1968	0.2649	0.1255

Source: Empirical Estimates.

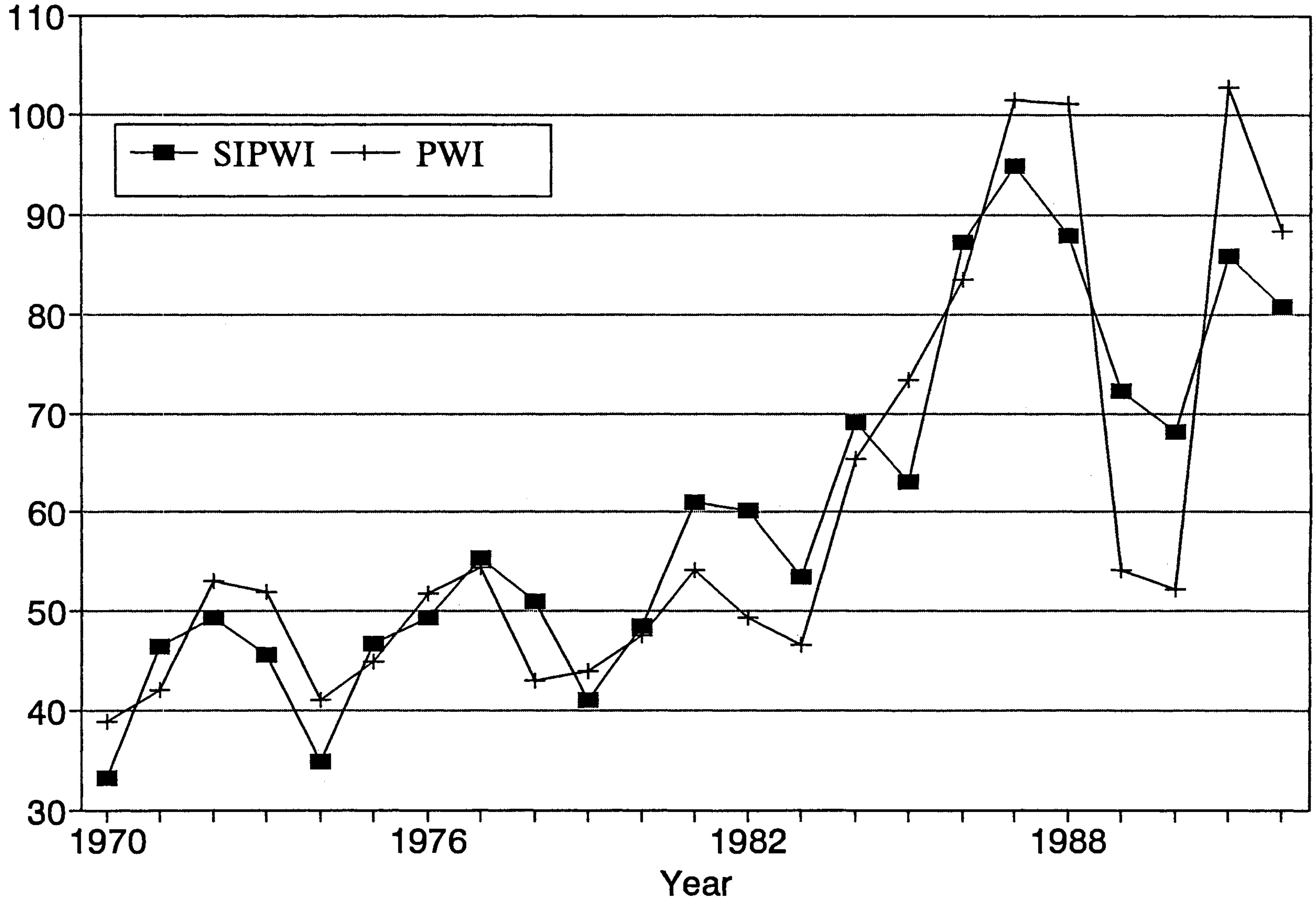

Figure 5.1. Historical Simulation of Per Capita Wheat Import (PWI)

