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An agricultural policy and trade model for Morocco

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An agricultural policy and trade model for Morocco

by

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CHAPTER I. INTRODUCTION

Problem Setting

The governments of both developed and developing countries have a history of intervention in their general economies and particularly within their agricultural sectors. An array of policy instruments have been used in this respect, ranging from domestic policy instruments (price supports, input and output subsidies) to border policy instruments (tariffs, quotas, and subsidies). The arguments and reasons to justify these interventions are a function of the nature of the economies. In general, many driving economic and political forces are behind government intervention in agriculture. These forces are mostly generated by economic characteristics unique to agriculture: political power of agricultural lobbies, national self-sufficiency and price stabilization goals, or simply a deep distrust in market mechanisms. Numerous studies have shown that developing countries provide significantly more protection to agriculture than to industry, while in many developing countries, agriculture is taxed and manufacturing is protected from import competition (Anderson and Hayami, 1986; FAO, 1987). This, of course, masks the fact that some subsectors within the agricultural sector have been protected by heavily subsidizing agricultural credit, fertilizer, and other agricultural inputs. For most developing economies, this web of government interventions has reduced agricultural productivity by reducing producers' incentives and has had a negative impact on economic growth (Fulginiti and Perrin, 1991; Kruger, Schiff, and Valdés, 1988).

Because of serious economic difficulties, since the 1980s many developing countries have begun to revise trade and pricing policies, moving from a regulated economy to one more responsive to domestic and international market forces. However, the growth benefits of these unilateral economic reforms may diminish in the absence of global agricultural liberalization. As Valdés (1987) has noted, the direct effect that industrial countries' farm policies have on other countries has three dimensions: they depress world prices and thus developing country export earnings; they result in reduced import costs for the developing countries; and they induce more instability in world prices.

A most striking and common conclusion of recent studies on agricultural liberalization, either global or in Organization for Economic Cooperation and Development (OECD) countries only, is the increase in the stability and the level of world prices (Anderson and Tyers, 1988; Krissoff, Sullivan and Wainio, 1990). The implication of this liberalization for developing countries' agriculture is, however, controversial in the sense that different modeling approaches can show major differences among the potential effects for a given economy. In other words, the implications are related to how disaggregated the model of the agricultural sector is and to the choice of variables, assumptions, and relationships considered in the model. Major issues in the debate on benefits or impacts of policy reform that should be emphasized are limited data, misspecifications of models, and treatment of policies. Research in this area is still rudimentary, and numerous models developed in recent years to quantify the effects of agricultural policy and trade changes in both developed and developing countries suffer from theoretical and empirical deficiencies.

Post independence period

In Morocco, government intervention in agriculture and food production has increased significantly since the country became independent in 1956. The agricultural economy in Morocco can be viewed as mixed because production activities are mostly private, but the markets, prices, and acquisition of key inputs are managed by the State.

The important policy instruments used in the Moroccan agricultural sector can be grouped into:

1. Marketing boards that set grain price and monopolize imports;
2. Input and service subsidies;
3. Regulations and fixation of intermediaries' profit margins in the agro-processing/marketing chain;
4. Consumption subsidies for basic foodstuffs (flour, sugar, and edible oils); and
5. Foreign exchange overvaluation and use of trade and nontrade barriers to insulate sensitive commodities from external shocks (Wenner, 1992; Laraki, 1989; Tuluy et al., 1989).

The different types of interventions in the agricultural sector have resulted heavy budget costs. For grain markets, the cost to the treasury rose from 200 million dirhams (DH) in 1977 to about 1.7 billion DH in 1985, or about 1.5 percent of Gross Domestic Product (GDP) (World Bank, 1987). The most costly item to the treasury from government intervention in cereal markets is the consumer subsidy. This has grown from 27 million DH in 1978 to about 1.2 billion DH in 1984, or about 1.1 percent of GDP, as the government was seeking to maintain the price to the consumer at the 1979 level even with rising import costs (Mateus, 1988). The budgetary constraints for the government were such that millers and other agents intervening in the agro-processing/marketing chain were not reimbursed for their costs and as a result faced severe cashflow constraints. For example, in 1984, outstanding subsidy payments due to millers to fund the consumer subsidy were 743 million DH, or about 30 percent of total expenditure on the soft wheat subsidy program (Mateus, 1988).

For some other measured policies used by the Moroccan government

Table 1.1 Transfers by instruments, 1982-85

Instruments	Level	Level/Total agricultural market value
	(Million DH)	(Percent)
Marketing board	305.00	5.0
Fertilizer	300.00	4.9
Credit	29.00	.5
Irrigation	140.00	2.3
Foreign exchange	-480.00	7.0
Transport	-78.00	1.3

in the agricultural sector, Table 1 provides the level and importance of transfers by policy instrument calculated from Wenner (1992) and MARA (1991) for the 1982-85 period.

Positive values are subsidies and negative values are taxes. Marketing board policy combines the effects of price supports and state trading restrictions on imports. Transport policy corresponds to transportation assistance on imported grain. Irrigation represents irrigation water and capital subsidies. Foreign exchange is the implicit taxes associated with an overvalued exchange rate and movements in the international reference price.

Shortly after independence, Morocco adopted a general import program that defined the customs and trade regimes. Thus, goods were allocated to one of three lists: List A for goods that may be imported freely, list B for goods subject to import licensing, and list C for goods whose imports were prohibited. In 1986, list C was abolished. Based on 1984 data, lists A, B, and C accounted for 82 percent, 17 percent, and 1 percent of total merchandise imports. Because of their sensitivity, most agricultural products, including cereals and livestock products, are subject to control either through licensing or state trading. However, procedures for importing agricultural commodities are nondiscriminatory and provide equal treatment on the basis of price, freight costs, and financing conditions made available by the exporting countries. In 1984, food imports represented about 15 percent of total imports. In addition to quantitative import controls, the Moroccan government has been using tariffs as a means to protect domestic industries. In 1982, the customs tariff system included 8,171 tariff lines (GATT, 1990).

The main objectives of government intervention in agriculture have been to increase agricultural productivity, to attain self-sufficiency for staple commodities, and to provide cheaper food. These objectives can be evaluated by analyzing both the degrees of intervention in Moroccan agriculture estimated by previous research and the performance of key agricultural subsectors before the first agricultural structural adjustment program in 1985. Indeed, average nominal protection rates for the 1960-84 period, reported in Tuluy (1989) and Fulginiti (1992), show sizable discrimination against agriculture in Morocco. Estimates of the degree of direct and indirect intervention in agriculture averaged a tax equivalent of 32 percent. Indirect effects, including both the effect of trade and macroeconomic policies on the real exchange rate and the extent of protection afforded to nonagricultural commodities, had the same impact on agricultural incentives (a tax equivalent of 16 percent) as policies aimed directly at agriculture.

It is thus clear that the policy environment during the 1960-84 period was not conducive to the growth and development of agriculture in Morocco. In fact, annual cereals production decreased by about 3 percent on average during this period. Average yields varied from .5 to 1.1 metric tons per hectare (1 hectare = 2.5 acres). This was far below the technological possibilities of grain production suggested by agronomic studies (MARA and FAO, 1982). For livestock products, the productivity levels have also been too low when compared with those of other developing countries. For example, these levels represented less than 70 percent on average of the Middle East countries (Khaldi, 1984).

The government goal of reducing grain imports has not been that successful. Confronted with demographic pressure evidenced by a population growth rate of 2.6 percent per year, imports have increased threefold from 1960 to 1990. The self-sufficiency ratio (domestic production/domestic demand) for cereals decreased from about 90 percent in the early 1960s to 60 percent in the early 1980s. Thus, the self-sufficiency objective in grains has not been achieved during this period. For livestock products, imports were negligible and self-sufficiency was achieved by the mid-1980s at the expense of consumers who were taxed as compared with the free trade situation. These taxes amounted to 27 percent for meats and 67 percent for milk (MARA et al., 1989).

There is no doubt that the succession of droughts that have hit Morocco since the 1970s has had negative impacts on agriculture. However, government intervention has largely contributed to the decline of agricultural performance. Systematic intervention in the economy and in agriculture, in particular, was primarily generated by the revenue surplus from the phosphate exports boom during the 1970s. As a result, public investment more than tripled during 1974-77, food prices were heavily subsidized, and government employees received a pay raise of 26 percent (Morrisson, 1991). Expansionary policies, resulting in a 7.5 percent annual growth of real GDP for the 1970s, were funded mainly through foreign loans (GATT, 1990). However, the happy days of the early 1970s ended abruptly when phosphate prices fell, oil prices rose, and severe droughts occurred in the early 1980s. As a result, the budget deficit had grown to about 12 percent of GDP, the current account deficit to 13 percent of GDP, and the debt service-exports ratio to 45 percent by 1982 (GATT, 1990; Bourguignon et al., 1992).

Post structural reform

To overcome these critical economic conditions, the government attempted twice to adjust the economy, in 1978 and in 1980, but failed for both internal and external reasons (Bourguignon et al., 1992). The third attempt at policy reform began in 1983 in collaboration with the International Monetary Fund (IMF) and the World Bank.

The major components of the agricultural structural adjustment were (1) liberalizing agricultural and food products pricing and marketing; (2) restructuring the public investment priorities; and (3) rationalizing government agricultural support (World Bank, 1987).

The assessments of the results of the measures implemented since 1983 show that the budget deficit was reduced from 14 percent of GDP in 1982 to 4 percent of GDP in 1988. Food subsidies were reduced from 2.5 percent to less than 1 percent of GDP (GATT, 1990). According to World Bank (1990) estimates, government expenditure declined from about 33 percent of GDP to 27 percent, public investment from 6 percent of GDP to 4 percent of GDP between 1982 and 1988, and agricultural investment fell from 1.4 billion DH in 1982 to 600 million DH in 1988. Significant progress has also been made in reducing subsidies on inputs. Fertilizer subsidies were reduced from 440 million DH in 1985 to 50 million DH in 1990. Prices of wheat bran and sugar beet pulp were increased 60 percent and 17 percent during the 1985-88 period (MARA-DPV, 1991; Bouanani and Tyner, 1991). Furthermore, marketing and prices for durum wheat, corn, and barley were completely freed in 1989, and subsidies on high-quality wheat flour were fully eliminated in 1985.

A significant component of the reform package was trade liberalization. In fact, export taxes on all agricultural products were eliminated, and all export licensing was lifted. On the import side, the maximum tariff was reduced from 400 percent in 1982 to 45 percent in 1988, and the number of products requiring import licensing has been reduced. Only 13 percent of imports needed import authorization in 1988 compared to more than 80 percent in 1982 (GATT, 1990). However, state import and marketing monopolies remain responsible for imports of agricultural and petroleum products. An initiative to link domestic prices to world prices was adopted in 1989 for soft wheat with a safety clause stipulating that domestic prices would not fall below the 1986 real support price in the event of a decline in world market prices. For other cereals, reference prices were determined on the basis of the efficiency of each cereal's market. For example, Casablanca (Morocco) is chosen as the reference market for corn (MARA et al., 1992).

To improve the current account balance, a series of exchange rate devaluations has taken place between 1982 and 1988. The depreciation of the real exchange rate by more than 25 percent generated a growing surplus in 1987 and in 1988 (Morrisson, 1991).

Thus, the current situation of Morocco's economy indicates a strong commitment to economic reform. It also reflects a period of transition from a regulated environment to one that is driven more by market forces. A question that should be asked at this stage is what impact these reforms have on agricultural sector performance. The answer is not obvious because of the dynamic interactions among various subsectors within agriculture and sectoral linkages within the economy.

Analytical models

To better understand and assess the agricultural economy's response to alternative policy strategies, an analytical framework of the Moroccan agricultural sector that has multimarket is required. The few studies that have assessed the effects of some components of the structural adjustment on the Moroccan agricultural sector and available at this time are the World Bank's computable general equilibrium (CGE) models in which the agricultural sector is not well represented or disaggregated (Mateus, 1988; Morrisson, 1989), the noneconomic version of a multimarket simulation model developed by the World Bank and implemented by the Ministry of Agriculture (Aloui et al., 1989), and some single and multicommodity ad hoc models (Baijou, 1990; Britel, 1990; Esslimi, 1990; Moulay-Benaissa, 1992).

Mateus (1988) developed an econometric model for the Moroccan cereal subsector using time series data from 1959 to 1984. The model was used to simulate the behavior of producers and consumers in response to policy reforms in grain markets. The demand system was a Linear Expenditure, and the supply system was from a Cobb-Douglas type of production function. Grain imports were estimated as a residual and added to production. Based on cereals import controls, this model assumed a closed economy. Despite its ease of estimation, this model imposed too much structure on technology and on the demand system. Its results are limited in the sense that it can not reflect the behavior of a reformed and open cereals subsector linked to the world market, and it ignored the linkages of the grain market to other markets such as livestock.

The multimarket simulation model created by Aloui, Dethier, and Houmy (1989) was developed from the World Bank's trade modeling system (Braverman and Hammer, 1988). It is an adaptation of the original model by Yotopoulos and Lau (1974). This version does not require complicated calibration techniques and specific functional forms. It is a differentiated version of the model where the market clearing equations are totally differentiated so that changes in the outcome of interest can be solved in terms of changes in the available policy options. Even though it can represent the outcomes of policy reform, the model is not that flexible. Quantitative restrictions on cereals imports can not be represented, and government decisions are assumed exogenous. Another drawback of this version is that supply-demand elasticities can not easily be related to specific assumptions about consumer preferences and production technology. Much of the interpretation of the results hinges upon the subjective judgments of the users.

Morrisson (1989) applied a macro-micro model, developed by Bourguignon, Branson, and de Melo (1989), to Morocco from 1980 to 1986. This model integrates a standard CGE model and macroeconomic closure. The main objective of this study was to assess the implications of structural adjustment on income distribution and poverty in Morocco. A highly aggregated agricultural sector is considered as one of the six representing the Moroccan economy. Despite its emphasis on the linkages between agriculture and the rest of the economy, this study ignores the adjustments within the agriculture as a result of macroeconomic stabilization programs. As far as primary exports are considered, agricultural exports, such as citrus and vegetables, are also ignored in this model. The failure to fully represent the agricultural sector in Morocco may provide false signals to policymakers about income distribution responses to structural adjustments.

Baijou (1990) also applied the general econometric spreadsheet simulator model to the Moroccan agricultural sector. A double logarithmic form was used to estimate both supply and demand functions. However, elasticity estimates were considered by the author too inaccurate to be used for policy simulation, because the elasticity matrices were completed from previous research results on Moroccan agriculture, in particular, Laraki (1989). Furthermore, the assumption of a double logarithmic form for the supply and demand functions places many prior restrictions on production technology and is generally inconsistent with the description of consumers' behavior in the context of utility maximization.

The common feature of most studies on Moroccan agriculture is either lack of a rigorous theoretical foundation or that the agricultural sector is not disaggregated sufficiently to capture most of the intersectorial and intrasectorial adjustment in response to policy reforms.

The focus of this study is thus to partially fill this gap by constructing a disaggregated and analytically and theoretically well-based model to assess the effects of some agricultural policy and trade reforms in Morocco. This study develops a more rigorous econometric model than has been available to date. Even though collecting and processing of data was a challenging task, the resulting model can provide a strong and valuable analysis tool that fits the needs of policymakers and can strengthen the Ministry of Agriculture's policy analysis and monitoring capability. In terms of improved policy analysis and forecasting, the benefits for improved policy and strategic decisions of the private and public sectors of the model should outweigh the added cost involved in building it.

Objective

It has not been a tradition in Morocco to apply analytical models to evaluate alternative policy effects within the agricultural sector. Analysts and policymakers only developed an interest in modeling in the late 1980s. From previous studies of Moroccan agriculture, it appears that added model development is needed for the agricultural sector in order to capture more of the linkages within it and to be able to identify and assess adjustments in cereals and livestock production that may occur in response to alternative policy actions.

This study proposes to represent explicitly the main agricultural products (cereals and livestock, in particular), and important inputs in a multiproduct technology framework and in the context of an integrated system consistent with endogenous behavior of producer, consumer, and government. The model is structural and derived explicitly from relevant economic theory of producer and consumer behavior.

The approach proposed for the Moroccan cereals and livestock subsectors is to estimate a multiple-input, multiple-output profit function in a dual framework. In order to represent policy instruments adequately and keep track of linkages essential for analyzing the effects of agricultural policy changes, it also is important to supplement this model with government pricing behavior and the sectors of household consumption and external trade.

The specific objectives of the study are:

1. To construct and estimate a coherent set of interrelated supply functions for cereals (wheat, barley, and corn), livestock products (red meat, chicken, and milk), and input/feed demand functions for fertilizer, labor, wheat bran, coarse grains, and other feed;
2. To estimate food demand for cereals and livestock products;
3. To estimate import demand functions for cereals;
4. To construct and estimate a model for government pricing behavior; and
5. To simulate production, consumption, and trade responses to exogenous economic stimuli such as subsidies, and to analyze the

implications of subsidized exports of the major grain suppliers (United States and European Union) and food assistance on Moroccan agricultural economy.

Organization of the Study

The present study is organized into seven chapters. Chapter 1 discusses the problem and gives the objectives of the study. This chapter also reviews some government policies that have affected agriculture in Morocco. Chapter 2 provides an overview of Moroccan agriculture and the contribution of the cereals and livestock subsectors. Chapter 3 presents the theoretical framework that has been used to construct a satisfactory model for Moroccan agriculture. Chapter 4 explains how various data series are developed and also outlines the econometric estimation procedures used in the empirical work. In Chapter 5, empirical results and their interpretation are provided. Chapter 6 presents the model validation exercises and discusses the results of policy simulations. Finally, Chapter 7 summarizes the major empirical findings of the study, identifies strength and weaknesses of the present Moroccan agricultural and trade model, and suggests possible improvements.

CHAPTER II. BACKGROUND OF THE MOROCCAN AGRICULTURAL SECTOR

Since independence in 1956, agricultural growth and development have been a priority for the Moroccan economy. Agricultural activities in 1989 contributed approximately 17 percent of Gross Domestic Product (GDP), employed about 40 percent of the labor force, generated about 25 percent of total export earnings, and directly and indirectly supported more than 50 percent of the population.

Agricultural development is significantly influenced by weather. Indeed, the importance of the agricultural sector declined, as evidenced by its slipping to 15 percent of GDP in 1981 when the drought severely affected the agricultural performance and, therefore, the whole economy. The problems are much more pronounced when differences in performance in the irrigated and rain-fed subsectors are examined. The 7.8 million hectares of agricultural land are largely devoted to cereals, particularly wheat and barley, citrus, and olives. Only 10 percent of the land is irrigated and primarily devoted to sugar beets, sugar cane, oilseeds, and vegetables. Furthermore, public investment favoring irrigated areas, as well as the drought, has made productivity gains highly variable in rain-fed areas; thus the year-to-year variability of agricultural output is closely related to rainfall. The system of land tenure and slow technology adoption have also contributed to low productivity gains.

