A STOCHASTIC AGRICULTURAL PRICE ANALYSIS MODEL OF THE MOROCCAN AGRICULTURAL SECTOR

By

AHMAD BAIJOU

Diplome D'Agronomie Generale
Institut Agronomique et Veterinaire
Hassan II Rabat
1978

Diplome D'Agronomie Engineer
Institut Agronomique et Veterinaire
Hassan II Rabat
1980

Master of Science
Oklahoma State University
1989

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
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the Degree of
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Thesis Approved:

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Thesis Adviser

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Dean of the Graduate College

I dedicate this work to my Father
who unselfishly provided me
with all needs to achieve my
education

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CHAPTER I

INTRODUCTION

Morocco, like many other developing countries has used agricultural price policies extensively in its development efforts. Agricultural price policy, as defined here, may include producer price support, input subsidies and/or taxes, and international agricultural market price subsidies and/or taxes. Through price policies Morocco has pursued a number of different goals with a variety of tools. Based on the study done by Tolley, Thomas and Wong 1988, insufficient attention has been given to the effects of those policies, thus the results of these policies have not always been satisfactory. The policies instituted have been ad-hoc without in depth analysis of their major goals and side effects. Even in the most satisfactory policy application cases, a need exists for ongoing analysis of the program to evaluate its effectiveness and guide its modification.

The general objectives of agricultural price policy analysis are to analyze the intended and the unintended effects of agricultural price policies and to quantify, if possible, the magnitude of the impact of past price policy effects so that future price policies can be more accurately formulated. A major concern in price policy analysis is to determine sources of volatility of agricultural prices, be they domestic or internationally based. The analysis to be conducted here focuses on quantifying the effect of price volatility on the net balance of trade and upon government costs and revenues associated with subsidies, support prices and taxes.

In the case of Moroccan agricultural price policy analysis the attainment of food self-sufficiency, for major food categories is a major policy objective. Foods for which self-sufficiency is sought include, soft wheat, hard wheat, barley, corn, beef, lamb, and chicken. Coupled with these self-sufficiency goals are the goals of price stability and the earning of adequate foreign exchange.

The Objectives of the Study

The purpose of this study is to show how selected agricultural sector activities can be affected by price policies. The analysis will estimate the effects of selected price policies, and when appropriate, make policy recommendations.

Primary considerations will be given to the measurements of the effects of price policy on producer income, consumer expenditures, government revenue and cost, and the net trade balance. Deterministic estimates of the expected impact of policy on these key economic variables as well as estimates of the stochastic range of possible outcomes of a given pricing policy on these variables will be made. Specifically, deterministic estimates of the impact of three policy scenarios will be analyzed: a) removal of input subsidies for major cereal crops; b) a free-trade policy; and c) a subsidy/tax policy to achieve self-sufficiency for soft-wheat. Additionally the stochastic aspects of subsidy removal and of free-trade will be analyzed. These specific policy applications were selected because they have relevance to current pricing policy issues in Morocco and because they demonstrate the capability of the model to analyze numerous pricing policy questions.

The use of stochastic modelling methods is considered because prices are subject to unintended changes in the domestic and international market as well.

It is well known that agricultural commodity prices are volatile. Price volatility is due to changing response by consumers and producers to price variation (i.e. stochastic supply and demand response), weather, government intervention, and world price instability. Government interventions in the form of input subsidies, producer price supports, and production incentives can not always control all the sources of price stochasticity. International market price volatility is due to world market volatility as well as import/export subsidies and taxes, embargoes and boycotts, and numerous other policies that lead to price distortion. This kind of price distortion drives the market equilibrium seeking process into chaos, which in most cases contributes to misallocation of resources.

The introduction of price stochasticity could be justified as the legitimate assumption of the nature of prices in terms of policy formulation. Quantification of the stochasticity present gives an indication about the randomness of prices that affect the course of the policy decisions made.

Based on the characteristics of the agricultural market cited earlier, a major concern addressed in this dissertation is to define the source of price volatility in the Moroccan agricultural sector. The basic tool that will be used in this effort is the general econometric spreadsheet simulator model (GESS) applied to the Moroccan agricultural sector. The specific nature of this model will be developed in Chapter IV.

Dissertation Organization

This dissertation will be organized into six chapters. The first chapter has defined the scope and purpose of the dissertation. The second chapter envisages an overview of the Moroccan agricultural sector. The third chapter reviews past literature related to agricultural price policy and summarizes the methodologies used and policy implications obtained from these studies. The fourth chapter describes the methodological approach that will be used to quantify the agricultural price policies in Morocco. The fifth chapter will present analysis results, discuss their validity, and interpret the implications of the results. The sixth chapter will provide a summary of key results and suggest future research possibilities.

CHAPTER II

AN OVERVIEW OF THE AGRICULTURAL SECTOR IN MOROCCO

Introduction

Morocco is a North African nation of 25 million people. It is the world's leading exporter of phosphate rock and is endowed with the world's largest reserves of phosphate. Phosphate and its derivatives represent a substantial percentage of Moroccan exports. Profit from its export is about 21 percent of total government revenues (1985 data). Besides phosphate, other mining activities are also conducted by the public sector. Technical and commercial management in the mining sector is still heavily dependent on foreign demand and technology. Mining production and exports have tended to stagnate over the past ten years except for lead and manganese. The average volume of ores extracted during 1972-77 at 1969 prices was divided as follows: 30 percent for lead, and some ten percent each for iron and other ores.

The production of fisheries off the Moroccan coast is estimated at three million tons, of which two million tons is from the areas to the south of Tarfaya. The fisheries sector remains underdeveloped despite its importance as a source of Moroccan food and revenue to the government. Domestic demand for fisheries products are almost totally met from local production, but the market is still far from saturated. Per-capita consumption was only 3.57 kg per year in 1971. Canned fish is a major export product and Morocco is a leading world supplier of canned sardines. The fisheries sector accounts for .2 percent of total Moroccan production and employs 22,000 people or two percent of the labor force in the secondary sector.

Industry plays an important role in the Moroccan economy through its contribution to production and its impact on foreign trade. From 1967-1977 the the secondary sector's (modern industry, small scale and traditional industry) share of the GNP remained between 16 percent and 17 percent according to national accounts. The modern industrial sector experienced, as did the economy as a whole, a marked acceleration in growth under the 1973-1977 plan. At 1969 prices the value added by the modern industrial sector expanded by 5.4 percent per year from 1968-72 and by 7.0 percent per year under the 1973-77 plan period. Few statistics are available on either small-scale or traditional industry. Their value added appears to have increased very slowly (1-3 percent per year). The share of jobs of modern industry was .4 percent. Small-scale and traditional industry each provided 3.5 percent of total jobs in Morocco. Thus the entire industrial sector comprises nearly 8 percent of all jobs.