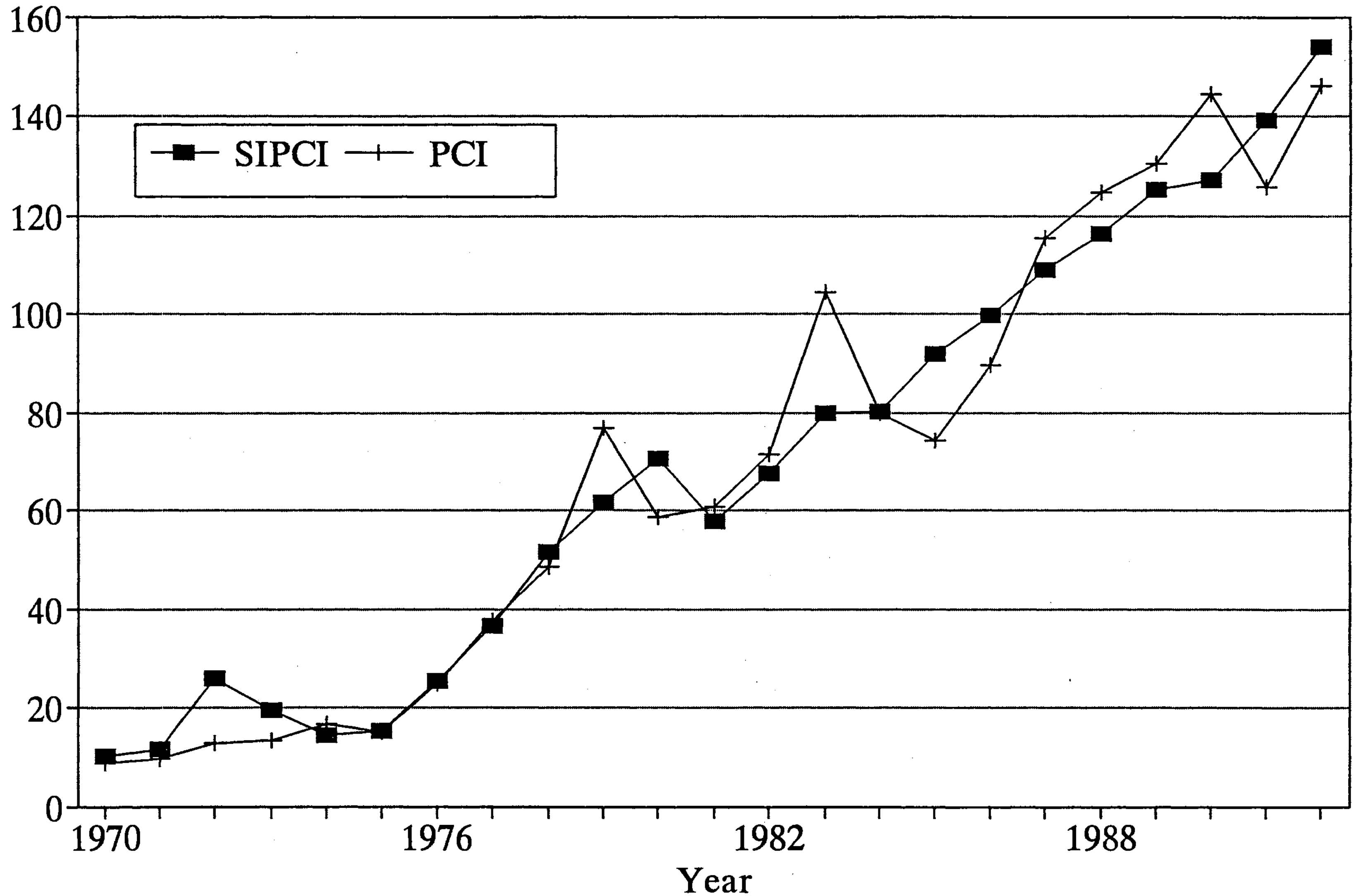

Figure 5.2. Historical Simulation of Per Capita Corn Import (PCI)