Besides these structural and weather constraints, macroeconomic and sectorial policies have negatively affected Moroccan agriculture and hence the domestic food supply. Indeed, the overvalued exchange rate and highly regulated foreign trade had disadvantaged agricultural exports and, consequently, generated disincentives for farmers to improve their productivity. The agricultural price system, characterized by systematic controls of prices and regulations of major agro-industrial activities, has also contributed to this situation.

In socioeconomic terms, cereals and livestock are considered as the most important activities in the Moroccan agricultural sector. Thus, prior the development of a model for policy evaluation, it is essential to understand the structure and characteristics of these two subsectors.

Cereals Subsector

The cereals subsector represents more than 30 percent of the agricultural gross domestic product (AGDP), employs about 45 percent of agricultural labor, and utilizes more than 60 percent of agricultural land and 80 percent of planted land. The major cereals grains are soft wheat, durum wheat, barley, and, to a lesser extent, corn. These crops are predominantly grown in the rain-fed areas where limited use is made of high-yielding varieties, fertilizers, and machinery. Since the 1960s, cereal production has fluctuated dramatically due mainly to chronic droughts. During the period 1960-90, average yield for all cereals varied from .3 to 1.5 metric tons per hectare (mt/ha).

Cereals are also a staple in the Moroccan diet with more than 24 percent of food expenditure and the main source of caloric intake; about 64 percent of total calories came from cereals in the early 1980s (MARA, 1984). On average, annual per capita consumption of cereals decreased from 216.4 kilograms (kg) in 1970 to 210.4 kg in 1985, or a drop of only .17 percent (MP-DS, 1985). The principal cereals consumed in Morocco are soft wheat, hard or durum wheat, barley, and corn. The share of soft wheat in total consumption of cereals increased from 20 percent in 1969 to 50 percent in 1990. For durum wheat, barley, and corn, the shares decreased from 40 percent, 30 percent, and 10 percent in 1969 to 20 percent, 18 percent, and 5 percent in 1990. This trend is mainly a result of the government's pricing policy of heavily subsidization soft wheat at the expense of other cereals that has been in effect since the early 1970s.

Barley and corn are produced for both human consumption and animal feed. Because of structural problems similar to those of the agricultural sector and a distorted price system, cereals production has not followed rapid demand growth and as a result, imports keep rising. Morocco depends on imports for 30 percent of its total grain consumption. Since the early 1960s, cereals have occupied first place in food imports with more than 60 percent. This import growth has been dominated by soft wheat used in human consumption and corn for feed grain. On average, soft wheat accounts for more than 85 percent of total cereals imports and corn for about 10 percent per year (MARA, 1993). Durum wheat and barley are imported whenever there is urgent need, such as during drought period.

Through the years, Moroccan food grain price policy has had many goals such as food self-sufficiency, ensuring low prices for consumers, ensuring remunerative prices to farmers, and achieving and maintaining food price stability. For political and socioeconomic reasons, some of these potentially conflicting goals have been given greater weight than others. The government intervenes in the cereals market at all stages of production, processing, and consumption. This includes fixing consumer prices for wheat products (flour and bread), setting procurement prices for soft wheat, and until 1989, supporting prices for durum wheat, barley, and corn. Government intervention in the cereals market has been more effective and in favor of soft wheat. In terms of production, the specific procurement policy and the allocation of more land to soft wheat have made this crop's growth the largest in the 1980s. The area allocated to soft wheat has more than doubled during the 1980-90 period. The average yield increased from about .8 mt/ha in the 1970s to 1.4 mt/ha in the 1980s, compared with

1.2 mt/ha for durum wheat, .9 mt/ha for barley, and .7 mt/ha for corn (MARA, 1992a). Since 1974, consumer price subsidies also have targeted soft wheat, and decreasing relative prices of this commodity have increased its domestic demand so that it is now a necessary food in the Moroccan diet. The limited imports and less effective pricing policy generated large fluctuations in output and market prices of durum wheat, barley, and corn. The current government policy is still in favor of soft wheat products, such as low-quality flour, through consumer subsidies.

In Morocco, control and regulation of grain markets are managed by a public agency, the National Cereals and Pulse Office or ONICL, whose role is to ensure that a competitive process occurs in establishing domestic and border prices. ONICL is responsible for purchasing farm-level supplies of cereals grains, storage, processing, and distribution of final products to retailers. To operate these activities, this agency relies on cooperatives (SCAM and CMA), on milling industries, and on licensed traders. Besides the subsidy to millers who sell cereals flour to wholesalers and bakers at a fixed price, ONICL supports the costs of storage, transportation of grains to millers, and transportation of flour to wholesalers. Industrial millers (83 in 1990) are authorized to buy cereals only from licensed traders (SCAM and CMA). The rest of the marketed domestic production (about 45 percent in 1990) was processed by "artisanal" millers (more than 7,900). By maintaining a statutory monopoly over the marketing of grains that enter domestic markets, ONICL ensures a single consumer price throughout the country and availability of grains to all Moroccan regions at the single price.

In the absence of incentives for private grain storage, ONICL holds government grain stocks to smooth out fluctuations in supplies and maintains a strategic stock equivalent to one month of wheat consumption to meet emergency situations. Since 1980, the so-called "security stock" has been changed to a level equivalent to two and one-half months of grain consumption of soft wheat (MARA, 1992c). To operate government stocks, ONICL adjusts the stock levels on the basis of its planned imports, expected domestic production, and the beginning stocks.

Like many countries, the Moroccan government controls imports in order to achieve both internal and external goals. Cereals import decisions are made by ONICL, which monopolizes both internal and external trade of all cereals. Annual grain import needs are determined by this agency, but the Ministry of Finance has effective power. Besides weather variations, external debt has been an important constraint to the government's cereals importing behavior. As a result, credit offers by exporting countries have always been necessary before tendering is allowed.

The United States and the European Community, and France, in particular, have been the major suppliers of grain to Morocco. Their credit offers, credit terms, and availability determine their respective market shares. Morocco imports U.S. grains, soft wheat, in particular, under two forms of credit programs: PL-480 Title I, which is considered as the most extreme form of subsidized credit (Gardner and Skully, 1986), and General Sales Manager or GSM-102 and GSM-103 credit programs where the U.S. government provides the line of credit offered to Morocco. French grain imports to Morocco are covered by blended credits guaranteed by the French government through COFACE or Compagnie Francaise d'Assurance pour le Commerce Exterieur (MARA et al., 1992). The difference between PL-480 and COFACE credit is actually a matter of degree, not of kind.

The cereals subsector also has been a target for input subsidies. As an incentive to production, the government subsidizes seed, irrigation water, fertilizer, credit, and research and extension services. For the fertilizer subsidies, the government monopolizes the import and sale of fertilizer. The difference between manufacturing costs and the guaranteed price is reimbursed by the government.

Livestock Subsector

Farming practices in Morocco can be considered as mixed in the sense that cereals and livestock production are integrated regardless of the size of the farm. All farmers raise livestock, but to varying degrees. It is estimated that 20 percent of the agricultural labor force is absorbed by the livestock sector (Glenn, 1988). Livestock activities contributed approximately 44 percent of agricultural value added in the late 1980s, and their importance to the agricultural sector keeps rising (MARA et al., 1989). Livestock operations include dairy and beef cattle, goats, sheep, and poultry. The main livestock products are red meat, which includes beef, lamb, and to a lesser extent goat; poultry; and milk. Large livestock operations are the exception rather than the rule in Morocco. Most dairy cattle are dual purpose (milk and meat), and specialized beef operations are scarce. Like crops, livestock production is very sensitive to weather variation. In the 1981 drought, the numbers of cattle, sheep, and goats had decreased by 22, 35, and 25 percent (The American University, 1985). In terms of household consumption, meats and dairy products represented more than 26 percent of total food expenditure in 1985. This share keeps rising as the average income increases. Despite the decline in red meat consumption between 1970 and 1985, poultry and fluid milk annual per capita consumption increased from 2 kg and 12 liters (1 liter = 1/2 quart) in 1970 to about 6 kg and 18 liters in 1985. This trend is due mainly to an increase in urban population and a decrease in relative prices of poultry (MP-DS, 1985; MARA, 1989). For religious and cultural reasons, Moroccans do not eat pork, a popular meat in many other countries. Instead beef, lamb, and chicken are the most often consumed meats.

In contrast with cereals for which consumption has been heavily subsidized, meat and milk consumption have been taxed with a tax equivalent to 27 percent for meats and 67 percent for milk.

<u>Red meat</u>

Despite large fluctuations in feed supply, red meat production has been stable during the past several years due basically to high productivity. In Morocco, there are two distinct red meat production systems. The traditional method of raising animals carried on by most farmers is found mostly in the rain-fed areas. This system competes mainly with cereals production in terms of input use, land, and labor, in particular. The second method, consisting of large livestock operations, is found in irrigated regions and high-rainfall areas but carried on by a small number of farmers. As stated in MARA et al. (1989), the modern system of livestock production has no comparative advantage in meat production because of high opportunity costs of feed and land uses. The traditional or less intensive system is, however, more efficient.

To date, red meat domestic production has been sufficient and has kept pace with increasing domestic demand. It can be argued that both productivity improvement and imports prohibition have had a positive impact on meat self-sufficiency. In contrast to cereals and milk, the red meat market is less regulated and only indirectly affected by government pricing policy. Red meat imports have been limited to army needs, and as long as there is no excess demand, this market will remain, with no doubt, highly protected.

<u>Poultry</u>

Since the early 1970s, the poultry industry has rapidly changed in terms of production and technology adoption. Like red meat, poultry is free of direct government intervention, and imports are tightly controlled. However, government pricing policy in the feed market has an impact on production. Indeed, the general decline in poultry production since 1986 has been attributed to a rise in poultry price as a result of feed prices increasing 30 percent over this period (Metzel, 1992). For consumption, Morocco is fully self-sufficient in white meat. The demand for chicken has grown the most during the last decade at the expense of red meat (MP-DS, 1985).

Milk

Milk and, to a lesser extent, other dairy products occupy the second position, after red meat, with 16 percent of total livestock production. Their production growth has averaged 5 percent per year since 1975 when the so-called "Plan Laitier" or Dairy Program was implemented (MARA et al., 1989). This improvement is basically due to improved production practices, technological innovation, and a well-established network of fluid milk collection.

Since 1971, both farmer and consumer prices have been supported by the government. In addition, in 1983 the government set two different producer prices in order to smooth out the milk production between peak and lean seasons. Milk imports are also under government control. Despite government support, this subsector has faced many constraints:

1. Inefficiency of most large-scale dairy farms;
2. Distortions in the milk pricing system generated by government regulations and exacerbated by seasonality of production; and
3. Highly taxed consumer prices (MARA et al., 1989).

Feed products

In Morocco, a wide variety of feedstuffs are used in livestock production. The focus of this section is cereals and by-products from industrial manufacturing. It is estimated that about 50 percent of corn, 40 percent of barley, 20 percent of sorghum, and about 90 percent of oats are used for animal feeds by the livestock subsector (Metzel, 1992). This importance of cereals as feed provides another component of the link between cereals and livestock production and supports the rationality for integrating these two activities in policy analysis. Industrial by-products involve wheat bran, dry beet pulp, and oilseed meal. These are basically used as feed concentrates for livestock.

The expansion of the feeds market has been related to that for livestock products. Feed products have generally increased in proportion with livestock production. Government intervention in the feed market has thus been transmitted to the livestock subsector. In addition to the regulations in the primary products, by-product feeds also have been tightly controlled. The government intervenes at all stages of production, distribution, and imports. Prices are set and margins fixed. Feed components (pulp, bran, and meal) are subsidized to livestock producers to encourage their use. To combat drought impacts on livestock, the government has been directly involved in the distribution of dry beet pulp, barley, and cereal bran to provide feed to drought-affected areas at subsidized rates.

CHAPTER III. THEORETICAL FRAMEWORK

In the past 10 years there has been an important and controversial debate about the merits of agricultural trade liberalization in all economies, and structural adjustment in developing countries in particular. As a result, a considerable body of literature has emerged about open and adjusted economies. The determinations of implications of policy reforms have increasingly relied on modeling, and many food and agricultural sector models have been built. Some have been for descriptive purposes, some for forecasting purposes, and others for policy formulation and decision analysis. Single commodity, multicommodity, and a general equilibrium models have been the analytical tools for the studies. A retrospective paper by Tom Hertel (1990) reviews the development of these models and their use in agricultural trade liberalization studies.

The framework prepared for this study is a hybrid between general equilibrium and partial equilibrium models. It is a realistic representation of the Moroccan agricultural sector in the sense that the interactions among many sectors are explicitly modeled. To put this specification into perspective, it is useful to lay out alternative theoretical and empirical models that have already been developed and implemented.

Throughout the 1950s and the 1960s, agricultural economists demonstrated the effectiveness of a combination of statistics and economic theory with empirical analysis. The early efforts focused on econometric estimation of supply and/or demand of particular commodities (Fox, 1958). Commodity models emerged as a distinct area of economic analysis to provide forecasting and policy analysis. As examples of studies related to agricultural commodities, we report the study by Barr (1973) on wheat in the U.S., Mahe (1979) on beef and pork in France, and Otsuka and Hayami (1985) on rice in Japan. Over the years, these single-equation representations were improved through model specification and estimation and in commodity coverage. In the 1980s, agricultural policy and trade studies by Valdés and Zietz, Gardner, and Tyres and Anderson led the application of partial equilibrium models to the evaluation of policy reforms and trade liberalization.

Despite the gains of a more detailed treatment of agriculture, the partial equilibrium approach lacks the linkages to other sectors and tends to neglect the large leakages out of and into agriculture. In the past few years there have been many attempts to apply general equilibrium approaches to deal with the interactions of the agricultural sector with the rest of the economy. Computable general equilibrium (CGE) has become an attractive tool in carrying out policy analysis. Harris and Cox (1984), Tyres (1985), Adelman and Robinson (1986), Parikh (1987), Robinson (1990), and Burniaux et al. (1990) represent the growing literature in this area. In particular, Hertel (1989) has surveyed the treatment of agriculture in CGE models focusing on issues of aggregation, specification, and modeling of agricultural policies. De Janury and Sadoulet (1987) used the CGE approach to assess the implications of alternative agricultural policies in six developing countries and found the results quite different from those derived from partial equilibrium and multimarket approaches.

The major limitation of most CGE models is they lack consistent estimation procedures based on time-series data to compute necessary parameter estimates and for calibration. The results produced by these models would only suggest potential effects. While the CGE analysis has proven useful in guiding policymakers' decisions, it also has demonstrated the need for more modeling work. One strand of this work has sought to improve the specification of agricultural technology, factor markets, and the demand system for agricultural products (Robinson, 1990). A second strand of this work has concerned modeling linkages of agriculture to world markets.

Estimation of a well-developed agricultural supply is important for forecasting purposes and policy evaluation exercises. Since the late 1950s, supply functions have been estimated for a large number of agricultural commodities using different approaches, econometric analysis of time-series data and/or cross-section data, production functions, and mathematical programming. As described by Nerlove and Bachman (1960), these approaches were complementary rather than competitive. Regarding the positive studies, in particular, important developments have been made of refinements of expectations models (Nelson, 1975; Gardner, 1976; Charas and Johnson, 1982), explicit treatment of risk (Hallam et al., 1982), and estimation procedures. Commodity supply analysis also has been carried out in a multimarket framework where interactions among crops has been included explicitly. Some of these studies include Gadson et al. (1982), Westcott and Hull (1985), and the Food and Agricultural Policy Research Institute (1987; 1988). Most of these studies used ad hoc linear models with no solid theoretical base.

The interaction of agricultural input markets with the supply side of the agricultural sector has been recognized by many studies (Fox and Norcross, 1952; Roop and Zeitner, 1977; Chaimbers and Just, 1982; Adelman and Robinson, 1986) as an important component of the interface between the agricultural sector and the general economy. Comprehensive knowledge of both output interrelationships and input-output linkages is important to help policymakers in formulating public policy and assisting farmers with production decisions. Many studies provide econometric evidence of the jointness of agricultural technology and measures of output supply and input demand elasticities (Weaver, 1983; Shumway, 1983; McKay et al., 1983; Ball, 1988). Understanding intercommodity and distributional consequences requires reliable estimates of commodity supply and input demand responses to changes in prices and environmental factors.

The econometric applications of the new production theory based on duality represent a significant step toward appropriate empirical estimates of agricultural supply and input demand functions (Lau and Yotopoulos, 1972; Yotopoulos et al., 1976; Sidhu and Baanante, 1981). Furthermore, the duality approach has made it easier for economists to investigate other issues, which could not be studied or were ignored before, such as technical change, returns to scale, output bias, and input substitutability. As expressed by Chambers (1988), duality is not so much a panacea as it is an alternative way of looking at the economic world. The main reason for relying heavily on dual results is that it considerably simplifies and clarifies derivations and results that are otherwise quite difficult.

The consumption module, which includes demand for agricultural commodities, forms another important component in applied general equilibrium modeling. In general, throughout the last decades, household consumption studies followed the same pattern of research concerns as the agricultural supply studies did. Commodity demand analysis has been carried out both in a single market and multi-market frameworks. The major limitation of these models is their lack of economic structure. They are driven by reduced form demand elasticities that can not be related back to specific assumptions about consumer preferences (Hertel, 1990). The treatment of household demand, in particular, in applied general equilibrium models also has been too limited, primarily because of the severe data requirements (Clarete and Roumasset, 1986).

Since the 1950s, empirical demand analysis has focused on the estimation of a complete household demand system consistent with the requisites of demand theory. The continuing search for alternative specifications and functional forms to the linear expenditure system proposed by Stone (1954) has led to the use of many models in empirical work. The most important and commonly used are the Rotterdam model (Theil, 1965, 1976; Barten, 1977), the translog model (Christensen, Jorgenson, and Lau, 1975), and more recently, the almost ideal demand system (Deaton and Muellbauer, 1980). These models have attracted the attention of many agricultural policy and trade modelers whith interests in estimating sets of parameter elasticities that can be used in policy assessments with real confidence. Hassan and Johnson (1984), McKenzie and Thomas (1984), Chalfant (1987), Whahl (1989), and Hayes (1990) are a few of these studies. Even in developing countries where data are less plentiful, a good deal of research has been carried out. With good imagination, flexible models of consumer theory were fit to the available data in order to anticipate the changes in consumer demand resulting from changing market and institutional conditions (Ray, 1980; Deaton, 1987).

As the world economies become increasingly interdependent, it is no longer appropriate or useful to build empirical models for closed economies or closed agricultural sectors, in particular. The rapid change in international relations and the expansion of international markets point toward an open system modeling approach. Indeed, for several years researchers have been aware of this phenomenon. Many issues, such as application of international trade theory to agriculture, agricultural trade models, trade policy, prices in international agricultural trade, agricultural protectionism, and agricultural trade liberalization, have been described and appraised in a number of studies (Johnson, 1973, 1977; Josling, 1977;

Tyers,1984; McCalla and Josling, 1981; Baldwin, 1989; Goldin and Knudsen, 1990).