The agricultural sector plays an important role in Moroccan economy in terms of employment, foreign exchange earnings and supply of major commodities for domestic demand. The remainder of this chapter will give an overview of the Moroccan agricultural sector with regard to its performance, supply and demand characteristics, resource allocation, and pricing system.

Agricultural Performance

Over the last few years of available data, agricultural output is shown to have grown at an average rate of 2.4 percent per annum (World Bank 1981).

Agricultural output fluctuates annually, mainly because of variation in weather conditions. Domestic agricultural production has not kept up with the increased demand caused by urbanization and by income and population growth. Based on the study done by the World Bank 1981, the average annual rate of increase in food imports from 1970 to 1977 was 2.1 percent. During the last decade, food imports have varied with weather conditions, especially, wheat grain. About 15 percent of total imports consist of food stuffs, primarily, sugar, wheat, dairy products and vegetable oils. Agricultural export value rose by six percent per annum in nominal terms between 1970-1977. The expansion of agricultural imports, along with some switching of some exports to domestic consumption as a result of marketing difficulties overseas, has permitted maintenance of a generally adequate food supply and nutritional level.

Performance has varied between agricultural zones: irrigation perimeters, high rainfall areas (400 mm per year and above), and low rainfall areas. Irrigation and high rainfall areas have progressed most rapidly. Modern production techniques and inputs have been introduced wherever it is possible in these two areas. This technology, together with a price structure that provides a sufficient remunerative net income per hectare and per day of family work has brought notable, rapid progress in certain commodities. Examples are sugar beet and sugar cane production, which have been introduced in modern irrigation areas. Marketing of production is provided through contracts between producers and processors. Similarly, milk production increased significantly due to the introduction of improved high yield cows. Construction, by the government, of milk collection centers around which milk producer cooperatives have been created, together with promotion of irrigated forage production, provision of animal health services, subsidization of milk prices paid to producers, and investment in milk pasteurization plants have combined to provide notable progress in milk production. Production of vegetables has grown significantly largely due to the additional area put under irrigation.

Government efforts to increase crop production by altering farming practices for non-irrigated crops (cereals and pulses), or through price policy which did not permit farmers to obtain sufficient income (oil seeds, cotton, maize), have had limited or no success. Cereal yields increased by only .12 tons/ha in 18 years (with considerable annual variation as is shown in figure 2 presented on page 10. The production of pulses, olives and fruit has shown no long run improvement, largely as the result of stagnation of farm technology used in production, lack of investment over a number of years, and lack of government promotion.

Promising results have been obtained by agriculture research in Morocco, especially for cereals, basic seeds, and tree crops. The government's economical social development plan specified that agriculture was to receive an important part of public investment (World Bank 1981). Public investment in agriculture is targeted at about 18 percent of total government investment. The objectives assigned by the government, to the agriculture sector plan include; a) the pursuit of food self-sufficiency to reduce dependency on food imports; b) increased rural incomes; c) greater food availability; d) employment generation; 3) foreign exchange earnings and saving, and f) general economic growth. In order to achieve these goals, greater government control over resource use in agriculture has been necessary. Figures 1 through 10, reported on pages 11 to 15, depict Moroccan cereal and meat supply and demand quantities and prices. Quantities are reported in total quintals (QL) or quintals/hectare (QL/HA). A quintal is equal to one-hundred kilograms. Prices are reported in Dirhams (DH) which is Moroccan basic currency unit. They are descriptive and illustrative of Moroccan agricultural performance during the period from 1969-1985.

Supply of and Demand for Agricultural Products

As a country moves out of poverty into the middle-income levels, the pull of other sectors on agriculture becomes more important. Farmers produce less for subsistence and more for the market. With urbanization, the market increasingly consists of a larger percentage of urban consumers. As urban incomes increase, demand for agricultural production diversifies from low value cereals and pulses, to higher value products such as fruits, vegetables, and dairy products. Morocco experienced, and continues to experience, relatively rapid development of its non-agricultural sectors and of its agro-industry.

As stated previously, agricultural production growth rates in Morocco have not kept up with demand growth rates. Because of this, two significant impacts have occurred. First agricultural imports have risen, and secondly agricultural exports have been diverted to fill domestic demand. Moreover, significant variation in the growth of demand and production between commodities has caused an important structural change in the agricultural sector. In general, both consumption and production of high value irrigated crops and livestock products have increased most rapidly (vegetables, fruit, milk, meat). Higher per-capita incomes and urbanization have increased demand for these high value food stuffs more rapidly than for traditional food stuffs (cereal, olive oil, sugar). This has stimulated a switch in production to higher value crops, a switch which creates additional agricultural value added. Technological change has also been particularly rapid for high value commodities (irrigation of fruits and vegetables, genetically superior livestock, industrial poultry production, and green houses). As a result, an increased percentage of agricultural value added is generated by the production of high value commodities, and less by the traditional commodities (cereals, olive oil, and wine grapes).

Diagrams of production and consumption and prices during the period, 1969-1985 are displayed on pages 11 to 15. Figure 9 and figure 10, respectively, for farm and wholesale prices of beef, lamb, and chicken, show two main differing patterns. Up to 1975 farm prices for chicken were the highest, followed by lamb and then beef prices. The relative magnitude of farm prices is reflected also on the demand side with wholesale prices having roughly the same magnitude rank as farm prices for the same period. 1973 to 1981 can be considered as a transitional period. During this period chicken prices began to fall relative to lamb and beef. Also, as shown in Figures 7 and 8 production and consumption of chicken began to rise relative to lamb and beef. The 1981-1985 period is the second main pattern. During this period wholesale and farm prices for chicken fell below lamb and beef prices and remained stable relative to prices from 1976-1981. This decrease in chicken prices was due to rapid technological improvement in chicken production and processing and chicken feed production.

Farm level prices for cereal products are reported in figure 4. They follow the same general pattern as meat price with the tendency of price increases over time. The changes in farm and wholesale prices for cereals, shown respectively in figure 4 and figure 6, follow the international market price perturbations shown in figure 11. In terms of cereal production reported in figure 3, it can be noticed that barley production is the highest, followed by hard wheat, soft wheat, and corn. These differences in total production are related to the crop area devoted to each crop as shown in figure 1.