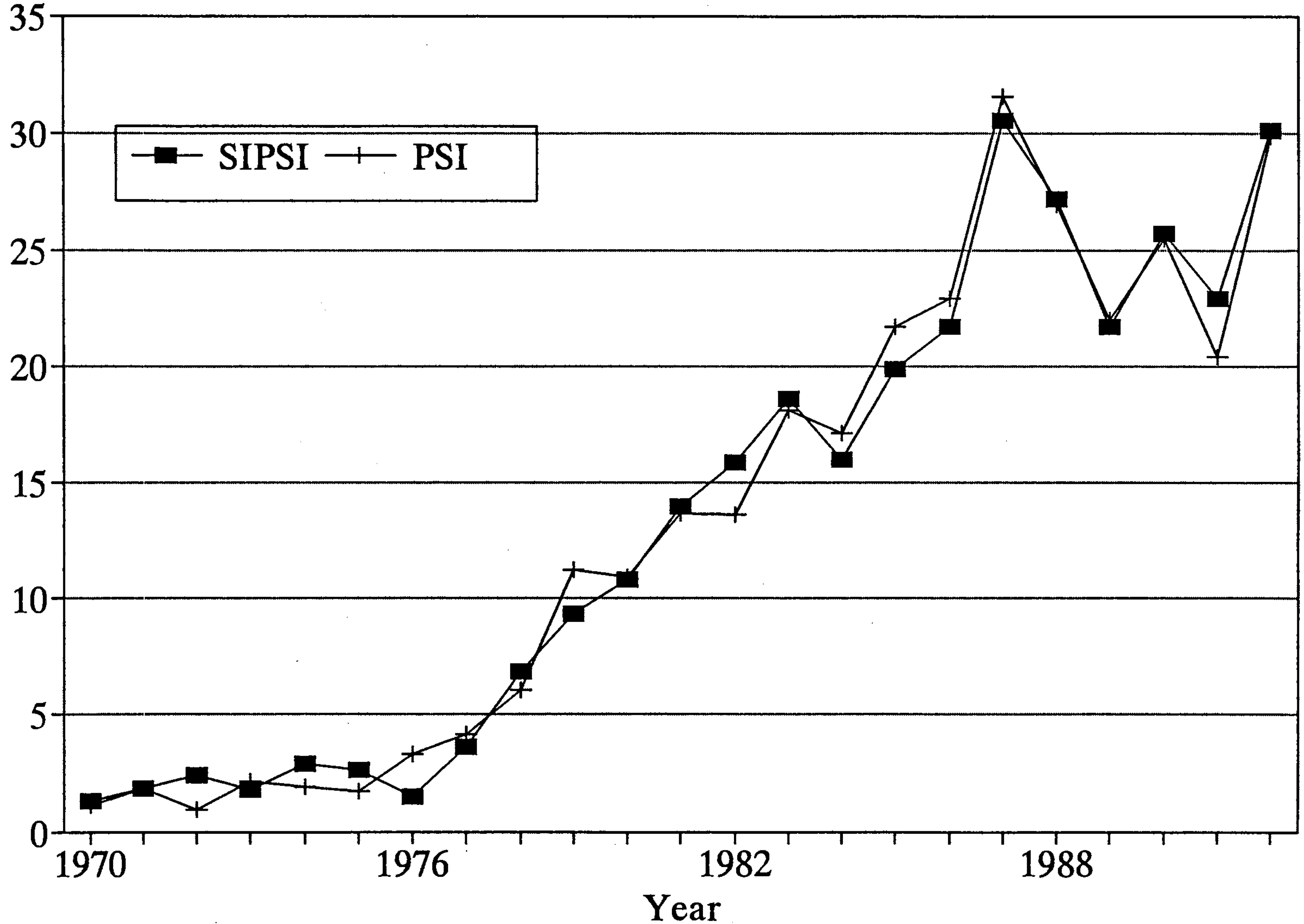

Figure 5.3. Historical Simulation of Per Capita Soybean Import (PSI)

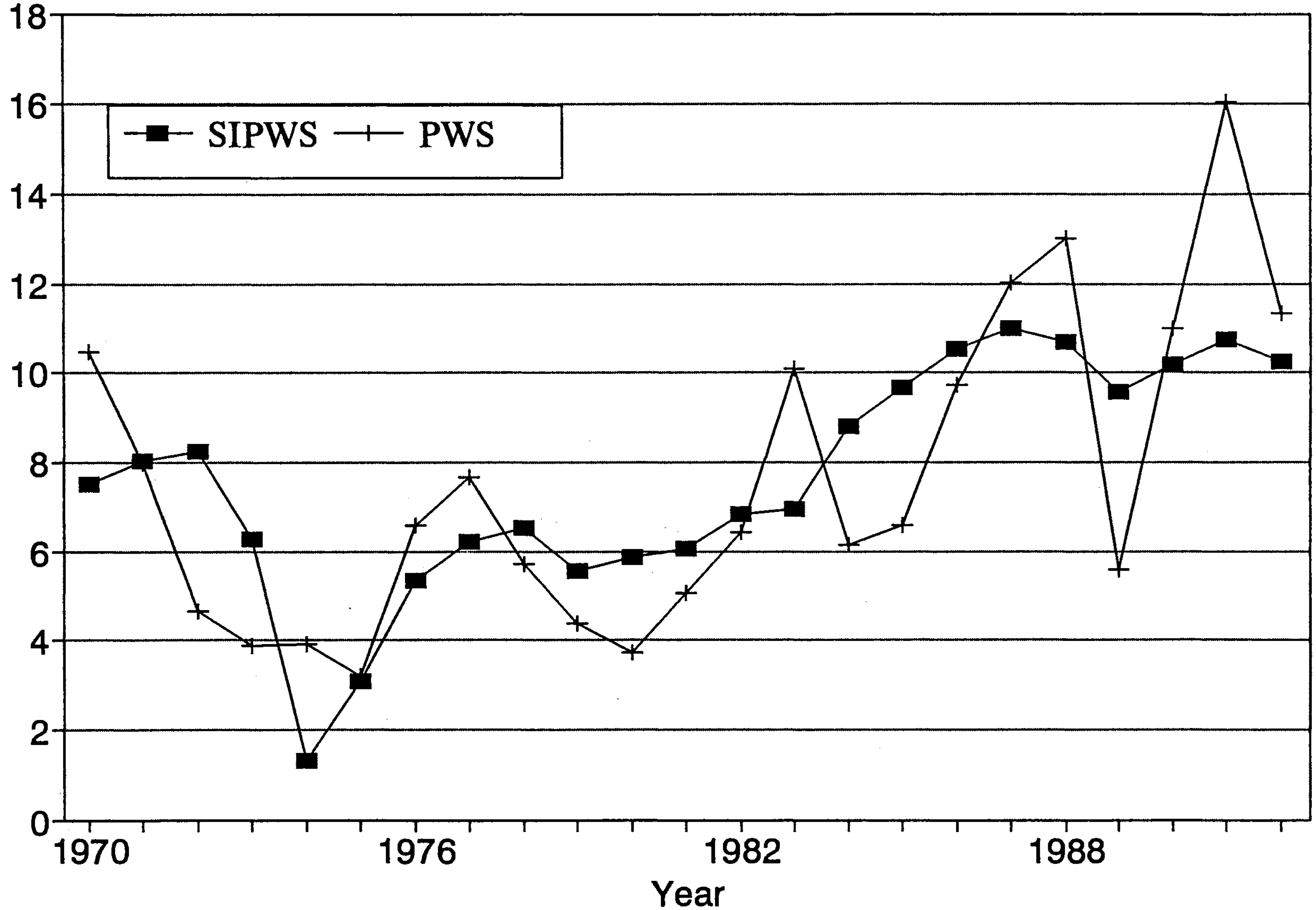

Figure 5.4. Historical Simulation of Per Capita Wheat Stock (PWS)