In the 1960s, most agricultural trade models were specified as one-commodity systems. They were built to understand structure, to evaluate alternative policies, and to carry out forecasting. Market shares and the development of spatial equilibrium models were important (Bawden, 1966; Takayama and Judge, 1971). The early empirical spatial models of agricultural trade were built in the mid-1960s (Schmitz, 1968; Bjarnason, 1967; McGarry, 1968). Because of their simplicity and ease of simulation, spatial equilibrium trade models with linear functions have been widely implemented (Heady and Srivastava, 1965; Hall et al., 1968; Keo, 1984).

The analytical framework that captured most of applied economists' attention is the nonspatial equilibrium model. It is a special case of spatial equilibrium models in that it does not identify trade flows among specific regions, and only the net trade for each trading country. The main advantage of these models is that they are cheaper and easier to solve than are the spatial equilibrium models (Thompson and Abbott, 1982). A number of the nonspatial agricultural trade models are explicitly specified and estimated within a general framework encompassing domestic market models and price linkages equations (Devadoss et al., 1989; Roningen et al., 1991). Most of these use partial equilibrium but could deal with multiple products and/or multiple countries' interactions through price linkages.

Nonspatial price equilibrium models also have been considered in a general equilibrium structure. One earlier attempt to build a computable general equilibrium trade model with an emphasis on agricultural trade is the one initiated by the International Institute for Applied Systems Analysis (IIASA) in Austria. The system of linked national models of IIASA, called the Basic Linked System (BLS), was used by Parikh et al. (1988) and Frohberg and Parikh (1990) to assess the implications of agricultural trade liberalization on developing countries' economies and institutions and continues to be updated at the Center for Agricultural and Rural Development (CARD) at Iowa State University, Ames (Eswaramoorthy, 1991). Recent general equilibrium trade models, which include agriculture as one or more sectors, have been built or used by Robinson (1990) and Loo and Tower (1990) for a single country, and Burniaux et al. (1990) for multiple world regions. Over the past decade, as world markets for agricultural products become increasingly recognized as distorted through the use of tariffs, nontariff barriers, and export subsidies, the emphasis of modeling efforts have shifted to measuring the gains from trade liberalization using partial equilibrium models (Anderson and Tyers, 1990; Zietz and Valdés, 1990) and economywide computable general equilibrium models (Burniaux et al., 1990a; 1990b; Sadoulet and de Janvry, 1990).

Recent developments in international trade theory have relaxed many assumptions of the traditional models. For agricultural trade, product differentiation, imperfect competition, and risk and imperfect information has been considered by agricultural trade economists as the most relevant modifications. Related to the current research, the emphasis of this review is differentiated product models. Agricultural trade under imperfect competition has been investigated by a number of authors, for example, Caves and Pugel (1982), Paarlberg and Abbott (1986), and Thursby and Thursby (1990). Surveys on uncertainty and imperfect information in trade models are provided by Pomery (1984) and Grinols (1987).

Differentiated product models recognize that agricultural products are not perfectly homogeneous. In practice, different qualities and other aspects of heterogeneity, such as reliability of supply, discounted prices, or political bias of governments in favor of particular suppliers, contribute to product differentiation. One of the most popular specifications in this area is the Armington (1969) model. It is a model of trade in products differentiated by country or regional origin, based on a two-stage budgeting process. In the first stage, total expenditures for the good are determined on the basis of a homothetic, weakly separable utility function subject to a budget constraint. At the second stage, the allocation of expenditure on imports from each source is then decided according to a constant elasticity of substitution (CES) function to minimize costs. The Armington model has been extensively used in agricultural trade modeling (Johnson et al., 1979; Sarris, 1983; Duffy et al., 1990; Ito et al., 1990).

Despite its simplicity and ease of estimation, the Armington model has been criticized for imposing homotheticity and separability on the underlying utility function, excluding domestic production from import share functions, and for using CES functional forms. Winters (1984) and Alston (1990) have shown that these restrictions are not reasonable. Davis and Kruse (1993) have shown that the Almost Ideal Demand System (AIDS) or Rotterdam specification performs better than the Armington model, which yields biased measures of first-stage elasticities.

The past few years have seen a tremendous effort to empirically investigate the behavior of foreign trade flows. Elasticities of import demand and export supply are increasingly used in applied agricultural trade to assess the trade barrier implications and to examine trade policy options. There have been many studies designated to estimate import and export functions disaggregated by commodities. Magee (1975) provides an excellent review of the early models. As the data become available and adequate, a number of estimations also have been made for developing countries (Khan, 1975; Weisskoff, 1979). Different model specifications for import demand functions have appeared. Sarris (1981) reviews most of these developments. The main point is that the economic theory does not provide much assistance to choosing the appropriate functional forms and that the choice is rather made on grounds of convenience.

Import demand has been estimated primarily by two methods. The first is the traditional trade commodity models, which take an excessively free trade view of agricultural markets. Under this restriction, trade is considered as a residual of domestic supply and demand. As a result, import elasticity is the sum of domestic demand and supply elasticities weighted by import shares (Tweeten, 1967; Johnson, 1977; Roe et al., 1986). The second methodology treats import demand as the outcome of government intervention in the foreign trade market. Recognizing this phenomenon, Abbott (1978), Sarris and Freebairn (1983), and Kim (1986) used a formal model of endogenous government behavior to derive import demand functions and to incorporate the quantitative impacts of pricing policies in these functions. The issue of quantitative restrictions also has received the attention of many international trade economists. Hemphill (1974), Ghose et al. (1986), and Moran (1989) developed analytical frameworks designed to address the issue of foreign exchange constraints on imports in less developed countries. Gerrard and Roe (1983) used a government behavioral model to simulate the effect of grain self-sufficiency on external trade in Tanzania.

An issue related to import demand elasticities is price transmission between domestic price and world price. The first attempt at measuring the degree of insulation of the domestic market from world market shocks was encountered by Johnson (1977) and Tweeten

(1977) in their estimation of elasticity of foreign demand for U.S. agricultural products. Noticing that the Johnson-Tweeten estimates did not account for government policies, Bredahl et al. (1979) created an alternative procedure in which the price transmission elasticity is zero or near zero if governments intervene and one otherwise. Going one step further, Sarris and Freebairn (1983) and Roe et al. (1986) expanded the Abbott (1978) model and derived price transmission functions consistent with an explicit government behavior in the international grain markets. It is believed that besides world price other policy variables, such as import capacity, balance of payments constraints, and/or food security, might be added to improve the specification and get reasonable price elasticities.

The issue of export subsidies also has been addressed in international trade literature. In standard trade theory, export subsidy is an irrational policy both for the small country, which has no impact on its terms of trade, and for the large country, which can influence its terms of trade. However, the development of several frameworks based on the relaxation of the assumptions of the traditional competitive model has produced controversial results. Relaxing the assumption of homogenous goods and putting a higher marginal weight on the welfare of producers, Paarlberg (1984) showed that an export subsidy could be welfare improving. Another justification for the use of global export subsidies arises from an exporter's failure to exploit market power in another good. Itoh and Kiyono (1987) used a three-good trade model to argue that subsidies on a good that is exported in small quantities can increase the national welfare in the subsidizing country. Also using a three-good model, Feenstra (1986) showed that it is possible for the pattern of substitutability and complementarity across goods to allow subsidies to increase welfare.

Export subsidies also can be beneficial with imperfectly competitive markets or when increasing returns to scale are present (Tower, 1983; Spencer and Brander, 1985). A version of this phenomenon is the use of targeted export subsidies that are essentially price discrimination. The exporting country must be able to separate markets and sell at different prices in different markets. Abbott, Paarlberg, and Sharples (1987) used a standard general equilibrium model of international trade to demonstrate that targeted export subsidies can improve the social welfare of the subsidizing country. However, the empirical analysis of the world wheat trade with this model indicated that subsidies produce large disruptions in world trade and yield very small net gains in U.S. welfare.

Bohman, Carter, and Dorfman (1991) used a general equilibrium approach to find that the potential for a targeted export subsidy to be welfare increasing is inversely related to the size of the subsidized market as well as to the relative size of the income elasticities. Subsequently, Anania, Bohman, and Carter (1992) argued that the United States has been unable to separate wheat markets and sell a significant share of exports at a higher price in nonexport enhancement program (EEP) markets such as Japan, Korea, and Taiwan.

Export subsidies are an important form of agricultural trade policy for larger traders such as the United States and European Union. The effort to expand U.S. farm exports and to counter EU export subsidies has been approached with several programs. The most important program is the EEP. The EEP uses surplus agricultural commodities from Commodity Credit Corporation (CCC) stocks to reimburse exporters and to permit them to meet competitors' prices in targeted markets. Seventy percent of all EEP bonuses between 1985 and 1989 were devoted to wheat or flour exports (Seitzinger and Paarlberg, 1989). For the European Union, export restitutions equal to the difference between the EU market price and the world price are used to export wheat to foreign markets. Abbott (1985) argued that the countries receiving U.S. export subsidies were chosen only because of their responsiveness to a lower import price and, therefore, may generate additional U.S. market shares in their respective markets.

The U.S. government has been using a variety of programs to boost U.S. agricultural exports (Grigsby and Jabara, 1984). Abbott (1985) classified these programs as those that alter the border price faced by an importer, those that increase importer expenditure, and those that alter technology and consumer behavior in potential importing nations to increase demand for U.S. agricultural exports. The most widely studied of such policies is PL480. The impact of either export subsidy or food aid policies on the receiving countries' economies has been controversial. Despite humanitarian objectives that involve help for the needy, these policies have been criticized as being commodity surplus dumping policies that have hindered agricultural development in the targeted countries. Isenman and Singer (1977) have showed the disincentive effect of PL480 on a recipient's domestic agricultural production. Sarris et al. (1979) found that PL480 imports were additional to commercial imports only partially in most instances. In a study of Brazil's grain sector, Hall (1980) observed that PL480 wheat imports generated an increase in domestic wheat production but displaced commercial wheat imports. Alternatively, Rogers et al. (1972) found that PL480 shipments did not substitute for commercial imports but rather created additional demand. Abbott (1985) argued that the use of export subsidies, credit, or aid as a means of generating additional agricultural imports is likely to be expensive and an inefficient mechanism for both donor and recipient countries. To identify targets to apply subsidies or credit, Abbott suggested that governments should seek the more elastic markets where the price transmission elasticities are high. Aid should go where income elasticities and expenditures are greater or where restrictions may be effectively employed to ensure additionality of imports.

Modeling Approach

As in many developing countries, the agricultural firms in Morocco use multiproduct technologies. Any model designed to deal with the price policies followed by the Moroccan government should thus take into account the technology structure, output supply, and input demand sensitivities to these policies. Numerous modeling approaches for representing sector behavior, either normative or positive (or both), are now available in the literature (Rausser, 1982; Goldin et al., 1990). General equilibrium and partial equilibrium models have been the two broad frameworks widely used in modeling studies. This study is concerned with the specification and estimation of a multisector econometric model of an open economy. This model treats both the production structure and the demand system in a consistent framework. It is a way of modeling the behavior of three agents--producers, consumers, and government.

Modeling the processing and distribution industry for agriculture in Morocco in a rigorous way is a cumbersome task in the context of the current study. Given the available data on farm and retail prices and the market structure of the food-processing marketing system in Morocco, which fulfills most of the requirements of a competitive market structure (MARA, 1992d; MARA, 1989), we consider that prices, either established by a price support program, as is the case for cereals, or market determined, in the case of meats, are the integrating force between market levels. Thus, to avoid model specification complexities and to make the model understandable by decision makers or users, no major treatment is given to the behavior of intermediaries in the cereals and livestock product markets.

Model specification

Conceptually, the model has three basic components. The first component concerns both the supply of cereals and livestock commodities and the demand for factor inputs. The second component includes the demand for food. The third component deals with imports of cereals. The main assumptions of the study are summarized as follows.

1. There are three agents in the agricultural economy: farmers, households, and government.
2. Farmers are price takers in input and output markets.
3. Multiproduct technology farm firms maximize expected profit and are risk neutral. In general, output prices are not known when producers make input and output decisions. However, the risk neutral producer behaves as if prices are known with certainty and equal to the expected value (Sandmo, 1971). As a result, a profit function with certainty is equivalent to the expected profit function for risk neutral producers.
4. Farm production decisions are separable from household consumption decisions when output and variable input prices are determined in the market.
5. N identical consumers minimize a given expenditure function.
6. The government monopolizes imports of cereals and is price taker on the world market.
7. Net trade of livestock products is given by their excess demand.

Agricultural output supply and input demand

This part of the model is analyzed using duality theory in a manner similar to some previous studies by Antle and Aitah (1986); Aradhyula (1989); Fulginiti and Perrin (1990); Shumway (1983); Shumway, Saez, and Gottret (1988); and Huffman and Evenson (1989). Under the assumption that Moroccan farmers maximize economic profits, and given the integration of crop and livestock production on most Moroccan farms, a multiproduct profit function is used to estimate five input demand functions (labor, fertilizer, wheat brain, feed grain, and other feed items), and output supply functions for crop commodities (soft wheat, hard wheat, barley, and corn), and livestock commodities (red meat, chicken, and milk). Land, precipitation, machinery use, and animal stocks are considered as fixed inputs. Time is included to index technological change. Production dynamics are modeled in a largely ad hoc manner in the sense that lagged structures are incorporated to reflect partial adjustments in both crop and livestock production responses to input and output prices. Lack of more disaggregated data on the livestock subsector, in particular, makes modeling production dynamics in an intertemporal optimizing framework similar to that in Mclaren and Cooper (1980) and Eswaramoorthy (1991) difficult, if not impossible.

The main reason for specifying the dual profit function rather than its primal production or transformation function is that the dual approach simplifies the derivation of output supply and input demand relationships from the profit function by simple differentiation. Also, as stated by Shumway (1983) and Lopez (1984), contrary to the primal approach, the dual framework does not require output specific input use; only aggregate input use is sufficient for estimation. This feature is of great importance because in Morocco data on crop-specific input use are not available. As McFadden (1971) has shown, there is a one-to-one correspondence between the set of concave production functions and the set of convex profit functions. Therefore, without loss of generality, one can use only the profit function in the applied production analysis.

A primary objective of applied production analysis is empirical measurement of the economically relevant information that characterizes the economic agent's behavior. The estimation of product supply and input demand relationships requires the specification of a functional form that imposes the plausible restrictions on the function being estimated. To be flexible, a function form in n variables should have at least $\frac{1}{2}(n + 1)(n + 2)$ distinct parameters. The contribution of flexible functional forms (FFF) to empirical analysis lies not in their approximation properties but in the fact that they place fewer restrictions prior to estimation than the more traditional Leontief, Cobb-Douglas, and CES technologies (Chambers, 1988).

Besides measuring all the economically relevant effects, research economy suggests choosing functional forms that are easy to estimate and useful in empirical applications. Several FFFs for profit function have been proposed by Diewert (1973) and Baffes and Vasavada (1989). Generalized Leontief (Diewert, 1971), translog (Christensen et al., 1973), normalized quadratic (Lau, 1978), and generalized McFadden (Diewert and Wales, 1987) are frequently implemented in agricultural production analysis.

Here, a normalized quadratic functional form is used to model Moroccan agricultural production technology. It is the normalized version of the quadratic form originally proposed by Lau (1974) and applied in agricultural production analysis by Shumway (1983), Moschini (1988), Aradhyula (1989), and Huffman and Evenson (1989). This functional form represents a second-order Taylor series approximation to the true and unknown profit function.

The restricted or variable profit function can be defined as:

$$\Pi(P,W,Z)=\max\{PY-WX;(Y,X,Z)\in S\},$$

where

Π is profit (receipts less variable costs);

S is the production possibilities set;

Y is a vector of outputs that includes soft wheat, hard wheat, corn, barley, red meat, chicken, and milk;

X is a vector of variable inputs that includes fertilizer, labor, wheat bran, coarse grains, and other feed items;

Z is a vector of fixed inputs that includes land, precipitation, animal stock, machinery use, and trend as an index for technological change;

P is a vector of output prices; and

W is a vector of variable input prices.

The profit function has the following properties (Chambers, 1988):

1. It is nonnegative for all positive P and W and any Z.
2. It is homogenous of degree one in P and W.
3. It is convex and continuous in P and W for every Z.
4. It is concave and continuous in Z for every P and W.
5. It is nondecreasing in P, nonincreasing in W, and nondecreasing in Z.

If the profit function is differentiable in its arguments, then output supply and variable input demand equations can be obtained by using Hotelling's lemma:

$$\delta\Pi(P,W,Z)/\delta P_i = Y_i(P,W,Z) \quad i^{th} \text{ output supply}$$

$$\delta\Pi(P,W,Z)/\delta W_j = -X_j(P,W,Z) \quad j^{th} \text{ variable input demand}$$

The normalized quadratic specification is:

$$\Pi^*(P,W,Z) = a_0 + \Sigma a_i P_i + \Sigma b_j w_j + \Sigma c_k z_k + \tfrac{1}{2}\Sigma\Sigma a_{im} P_i P_m + \tfrac{1}{2}\Sigma\Sigma b_{jn} W_j W_n + \tfrac{1}{2}\Sigma\Sigma c_{ki} Z_k Z_i + \Sigma\Sigma d_{ij} P_i W_j + \Sigma\Sigma f_{ik} P_i Z_k + \Sigma\Sigma h_{jk} W_j Z_k,$$

where Π^* is the normalized profit (profit divided by the price of j^{th} variable input) and a, b, c, d, f, and h are parameters to be estimated. Π^* is linearly homogeneous by construction, while symmetry requires that

$$a_{im}=a_{mi};b_{jn}=b_{nj};d_{ij}=d_{ji} \text{ for all } i,j,m,n.$$

Output supply and input demand functions to be estimated are:

$$\delta\Pi^*/\delta P_i=Y_i=a_i+\Sigma a_{im}P_m+\Sigma d_{ij}W_j+\Sigma f_{ik}Z_k$$

$$\delta\Pi^*/\delta W_j=-X_j=b_j+\Sigma b_{jn}W_n+\Sigma d_{ij}P_i+\Sigma h_{jk}Z_k.$$

A normalized quadratic profit function satisfies accepted definitions of flexibility and has a Hessian of constants so that the curvature property of convexity can be tested globally. Also, this form allows restricted profit to be negative, a possibility that the translog functional form does not provide, and output supply and input demand equations to be linear in variables and parameters, a feature that eases estimation.

Domestic demand for final goods

Since independence, the share of household food expenditure in total expenditures has steadily decreased. The results from the three household expenditure surveys show that food purchases by households in 1985 represented 48.6 percent of total expenditures, down from 54 percent in 1970 and 70.2 percent in 1960. This trend is mainly attributed to the emerging needs for nonfood goods such as education and transport. In Morocco, the food expenditure share is still relatively high when compared with other countries, such as Tunisia (45 percent) and France (26.4 percent) (MP-DS,1985). According to a 1984-85 consumer survey, more than 50 percent of the food expenditure was allocated to cereals, meats, and dairy products.