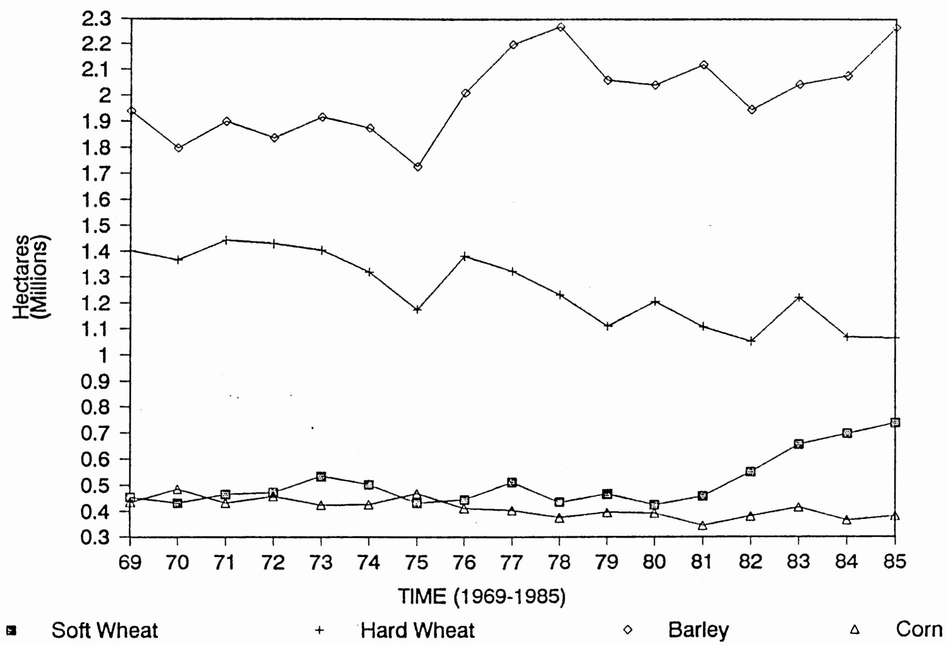

Figure 1. Agricultural Crop Area for Major Cereal Grains.

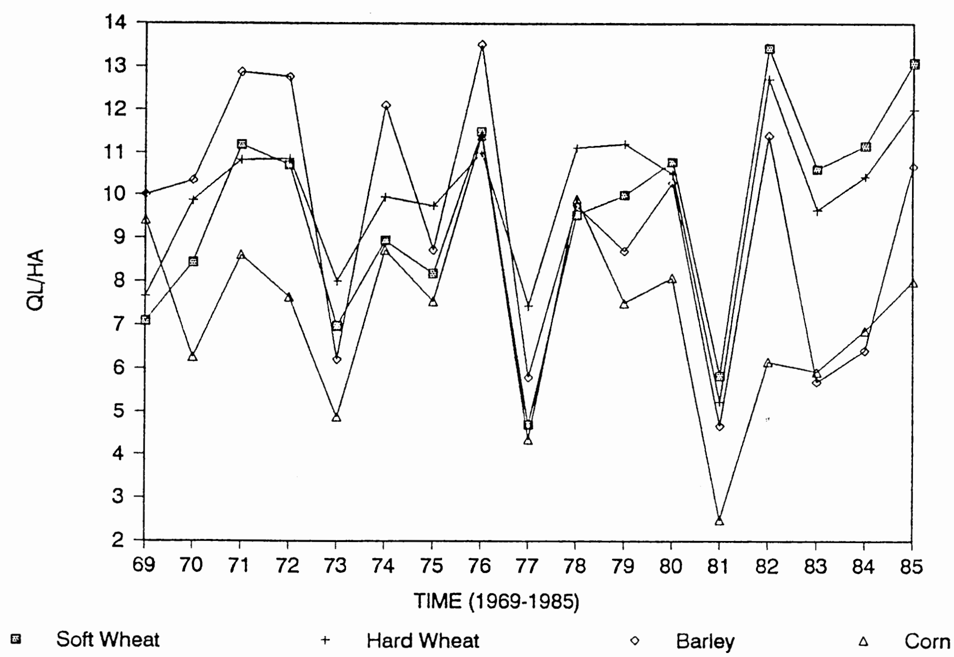

Figure 2. Crop Yields for Major Cereal Grains.

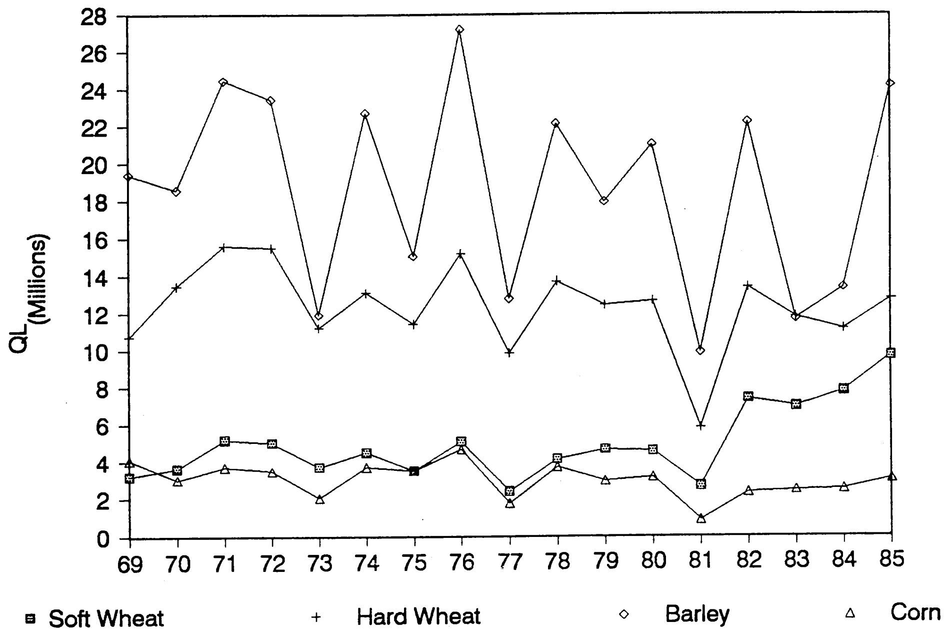

Figure 3. Production of Major Cereals.

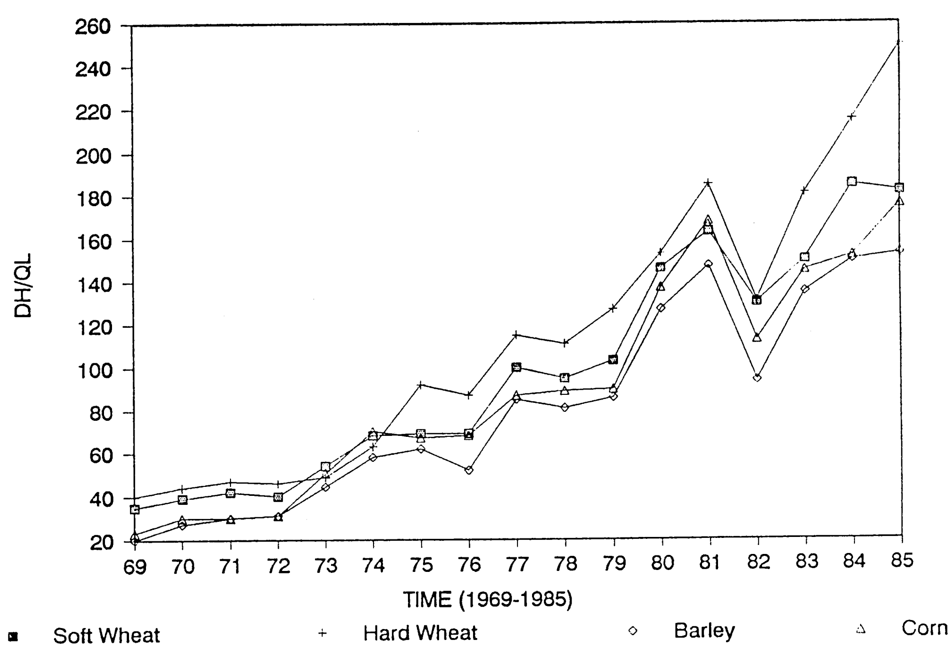

Figure 4. Nominal Farm Level Crop Prices for Major Cereal Grains.