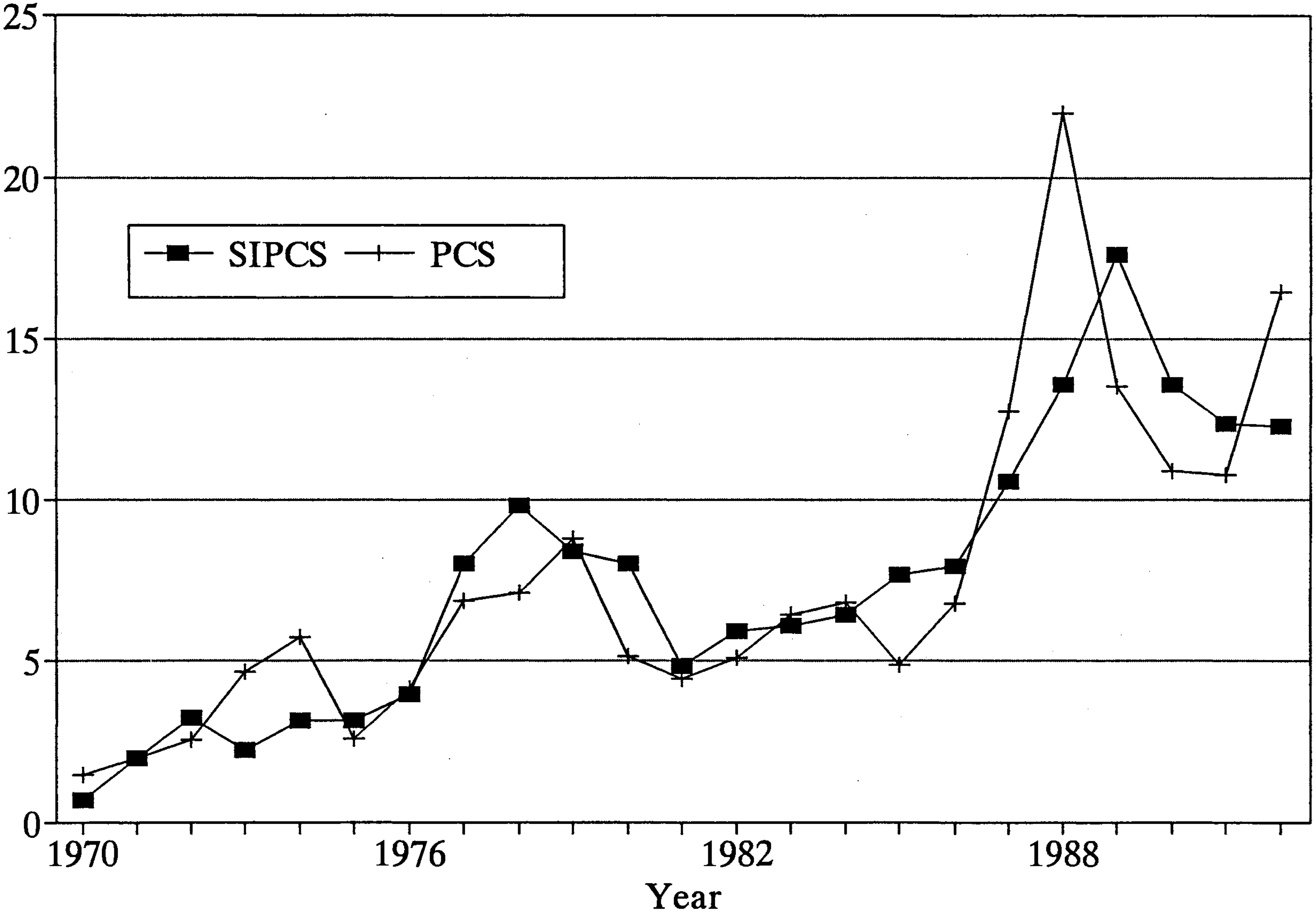

Figure 5.5. Historical Simulation of Per Capita Corn Stock (PCS)