Sugar, vegetables, and fats also are considered important in the Moroccan diet. However, the inadequacy of data for these commodities has limited us to cereals, meats, and milk. In addition, large food budget shares and pricing policy contrasts make cereals and livestock commodities an important and interesting case to investigate in the context of consumption responses to policy reform.

Thus, the household demand functions to be estimated in the current study are for cereals (wheat, barley, and corn), meats (red meat and chicken), and milk. After consideration of various functional forms used in the estimation of demand systems, the Almost Ideal Demand System (AIDS) has been chosen and is used to estimate these demand equations. The AIDS has many attributes: (1) it gives an arbitrary first-order approximation to any demand system, (2) it satisfies the axioms of choice exactly, (3) it aggregates perfectly over consumers, (4) it has a functional form consistent with previous household budget data, (5) it is simple to estimate, and (6) it can be used to test the restrictions of homogeneity and symmetry (Deaton and Muellbauer, 1980).

The AIDS model is based on the following cost function:

$$\mathrm{Log}C(u,p)=\alpha_0+\sum\alpha_j \log p_j+\tfrac{1}{2}\sum\sum\partial_{ij}\log p_i \log p_j+u\beta_0\Pi p^{\beta}{}_j$$

$i,j=1,\ldots,M$ goods.

Using Shephard's Lemma, logarithmic differentiation of the AIDS cost function gives the budget shares as a function of prices and total expenditure:

$$w_i=a_i+\sum\partial_{ij}\ln p_j+\beta_i \ln(X/P) \qquad i,j=1,\ldots,M$$

w_i is the expenditure share of the i^{th} commodity.

p_j is the j^{th} commodity's retail price,

P is the price index defined by $\log P=\alpha_0+\sum_k\alpha_k \log p_k+\tfrac{1}{2}\sum_{jk}\sum\sum\partial_{kj}\log p_k \log p_j$, and

X is total expenditure on the M goods.

For estimation convenience, the price index P can be approximated using Stone's index:

$$\ln P=\sum s_k \ln p_k,$$

where s_k is the share of the k^{th} commodity. The advantage of this approximation is that the demand system is linear in the structural parameters. Thus, for this analysis, a Linear Approximate AIDS

(LA[AIDS]) is used to estimate the demand system for soft wheat, durum wheat, barley, corn, red meat, chicken, and milk using the time series disappearances data.

The standard restrictions from consumer theory and for this case can be represented as:

1. $\Sigma_i \alpha_i = 1$ $\Sigma_i \partial_{ij} = 0$ $\Sigma_i \beta_i = 0$ (Adding-up),
2. $\Sigma_i \partial_{ij} = 0$ (Homogeneity), and
3. $\partial_{ij} = \partial_{ji}$ (Symmetry)

Import demand functions

Morocco's main imports are crude petroleum, cereals, and vegetable oils. The most important concern of the Moroccan government has been its dependence on the rest of the world to feed its population. As far as imports are concerned, Morocco spends on average $4 billion every year with crude oil accounting for 20 percent and food for about 13 percent or $500 million in any given year (Wenner, 1992).

The importance of cereals in Morocco's trade issues and the availability of adequate data have led us to limit our commodity coverage to cereals to estimate import demand functions. Thus, the focus is on cereal imports (soft wheat, hard wheat, corn, and barley). We treat all the four cereals as tradeable even though the frequent zero imports of hard wheat and barley might suggest otherwise. In other words, hard wheat and barley are considered to be potentially tradeable or, alternatively, that all zero observations represent standard corner solutions.

Concerned with the scarcity of its foreign exchange, Morocco has always welcomed any price discount on its imports or feed assistance programs. The question that should be asked at this level concerns the implications of all kind of food assistance for commercial imports and for agricultural development. To deal with this and other issues discussed in Chapter 2, we consider that the cereal imports strategy in Morocco implicitly embodies the optimization of a policy preference function one year at a time. In fact, every year the public agency ONICL calculates grain import needs on the basis of expected domestic supply and demand one year ahead, its foreign exchange reserves and expected balance of payment earnings. This frequent or long-run strategy is often disturbed by what we may call short-run factors. The most important disturbances for cereal imports are foreign assistance in-kind, terms and availability of credit offered by the United States and the European Union, and adjustments in imports because of unanticipated disturbances in supply and demand (drought, mistakes in expectations, etc.)

From the discussion in previous chapters, it appears that the traditional excess demand approach is not appropriate to deal with the Moroccan case and a formal model of government behavior may be a better framework to assess the effect of government intervention on cereal imports and, therefore, on cereal and livestock subsectors. Similar to Armington's procedure but in a more general and consistent framework, we postulate that government import decisions are a two-stage process. In the first stage, the government determines total imports of each type of cereals by minimizing the cost of being out of equilibrium and of making the adjustments to the desired value of imports. In the second stage, the government allocates imports of each cereal among exporters on the basis of export subsidies and credit terms.

For the first stage, we assume that the government is minimizing an annual quadratic welfare loss function that consists of a set of targets for the policy variable (imports) and a set of relative weights attached to the targets.

Minimize

$$W(m_t)=\alpha_1(m_t-ED_t)^2+\alpha_2(m_t-f_t)^2+\alpha_3(m_t-m_{t-1})^2+\alpha_4(m_t-m_t{}^d)^2$$

Subject to

1. $m_t{}^d=m^d(p_t,GDP_t,E_t,FA_t,f_{t-1})$,
2. $S_t{}^*=S_t(P,W,Z)$,
3. $D_t{}^*=D_t{}^H(P,X)+D_t{}^A(P,W,Z)$, and
4. $ED_t=D_t{}^*-S_t{}^*$,

where m_t is the actual volume of imports, and ED_t is the excess demand.

To account for the self-sufficiency goal, the self-sufficiency ratio ($FS_t = S_t{}^*/D_t{}^*$) could be used instead:

f_t is the level of foreign exchange receipts or export earnings plus net capital inflows,

$m_t{}^d$ is the desired or notional level of imports,

E_t is the exchange rate,

FA_t is food aid and/or PL480 imports,

p_t is the unit value of imports,

GDP_t is the Gross Domestic Product, and

$S_t{}^*$ and $D_t{}^*$ are the optimal domestic supply and demand generated by the domestic market conditions.

Solving the above constrained optimization problem gives the imports equation:

$$m_t=\partial_1 FS_t+\partial_2 f_t+\partial_3 m_{t-1}+\partial_4 p_t+\partial_5 GDP_t+\partial_6 E_t+\partial_7 FA_t+\partial_8 f_{t-1}.$$

$\partial_i(i=1,2...,8)$ are the parameters to be estimated and $m_t{}^d$ is assumed linear in its arguments such as:

$$m_t{}^d=\beta_1 p_t+\beta_2 GDP_1,+\beta_3 E_t+\beta_4 FA_t+\beta_5 f_{t-1}$$

For the second stage, we consider an allocation trade model where imports of cereals are distinguished by source. For Moroccan cereal imports, especially for wheat, the United States and European Union represent the main sources. However, for the sake of consistency, we consider the rest of the world (ROW) as the third source of imports.

Using David and Kruse's (1993) comparative results of different specifications of import functions, we implement the AIDS specification to estimate import share equations for cereals and to test the validity of Armington's restrictions:

$$w_i=\alpha_i+\Sigma\partial_{ij}\ln p_j+\beta_i\ln(M/P),$$

where

w_i is the budget share of imports from source i (i=U.S.,EC,ROW),

p_j is the import price from source j,

M is the expenditure on total imports from all sources, and

P is the aggregate price.

We use Stone's price as an approximation:

$$(\ln P=\delta w_k p_k).$$

<u>Pricing behavior model</u>

Like many developing countries, the Moroccan government has, as a principal objective, increasing food production to meet demand at the lowest possible price to consumers. This desire has been the basis for government intervention in food production and its insulation from world market shocks. In essence, prices of cereals, soft wheat in particular, are determined and guaranteed at levels that are different from the equilibrium prices. To enforce domestic price controls throughout the entire country and in order to clear the market at the official prices, the government makes the necessary adjustments in imports or in stocks and uses subsidies.

Even though stocks are a possible government policy that may affect its pricing behavior, decisions regarding the size of stocks and how the government holds reserves are not well known and clear enough to be dealt with in this study.

A second guess about the behavior function of stocks or the structural model generating it is not adopted in this study. Our concern is to investigate the implications of stocks on hand or deviations from a long-run target level of carryover stocks on the pricing behavior of government. On the assumption that the government has in the past achieved the desired level of strategic reserve for the end of each year, the long-run target is estimated as either the average or the fitted values of a linear trend of actual observed stock levels.

In terms of government subsidy expenditures, the soft wheat program is considered as the main item of government cost. This includes the producer, consumer, and other subsidies such as handling and processing margin, and storage and transport subsidies. In contrast to soft wheat, hard wheat, barley, and corn represent only a small portion of the food subsidy programs. Their prices are little affected, if at all, by subsidy expenditures. Markets for livestock products are considered free of government control and not affected by its pricing policy.

Our concern in this study is to investigate the government's motivation for intervention in food production through its pricing behavior. The objective of this section of the model is to formulate behavior functions for domestic prices of cereals in order to describe the policy rules and capture the basic structure of the actual policies practiced in Moroccan cereal markets.

Model

To derive the policy rules and evaluate the government policy in the Moroccan agriculture, we consider the application of welfare economics concepts to intervention in the market for a single product. It is assumed that the government maximizes a weighted sum of producers' surplus and consumers' surplus subject to a budget constraint. The policy variables being producer and consumer prices:

$$\text{Max } W = \theta_s \Pi(P,W,Z) + \theta_{d\delta} Q_d(P)\,dP$$

Subject to:

$$(P_s-P_w)*R+(P_w-P_d)(R+M)<B$$

The first term of the objective function represents producers' surplus which is equivalent to the restricted or variable profit function. The second term represents consumers' surplus. θ_s and θ_d are welfare weights. P_o, P_d, and Q_d represent initial consumer price, final consumer price, and domestic demand, respectively.

The first component of the budget constraint is the government subsidies to producers for the procurements R. The second component represents the government subsidies to consumers for domestic procurements and imports M. B represents the annual budget allotment for the commodity. P_w is the world price.

The objective of this setting is not to derive specific algebraic equations for prices, rather to identify the arguments that may explain price behavior overtime. Solving for this optimization problem, reduced form equation for both producer and consumer prices is derived:

$$P_{s,d}=P(P_w,B,SSR,PL480,Z)$$

where

SSR is self-sufficiency index,

PL480 is PL480 imports, and

Z is other import function arguments such as import capacity, stocks, and debt.

Margins

$$M_i=P^d{}_i-P^s{}_i \quad i\text{=the } i^{th} \text{ commodity}$$

Mark-up equations for livestock products

$$P^d{}_j=P^d(P^s{}_j) \qquad j\text{=the } j^{th} \text{ commodity}$$

To complete the model, we consider the following market-clearing conditions:

$$S_t+M_t-D_t=\Delta I_t \qquad \text{for cereals}$$

$$D_t-S_t=0 \qquad \text{for livestock}$$

where

ΔI_t is change in stocks,

M_t is level of imports,

D_t is domestic demand, and

S_t is domestic supply.

CHAPTER IV. DATA AND ESTIMATION

The data to estimate the proposed econometric model consist of aggregate annual data for Morocco. The time-series data are drawn from published and unpublished reports of many institutions in Morocco. The main source of the required data for agricultural commodities is the Ministry of Agriculture. Other important sources are the World Bank, U.S. Department of Agriculture (Economic Research Service, USDA-ERS), and the International Monetary Fund (IMF).

The sample period for the supply bloc is from 1960 through 1990. For the domestic demand side, the available data cover the period 1969-90. Data for the estimation of import functions are from 1960 to 1990.

Supply Side Data

Output

Data on the annual production of wheat, barley, corn, red meat, chicken, and milk are readily available; and manipulation of data is not necessary. Farm prices for red meat and chicken are market prices. For milk price, it is a weighted average of peak and lean season prices. For the four cereals, farmers face both support prices, often announced by the government at the beginning of each crop year, and market prices. The producer is thus concerned with the variability of support price and the uncertainty of market price when expectations are formed. For our estimation we postulate that price expectations are formed on the basis of one-period lagged market price and on current support price. The producer puts different weights on each source of price information. The expect farm price for the four cereals is modeled as:

$$EP_t = f(PS_t, PM_{t-1})$$

$$EP_t = \alpha PM_{t-1} + (1-\alpha) PS_t$$

$$= PS_t + \alpha (PM_{t-1}) - PS_t$$

$$= PS_t + \alpha D_t, 0 \leq a \leq 1.$$

Thus, the expected price the farmer receives is the support price (PS_t) plus a proportion of the difference (D_t) between lagged market price (PM_{t-1}) and current support price (PS_t). The weights can vary over time with changing market conditions. In this estimation we assume that these weights are not constant over time and that they follow an a priori systematic pattern. This pattern is thus determined by a general assumption that farmers always overweight higher price situations; that is, they put weights on the price gap D_t, in a proportional manner. The weights α are calculated as:

$$\alpha=0 \text{ if } PS_t \geq PM_{t-1}.$$

In this case, the government is willing to buy whatever quantity is offered at the support price.

$$\alpha = 1 \text{ if } PS_t = 0$$

$$\alpha=k/(k+1) \text{ if } PM_{t-1}=k^{*}PS_t \text{ for } k>1.$$

This procedure has the advantage of treating α variable to some extent and of gaining degrees of freedom by not estimating it as a parameter in profit function.

Variable inputs

Labor includes both hired labor and self-employed labor. Because of limited data on annual hours of both farm operator and hired labor employed on farms, labor data consists of the number of workers in the agricultural labor force. The wage rate for farm labor is the average annual rate. Workers are assumed to work on average eight hours per day for 300 days per year.

Fertilizer includes total primary nutrients use of nitrogen (N), phosphoric acid (P_2O_5) and potash (K_2O) as aggregate fertilizer input. Use of fertilizers for cereals is estimated by the Ministry of Agriculture in Morocco to be about 50 percent of total use every year. Data available on prices are limited to prices of widely used mixed grade fertilizer. But for the estimation we need to determine an aggregate price for the primary nutrients.

The real issue here is to determine the price of each nutrient in mixed grade fertilizer where we observe one price for a bundle of nutrients. A consistent way to overcome this problem is to apply the hedonic technique widely employed in consumer theory. The purpose is to estimate the shadow prices of the nutrients for a given year. By using multiple regression, we use the nutrient proportions to explain the price of fertilizer and then use the parameter estimates to get a weighted average price of the nutrients for each year.

For the estimate we consider the following regression:

$$P_F = \alpha_0 + \acute{o}_1 b_N + \alpha_2 b_{P205} + \alpha_3 b_{K20} + \epsilon,$$

where P_F is fertilizer price, $b_i (i=N, P_2O_5, K_2O)$ is the nutrient proportion in fertilizer F, and ϵ random disturbances. The price of nutrient i is given by:

$$\delta P_F / \delta b_i = \alpha_i, \quad i=N, P_2O_5, K_2O.$$

Feed products include wheat bran and a composite index of corn, sorghum, barley and oats, and other feed items (meal and pulp). Prices received by producers of these feed products will be used in constructing the divisia price and quantity indices for the aggregate grain feed and others. For wheat bran, we will consider the market price as the marginal cost since this price is always above the support price set by the government. The latter price does not present enough variability to be considered anyway.

Fixed inputs consist of land, stock of capital, and rainfall.

Land is total area planted of the four cereals plus forage production area, which represents total land use. It is postulated that forage area is a proxy for land used to sustain the animal stock at the beginning of each crop year.

Capital stock, a fixed input, distinguishes between stock of animals used mostly in animal traction, stock of animals used in livestock production, and machinery use, especially in cereal production. Animal stocks correspond to the number of animals at the beginning of each year.

Rainfall in Morocco follows a bimodal pattern. Rains often occur between October and December and again between February and April. The first period coincides with planting time while the second corresponds to the vegetative stage of the plants. For the estimations, we consider the average of actual precipitation received during each of these two periods.

Data for Food Demand System

The available data necessary to estimate the structure of Moroccan consumer food demand may be categorized into two groups, the first time-series data of aggregate consumer consumption and the second cross-sectional data on household level consumption.

The objective of this study is to analyze Moroccan consumer food demand at disaggregate commodity levels, and to investigate how consumption patterns of all households are affected by food policy reform. Our concern is not addressing issues of consumer welfare in the context of economic reforms, but rather providing parameters that can capture responses in aggregate consumer consumption to prices, income, and policy shocks. The objectives are better served by the set of time-series data that represent an aggregation over all consumers. Given the importance of cereals, meats, and milk in the Moroccan diet and their priority in food policy programs, discussed earlier, per capita disappearances are calculated for soft wheat, durum wheat, barley, corn, red meat, chicken, and milk over the 1969-90 period. The constructed series is then compared to an old series developed by the Moroccan Ministry of Agriculture for 1969-85 (MARA,1984). Our computations of per capita disappearances are based on the Ministry of Agriculture's assumptions. Food demand is interpreted as the food available for consumption based on the food balance sheet calculations. For cereals we account for wastes that are assumed to represent 3 percent of total supply for wheat and barley, and 2 percent for corn. Seed use deductions are based on assumptions of 1.2 quintal per hectare (Ql/ha) for wheat, .3 Ql/ha for barley, and .4 Ql for corn (1 ql = .1 metric ton).

Prices for cereals and livestock products are the retail prices paid by consumers. Per capita food expenditure are used as total expenditure on cereals, meats, and milk. Per capita GDP could alternatively be used in the estimation.

Data for Trade

The volume of imports for the four cereals are actual total imports of each type of cereals from all sources and from the United States and European Union. The import prices we use are the unit value of imports or CIF (cost, insurance, and freight) prices. The definitions of the variables used are listed in Table 4.1.

Import capacity is represented either by foreign exchange or by exports of goods and services. The choice of either variable depends on its importance in explaining the import demand. Annual outstanding debts are considered separately. The world price considered for soft wheat (#2 hard red winter ordinary protein), barley and corn is either the U.S. Gulf price (FOB) or the Rotterdam price (CIF). For durum wheat, we use Minneapolis price for #2 and #1 hard amber to which we add transportation costs to get U.S. Gulf price.