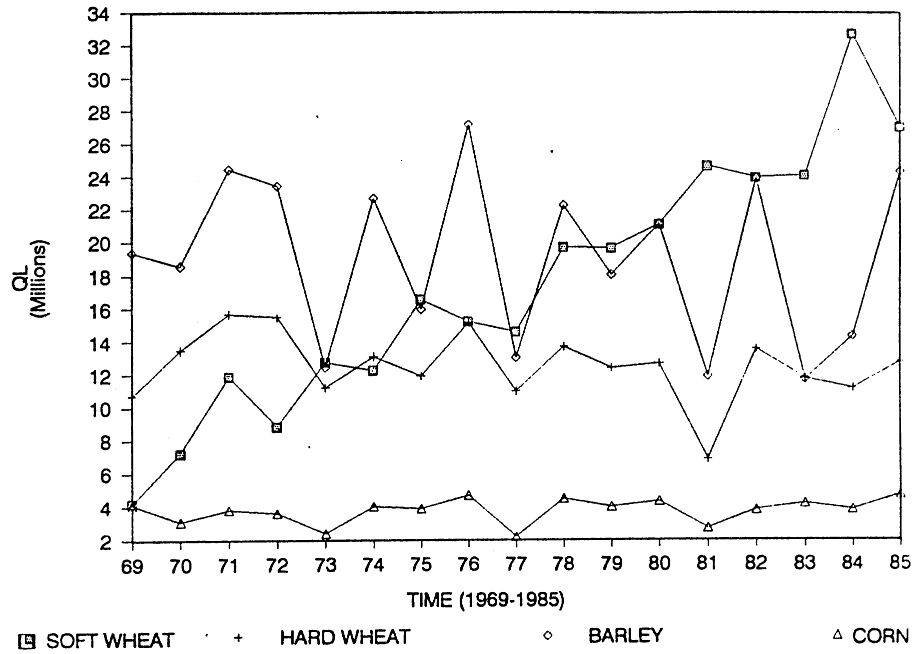

Figure 5. Demand Quantities for Major Cereals.

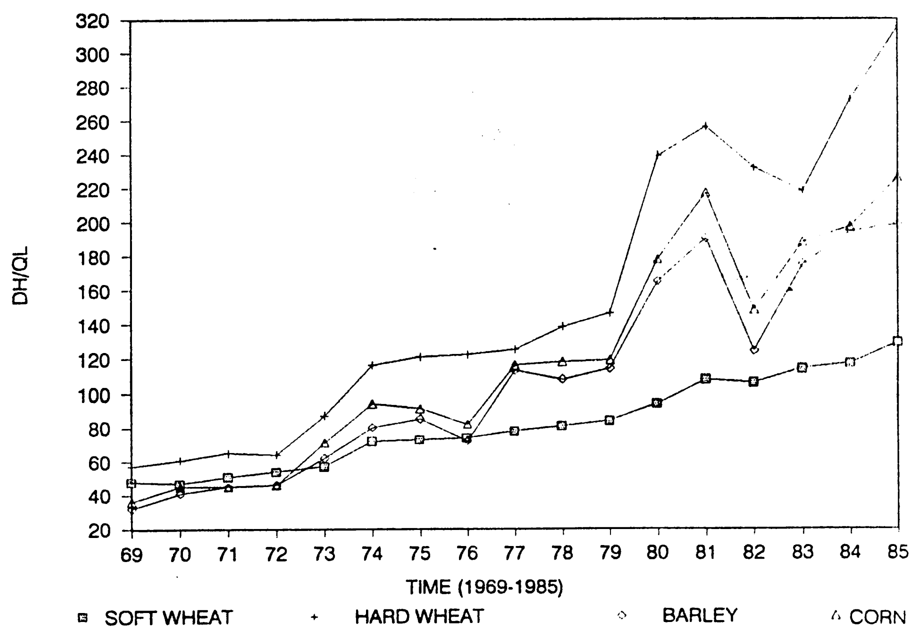

Figure 6. Nominal Wholesale Prices for Major Cereals.

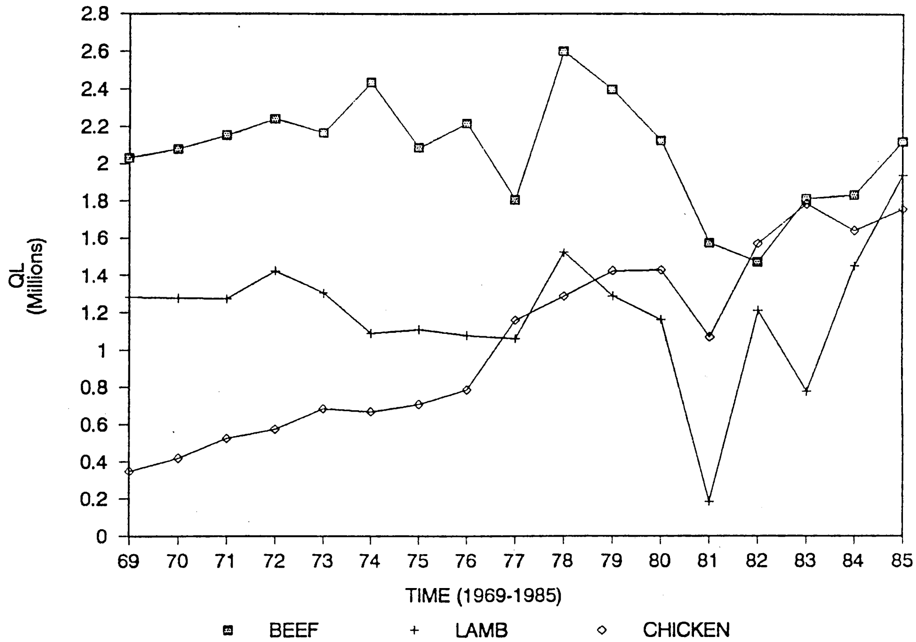

Figure 7. Production of Major Meats.