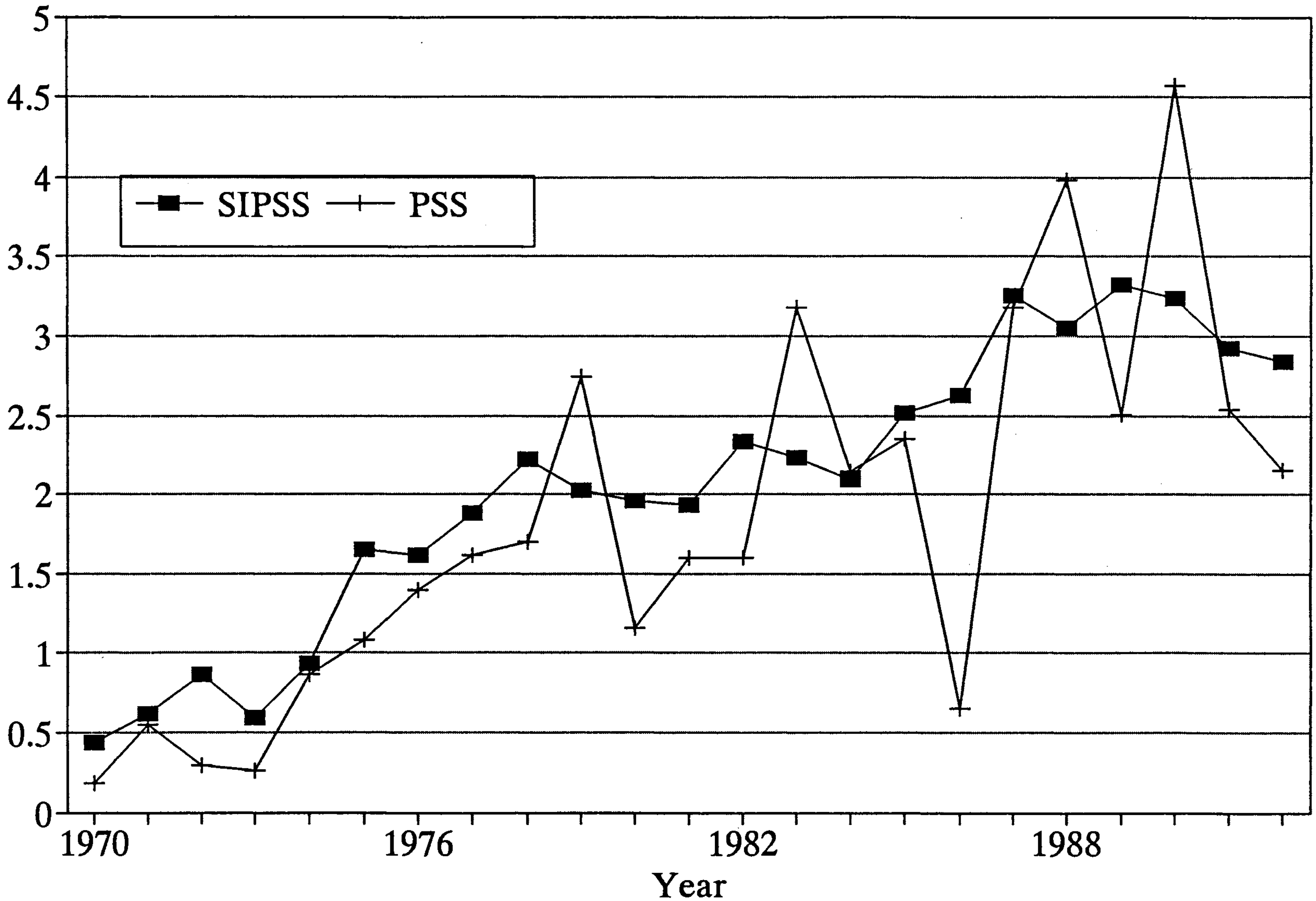

Figure 5.6. Historical Simulation of Per Capita Soybean Stock (PSS)

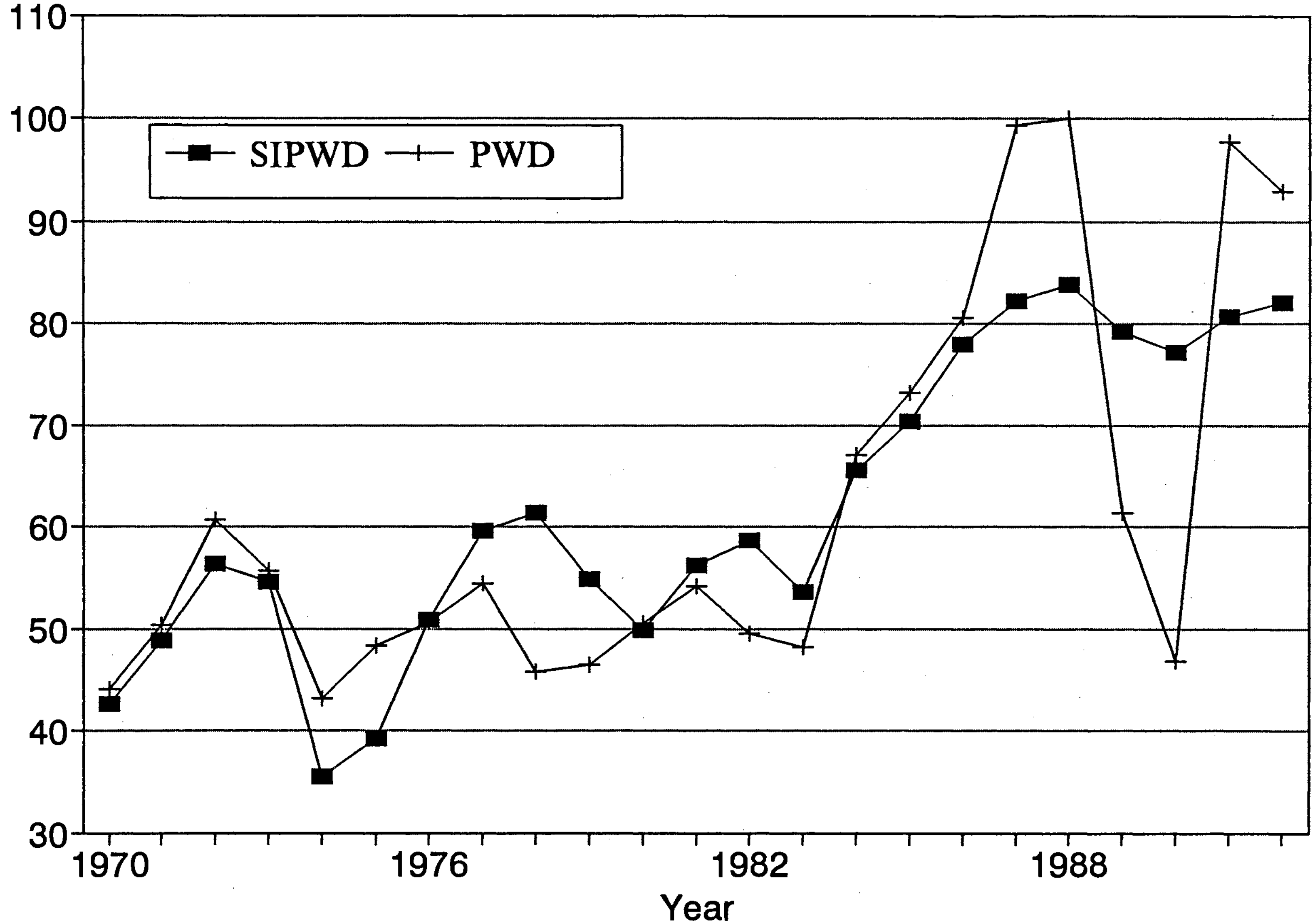

Figure 5.7. Historical Simulation of Per Capita Wheat Disappearance (PWD)