Table 4.1. Definitions of variables

Variable	Definition	Units
SWTPD	Soft wheat production	100 tons
HWTPD	Hard wheat production	100 tons
BRLPD	Barley production	100 tons
CRNPD	Corn production	100 tons
RMETPD	Red meat production	Tons
CKNPD	Chicken production	Tons
MLKPD	Milk production	Million liters
FERUS	Fertilizer use	Million tons
LABUS	Labor use	Million workers
BRNUS	Wheat bran use	1,000 tons
GRFUS	Gain feed use	Index
OFEDUS	Other feed use	Index
RAIN1	Rainfall for October-December	Millimeter
RAIN2	Rainfall for February-April	Millimeter
LNDUS	Land use	1,000 hectares
TRCUS	Tractor use	1,000 horsepower
ANMSTK	Animal stock for traction	1,000 heads
SWTEP	Soft wheat farm price	Dirhams/quintal
HWTEP	Hard wheat farm price	DH/ql
BRLEP	Barley farm price	DH/ql
CRNEP	Corn farm price	DH/ql
RMETP	Red meat producer price	DH/kg
CKNFP	Chicken producer price	DH/kg alive
MLKFP	Milk producer price	DH/liter
FERFP	Fertilizer farm price	DH/ton
WAGE	Farm wage rate	DH/day
BRNFP	Bran farm price	DH/ton

Table 4.1. Continued

Variable	Definition	Units
GRFPI	Grain feed price	Index
OFEDPI	Other feed price	Index
SWT	Soft wheat disappearances	kg per capita
HWT	Hard wheat disappearances	kg per capita
BRL	Barley disappearances	kg per capita
CRN	Corn disappearances	kg per capita
RMET	Red meat disappearances	kg per capita
CKN	Chicken disappearances	kg per capita
MLK	Milk disappearances	kg per capita
PSWT	Soft wheat retail price	DH/kg
PHWT	Hard wheat retail price	DH/kg
PBRL	Barley retail price	DH/kg
PCRN	Corn retail price	DH/kg
PRMET	Red meat retail price	DH/kg
PCKN	Chicken retail price	DH/kg
PMLK	Milk retail price	DH/liter
IND	Real total expenditure on cereals and livestock products	Derived
MSWT	Soft wheat imports	Tons
MHWT	Hard wheat imports	Tons
MBRL	Barley imports	Tons
MCRN	Corn imports	Tons
MPSWT	Soft wheat import price	DH/ton
MPHWT	Hard wheat import price	DH/ton
MPBRL	Barley import price	DH/ton
MPCRN	Corn import price	DH/ton
MCAP	Import capacity	Billion DH
DET	Outstanding debt	Million DH

Table 4.1. Continued

Variable	Definition	Units
SSRSWT	Self-sufficiency ratio for soft wheat	Index
SSRHWT	Self-sufficiency ratio for hard wheat	Index
SSRBRL	Self-sufficiency ratio for barley	Index
SSRCRN	Self-sufficiency ratio for corn	Index
EXCR	Exchange rate	DH/U.S.$
PL480I	Imports under PL480 Title I	Tons
PL480II	Imports under PL480 Title II	Tons
EXPS	Total real expenditure on soft wheat imports	Derived
EXPH	Total real expenditure on hard wheat imports	Derived
EXPB	Total real expenditure on barley imports	Derived
EXPC	Total real expenditure on corn imports	Derived
PSWTUS	Price of imports of soft wheat from US	DH/ton
PSWTEC	Price of imports of soft wheat from EC or EU	DH/ton
PSWTROW	Price of imports of soft wheat from the rest of the world	DH/ton
PHWTUS	Price of imports of hard wheat from US	DH/ton
PHWTEC	Price of imports of hard wheat from EC	DH/ton
PHWTROW	Price of imports of hard wheat from the rest of the world	DH/ton
PRBLUS	Price of imports of barley from US	DH/ton
PRBLEC	Price of imports of barley from EC	DH/ton
PBRLROW	Price of imports of barley from the rest of the world	DH/ton
PCRNUS	Price of imports of corn from US	DH/ton
PCRNEC	Price of imports of corn from EU	DH/ton
PCRNROW	Price of imports of corn from the rest of the world	DH/ton

Table 4.1. Continued

Variable	Definition	Units
SWTWP	Soft wheat world price	$/ton
HWTWP	Hard wheat world price	$/ton
BRLWP	Barley world price	$/ton
CRNWP	Corn world price	$/ton
SWTUS	Soft wheat imports from U.S.	Tons
SWTEC	Soft wheat imports from EU	Tons
SWTROW	Soft wheat imports from the rest of the world	Tons
HWTUS	Hard wheat imports from U.S.	Tons
HWTEC	Hard wheat imports from EC	Tons
HWTROW	Hard wheat imports from the rest of the world	Tons
BRLUS	Barley imports from the U.S.	Tons
BRLEC	Barley imports from EU	Tons
BRLROW	Barley imports from the rest of the world	Tons
CRNUS	Corn imports from U.S.	Tons
CRNEC	Corn imports from EU	Tons
CRNROW	Corn imports from the rest of the world Tons	
BUDGET	Government budget for soft wheat program	DH
PROCSWT	Soft wheat grain procurement	100 tons
DUM81	Dummy variable for drought year 1981	
MARGSWT	Soft wheat margins	DH/kg
MARGHWT	Hard wheat margins	DH/kg
MARGBRL	Barley margins	DH/kg
MARGCRN	Corn margins	DH/kg
MARGRMET	Red meat margins	DH/kg
MARGCKN	Chicken margins	DH/kg
MARGMLK	Milk margins	DH/liter

For food aid data, we distinguish between foreign donations and aid of cereals and concessional cereal exports to Morocco, PL480 shipments in particular.

Estimation Procedures

<u>Output supply and input demand equations</u>

The system of output supply and input demand equations to be estimated is:

$$Y_i = a_i + \sum_{m=1}^{7} a_{im} P_m + \sum_{j=1}^{4} d_{ij} w_j + \sum_{k=1}^{6} f_{ik} Z_k \qquad i=1,2,\ldots,7 \qquad (5.1)$$

$$-X_j = b_j + \sum_{n=1}^{4} b_{jn} w_n + \sum_{i=1}^{7} d_{ji} P_i + \sum_{k=1}^{6} h_{jk} Z_k \qquad j=1,2,3,4 \qquad (5.2)$$

where

Y_i = production of i^{th} crop (soft wheat, hard wheat, barely, corn, red meat, chicken, and milk),

X_j = quantity of j^{th} input used in the Moroccan crop and livestock subsectors,

P_i = farm price of i^{th} output (i=m),

w_j = farm price of j^{th} input (j=m), and

Z_k = quantity of fixed input, including time variable.

This system of 11 equations can be used jointly with the profit function equation (in Chapter 3) to estimate all the parameters of the restricted profit function. However, this is problematic because the C_k and C_{kl} parameters of the fixed inputs only appear in the profit function. Given the sample size and the high number of constraining variables, this system of equations cannot manage the estimation. Thus, the estimation is restricted to equations (5.1) and (5.2). In order to ensure the existence of a primal technology, the system of equations is estimated maintaining homogeneity, symmetry, and convexity. Monotonicity of the profit function is not explicitly imposed in the estimation but can be evaluated at each sample point using the parameter estimates. This requires that predicted Y_i and X_j must be nonnegative for all prices. Homogeneity in output and input prices is imposed by normalizing all prices on the right hand side of equations (5.1) and (5.2) by the wage rate. Symmetry is maintained with equality restrictions on cross-price parameters; that is, $a_{im} = a_{mi}$; $b_{jn} = b_{nj}$; and $d_{ij} = d_{ji}$ for i,j,m,n.

To test and possibly impose convexity of the restricted profit function, equations (5.1) and (5.2) are transformed using Cholesky factorization. Letting I be the 11x11 matrix of the a_{im}, b_{jn}, and d_{ij} coefficients, the restricted profit function is convex if I is positive semidefinite. To investigate this, the matrix I is represented in the nonlinear factorization I = LDL' where L is a unit lower triangular matrix and D is a diagonal matrix whose elements are the Cholesky values. The matrix A will be positive semidefinite if and only if all Cholesky values are all nonnegative (Lau, 1978).

With the Cholesky factorization, the system of equations (5.1) and (5.2) becomes nonlinear in the parameters. To estimate this system, the following stochastic version of the model is utilized:

$$Q_t = f(G_t, \theta) + u_t \qquad t=1,\ldots,T \qquad (5.3)$$

where t indexes the time-series observations, Q_t is a vector of output supply and input demand quantities at time, G_t is a vector of all exogenous variables at time t, θ is a vector of parameters to be estimated, and T represents the number of observations. The stochastic error term, u_t, is assumed to be independent and identically distributed with mean zero and a constant variance-covariance matrix, Ω:

$$E(u_t) = 0, E(u_t u_t') = \Omega \text{ and } E(u_t u_s') = 0 \ (t \neq s) \qquad (5.4)$$

If u_t is also multinormally distributed, a maximum likelihood estimation can be performed. Under these assumptions, the maximum likelihood estimators are consistent, asymptotically normal, and asymptotically efficient (Amemiya, 1983; Fomby et al., 1984). The method used to obtain the maximum likelihood estimator in this study is a Quan-Newton algorithm as implemented in SHAZAM® 6.2.

Domestic demand system and import share equations

The demand system chosen for both domestic demand and import share equations, the Linear Approximate Almost Ideal Demand System (LA/AIDS), allows the theoretical restrictions such as homogeneity, adding-up, and symmetry to be tested and imposed. Both models are estimated by using the nonlinear regression method based on the maximum likelihood procedure, in SHAZAM®. Because of the adding-up condition, the contemporaneous covariance matrix of the system is singular. The standard procedure of arbitrarily deleting an equation is used. The iterative solutions estimates produced by the maximum likelihood procedure are independent of the deleted equation (Barten, 1969).

Import demand equations

The OLS method is used to estimate the import demand equation for soft wheat. Both OLS and Tobit estimations are applied to the import data of durum wheat, barley, and corn. The method of Tobit estimation is used because Morocco is a potential importer of durum wheat, barley, and corn and all zero observations represent standard corner solutions. This statistical technique is then compared with the OLS method in order to choose a better specification.

Import demands for durum wheat, barley, and corn restricted by zero imports fall into the category of limited dependent variable with censored data. The use of the conventional OLS technique can generated biased and inconsistent parameter estimates. Tobit analysis is more appropriate in such cases (Maddala, 1992). To estimate a single behavioral equation for each of the three cereals, the following Tobit model is considered:

$Y_i = \beta' X_i + \epsilon_i$ if $y_i^* > 0$ $Y_i = 0$ otherwise (5.5)

where Y_i^* is a latent variable, β is a kx1 vector of coefficients to be estimated, X_i is a kx1 vector of all exogenous variables, ϵ_i are residuals that are independently and normally distributed, with mean zero and a common variance σ^2, and Y_i is the observed dependent variable or imports of the i^{th} cereal. Estimation of equation (5.5) is performed using the maximum likelihood method with the likelihood function defined as:

$$L = \prod_{y=0}(1-F_i)\prod_{y>0} 1/(2\pi\tau^2)^{1/2} \exp[-1/2\sigma^2(y_i-\beta' X_i)^2]$$

where the first product is over the observations for which $y_i = 0$ and the second product is over the observations for which $y_i > 0$. F_i is the distribution function of ϵi (Maddala, 1992). This estimation is carried out by using Tobit regression in SHAZAM®.

Price equations

The OLS technique is used to estimate the mark-up equations for livestock products. Cereal price equations are estimated using Iterated Seemingly Unrelated Regressions (ITSUR) and Iterated Three-Stage Lease Squares (IT3SLS) to obtain efficient parameter estimates when cross-equation error correlations may not be zero and simultaneous equation bias may exist. These estimations are also implemented by using the system of equations procedure, SYSTEM, in SHAZAM®.

CHAPTER V. EMPIRICAL RESULTS

Output Supply and Input Demand Equations

Estimates of the parameters of the 11 supply and demand equations are reported in Table 5.1. Because of the Cholesky reparameterization, the estimated parameters of the price variables in Table 5.1 are computed from nonlinear combinations of the estimated Cholesky factorization parameters. The t-ratios for these estimates are derived by calculating the respective standard errors using first order Taylor series expansion of the nonlinear functions of the Cholesky parameters and then applying the standard results for variance and covariance of linear functions of random variables (Goldberger, 1964).

To choose the final model to be used in the simulation system, tests for monotonicity, convexity and nonjointness are first conducted. Indeed, non-negative predicted values of output supply and input demand at each observation point show that monotonicity is satisfied at the sample points. As mentioned in Chapter 4, convexity test is conducted using Cholesky values D_{ii}, reported in Table 5.2, in the following null hypothesis:

$$H_0: \; D_{ii} \geq 0 \quad i = 1, \ldots, 11$$

against the alternative,

$$H_1: \; D_{ii} < 0 \quad \text{for at least one } i.$$

According to Morey (1986), H_0 will be rejected if at least one D_{ii} is significantly negative. Parameter estimates in Table 5.2 indicate that four of the eleven Cholesky values are negative, thus violating the property of convexity. Following Moschini (1988) and Aradhyula (1989), the Bonferroni t-statistic is used to test for the significance of the individual D_{ii}, given that H_0 involves simultaneously eleven inequalities. A 0.05 overall level of significance of the test implies that the one-tailed critical value of the Bonferroni t-statistics for the individual t-ratios is given by the Student t-distribution at the 0.05/11 or 0.0045 significance level. The critical value is 2.577 for ∞ degrees of freedom. Thus, D_{33} and D_{44} are significantly negative and hence the null hypothesis of convexity is rejected at the 5 percent level of significance. Given that convexity is necessary for the profit function to be a dual to a well defined technology, this property was imposed.

Table 5.1. Estimates of output supply and input demand in Morocco[a]

SOFT WHEAT

$$\begin{aligned} \text{SWTPD} = & -\underset{(-4.04)}{1643} + \underset{(3.65)}{.985}\ \text{SWTEP} - \underset{(-2.75)}{.171}\ \text{HWTEP} - \underset{(-1.99)}{.022}\ \text{BRLEP} + \underset{(1.88)}{.988}\ \text{CRNEP} \\ & - \underset{(-3.15)}{.734}\ \text{RMETP} + \underset{(1.57)}{.870}\ \text{CKNFP} - \underset{(-3.27)}{1.925}\ \text{MLKFP} - \underset{(-4.12)}{.465}\ \text{FERFP} \\ & - \underset{(-.72)}{.393}\ \text{BRNFP} + \underset{(.49)}{.006}\ \text{GRFPI} + \underset{(1.08)}{0.27}\ \text{OFEDPI} + \underset{(9.15)}{.724}\ \text{RAIN1} \\ & + \underset{(2.78)}{.025}\ \text{RAIN2} + \underset{(7.37)}{5.504}\ \text{LNDUS} + \underset{(2.30)}{2.483}\ \text{TRCUS} - \underset{(-1.86)}{2.766}\ \text{ANMSTK} \\ & + \underset{(17.09)}{8.481}\ \text{TIME} \end{aligned}$$

$R^2 = .86$ D.W. = 1.69

DURUM WHEAT

$$\begin{aligned} \text{HWTPD} = & \underset{(2.03)}{1802} - \underset{(-.275)}{.171}\ \text{SWTEP} + \underset{(23.04)}{.737}\ \text{HWTEP} - \underset{(-12.02)}{.598}\ \text{BRLEP} + \underset{(3.14)}{.682}\ \text{CRNEP} \\ & + \underset{(4.24)}{.204}\ \text{RMETP} - \underset{(-1.78)}{1.241}\ \text{CKNFP} - \underset{(-.35)}{.472}\ \text{MLKFP} - \underset{(-7.18)}{.611}\ \text{FERFP} \\ & - \underset{(-1.05)}{.156}\ \text{BRNFP} - \underset{(-.15)}{.024}\ \text{GRFPI} - \underset{(-2.01)}{.051}\ \text{OFEDPI} + \underset{(3.27)}{.328}\ \text{RAIN1} \\ & - \underset{(-1.07)}{1.091}\ \text{RAIN2} + \underset{(2.36)}{1.435}\ \text{LNDUS} + \underset{(2.48)}{2.546}\ \text{TRCUS} - \underset{(-2.01)}{2.124}\ \text{ANMSTK} \\ & + \underset{(5.19)}{5.103}\ \text{TIME} \end{aligned}$$

$R^2 = .76$ D.W. = .86

[a]t-ratios are reported in parentheses. Convexity in prices and symmetry are maintained.

Table 5.1. Continued

BARLEY

$$BRLPD = \underset{(5.07)}{1765} - \underset{(-1.99)}{.022}\,SWTEP - \underset{(-12.02)}{.598}\,HWTEP + \underset{(31.05)}{1.234}\,BRLEP - \underset{(-1.59)}{1.00}\,CRNEP$$

$$+ \underset{(2.81)}{1.213}\,RMETP + \underset{(.45)}{3.736}\,CKNFP + \underset{(4.32)}{.030}\,MLKFP + \underset{(1.07)}{6.05}\,FERFP$$

$$+ \underset{(3.05)}{.144}\,BRNFP + \underset{(6.41)}{.126}\,GRFPI + \underset{(1.89)}{.086}\,OFEDPI + \underset{(4.75)}{.287}\,RAIN1$$

$$+ \underset{(.91)}{.918}\,RAIN2 + \underset{(2.82)}{2.659}\,LNDUS + \underset{(.61)}{.700}\,TRCUS + \underset{(2.43)}{2.226}\,ANMSTK$$

$$+ \underset{(1.06)}{1.044}\,TIME$$

$R^2 = .68$ D.W. = 2.03

CORN

$$CRNPD = \underset{(-5.17)}{-1278} + \underset{(1.88)}{.988}\,SWTEP + \underset{(3.14)}{.682}\,HWTEP - \underset{(-1.59)}{1.00}\,BRLEP + \underset{(7.09)}{3.190}\,CRNEP$$

$$+ \underset{(4.15)}{2.439}\,RMETP + \underset{(2.07)}{5.719}\,CKNFP - \underset{(-1.14)}{.563}\,MLKFP - \underset{(-5.22)}{.762}\,FERFP$$

$$- \underset{(-1.89)}{.739}\,BRNFP - \underset{(-3.11)}{.129}\,GRFPI - \underset{(-5.35)}{.121}\,OFEDPI + \underset{(.28)}{.281}\,RAIN1$$

$$+ \underset{(4.78)}{5.895}\,RAIN2 + \underset{(4.77)}{.243}\,LNDUS + \underset{(3.53)}{3.675}\,TRCUS + \underset{(2.99)}{1.838}\,ANMSTK$$

$$- \underset{(-.62)}{.587}\,TIME$$

$R^2 = .71$ D.W. = 2.27

RED MEAT

$$RMETPD = \underset{(1.84)}{38.412} - \underset{(-3.15)}{.734}\,SWTEP + \underset{(4.24)}{.204}\,HWTEP + \underset{(2.81)}{1.213}\,BRLEP + \underset{(4.15)}{2.439}\,CRNEP$$

$$+ \underset{(7.85)}{9.252}\,RMETP - \underset{(-15.14)}{16.095}\,CKNFP - \underset{(-2.61)}{6.942}\,MLKFP + \underset{(1.45)}{1.662}\,FERFP$$

$$+ \underset{(3.41)}{.135}\,BRNFP - \underset{(-6.33)}{3.09}\,GRFPI - \underset{(-2.67)}{.472}\,OFEDPI + \underset{(1.32)}{.185}\,RAIN1$$

$$+ \underset{(4.14)}{.204}\,RAIN2 + \underset{(11.01)}{15.058}\,LNDUS - \underset{(-.31)}{.312}\,TRCUS + \underset{(5.10)}{5.464}\,ANMSTK$$

$$+ \underset{(5.76)}{7.512}\,TIME$$

$R^2 = .65$ D.W. = 1.32

Table 5.1. Continued

POULTRY

CKNPD = 31.883 + .870 SWTEP - 1.241 HWTEP + 3.736 BRLEP + 5.719 CRNEP
(3.15) (1.57) (-1.78) (.45) (2.07)