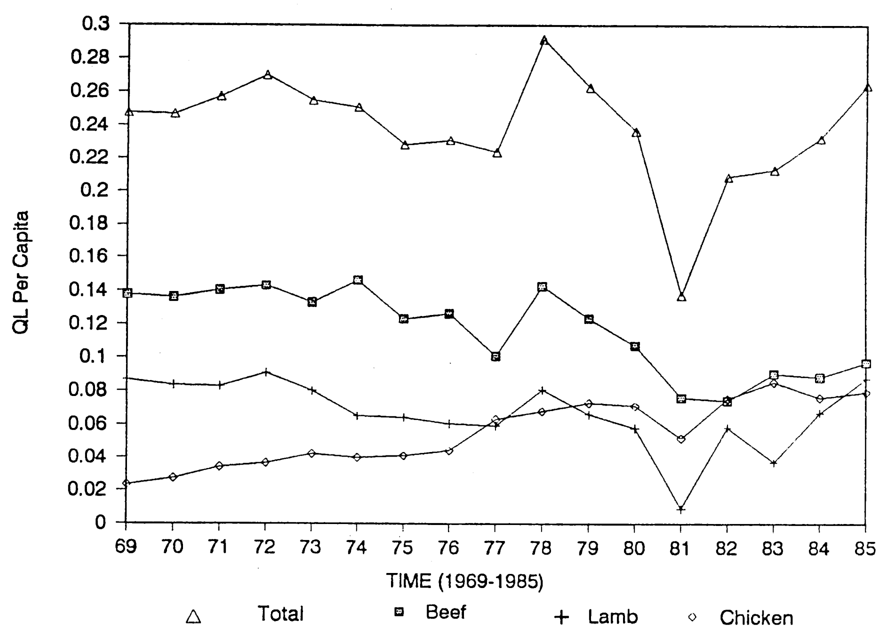

Figure 8. Beef, Lamb, Chicken and Total Per-Capita Meat Consumption.

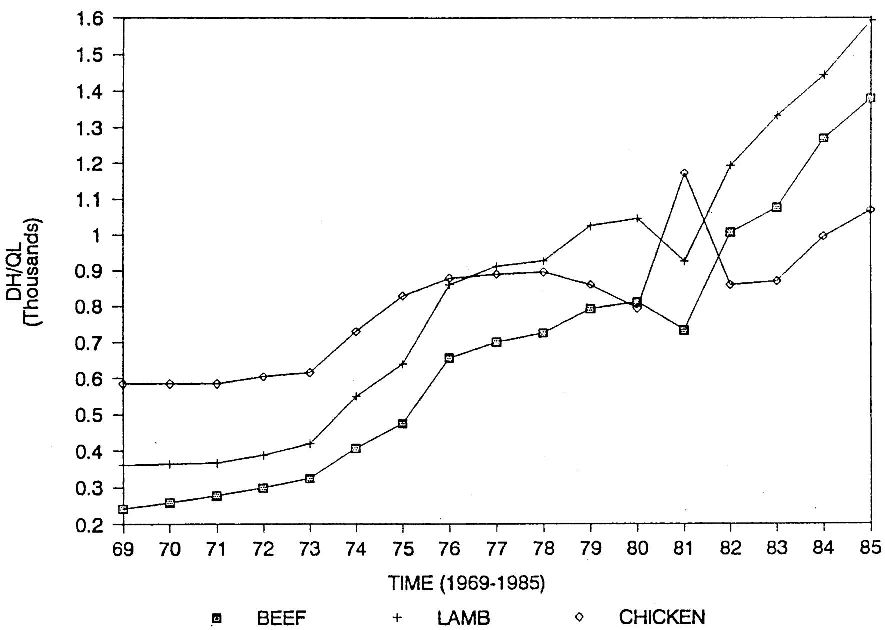

Figure 9. Nominal Farm Prices for Major Meats.

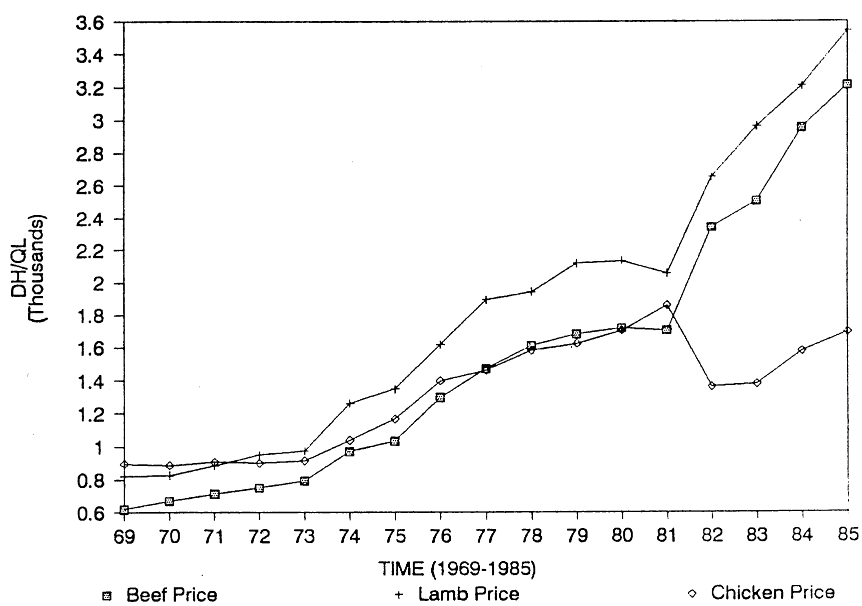

Figure 10. Beef, Lamb and Chicken Wholesale Prices.

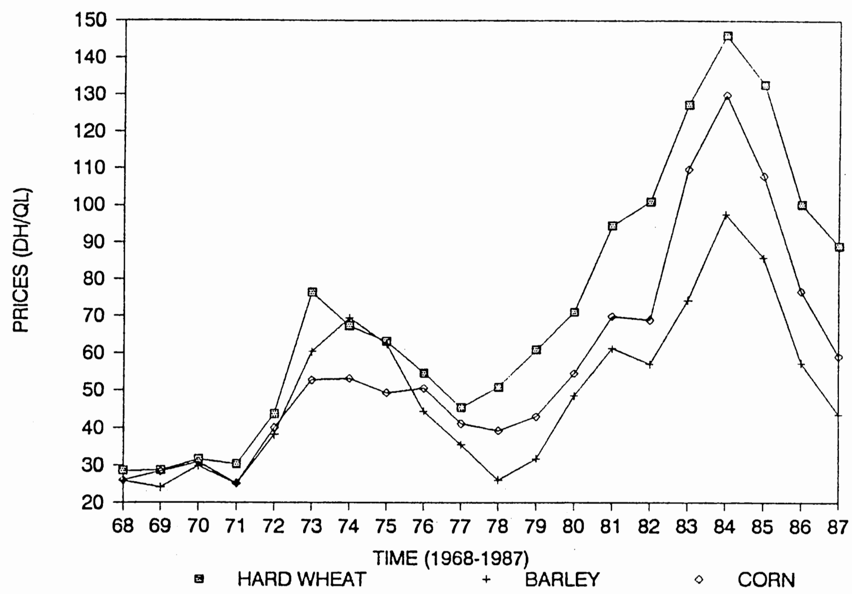

Figure 11. International Market Prices for Cereals: (hard wheat, barley, corn).