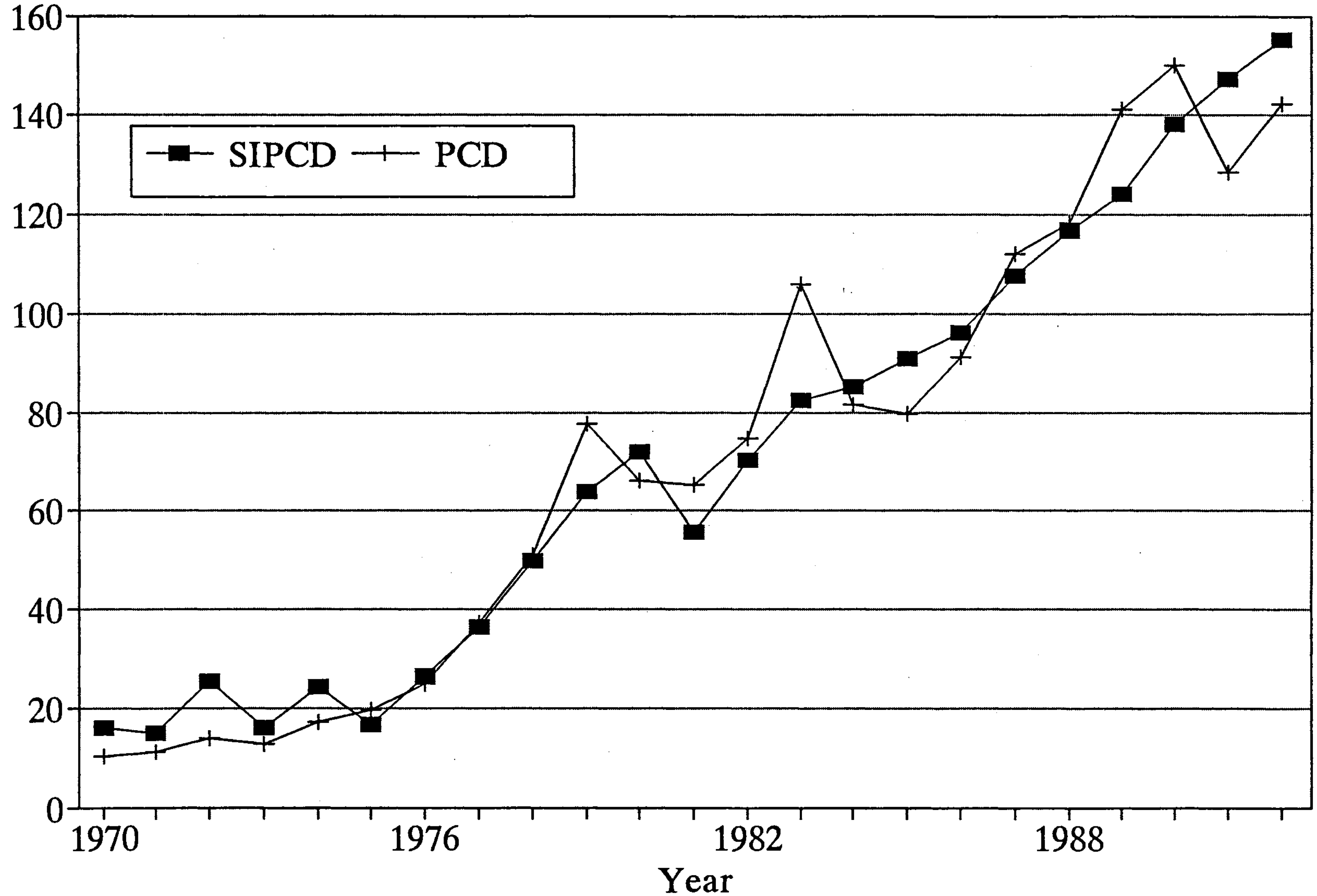

Figure 5.8. Historical Simulation of Per Capita Corn Disappearance (PCD)