- 16.095 RMETP + 31.126 CKNFP + 11.585 MLKFP - 1.911 FERFP
(-15.14) (25.32) (1.39) (-.23)

+ .175 BRNFP + .801 GRFPI + .742 OFEDPI + .021 RAIN1
(1.04) (1.51) (1.92) (1.07)

+ .104 RAIN2 = .058 LNDUS + 1.034 TRCUS - .541 ANMSTK
(2.16) (-.78) (1.02) (-.53)

+ .629 TIME
(3.59)

R^2 = .95 D.W. = .86

MILK

MLKPD = - 368.280 + 1.925 SWTEP - .472 HWTEP + .030 BRLEP - 5.63 CRNEP
(-14.52) (3.27) (-.35) (4.32) (-1.14)

- 6.942 RMETP + 11.585 CKNFP + 10.670 MLKFP - 2.539 FERFP
(-2.61) (1.39) (27.78) (-6.15)

- .469 BRNFP + .368 GRFPI + .017 OFEDPI + .296 RAIN1
(-4.85) (1.66) (2.07) (3.68)

+ .599 RAIN2 + .018 LNDUS + .431 TRCUS + .035 ANMSTK
(2.08) (.42) (1.59) (.36)

+ .021 TIME
(2.91)

R^2 = .91 D.W. = 1.66

FERTILIZER

FERUS = - 109.420 - .465 SWTEP - .611 HWTEP + .605 BRLEP - .762 CRNEP
(-2.10) (-4.12) (-7.18) (1.07) (-5.22)

+ 1.662 RMETP - 1.911 CKNFP - 2.539 MLKFP + 2.449 FERFP
(1.45) (-.23) (-6.15) (5.85)

+ .340 BRNFP + .116 GRFPI + .042 OFEDPI - .371 RAIN1
(1.36) (1.34) (.37) (7.12)

- .122 RAIN2 - 2.604 LNDUS - 1.986 TRCUS - .849 ANMSTK
(2.24) (2.06) (-1.92) (-7.72)

- .288 TIME
(-3.27)

R^2 = .76 D. W. = 1.09

Table 5.1. Continued

<u>WHEAT BRAN</u>

BRNUS = 110.800 - .393 SWTEP - .156 HWTEP + .144 BRLEP - .739 CRNEP
(1.10) (-.72) (-1.05) (3.05) (-1.89)

+ .135 RMETP + .175 CKNFP - .469 MLKFP + .340 FERFP
(3.41) (1.04) (-4.85) (1.36)

+ 2.132 BRNFP - .015 GRFPI - .015 OFEDPI + 1.015 RAIN1
(1.74) (-2.17) (-3.24) (1.00)

- 2.608 RAIN2 - .098 LNDUS - .225 TRCUS - .354 ANMSTK
(-2.58) (-.52) (-.24) (-6.37)

+ .382 TIME
(.58)

R^2 = .34 D.W. = 1.53

<u>GRAIN FEED</u>

GRFUS = - .506 + .006 SWTEP - .024 HWTEP + .126 BRLEP - .129 CRNEP
(-4.45) (.49) (-.15) (6.41) (-3.11)

- .309 RMETP + .801 CKNFP + .368 MLKFP + .116 FERFP
(-6.33) (1.51) (1.66) (1.34)

- .015 BRNFP + 1.367 GRFPI + 1.478 OFEDPI + .005 RAIN2
(-2.17) (2.48) (.37) (2.73)

+ .003 TIME
(3.12)

R^2 = .63 D.W. = .34

<u>OTHER FEED</u>

OFEDUS = - .526 + .027 SWTEP - .051 HWTEP + .086 BRLEP - .121 CRNEP
(-.52) (1.08) (-2.01) (1.89) (-5.35)

- .472 RMETP + .742 CKNFP + .017 MLKFP + .042 FERFP
(-2.67) (1.92) (2.07) (.37)

- .015 BRNFP + 1.478 GRFPI + 1.999 OFEDPI + .002 RAIN1
(-3.24) (.37) (2.70) (.73)

+ .004 RAIN2 + .003 TIME
(2.08) (4.02)

R^2 = .67 D.W. = .53

R^2_G = .97[b]

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[b]Baxter-Cragg R^2.

Table 5.2. Cholesky values (D_{ii}) of unrestricted model[a]

Parameters	Estimate	t-statistic
D_{11}	- .345	-2.41
D_{22}	- .093	- .63
D_{33}	- .881	-4.43
D_{44}	- .369	-3.15
D_{55}	.539	5.09
D_{66}	.387	2.68
D_{77}	1.175	6.05
D_{88}	.451	4.16
D_{99}	.285	1.88
D_{1010}	2.801	5.80
D_{1111}	3.062	4.77

[a]Convexity not imposed, symmetry imposed.

Convexity of the profit function is imposed by restricting the Cholesky values (D_{ii}) to be positive. This is compiled by replacing D_{ii} by exp (S_{ii}). One of the most important issues in policy reforms concerning Moroccan agriculture is whether cereal and livestock productions are independent. The success of any policy action crucially depends on jointness in production of these two activities. It is thus important to test for this structural feature of the Moroccan agricultural technology. For the restricted profit function, nonjointness requires that output supplies for cereals (livestock products) are independent of product prices of livestock (cereals). This in turn requires that three of estimated parameters in each supply equation of cereals and four in each supply equation of livestock products are set to zero. This parametric test is performed using the log-likelihood ratio determined by:

$$-2 \log \lambda = -2^* [\log L(\theta) - \log L(\theta^*)]$$

where θ represents the restricted maximum likelihood estimates of the parameter vector θ, and θ^* is the corresponding unrestricted maximum likelihood estimates. $-2 \log \lambda$ is asymptotically distributed as Chi-square with J degrees of freedom (J is the number of independent restrictions being tested) under the null hypothesis that θ is true. The calculated Chi-square 48.523 is higher than the critical value 36.415 for 5 percent level of significance and 24 degrees of freedom implying that nonjointness is rejected. Consequently, the aggregate technology of the Moroccan agricultural sector has jointness in production of cereals and livestock production.

Based on the above test results, the model is estimated with convexity and jointness constraints. This estimated model fits the data reasonably well as shown by the R^2 coefficients in Table 5.1. The overall goodness of fit of the entire system is obtained using the generalized R^2 proposed by Baxter and Cragg (1970):

$$R^2_G = 1 - \exp\,[2(L_0 - L_{max})/T],$$

where L_0 is the value of the log likelihood function when all parameters but intercepts were constrained to zero; L_{max} is the maximum log likelihood value when all parameters vary, and T is the total number of parameters. The calculated R^2_G is .97.

Although eighty of the 143 estimated parameters in Table 5.1 are not significantly different from zero at the 5 percent level, the results appear reasonable given the large number of parameters in the model. All own-price coefficients have the expected sign (by convexity constraint) and all, except for wheat bran, are significantly different from zero at the 5 percent level. The coefficients of the fixed factors are plausible. Greater preseason precipitation (October through December) increases the demand for fertilizer, and increases the quantity supplied of wheat, barley, and milk. In contrary, meats and corn productions increase in response to the second precipitation period (February through April). This is consistent with the fact that wheat and barley are planted during the first period while corn is planted during the second period.

Favorable rainfall conditions also decrease the demand for feed products. Increasing the land stock increases the quantity of fertilizer demanded and all outputs supplied, except for chicken. Quantity of feed demanded is not affected. An increase in the machinery stock increases the demand for fertilizer and wheat bran, and the quantity supplied of wheat. Barley production is little affected; it is rather positively affected by the stock of animals used in traction. Among the significant estimated parameters are those of the time variables which indicate a strong autonomous component in the trend of output supply (wheat, barley and all livestock products) and fertilizer demand. This may suggest that technical change increases the scale of production.

Output supply and input demand elasticities are reported in Table 5.3. All elasticities are computed using the following formulae at the sample means:

Output supply elasticities

$$\epsilon_{im} = a_{im} \cdot P_m/\gamma_i \qquad i, m = 1, \ldots, 7$$

Input demand elasticities

$$\eta_{jn} = b_{jn} \cdot W_j/x_n \qquad j, n = 1, \ldots, 4$$

Output-Input cross-price elasticities

$$\mu_{ij} = d_{ij} \cdot W_j/\gamma_i \qquad i = 1, \ldots, 7; \; j = 1, \ldots, 4$$

Input-Output cross-price elasticities

$$\partial_{ji} = d_{ij} \cdot P_i/x_j \qquad i = 1, \ldots, 7; \; j = 1, \ldots, 4$$

Output-Labor price elasticities

$$\epsilon_{iL} = -\sum_{k=1}^{7} \epsilon_{ik} - \sum_{l=1}^{4} \mu_{il} \qquad i = 1, \ldots, 7$$

Input-Labor price elasticizes

$$\epsilon_{jL} = -\sum_{l=1}^{4} \eta_{jl} - \sum_{k=1}^{7} \mu_{jk} \qquad j = 1, \ldots, 4$$

Labor-Output price elasticities

$$\epsilon_{Li} = -1/L\ [\sum_{k=1}^{7} a_{ik}\ P_k\ P_i + \sum_{l=1}^{4} d_{il}\ P_i\ w_l\ ]$$

Labor-Input price elasticities

$$\epsilon_{Lj} = -1/L\ [\sum_{l=1}^{4} b_{jl} w_j w_l + \sum_{k=1}^{7} d_{kj} w_j P_k\ ]$$

Own-price elasticity of labor

$$\epsilon_{LL} = -1/L\ [\sum_{i=1}^{7} \sum_{m=1}^{7} a_{im} P_i P_m + \sum_{j=1}^{4} \sum_{n=1}^{4} b_{jn} w_j w_n + \sum_{i=1}^{7} \sum_{j=1}^{4} C_{ij} P_i w_j + \sum_{j=1}^{4} \sum_{i=1}^{7} C_{ji} w_j P_i\ ]$$

where L is labor use; the other variables and parameters are explained in Chapter 3. The elasticities in Table 5.3 are from the estimated model where homogeneity, symmetry, and convexity are maintained.

The own price elasticities of all outputs are less than unity, ranging from .135 for corn to .871 for poultry. These elasticities are comparable to those reported by Baijou (1990) for similar commodities within Morocco, but smaller than the elasticity levels estimated by Mateus (1988) for cereals in Morocco using Cobb-Douglas production functions. Because of the superiority of multiple-input, multiple-output profit function framework over the production function framework in terms of using efficiently the information about technology, these differences are not surprising. Cross-supply elasticities are, in general, small in magnitude. This may suggest that quantity supplied of a product is mostly influenced by its own price. However, it is useful to examine these cross effects. Indeed, the results indicate that soft wheat, durum wheat and barley are substitutes in production. For livestock production, negative cross-supply elasticities indicate also substitutability relationships among these commodities. Another important result of this study is that red meat and milk productions are substitute for soft wheat production. However, red meat is found to be complementary with durum wheat, barley and corn.

Own price input demand elasticities range from -.433 for fertilizer to -1.517 for wheat bran. Except for fertilizer, the demand for the other inputs (labor and feed products) is price elastic, indicating high sensitivity of Moroccan farmers to these input prices. Furthermore, the results show fertilizer and labor to be substitutes. This is consistent with our previous finding where an increase in fertilizer use is associated with an increase in machinery stock.

Finally, supply elasticities of cereals with respect to fertilizer prices are, except for barley which actually uses less of this input, negative. For livestock production, there is no definite pattern. For example, red meat production is negatively affected by an increase in grain feed prices, while milk production is positively related to all feed prices. These output-input cross effects should be considered with care given their small magnitudes.

Domestic Demand Equations

The estimated parameters of the linear approximate version of the Almost Ideal Demand System (LA/AIDS) are presented for cereals, meats and milk in Table 5.4. The model specified appears to fit quite well over the 1969 to 1990 period, as evidenced by R^2 and standard errors of the estimated parameters. Most estimated coefficients are statistically significant at the 5 percent level and have the expected signs. Both Marshallian and Hicksian elasticities reported in Table 5.5 are derived from the estimated parameters in Table 5.4 as follows:

Table 5.3. Price elasticities of product supply and input demand evaluated at sample means[a]

Elasticity of	with respect to SWTEP	HWTEP	BRLEP	CRNEP	RMETP	CKNFP	MLKFP	FERFP	BRNFP	GRFPI	OFEDPI	WAGE
SWTPD	.327	-1.53	-.022	.112	-.015	.082	-.131	-.167	-.029	.006	.003	.089
HWTPD	-.113	.319	-.032	.042	.062	-.059	-.042	-.068	-.006	-.001	-.002	.048
BRLPD	-.001	-.031	.205	-.041	.113	.012	.179	.005	.004	.005	.003	-.169
CRNPD	.028	.021	-.028	.135	.104	.106	-.019	-.033	-.014	-.002	-.007	.015
RMETPD	-.005	.022	.109	.098	.664	-.307	-.105	.003	.006	-.023	-.038	-.019
CKNPD	.012	-.019	.004	.067	-.158	.871	.019	-.004	.001	.008	.004	.029
MLKPD	-.105	-.030	.038	-.080	-.079	.013	.632	-.040	.031	.008	.003	.167
FERUS	.105	.054	-.004	.021	-.001	.004	.011	-.433	-.002	-.061	-.004	.258
BRNUS	.017 .138	.004	-.001	.009	-.001	-.001	-.015	-.007	-1.517		.014	.015
GRFUS	-.003 -.091	.001	-.005	.001	*.009		-.005	-.002	-.022	.009	-1.316	-.151
OFEDUS	-.002	.001	-.002	.004	.010	-.003	-.001	-.001	.011	-.147	-1.123	-.182
LABUS	-.053	-.029	.113	-.011	.012	-.019	-.132	.118	.086	-.064	-.016	-1.24

[a]Variable descriptions are given in Table 4.1.

Table 5.4 Estimated coefficients and standard errors of LA/AIDS for cereals, meats and milk, for Moroccan data, 1969-1990[a]

Share	∂_{i1}	∂_{i2}	∂_{i3}	∂_{i4}	∂_{i5}	∂_{i6}	∂_{i7}	β_i	α_i	R^2	DW
Soft wheat	.073	.044	.010	-.001	-.010	-.11	.0003	.021	.184	.94	1.64
	(.023)	(.021)	.017	(.006)	(.029)	(.019)	(.005)	(.018)	(.005)		
Durum wheat		.075	-.025	.004	-.059	-.002	-.04	-.024	.195	.80	1.51
		(.030)	(.017)	(.013)	(.031)	(.025)	(.021)	(.021)	(.006)		
Barley				.055	-.002	-.017	.007	-.019	-.011	.109	.83
2.27											
			(.018)	(.007)	(.026)	(.018)	(.025)	(.016)	(.005)		
Corn				.021	.001	-.007	-.016	-.023	.028	.94	1.63
				(.012)	(.015)	(.010)	(.001)	(.008)	(.002)		
Red meat					.075	.010	.0009	-.003	.204	.67	1.71
					(.047)	(.038)	(.002)	(.032)	(.008)		
Chicken						.116	-.019	.059	.141	.76	1.98
						(.033)	(.001)	(.026)	(.006)		
Milk							.089	-.021	.136		
							(.021)	(.010)	(.002)		

[a]Standard errors are in parentheses. Symmetry and homogeneity are imposed.

$$\epsilon_{ii} = -1 + \partial_{ii}/w_i - \beta_i$$

$$\epsilon_{ij} = \partial_{ij}/w_i - \beta_i(w_j/w_i)$$

$$\delta_{ii} = -1 + \partial_{ii}/w_i + w_i, \text{ and}$$

$$\delta_{ij} = \partial_{ij}/w_i + w_j$$

where ϵ represents Marshallian elasticities and δ Hicksian elasticities. Expenditure elasticities are obtained as:

$$\eta_i = 1 + \beta_i/w_i$$

The standard errors of these elasticities are calculated at the mean assuming that the shares are fixed (Chalfant, 1987).

The own price elasticities are all negative as expected according to the theory of demand. The calculated price elasticities indicate that all cereal and livestock commodities are price inelastic and that soft wheat and red meat are the most price elastic of this food group. The ordering of this group according to relative uncompensated price elasticity proceeds with durum wheat being second most price elastic, barley third, milk fourth, corn fifth, and chicken the least price elastic.

The examination of expenditure compensated or utility constant cross-price elasticities reported in Table 5.5 reveals that soft wheat is price complement for chicken and price substitute for other cereals. Red meat is price complement for durum wheat and price substitute for other livestock products. However, one has to be extremely careful in assessing the practical relevance of the cross-price elasticities which are, in general, meaningless. Using the income elasticity of food in Morocco as reported by MARA (1992e) to be 0.85 on average, and the estimated expenditure elasticities reported in Table 5.6, all cereal and livestock products are normal and necessary as indicated by their respective income elasticities having positive values of less than one.

Table 5.5. Marshallian and Hicksian elasticities of Moroccan cereal, meats and milk expenditures[a]

Expenditure	Marshallian Elasticities		Hicksian Elasticities	
Soft Wheat				
Soft wheat	-.64	(.117)	-.43	(.121)
Durum wheat	.21	(.124)	.43	(.231)
Barley	-.007	(.663)	.11	(.105)
Corn	-.01	(.005)	.02	(.003)
Red meat	-.08	(.052)	.15	(.041)
Chicken	-.57	(.041)	-.43	(.102)
Milk	-.01	(.008)	.14	(.015)
Durum Wheat				
Soft wheat	.24	(.121)	.40	(.224)
Durum wheat	-.60	(.155)	-.42	(.157)
Barley	-.11	(.103)	-.02	(.097)
Corn	.02	(.147)	.05	(.048)
Red meat	-.27	(.201)	-.09	(.081)
Chicken	.004	(.016)	.16	(.127)
Milk	-.16	(.122)	-.04	(.038)
Barley				
Soft wheat	.03	(.002)	.19	(.013)
Durum wheat	-.21	(.201)	-.03	(.025)
Barley	-.48	(.163)	-.38	(.163)
Corn	-.01	(.124)	.01	(.132)
Red meat	-.14	(.134)	.05	(.082)
Chicken	.08	(.071)	.19	(.156)
Milk	-.16	(.124)	-.04	(.039)
Corn				
Soft wheat	.09	(.074)	.14	(.128)
Durum wheat	.28	(.188)	.33	(.325)
Barley	.02	(.019)	.05	(.036)
Corn	-.30	(.399)	-.29	(.400)
Red meat	.19	(.177)	.24	(.210)
Chicken	-.15	(.147)	-.12	(.115)
Milk	-.40	(.376)	-.36	(.233)
Red meat				
Soft wheat	-.05	(.041)	.14	(.128)
Durum wheat	-.28	(.236)	-.09	(.077)
Barley	-.08	(.078)	.02	(.010)
Corn	.006	(.007)	.04	(.035)
Red meat	-.63	(.233)	-.43	(.235)
Chicken	.05	(.040)	.18	(.166)
Milk	.006	(.005)	.14	(.107)

[a]The numbers in parentheses are standard errors.