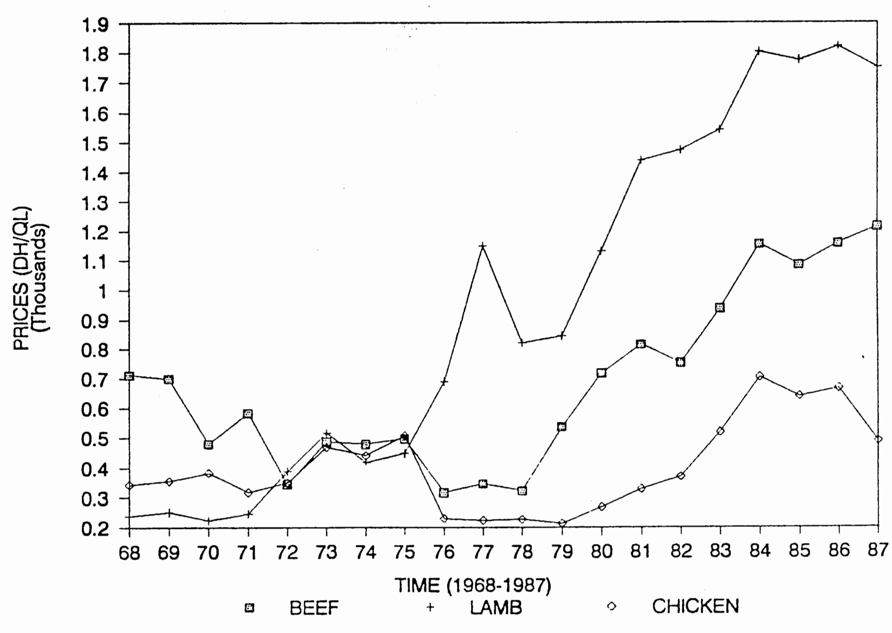

Figure 12. International Market Prices for Meat: (beef, lamb, chicken).

Resource Allocation within Agriculture

Issues in the agricultural sector are closely linked to the evolution of the Moroccan economy and the current austerity policy. This austerity policy is due to the World recession, the economic problems in developed and developing countries caused by the oil price increases in the early 80's, the debt crisis of the less developed countries (LDCs), and the general rise in agricultural commodity prices and manufactured goods prices as well. The impact of this austerity policy is reflected for Moroccan agriculture by many projects being either delayed, cut back in size, or suppressed. Therefore, any increase in government investment in agriculture as a percentage of the total government budget is difficult to implement at this time, despite the strong evidence of the desirability of such an increase for the sector. Public investment that has flowed into agriculture has been directed to equipping the irrigation zones. Government planning currently emphasizes completion of such investments. According to estimations made in 1978, 720,000 ha. of land were irrigated in Morocco compared to an irrigation potential of 1,180,000 ha. Morocco expects to reach this potential before the year 2000. Given the difficulties involved in increasing budgetary resources allocated to agriculture, an assessment of the costs and benefits of various projects relative to costs and benefits of large-scale irrigation projects and rainfed projects, is urgently needed.

Government studies indicate that rainfed agricultural production could increase considerably if certain constraints are overcome, including the land tenure problem, inefficient farming practices, inefficient use of agricultural credit and inputs, and inadequate infrastructure (roads, water supply). Many integrated projects have been started, but few of them are as comprehensive as those conducted in irrigated agriculture. These projects emphasize the training of farmers and extension agents who introduce new farming techniques and inputs. In addition to these integrated agricultural development projects, agricultural credit has been found to be highly productive in rainfed agriculture by financing the following types of investments: wells, pumps, livestock, equipment, and vegetables and fruit production. The cost to the government of distributing credit is negligible, since such credit is reimbursed with interest, while other agricultural projects require substantial non-reimbursable government expenditure. An additional advantage of credit projects is that they distribute investments widely over the development or irrigation projects.

Other interesting project possibilities for the rainfed areas include: a) integrated soil conservation; b) forestry and pasture land development linked to livestock production in heavily populated mountain areas; c) pasture improvement, as well as projects based on seeding of range land and introduction of new livestock species; d) farm improvement in semi arid regions; 3) and large scale irrigation projects. The increase in production of cereals, forage crops, and vegetable oil requires a persistent effort in rainfed areas, rather than in irrigated areas. In addition to the potential economic benefits of shifting the emphasis in favor of rainfed projects, there is a potential social benefit. The rural poor of Morocco live mostly in areas with little irrigation potential. Eighty percent of Morocco's rural population is dependent on rainfed agriculture. The investment costs per farm family tend to be lower in rainfed projects than in irrigation, and they benefit a much larger number of households.

Agricultural Pricing Policy

Agriculture, in Morocco, is the sector that most clearly evidences the problems of price policy. The government intervenes in the market for essential food products (flour, sugar, oil and dairy products) where producers' interests are opposite to those of consumers. A complex system of fixed and supported producer prices, (aimed at encouraging expansion of production) and subsidies for consumer prices (aimed at protecting the purchasing power of consumers) has been adopted for these products. Subsidies are paid to farmers to encourage them to use modern agricultural inputs. This system of price control and support requires large budgetary outlays which places constant pressure on the savings capacity of the government. The net benefits that it yields for the nation as a whole have not been evaluated. Such an evaluation is needed. The government establishes producer support prices for hard wheat, barley, maize, soft wheat, most industrial crops, and milk. On the other hand, the consumer price is fixed by the government also. In addition, subsidies are provided to the wholesalers and processing industries to maintain low retail prices (fixed by the government) for flour, bread, sugar, vegetable oil, and milk, as well as low farm input prices for fertilizers and high-yield varieties of seed. Agrarian reform cooperatives and farmers' associations receive special subsidies on their purchase of inputs.

This analysis conducted in this thesis will focus on four crops (soft wheat, hard wheat, barley, and corn) and four livestock products (beef, lamb, chicken, and milk).

CHAPTER III

LITERATURE REVIEW

Introduction

This chapter contains an overview of key past studies related to agricultural pricing policy and government intervention in the agricultural sector. The studies selected have a common relationships with the general topic of this dissertation. They provide a review of the issues related to agricultural policy analysis and the methodologies previously used to analyze these issues, thus they provide insight into interpretation of the results obtained from the issues to be treated in this dissertation. Most of the studies reviewed focus on developing countries. The chapter is divided into four parts: a) the first part discusses agricultural pricing policies; b) the second part, agriculture price analysis; c) the third part reviews articles dealing with issues related to the use of elasticities of supply, demand, and income in agriculture policy analysis; and d) the forth and last part of the chapter reviews a limited number of studies that have used stochastic models in policy analysis.