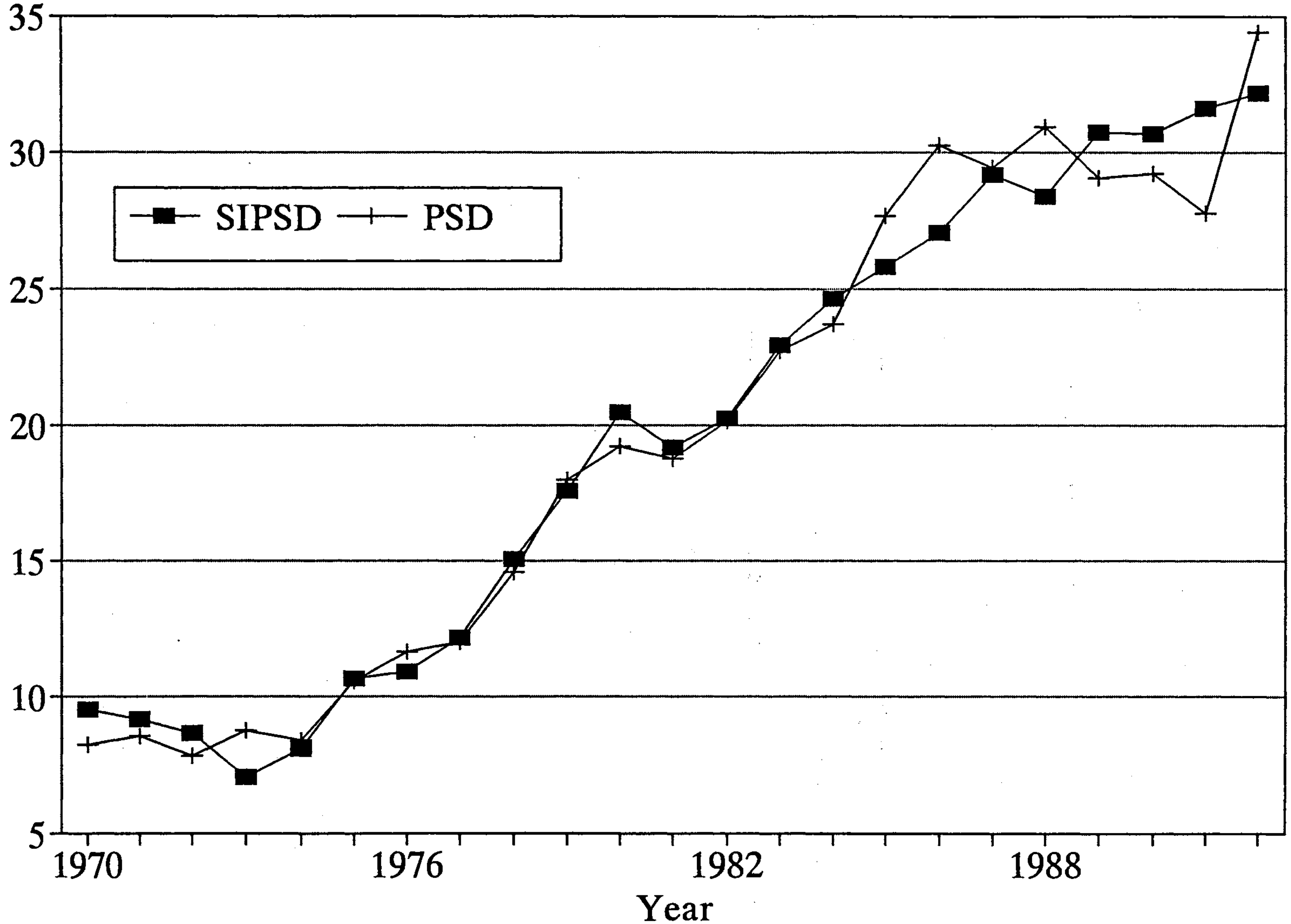

Figure 5.9. Historical Simulation of Per Capita Soybean Disappearance (PSD)

CHAPTER VI

SUMMARY AND CONCLUSIONS

The central objective of the study was to present the impacts of macroeconomic and government policy variables on an import demand system. Korea was taken as a case study in an econometric assessment of the demand system through three levels of marketing channels for wheat, corn and soybeans (which are the most important imported grains in Korea).

Economic forces that influence those markets were investigated in the framework of a system of nine simultaneous equations. This chapter summarizes the procedure for developing the model and presents the summary of the empirical results analyzed in Chapter V.

Data for some potentially important variables were not available. Data for proxies or other appropriate variables replaced those unavailable in our model. In addition, we included a foreign exchange variable as a separate regressor in the model. An annual average Korean won per SDR was used as the exchange rate variable to reflect multi-country inflation effects and trade interdependency instead of using bilateral exchange rates such as won per U.S. dollar. One of the objectives of the study was to include whether the model still reasonably explains the reality that has prevailed throughout the study period.

Despite some shortcomings arising from data unavailability, our model appears to fit well and is statistically sound, and the empirical results capture the important economic forces that exist in actual markets. The estimated coefficients and elasticities are consistent with a priori expectations or real market situations.

Macroeconomic variables such as per capita GDP and foreign exchange rates are significant and elastic for wheat imports. A strong income effect shows the actual upward trends of income and wheat imports. However, income and tax variables are not so significant in wheat disappearance. The inelastic nature of both variables and own price support the fact that wheat is a favorite food for consumers in Korea.

Per capita GDP is inelastic and its effect is not significant in either corn imports or disappearance. Foreign exchange is also inelastic in corn imports. Since meat consumption is found to have a strong complementary effect on corn imports and disappearance, these inelastic relationships are supported.

A significant negative income effect on soybean imports and disappearance may suggest to us potentially important implications. As income increases, the results may show that Korea tends to choose direct imports of beef to match the increasing demand, rather than raising domestic production of beef. Income elasticities for soybean imports and disappearance are inelastic but still responsive, which shows income is a fairly sensitive variable for soybeans. On the other hand, the foreign exchange variable is inelastic in soybean imports. This indicates that soybean imports are not much influenced by exchange rate movements. The interest rate, another macroeconomic variable, is found to explain soybean stocks but is inelastic and not significant, so it does not appear to be a major factor for stockholders.

The exchange rate variable in our study appears to be inelastic for corn and soybean imports while barely elastic in wheat imports. One interesting finding is that our estimated exchange rate elasticities on the import side are clearly lower than those on the export side in Chambers and Just (1981) whose high values were also noted by other empirical studies. Even if this study (won per SDR) and their study (SDR per U.S. dollar) used basically the same kinds of exchange rate variables, this result appears to be more reasonable.