Table 5.5. Continued

Expenditure	Marshallian Elasticities	Hicksian Elasticities
Chicken		
Soft wheat	-.92 (.913)	-.64 (.581)
Durum wheat	-.11 (.108)	.18 (.129)
Barley	.008 (.010)	.17 (.121)
Corn	-.07 (.041)	-.03 (.022)
Red meat	-.02 (.011)	.28 (.184)
Chicken	-.14 (.153)	-.05 (.154)
Milk	-.21 (.176)	-.007 (.006)
Milk		
Soft wheat	.03 (.102)	.19 (.165)
Durum wheat	-.23 (.191)	-.06 (.051)
Barley	-.12 (.107)	-.03 (.028)
Corn	-.11 (.101)	-.08 (.081)
Red meat	.04 (.015)	.21 (.162)
Chicken	-.11 (.099)	-.62 (.501)
Milk	-.35 (.085)	-.23 (.086)

Table 5.6. Expenditure elasticities of Moroccan cereal, meats and milk[a]

Expenditure	Mean Budget Share	Expenditure Elasticities
Soft wheat	.188	1.11 (.095)
Durum wheat	.198	.88 (.110)
Barley	.109	.90 (.145)
Corn	.031	.26 (.261)
Red meat	.205	.99 (.160)
Chicken	.126	1.17 (.200)
Milk	.141	.85 (.071)

[a]Elasticities are calculated at the means. Numbers in parentheses are standard errors.

Comparing our elasticity estimates with those obtained or reported by other studies (Table 5.7) reveals that our elasticities are comparable to most of them. Using similar methodology but smaller sample of meat expenditures, MDAFRI (1993) found that beef and poultry are elastic. His findings are, however, subject to a bias that might be caused by price collinearity of beef and mutton.

Table 5.7. Own price elasticities of previous domestic demand studies involving Morocco[1]

Commodity	MADFRI	MATEUS	ALOUI et al.	Baijou
Soft wheat		-.752	-.75[c]	-91[c]
Durum wheat		-.650	-.50	-.28
Barley		-.824	-.40	-.52
Corn		-.804	-.20	-.26
Red meat	-1.811;-.775[a]	-.32[b]	-.72;-2.09[a]	-.72;-.21[a]
Poultry	-1.263		-.24	-.24
Milk			-.45[c]	-.45[c]

[a]Beef and mutton.

[b]All meats.

[c]Average.

[1]Except for MDAFRI and MATEUS, the elasticities were obtained subjectively or from unpublished research.

Import Demand Equations

The estimated parameters of import demand equations for soft wheat, durum wheat, barley and corn for the 1960-1990 period are presented in Table 5.8. Overall, the model appears to fit very well over this period, as noted by high R^2 and t-statistics of the estimated parameters. In general, the signs of the coefficients are as expected. An improvement of Moroccan food self-sufficiency decreases commercial imports. As real import capacity, which represents foreign exchange reserves or total export earnings, increases, commercial imports increase. Outstanding debt has a negative impact on the volume of imports of wheat and barley. For corn this effect is not significant. Another important result of these estimations is the responsiveness of Moroccan grain imports to import prices. The price estimates reported in Table 5.8 have the expected signs; that is an increase in import prices decreases commercial imports. However, the estimated price elasticities at the mean, -.284; -.198; -.124 for soft wheat, barley and corn, respectively, suggest that grain import demands in Morocco are virtually price inelastic. For durum wheat, price has no role in explaining the variation of imports. It is also useful to notice that price coefficients in all import equations are not significant at the 5 percent level of significance. This may indicate that border prices are only a minor factor in determining the volume of grain imports in Morocco. The estimation results also show that self-sufficiency state, external debt and import capacity are the most important constraints in Moroccan grain importing behavior.

Table 5.8. Equations of the Moroccan cereal import model[a]

SOFT WHEAT

$$\underset{(4.27)}{MSWT = 1{,}388{,}700} - \underset{(-1.73)}{308{,}340\ MPSWT} - \underset{(-.51)}{23{,}274\ EXGR} + \underset{(4.96)}{96{,}802\ MCAP}$$
$$- \underset{(-3.36)}{12.622\ DET} - \underset{(-7.14)}{1{,}798{,}800\ SSRSWT} - \underset{(-1.30)}{.478\ PL480I} - \underset{(-.67)}{.621\ PL480II}$$

R^2 = .94 D.W. = 1.92

DURUM WHEAT

$$\underset{(3.32)}{MHWT = 1{,}319{,}800} - \underset{(-3.36)}{1{,}314{,}800\ SSRHWT} + \underset{(2.85)}{2671.5\ MCAP} - \underset{(-3.28)}{2.421\ DET}$$
$$- \underset{(-.39)}{.007\ PL480I} + \underset{(.88)}{.135\ PL480II} - \underset{(-1.09)}{7564.7\ EXGR}$$

R^2 = .98

BARLEY

$$\underset{(5.62)}{MBRL = 1{,}140{,}600} - \underset{(-1.15)}{15{,}654\ MPBRL_{t-1}} - \underset{(-.77)}{4129.4\ EXGR} + \underset{(2.34)}{1{,}309{,}300\ MCAP}$$
$$- \underset{(-5.71)}{1{,}169{,}300\ SSRBRL} - \underset{(-1.25)}{.311\ DET}$$

R^2 = .92

CORN

$$MCRN = 208{,}270 - \underset{(1.14)}{413.90\ MPCRN} + \underset{(.50)}{13{,}163\ EXGR} - \underset{(-6.51)}{267{,}410\ SSRCRN}$$
$$+ \underset{(2.61)}{73{,}091\ MCAP} - \underset{(-.47)}{.128\ DET}$$

R^2 = .91

[a]Numbers in parentheses are t-statistics.

Except for corn, the exchange rate variable in all equations in Table 5.8 has the expected sign. An overvaluation of the domestic currency (DH) tends to increase import flows. The statistical nonsignificance of the exchange rate coefficient in all import equations might have been caused by the Moroccan exchange rate being constant for long periods of time. The government's response to PL 480 title I wheat imports is negative, indicating that concessional imports do substitute for commercial imports. PL840 title II has the same impact on soft wheat commercial imports, but increases durum wheat imports. In soft wheat import equation, PL 480 titles I and II coefficients add up to -1, revealing that food aid does substitute perfectly for commercial imports.

Import Allocation Model Results

The following section presents tests for homotheticity and separability of import demands among import sources. The results of the accepted model are then presented. The two critical assumptions that make up the Armington model are homotheticity of import demand and the mutual separability of demands for different imports. Our objective in this section is to test these assumptions under the maintained hypothesis that import demand equations are of the AIDS form, using the approaches developed by Winters (1984).

The assumption of homotheticity says that the import shares are independent of the total import levels. The test in the AIDS import share equations is equivalent to testing that all the coefficients of the logarithm of real expenditures in the share equation of source i (β_i) are zero. To test for separability between import sources, we test whether the price from a particular import source contributes anything to the otherwise complete allocation model. Thus, for each import source (US, EU, and ROW), we estimate an AIDS excluding it and then test if its price has any effect on the included import shares. To test for homotheticity or separability, we use a t-test. To test the joint restriction of homotheticity and separability within the reduced demand system, we use F-test. To test for homotheticity alone in the complete system, we use likelihood ratio test.

Table 5.9 reports the detailed test results for Moroccan grain imports from the three sources. The inspection of these results reveals that the homotheticity restriction is rejected for all grains in the full system including all sources. For homotheticity within a reduced system, it is rejected in two of three cases for soft wheat, durum wheat and barley imports, and in all cases for corn imports. Considering separability over import sources, the restriction is rejected in two of three cases for soft wheat and barley imports, and only one of three cases for durum wheat and corn imports. For the joint test, it is found that the joint constraint is rejected in two of three cases for soft wheat, durum wheat and barley imports and in all cases for corn imports. Consequently, these parametric tests show that the necessary assumptions of Armington model are strongly rejected in most cases. This leads to the conclusion that Armington's framework frequently used in international trade studies can be a misspecified model. However, it is useful to keep in mind that the tests in Table 5.9 are run under the assumptions that the AIDS functional form is the true framework, and that the complete set of restrictions, including functional forms for demand, that make up the Armington model are not tested.

Table 5.9. AIDS model tests results for Moroccan grain imports[a]

Separable country or source	Homotheticity	Separability	Homotheticity and Separability
	(t, d.f. = 26)	(t, d.f. = 26)	F, d.f.= 2,26
SOFT WHEAT			
Rest of the World (ROW)	-1.214	1.743	2.178
European Unity (EU)	6.075*	2.784*	18,397*
U.S.A.	-2.182*	2.795*	4.632*
Complete system	$X^2(2)$ = 46.95*		
DURUM WHEAT			
ROW	.99	.93	.67
EU	3.42*	1.23	5.84*
US	2.17*	2.72*	3.7*
Complete System	$X^2(2)$ = 29.54*		
BARLEY			
ROW	3.48*	1.82	6.69*
EU	1.31	2.84*	2.27
US	-2.51*	-2.25*	5.71*
Complete System	$X^2(2)$ = 31.52*		
CORN			
ROW	-2.05*	2.57*	4.67*
EU	-2.54*	.27	3.38*
US	-2.42*	.717	3.73*
Complete System	$X^2(2)$ = 14.31*		

[a]The critical values of these statistics for .05 significance level are t_{26} = 2.056, $F_{2,26}$ = 3.37 and $X_2(2)$ = 5.99.

*Denotes significance at p = .05.

Based on these test results, the LA/AIDS is fit to soft wheat, durum wheat, barley and corn import data for the 1960-1990 period, from three sources (US, EU and ROW). In Table 5.10, the specified model for all import sources is shown to perform quite well in the explanation of the market share of American and French grains, as evidenced by R^2 levels and the Durbin-Watson statistic. The associated mean and expenditure elasticities are presented in Tables 5.11 and 5.12.

Except for barley, all of the grains are estimated to be price elastic. Close inspection of Hicksian cross price elasticities in Table 5.12 reveals that all American grains are price substitute for French grains. In the case of barley, both the US and EU grains are found to be price complement to the rest of the world barley. Such results are consistent with the notion that Moroccan government is willing to switch, with no additional costs, from one supplier to another based on the lower price offer. In terms of expenditure elasticities, it is found that for soft wheat imports, for instance, an increase in total expenditure will have only limited positive impact on demand for US soft wheat, opposite to EU and ROW soft wheat which have perfectly elastic and elastic response to total expenditure on soft wheat imports.

Table 5.10. Summary results for second stage grain import demand system

	Soft Wheat		Durum Wheat		Barley		Corn	
	US	EU	US	EU	US	EU	US	EU
R^2	.94	.87	.73	.68	.71	.85	.89	.86
D.W.	1.27	2.26	2.14	1.74	1.91	1.49	1.93	1.79

Table 5.11. Own price and expenditure elasticities of grain import demand system[a]

Import Source	Soft Wheat Own	Soft Wheat Expend-iture	Durum Wheat Own	Durum Wheat Expend-iture	Barley Own	Barley Expend-iture	Corn Own	Corn Expend-iture
US	-1.39	.79	-1.45	1.36	-.34	.89	-1.26	1.00
EU	-1.21	1.00	-2.61	1.70	-.64	1.00	-1.72	.95
ROW	-2.59	1.92	-1.27	.73	-.06	1.08	-1.66	1.00

[a]Elasticities are calculated using mean values.

Table 5.12. Mean price and expenditure elasticities for cereal imports in Morocco, 1960-1990[a]

Type of Expenditure	Marshallian Elasticities		Hicksian Elasticities	
<u>SOFT WHEAT</u>				
US Soft Wheat				
US soft wheat	-1.39	(.421)	-.77	(.401)
EU soft wheat	.09	(.070)	.69	(.152)
ROW soft wheat	.55	(.325)	.29	(.098)
Expenditure	.79	(.137)		
EU Soft Wheat				
US soft wheat	.10	(.051)	.88	(.202)
EU soft wheat	-1.21	(.091)	-.94	(.511)
ROW soft wheat	.10	(.074)	.28	(.079)
Expenditure	1.00	(.082)		
ROW Soft Wheat				
US soft wheat	1.57	(.457)	3.07	(2.055)
EU soft wheat	-.09	(.012)	.41	(.351)
ROW soft wheat	-2.59	(2.492)	-3.26	(1.901)
Expenditure	1.92	(1.05)		
<u>DURUM WHEAT</u>				
US Durum Wheat				
US durum wheat	-1.45	(.501)	-.135	(.322)
EU durum wheat	.08	(.011)	.09	(.045)
ROW durum wheat	.29	(.105)	.46	(.119)
Expenditure	1.36	(.491)		

[a]The numbers in parentheses are standard errors.

Table 5.12. Continued

Type of Expenditure	Marshallian Elasticities		Hicksian Elasticities	
EU Durum Wheat				
US durum wheat	.40	(.098)	.52	(.085)
EU durum wheat	-2.61	(.857)	-2.59	(1.007)
ROW durum wheat	1.07	(.900)	1.28	(.992)
Expenditure	1.70	(.705)		
ROW Durum Wheat				
US durum wheat	.20	(.072)	.25	(.105)
EU durum wheat	.12	(.017)	.13	(.066)
ROW durum wheat	-1.27	(.197)	-1.18	(.808)
Expenditure	.73	(.049)		
<u>BARLEY</u>				
US Barley				
US barley	-.34	(.077)	-.18	(.025)
EU barley	-.03	(.102)	.24	(.115)
ROW barley	-.56	(.413)	-.37	(.311)
Expenditure	.89	(.202)		
EU Barley				
US barley	-.04	(.011)	.13	(.069)
EU barley	-.64	(.221)	-.33	(.109)
ROW barley	-.33	(.167)	-.12	(.109)
Expenditure	1.00	(.551)		
ROW Barley				
US barley	-.49	(.310)	-.31	(.204)
EU barley	-.50	(.115)	-.18	(.094)
ROW barley	-.06	(.007)	-.16	(.101)
Expenditure	1.08	(.573)		
<u>CORN</u>				
US Corn				
US corn	-1.26	(.091)	-.73	(.104)
Eu corn	.03	(.021)	.09	(.010)
ROW corn	.23	(.144)	.47	(.095)
Expenditure	1.00			
EU Corn				
US corn	.25	(.108)	.75	(.213)
EU corn	-1.72	(.908)	-1.67	(1.002)
ROW corn	.52	(.416)	.74	(.313)
Expenditure	.95	(.307)		
ROW Corn				
US corn	.53	(.422)	1.06	(1.00)
EU corn	.13	(.110)	.19	(.093)
ROW corn	-1.66	(.771)	-1.43	(.692)
Expenditure	1.00	(.099)		

Given the great importance of soft wheat in Moroccan trade, it is also worthwhile to examine its own price and expenditure elasticities over time. The elasticity patterns cannot determine any structural change in import expenditure behavior, but may provide some facts that should be recognized in evaluating the future of grain imports from different sources. Table 5.13 presents the own price and expenditure elasticities computed at five-year intervals. This table indicates that US soft wheat shows the widest variation. For both EU and ROW soft wheat, expenditure and price elasticities appear relatively stable. This pattern is mainly generated by that of US and EU market shares in Moroccan grain imports. Historical ties with France and geographic proximity to Western Europe are the main factors that may explain the stability of Moroccan trade flows with Europe. For US, the frequent changes in its export policies and the use of different trade instruments (PL 480, subsidies, etc.) during the last three decades, either to enhance its exports or simply to confront subsidized exports of EU in North African markets, are among the major factors that have contributed to the relative instability of its market share.

Price Equations

In this section we present and discuss the results of government pricing behavior in cereal markets, and mark-up equations of livestock products. The parameter estimates of all equations are given in Tables 5.14 and 5.15. Considering cereal price equations, the model specified appears to fit the data quite well, as indicated by high R^2, the Durbin statistic, and t-statistics of the estimated parameters. As expected, the government budget allocated to soft wheat program has a significant impact on both farm and consumer prices. Indeed, a 10 percent increase in soft wheat budget increases producer price by 1.60 percent and decreases consumer price by 1.02 percent. The government procurement policy seems to be very effective, as indicated by the statistically significant coefficient of the procurement variable. This effect being to increase both producer and consumer prices.

Table 5.13. Expenditure and own price elasticities of soft wheat import share equations in Morocco, 1960-1990

Import Source	Period	Own Price Elasticities	Expenditure Elasticities
US	1960	-2.71	.08
	1965	-1.69	.67
	1970	-1.59	.71
	1975	-1.62	.70
	1980	-2.12	.51
	1985	-1.80	.64
	1990	-1.46	.77
EU	1960	-1.26	1.00
	1965	-1.38	1.00
	1970	-1.07	1.00
	1975	-1.67	1.00
	1980	-1.57	1.11
	1985	-1.13	1.00
	1990	-1.23	1.00
ROW	1960	-1.84	1.25
	1965	-1.89	1.27
	1970	-2.33	1.43
	1975	-2.83	1.05
	1980	-2.25	1.12
	1985	-2.35	1.41
	1990	-2.40	1.50

Table 5.14. Parameter estimates of Moroccan cereal price equations[a]

<u>Soft Wheat Farm Price</u>

$$LN(SWTEP) = -\underset{(-1.36)}{1.177} + \underset{(4.70)}{.712}\ LN(SWTWP_{t-1}) + \underset{(2.92)}{.157}\ LN(PROCSWT)$$

$$+ \underset{(2.94)}{.160}\ LN(BUDGET) + \underset{(2.28)}{.537}\ LN(EXGR)$$

$R^2 = .87$ D.W. = 1.82

<u>Soft Wheat Consumer Price</u>

$$LN(PSWT) = -\underset{(-3.69)}{3.103} + \underset{(3.55)}{.435}\ LN(SWTWP_{t-1}) + \underset{(2.23)}{.114}\ LN(PROCSWT)$$

$$-\underset{(-2.23)}{1.02}\ LN(BUDGET) + \underset{(4.52)}{.559}\ LN(PSWT_{t-1})$$

$$+ \underset{(2.50)}{.030}\ LN(PL480I)$$

$R^2 = .93$ D.W. = 2.01

<u>Durum Wheat Farm Price</u>

$$LN(HWTEP) = -\underset{(-1.39)}{.406} + \underset{(24.55)}{.953}\ LN(HWTEP_{t-1}) + \underset{(2.35)}{.142}\ LN(HWTWP)$$

$R^2 = .97$ D.W. = 2.21

<u>Durum Wheat Consumer Price</u>

$$LN(PHWT) = -\underset{(-4.38)}{1.744} + \underset{(13.83)}{.822}\ LN(PHWT_{t-1}) + \underset{(4.30)}{.361}\ LN(HWTWP)$$

$$+ \underset{(1.55)}{.010}\ LN(PL480I)$$

$R^2 = .95$ D.W. = 2.07

<u>Barley Farm Price</u>

$$LN(BRLEP) = -\underset{(-.95)}{.412} + \underset{(12.62)}{.849}\ LN(BRLEP_{t-1}) + \underset{(2.19)}{.254}\ LN(BRLWP_{t-1})$$

$R^2 = .94$ D.W. = 2.03

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[a]Numbers in parentheses are t-statistics. LN stands for natural logarithm. A lag of i periods is indicated by (t-i).