Agricultural Pricing Policies

Donalt (1983) presented a study summarizing and describing the policy positions taken by United States Agency for International Development (USAID) and the World Bank. Description of some of the agricultural price analysis research supporting these positions is also reported. Based on this study, Donalt claimed that governments for developing countries take a variety of actions that affect the prices of their agricultural products. These actions are in general taken in order to lower cost of production, decrease consumer prices, and increase supply. However, the interventions taken to achieve these objectives are not taken consciously. They lead to price distortion and in most cases a loss of some total society welfare. Donalt singled out two different country groups: The high income industrial country groups (United States, Western Europe and Japan) who keep many of their agricultural prices high, and the low income countries (Brazil, Argentina, Kenya . . etc.) who tend to hold agricultural prices down, below international levels. In the first country group, the number of farmers has diminished to low levels, despite the high food prices. The political influence of farmers in these countries appears strong. In the second country group, farmers are a high percentage of the population, but their interests tend to be neglected while those of urban consumers are far more influential on policy. Also, in low income countries a desire to emphasize industrial growth exists and there is a tendency to consider agriculture as relatively "backward." This view was more prevalent in the 50's and 60's than it is today. Today, agriculture is often given a much higher priority in developing countries, because it is a political and growth investment.

The word efficiency is revealed with much emphasize. Donalt defines efficiency to generally mean the production of a desired result with a minimum expenditure of energy, time, materials, or money. An interesting analysis presented by Donalt is that the principle of free movement of goods, people, and prices, is seen as the best guarantee of efficiency for the system as a whole and the best practical rule of thumb for policy guidance. However, there are some exceptions in which the government intervention is justified without the loss of efficiency. These points discussed earlier are seen according to an economist view. However, decision makers, do of course have objectives besides economic efficiency. Many of these objectives are often non-economic aims. Therefore, a service that economist or agro-economist are often requested to render is not to determine what is efficient, but to determine changes and/or conditions that a proposed policy will have on food production and consumption. The research to be undertaken here has the purpose of developing a model to answer such questions for Morocco.

The conclusion drawn by Donalt that is relevant to this study is that USAID and the World Bank are increasingly skeptical of government interventions in the agricultural markets. The world food council, a United Nations body, concluded its June 1983 meeting with a plea to Africa countries to increase their price incentives to farmers in order to reduce famines and to restore the continent's self-sufficiency in food. The USAID's advice to developing countries to accomplish this proposed self-sufficiency is:

- Food distribution programs should be targeted to particular groups.
- Subsidies to agricultural inputs (fertilizer, pesticides, etc.) are temporarily justified to introduce new techniques to farmers but should be phased out at the end of the project.
- Agricultural lending institutions receiving AID support should set interest rates according to the market demand for funds, or should make substantial efforts to reduce controls where they exist.

Scandizzo, and Bruce (1980) undertook a study concerning the methodologies for measuring agricultural price intervention effects. Their objective was to derive six informal measures of price intervention in six countries (Argentina, Egypt, Kenya, Pakistan, Thailand, Yugoslavia) and to subsequently analyze the measures developed. The measures used were:

a) Nominal and effective protection coefficients (NPC and EPC)

b) Domestic resource cost (DRC)

c) Net economic benefit coefficients (NEBC)

d) Producer and consumer surpluses

These different measures are used and evaluated as instruments of analysis to recommend appropriate advice to the government and their planning institutions concerned with pricing policies. The principles of each method are given below:

a) The nominal protection coefficient (NPC), is the ratio of the domestic price to its producer price (measured at the farm gate).

b) The effective protection coefficient (EPC), measures the effects of protection, not only on traded outputs but also on traded inputs, i.e the ratio of value added expressed in domestic market prices to value added expressed in border prices.

c) The effective subsidy coefficient (ESC) is the EPC measure adjusted by the sum of the difference between profits, taxes, interest and the price of non-traded goods actually and what is considered to be "normal charges", i.e. the value of direct and implied subsidies.

d) The producer subsidy equivalent (PSE) is the subsidy net of indirect taxes given to producers expressed as a percentage of the market value of each commodity.

e) The Domestic Resource Cost (DRC) is obtained by computing the value of domestic resources (primary and non-traded factors of production) in domestic currency units it takes to earn or save a unit of foreign exchange. DRC could be expressed as a coefficient or as a percentage. If DRC is expressed as a coefficient it could be compared to an accounting price (shadow price) of foreign exchange.

Therefore, if the DRC for a product is less than the appropriate accounting price of foreign exchange a comparative cost advantage exists in producing the commodity in question and vice-versa.

f) The Net Economic Benefit (NEB) is another way of looking at the comparative advantage in terms of economic efficiency. The NEB measure uses a time collapsed form of the Little-Mirrless/Squire Van-Der-Tak methodology which will not be explained here. The Little-Mirrless/Squire Van-Der-Tak methodology applies social weights in evaluating these different measures. The authors confirmed that for agricultural products in developing countries, where input costs are a relatively small proportion of output values, incentives/disincentive effects can be measured by nominal protection coefficients alone. This is desirable because NPCs are easier to evaluate than EPCs or ESCs. Where the land and labor requirements within specified agro-ecological zones do not differ very much as between different crops, the comparative-cost advantages of different crops can be measured by comparing relative yields and relative border prices. However, where land and labor requirement do differ DRCs, or preferably, NEB, have to be estimated.

Scandizzo and Bruce's study shows that market interventions have moved the domestic terms of trade substantially against agriculture in many developing countries to the detriment of farmer's income, foreign exchange earnings and food production. It implies that governments should review and evaluate their intervention policies; and also that agricultural policy analysis and sector work generally should receive priority over other forms of country economic and sector work. Any investments made in research, and extension to transfer the products of research to farmers will be thwarted if farmers are not given reasonable incentives to produce food and fibers in accordance with relative factor endowments and comparative cost advantages.

The work of Scandizzo and Bruce is a relevant study in which different characteristics of developing countries are shown in terms of the agricultural pricing policy. Similarly the GESS model that will be used as a tool for Moroccan agricultural pricing policy analysis uses nominal protection coefficients as the linkage parameters among different price in the GESS model. The use of nominal protection coefficients is well developed in the Scandizzo and Bruce study. However, the GESS model differs from Scandizzo and Bruce work by the stochastic price component that it contains. The stochasticness included in the model provides a capability to estimate the interval of price change effects which, is more powerful capability than the deterministic model that is used in the case of Scandizzo and Bruce's study.