Government purchase prices of corn and soybeans, as government policy variables, are not found to be significant for their corresponding imports. Low estimated elasticities suggest that government programs are not effective to change import levels. However, both policy variables significantly affect levels of stocks as expected. The stock level for each commodity appears to be responsive to changes in corresponding government purchase prices. The policy variable is very inelastic and not significant for wheat stocks. It is found that a policy variable for each commodity still positively affects the level of stocks.

Policy Implications

Knowledge of the relationship between endogenous and exogenous variables is important in policy decisions in response to, for example, exchange rate changes, GDP changes, and changes in import prices. Elasticity estimates are required not only as a basis for policy decisions but also for assessing the effects of changes in particular explanatory variables on imports or disappearance of a commodity.

The positive coefficient of lagged disappearance for each commodity may suggest a continuously increasing disappearance pattern. Understanding the relationships between endogenous and exogenous variables and the sensitivity of endogenous variables with respect to changes in exogenous variables may suggest trade and domestic agricultural policy guidelines.

The relative sizes of the estimates of per capita GDP in the wheat and soybean import equations have more significant effects than the exchange rate. This income effect is also bigger than the exchange rate effect in corn imports but the income effect is not significant.

Wheat imports appears to increase at approximately a one to one basis with the income and exchange rate variables as the estimated elasticities show. The estimated increasing rate of GDP in the next period would indicate the quantity of wheat to be imported in next period unless there is an unusual shock in other variables. When there are unfavorable fluctuations in the world wheat market, meat could be substituted to reduce wheat imports. Fifteen and eight tenths percent of wheat imports could be offset by 10 percent more meat consumption while other situations are stable. However, the significantly positive effect of lagged wheat stocks on imports suggests that wheat imports tend to increase as income goes up even if previous stocks are large. When we consider the superior nature of wheat and the strong positive income effect on imports, it may imply that wheat is a necessity and always available for disappearance.

Wheat stocks are the most sensitive by disappearance, i.e., price and income inelastic, in all stock equations, which means that wheat stockholders respond to the increasing disappearance, and this supports the null hypothesis. Wheat imports are also found to be hurt by the adverse movement of exchange rates. Thus an efficient and consistent operation of wheat stock policy is recommended. When previous wheat stocks are 10 percent larger, imports increase only three percent.

Corn imports do not appear to be responsive to changes in the exchange rate and, especially, in income whereas they are fairly responsive to changes in meat consumption. The complementary effect suggests that corn is also ready to be supplied as an important feed grain to satisfy an increasing demand for meat. Government programs are found not effective in reducing imports. A ten percent increase in the government purchase price reduces corn imports only 2.7 percent, which is about half as sensitive as own import price changes.

Soybean imports are relatively responsive to a government policy program and, unlike other commodities, previous stocks and imports move in different directions. Ten percent more previous stock reduces soybean imports by almost half. The government program is an inelastic variable for soybean stocks. Domestic soybean production is also a fairly responsive contributor to stock accumulation. Thus soybeans are a relatively hopeful crop to reduce foreign dependency and comparatively advantageous to maintain a proper self-sufficiency level. This may be another reason that its self-sufficiency level is relatively higher than those of wheat and corn.

Soybean disappearance has a fairly strong complementary relationship with meat consumption. The increase in meat consumption may be one of the major factors to increase the foreign dependency on soybeans. Since the increasing trend of meat consumption is expected to continue and soybeans are found to substitute corn, deliberate government policy is required to achieve the past level of self-sufficiency.

Limitations and the Need for Further Research

Many necessary data were unavailable for the study. The import price of each commodity was used even when the domestic price of the commodity might have been more appropriate. Data for trade barriers were also unavailable, we thus include other explanatory variables in import equations to eliminate or at least reduce any problems from the absence of trade restriction variables.

Stock equations were relatively not well fitted. Missing variables may have reduced the fitness of the equations, so there was room for those equations to be improved. Storage cost, rent, or other variables could have been included in specifying the equations, but even no proxy variables were available to replace those variables. Since stocks could also be considered government policy variables, more data availability would lead to better policy analysis.

The government purchase prices were considered as main policy variables. Historical data for other government support variables or political instruments were not available, and this could also limit the study.

Since our model is composed of system of equations, further research may include various advanced methodologies. First, in any single equation, an instability may not exist. When the equations in the model are combined and solved simultaneously, it is possible to have structural instability. When we solved all equations simultaneously, the results were fully acceptable, and the model thus looked stable.

Second, simulation models are often used to compare the short-run and long-run responses of one variable to another variable. We sometimes want to predict how a change in one variable is likely to affect other variables through time. For example, forecasting the future impact on market equilibrium of changes in income or changes in import demand. It is possible to examine this dynamic response by calculating multipliers associated with exogenous variables in the model. From the initial change in an exogenous variable, we obtain an import multiplier from the first period change in an endogenous variable, then the changes in the endogenous variable over time provide dynamic multipliers, and we finally obtain the total long-run multiplier which indicates the total long-run change in the endogenous variable that results from a unit change in an exogenous variable. Thus, we are able to capture the dynamic adjustment of the endogenous variable through time.

Third, we may want to use the model to perform some policy experiments to forecast the effects of alternative policies by formulating those policies in terms of changing the values of exogenous variables or coefficients in the model. Those simulation experiments would be compared and policy implications determined.

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