Table 5.14. Continued

Barley Consumer Price

$$LN(PBRL) = \underset{(-4.38)}{-\ 4.048} + \underset{(2.17)}{.336}\ LN(PBRL_{t-1}) + .639\ LN(BRLWP_{t-1})$$

$$+\ .722\ LN(EXGR)$$

$R^2 = .84$ D.W. = 1.75

Corn Farm Price

$$LN(CRNEP) = -\ .630 + \underset{(-1.70)}{.216}\ LN(CRNWP) + \underset{(2.39)}{.933}\ LN(CRNEP_{t-1})\ (20.60)$$

$R^2 = .97$ D.W. = 2.22

Corn Consumer Price

$$LN(PCRN) = \underset{(-4.53)}{-\ 5.473} + \underset{(4.68)}{.990}\ LN(CRNWP) + \underset{(3.51)}{.469}\ LN(PCRN_{t-1})$$

$$+\ \underset{(2.72)}{.616}\ LN(EXGR)$$

$R^2 = .90$ D.W. = 1.54

The results of the wheat model also suggest that PL 480 title I has a positive impact on consumer price. Thus, PL480 do not appear to create any additional demand. This result is consistent with our earlier results related to decreasing commercial imports of wheat in response to more PL 480 shipments.

Another important result of the grain price model is the existence of a certain response of internal prices to world market conditions. Considering the price transmission elasticities of all grains, soft wheat's producer price appears to be more responsive to world price. These elasticities are estimated to be .71, .14, .25, and .22 for soft wheat, durum wheat, barley and corn, respectively. For consumer prices, these elasticities are higher but still less than one.

Causality analysis between prices and government held stocks, using Granger Causality Test (Pindyck, 1991), shows that there is no causality relationships between both producer and consumer prices and stock levels. This result confirms the fact that Moroccan government stockpiling policy has been passive in terms of regulating soft wheat prices.

Mark-up equations for red meat, chicken and milk are documented in Table 5.15. For all products, a significant positive correlation is found between the retail price and the farm price. Red meat and milk retail prices appear to be more responsive and to adjust quickly to changes in farm prices. Negative coefficient on trend variable in the milk price equation may indicate that price tended to decrease over time. However, one should be careful in interpreting this coefficient. This may simply explain errors in data or misspecification of the equation.

Table 5.15. Parameter estimates of mark-up equations for meat and milk in Morocco[a]

Red Meat

$$LN(PRMET) = \underset{(2.40)}{.097} + \underset{(71.22)}{1.013}\ LN(RMETP)$$

$R^2 = .99$ D.W. = 1.34

Chicken

$$LN(PCKN) = \underset{(2.7)}{1.771} + \underset{(2.65)}{.175}\ LN(CKNFP) + \underset{(2.47)}{.107}\ LN(PCKN_{t-1}) + \underset{(3.20)}{.236}\ DUM81$$

$R^2 = .65$ D.W. = .86

Milk

$$PMLK = \underset{(.49)}{.05} - \underset{(-3.27)}{.048}\ TREND + \underset{(14.11)}{2.145}\ MLKFP$$

$R^2 = .99$ D.W. = 1.81

[a]Numbers in parentheses are t-statistics. LN stands for natural logarithm.

CHAPTER VI. VALIDATION AND SIMULATION OF THE MODEL

Historical Simulation

The model structure presented in Chapter 4 and estimated in Chapter 5 provides a rich framework that can be used for policy analysis. In a statistical sense, our results show that the structural specification of the model is reasonable and the estimated coefficients make sense. However, the ability of the model to simulate well is evaluated using simulation statistics. The criterion that is most often used for this evaluation is the fit of the individual variables in a simulation context. The historical simulation uses the sample data from 1969-1990 period. The performance of each equation is evaluated by using root mean square (RMS) simulation error and RMS percent error. The RMS error measures the deviation of the simulated variable from its actual time path. The RMS percent error measures the magnitude of the simulation error by comparing it with the mean of the variable in question (Pindyck and Rubinfeld, 1991). The RMS statistics are reported in Table 6.1.

In general, the simulation statistics given in Table 6.1 indicate that most of the estimated equations effectively simulate the corresponding historical data series. The main exceptions are milk production, fertilizer, and wheat bran use, demands for corn and chicken, and chicken retail price which have relatively higher RMS percent error. This indicates the problems in explaining the wide variations of these variables. Other simulation statistics such as Theil statistics would be helpful in this case. RMS percent error can be misleading when a variable takes a value zero in some years. For example, consider the case of durum wheat, barley and corn imports.

Table 6.1. Simulation statistics of the estimated model[a]

Equation	RMS Error	RMS Percent Error
Output supply equations		
SWTPD	540	7.66
HWTPD	687	5.23
BRLPD	875	4.43
CRNPD	546	16.12
RMETPD	7357	7.74
CKNPD	2075	3.03
MLKPD	239	42.49
Input demand equations		
FERUS	25450	30.73
BRNUS	327	43.89
GRFUS	0.128	0.16
OFEDUS	0.306	0.43
Domestic demand share equations		
Soft wheat	0.03	16.67
Durum wheat	0.04	21.02
Barley	0.02	18.11
Corn	0.01	33.20
Red meat	0.04	20.00
Chicken	0.06	46.15
Milk	0.03	21.40
Import demand equations		
MSWT	28909	0.26
MHWT	5207	3.91
MBRL	2717	0.84
MCRN	1494	0.16
Trade share equations		
Soft wheat		
US	0.04	5.13
EU	0.02	7.69
ROW	0.02	11.11
Durum wheat		
US	0.003	4.28
EU	0.002	15.38
ROW	0.01	8.33

[a]See text for variable definitions.

Table 6.1. Continued

Equation	RMS Error	RMS Percent Error
Barley		
US	0.004	7.38
EU	0.002	10.11
ROW	0.01	6.23
Corn		
US	0.05	8.05
EU	0.01	21.08
ROW	0.04	34.15
Price equations		
SWTEP	16.35	5.65
PSWT	22.81	7.12
HWTEP	10.46	4.13
PHWT	16.60	3.06
BRLEP	12.88	3.96
PBRL	15.76	2.65
CRNEP	14.66	5.96
PCRN	18.40	7.06
Red meat	22.82	4.01
Chicken	18.09	46.13
Milk	16.27	8.11

[b]Not meaningful.

Scenario Analysis

Two policy scenarios are evaluated using the estimated model reported in Chapter 5. These scenarios are: (1) the producer and consumer subsidies are eliminated, and (2) Concessional U.S. exports (PL 480 title I) and food assistance (PL 480 II) are eliminated. Results are prepared relative to a baseline scenario which represents agricultural and trade policies in Morocco as reflected by the model structure and its estimates. The simulation period used for policy evaluations is 1969-1990.

Elimination of producer and consumer subsidies for soft wheat

The results of this alternative are reported in Tables 6.2 and 6.3. This scenario is conducted in two steps. First, soft wheat farm and retail price equations are simulated using zero subsidies.

Average percent changes over the base run are derived for both prices and used in the second step in which output supply, input demand and output domestic demand are evaluated under price changes.

An abandonment of procurement and support price policy and an elimination of consumer subsidy decrease farm price by 1.5 percent on average and increases consumer price by .73 percent, on average over the 1969-90 period of simulation. As reported in Table 6.2, a decrease in soft wheat producer price results in a decrease of soft wheat production and an increase of durum wheat and barley productions which are considered the main substitutes for soft wheat. Red meat production increases and all the remaining output productions and input demands decrease in response to 1.5 percent increase in soft wheat producer price. As expected, fertilizer demand decreases as soft wheat price decreases, because soft wheat has been the main user of this input over the last two decades.

For domestic demand for cereals and livestock products, Table 6.3 provides the percent changes in quantities demanded under a .73 percent increase in retail price of soft wheat. The results show that soft wheat consumption decreases by an average of 9.5 percent over the baseline. On the contrary, durum wheat, barley and all meat consumption increase.

Table 6.2. Percent changes in output supply and input demand under a 1.5 percent decrease in soft wheat producer price[a]

Year	SWTPD	HWTPD	BRLPD	CRNPD	RMETPD	CKNPD
1969	-.005	.0002	.0001	-.003	0.041	-.0009
1970	-.006	.0002	.0002	-.004	0.023	-.0008
1971	-.005	.0002	.0001	-.003	0.024	-.0006
1972	-.004	.0004	.0003	-.002	0.030	-.0007
1973	-.003	.0001	.0000	-.002	0.061	-.0007
1974	-.006	.0003	.0000	-.003	0.052	-.0008
1975	-.012	.0002	.0000	-.002	0.026	-.0006
1976	-.004	.0001	.0001	-.002	0.040	-.0005
1977	-.004	.0003	.0002	-.003	0.049	-.0007
1978	-.003	.0002	.0000	-.002	0.013	-.0007
1979	-.004	.0004	.0001	-.002	0.015	-.0006
1980	-.003	.0003	.0002	-.003	0.027	-.0008
1981	-.004	.0002	.0003	-.003	0.027	-.0007
1982	-.005	.0001	.0003	-.002	0.048	-.0006
1983	-.005	.0004	.0002	-.003	0.040	-.0007
1984	-.005	.0002	.0001	-.002	0.022	-.0006
1985	-.002	.0003	.0001	-.002	0.025	-.0006
1986	-.003	.0001	.0000	-.003	0.027	-.0007
1987	-.002	.0001	.0000	-.002	0.024	-.0007
1988	-.001	.0002	.0000	-.001	0.015	-.0006
1989	-.001	.0001	.0000	-.001	0.025	-.0006
1990	-.001	.0001	.0000	-.001	0.020	-.0006
1969	-.077	-.0006	-.004	-.027	-.117	
1970	-.091	-.0006	-.005	-.038	-.134	
1971	-.065	-.0005	-.004	-.034	-.144	
1972	-.064	-.0005	-.004	-.038	-.157	
1973	-.059	-.0004	-.004	-.034	-.141	
1974	-.067	-.0005	-.004	-.026	-.114	
1975	-.058	-.0005	-.004	-.031	-.134	
1976	-.053	-.0004	-.003	-.029	-.122	
1977	-.062	-.0005	-.002	-.033	-.137	
1978	-.059	-.0005	-.003	-.032	-.134	
1979	-.054	-.0005	-.004	-.035	-.146	
1980	-.059	-.0005	-.004	-.036	-.147	
1981	-.059	-.0006	-.003	-.031	-.131	
1982	-.054	-.0006	-.004	-.030	-.127	
1983	-.046	-.0004	-.002	-.037	-.148	
1984	-.048	-.0005	-.003	-.032	-.123	
1985	-.052	-.0004	-.004	-.028	-.115	
1986	-.044	-.0004	-.004	-.027	-.116	
1987	-.044	-.0004	-.003	-.031	-.132	
1988	-.036	-.0004	-.002	-.034	-.142	
1989	-.034	-.0003	-.001	-.043	-.169	
1990	-.031	-.0003	-.001	-.039	-.154	

[a]See text for variable definitions.

Table 6.3. Percent changes in domestic demand for cereals and livestock products under .73 percent increase in soft wheat retail price[a]

Year	SWT	HWT	BRL	CRN	RMET	CKN	MLK
1969	-15.91	18.89	8.88	-3.71	3.94	9.05	-1.15
1970	-14.39	18.94	8.00	-3.41	3.97	8.79	-1.24
1971	-14.55	18.08	7.29	-4.11	3.79	8.65	-1.37
1972	-14.14	17.76	6.61	-4.36	3.56	8.65	-1.34
1973	-13.17	14.85	5.52	-3.56	3.69	8.21	-1,43
1974	-12.61	12.32	4.63	-3.75	3.02	6.89	-1.59
1975	-12.85	10.95	4.25	-3.10	2.63	5.17	-1.45
1976	-12.95	9.49	2.53	-2.81	2.03	3.45	-1.12
1977	- 9.45	7.40	2.83	-1.51	2.44	2.29	-1.07
1978	- 6.62	7.98	3.21	-1.22	1.45	1.51	- .85
1979	-12.35	7.36	1.59	-1.22	2.72	9.69	-1.28
1980	-12.22	7.78	1.22	-1.02	1.34	3.55	-1.33
1981	-15.20	6.88	2.46	-2.94	2.21	5.81	- .47
1982	-16.88	10.01	2.67	-3.23	1.65	1.73	- .81
1983	- 9.67	12.67	4.23	-1.41	2.93	2.19	- .87
1984	- 8.69	11.59	2.27	-1.55	1.46	2.78	-1.60
1985	-14.00	12.24	3.23	-1.05	1.87	3.52	-1.05
1986	- 7.97	13.30	3.97	-2.11	2.12	4.36	-1.75
1987	- 7.40	14.56	3.16	-3.17	2.20	5.84	-1.83
1988	- 6.57	12.31	3.32	-2.21	2.44	7.03	-1.09
1989	- 7.79	12.44	4.17	-3.81	3.01	8.65	-1.11
1990	- 8.77	12.19	4.05	-3.09	3.07	5.08	-1.26
Average	- 9.41	12.55	4.12	-3.01	2.85	6.12	-1.27

[a]See text for variable definitions.

Elimination of PL 480 shipments to Morocco

In this scenario, PL 480 titles I and II for soft wheat are brought to zero levels. As reported by the model structure in Chapter 5, PL 480 shipments affect commercial imports and consumer price of soft wheat. An elimination of PL 480I results in .29 percent decrease in soft retail price, on average, and an increase of about 6.2 percent in commercial imports of soft wheat. Zero shipments of both PL 480I and PL 480II to Morocco result also in an increase in commercial imports of soft wheat by an average of 12.5 percent. The results of this scenario are provided by Table 6.4.

An interesting issue that should not be ignored is the implications of the PL 480 cut on the market shares of both US and EU in Moroccan wheat market. The results in Table 6.5 show that an elimination of PL 480 exports decreases US share by an average of 44 percent and increase EU share by about 15 percent (over the baseline) during the 1969-90 simulation period. It is thus obvious from our simulation results that an increase in Moroccan imports of soft wheat as a result of US abandonment of food assistance policy is not helping the US improve its grain exports to Morocco. The EU seems, however, to gain from this policy. The remaining part lost by US in Moroccan soft wheat market goes to other exporting countries.

Table 6.4. Percent changes in commercial imports of soft wheat under elimination of PL 480

Year	Elimination of PL 480I	Elimination of PL 480I and PL 480II
1969	0.00	20.86
1970	0.00	17.96
1971	16.93	35.85
1972	33.21	60.93
1973	1.50	8.33
1974	5.04	12.71
1975	0.00	4.26
1976	0.00	2.83
1977	5.25	7.91
1978	6.27	9.45
1979	0.98	1.59
1980	1.18	2.03
1981	3.98	5.84
1982	7.34	9.03
1983	3.81	5.36
1984	6.11	7.26
1985	9.39	10.43
1986	8.28	9.19
1987	4.86	5.46
1988	8.15	14.23
1989	8.09	13.58
1990	5.86	9.85
Average	6.19	12.50

Table 6.5. Percent changes in US and EU shares in Moroccan soft wheat imports, under elimination of PL 480

	Elimination of PL 480I		Elimination of PL 480I and PL 480II	
Year	US	EU	US	EU
1969	-25.83	5.36	-25.70	3.18
1970	-28.98	5.84	-28.81	4.48
1971	-28.02	3.14	-27.85	3.53
1972	-34.01	5.73	-33.86	2.95
1973	-38.78	3.48	-38.68	2.00
1974	-46.03	4.91	-46.02	2.07
1975	-46.90	4.98	-46.26	5.19
1976	-43.87	4.06	-43.83	2.03
1977	-42.37	9.10	-42.24	4.32
1978	-45.76	2.02	-45.66	2.92
1979	-52.12	3.29	-52.05	1.31
1980	-51.39	2.91	-51.36	6.21
1981	-56.79	2.30	-56.78	3.95
1982	-35.19	6.13	-35.16	1.93
1983	-55.54	3.97	-55.55	4.30
1984	-64.20	1.08	-54.25	1.08
1985	-65.44	1.08	-55.48	4.17
1986	-56.61	5.15	-37.38	4.08
1987	-47.42	2.63	-37.39	1.64
1988	-55.55	4.09	-45.55	2.10
1989	-58.24	3.47	-48.28	3.38
1990	-54.99	4.41	-44.99	2.42
Average	-44.04	4.88	-43.95	4.95

CHAPTER VII. SUMMARY

The present study was conducted with two main objectives. The first was to develop an econometric model for Moroccan agriculture using relevant economic theory as background for model conception, and to ground the model in the Moroccan policy situation and its data system. The second objective was to use the right estimation techniques to derive consistent and reasonable supply and demand elasticities.

The contribution of the current study is in the development of an integrated system consistent with endogenous behavior of producers, consumers, and government. The properties of duality were exploited in constructing some modules of the model. More specifically, a multi-output, multi-input normalized quadratic profit function was used to derive product supply equations for four crops (soft wheat, durum wheat, barley and corn) and three livestock products (red meat, chicken and milk), and three variable input demand equations for fertilizer, grain feed, and other feed products. For domestic demand and import share equations, an AIDS framework was applied to derive demand elasticities for cereals and livestock commodities.

As an alternative to the traditional excess demand approach, and to represent the outcomes of a reformed and open cereal subsector in Morocco, the study introduces a module that endogenizes government behavior of cereal imports. The study took a bold first step toward incorporating a policy structure in a theoretically sound framework for soft wheat price determination. Overall, the model as specified in this study fits the data quite well and the estimated parameters are reasonable and make sense. These estimates implied plausible own price elasticities. Estimated cross-price elasticities are, in general, small and sometimes meaningless. The model was also used to conduct statistical tests of convexity of profit function, integration of cereals with livestock products, and necessary assumptions of Armington model (homotheticity and separability). The results of these tests show that convexity is rejected, cereal production is integrated with that of livestock, and Armington model is not suitable for Moroccan cereal imports.

The estimated model performed reasonably well in a historical simulation. The estimated equations were then used to conduct some policy analysis. Results indicated that abandonment of government policy in soft wheat market results in a decrease in producer price and an increase in consumer price. The implications on production and domestic consumption were also significant. In addition, an elimination of concessional US exports and food assistance to Morocco appeared to increase commercial imports of soft wheat. The US export share decreased over the 1969-1990 period of simulation, while the EU seemed to gain from this policy with increased export share over the same period.

Though the results from the present study are satisfactory in several aspects, some improvements can be made in the model. First, modelling the processing and distribution industry for agriculture and the associated impacts on production and consumption could be incorporated. Improvements can also be made in modelling the policy. One idea is to consider the endogenous policy change for agriculture. That is, policies that would be driven by the political economy of the agricultural situation such as World Bank, IMF or GATT restrictions on restructuring the economy. Finally, the rich policy structure in the estimated model can be fully exploited for more policy analysis and for forward-looking policy scenarios.

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