Due (1986), presented a summary concerning the economic growth problems that the countries of tropical Africa have been dealing with since 1974. Due presented an outline of a disastrous economic situation due to both internal and external factors. All sectors of the economy are perceived as weak. Externally, the world recession reduced import demand and, therefore, Africa's export earnings. Since 1974 some tropical African countries have been spending more than 50 percent of their foreign exchange earnings on petroleum. Debt burdens have increased from 5.1 percent of export earnings in 1970 to 12.6 percent in 1982 (World Bank, 1984 p 69). Besides these two external factors there are other internal problems including war, civil strife, and political instability. Over evaluated exchange rates have exacerbated export-import trends. Left uncorrected these overvalued exchange rates have misallocated resources in favor of large scale schemes to the detriment of the small farm families and have contributed to the poor performance of the agricultural sector. Inefficient marketing systems further reduced the earnings of the export agricultural sector, thus forcing farm families to turn to domestic crops where possible. Human capital for administration, management and research/extension was extremely scarce which implies the whole economy suffered. Due claimed that agriculture in tropical Africa is characterized by small scale farms; limited rainfall, bad agricultural planning for domestic crop production, and low input use. In terms of government agricultural strategies, it was believed that agriculture and livestock production could be increased easily by improving agronomic conditions, adequate methods of disease and insect protection, suitable soil, and sufficient seed supplies. However, it is very apparent that price and price policy, marketing arrangement, input supplies, and other incentives are also important. Pricing policies of Africa governments appear to have been based primarily on political rather than economic considerations. Prices to farmers for domestic crops have been kept low. Thus small farmers who produce 85 percent of domestic and export crops have had little incentive to produce beyond their subsistence needs. Besides pricing policy problems one has to add marketing problems created by replacement of foreign marketing firms by government agencies which lack resources to operate and provide adequate facilities, such as transportation, roads, storage facilities, and timely payments to farmers. There are also problems in terms of research and extension. Research conducted on research stations has little relationship to farmers' problems and communication between extension and research workers is minimal. Based on this investigation what can be done is:

- Improvement of incentives
- Price information is needed before the beginning of the planning season
- Decrease in export taxes and increase in domestic export prices

- Increase in wages
- Provide sufficient and timely input supply and on time
- An efficient marketing system (transportation, road, rail)
- Export sector for forcing exchange earnings
- Uniformity of national prices for major agricultural crops all year long or by season
- Research and extension improvement and relationship with agricultural practices
- Population policy
- Development of long term consistent policies and plans in terms of decades rather than two year spans

Janvry and Sadoulet (1987) as part of their research, conducted a literature review of price policy studies in developing countries and classified the studies they reviewed with regard to the methodological approach used. The principal classes of models used were as follows: a) farm and household models done by Singh, Squire, and Strouss; b) partial equilibrium models of supply and demand (Tolly, Thomas, and Wong), c) multimarket models (Bins Yanger, Braverman, Hamer); and d) different types of economy wide models including linear programming, Econometric and computable general equilibrium (CGE) specifications. The study to be undertaken here can be classified as using a multimarket model based on econometric methods and subjectively developed parameters. Janvry and Sadoulet concluded that, in general, the intersectorial, interclass, and intertemporal effects of price policy have been poorly modeled even though these effects are key to an understanding of the growth and welfare consequences of price policy. The main purpose of Janvry and Sadoulet's study is to use computable general equilibrium models for six different countries to analyze key agricultural policy questions. The six countries were India, Peru, Mexico, Egypt, Korea, and Sri Lanka. Comparison of the models for these six countries allowed the authors to understand the key differences in the economic structures of these countries that led to differences in results obtained for identical policy instruments. The policy experiments conducted for each country were analyzed in terms of their intersectorial, interclass, and intertemporal effects. The concern of the policy experiments was with the questions of output increase under different price regimes, price incentives in the short and the long run, investment priorities in agriculture versus industry, and food subsidies with different targeting options and sources of financing. More specifically, the models used were Walrasian CGE Models which included three markets, a labor market, a product market, and the demand functions. Equilibrium is ensured by corresponding flexible prices (wages, product prices, and exchange rate) on the three sets of markets. The key assumptions made in the six models used are as follows: Labor categories, usually corresponding to different skills, are assumed perfectly substitutable among each other and with capital. On the other hand very low elasticities of substitutions among all other factors was assumed. Low elasticities of substitution will induce almost no price response of supply, reflecting the short term rigidity of agricultural production. The extreme case of low substitutability among factors of production is implemented with a Leontief fixed-coefficient of production function. The asymmetry of treatment in intermediate goods and labor inputs differentiates the CGE models used from most multimarket models in which all inputs are substitutable. The equilibrium of all the labor and product markets determines the equilibrium wage. For the general equilibrium policy experiments conducted, the figures reported are elasticities with respect to exogenous variables. For example percentage changes for a one percent increase in investment in agriculture are reported.

Likewise percentage changes induced by an increase in food subsidies equal to one percent of GNP are reported. Long-run effects in the Egypt, Korea, and Sri Lanka models are measured as the difference between the impact of a one-time change in the exogenous variable obtained over time, and the dynamic base-run solution. The results of price, productivity, and investment policies in six countries suggest that five structural features are determinant of the poverty alleviation effects of these policies:

1) Sufficient access to land for the small farmers to make them net sellers of crops if there are to be benefits from increasing output with price support programs or an open economy.
2) Technological advances targeted at the cropping patterns of small farmers if they differ from those of large farmers.
3) Labor market conditions that make agricultural wages sensitive to changes in the marginal value productivity of labor, requiring the resorbing of surplus labor.
4) Downward flexible prices that allow translation of the bulk of productivity gains in agriculture into lower food prices and higher real incomes for net buyers.
5) An industrial sector capable of responding to changes in effective demand created by productivity enhancing investments in agriculture.

General equilibrium analysis of technological and price policies, intersectorial investment allocation, and food subsidy programs revealed that these interventions create complex income effects across social groups and time periods, with few instances where net gains are derived by all groups at all times. The complexity of the implications revealed makes it all the more imperative to refine further the theoretical specification of these models and their empirical measurement so they may become increasingly useful tools for policy analysis.

Lutz and Saadat (1988) studied agricultural pricing policies and their effects on consumers, producers, and the government in seven developing countries (Argentina, Brazil, Mexico, Thailand, Indonesia, Egypt, and Kenya). They reported that many studies had been done on agricultural pricing policies using partial equilibrium analysis, but linkages between the commodity markets were not considered. The purpose of their study was to determine the effects of agricultural pricing policies for a sample of developing countries (Argentina, Brazil, Mexico, Thailand, Indonesia, Egypt, and Kenya), by using the partial equilibrium approach and introducing cross-price elasticities on the supply and demand side to capture the effects due to the interaction of pairs of the most interlinked commodities. The partial equilibrium framework is used with and without distortions in order to analyze the policy interventions. Lutz and Saadat found that the inclusion of cross-price effects improved the accuracy of the estimates of the effect of pricing policy intervention on consumption, production, trade, net social welfare, and government revenues in all seven countries sampled.

The work done by Lutz and Saadat in which the partial equilibrium model is used and the linkages among markets are considered, is similar to the GESS model for which the partial equilibrium model is the core of the model. However, the number of commodities included in Lutz and Saadat's model is less than that included in the GESS model. Moreover, Lutz and Saadat's model did not envisage the stochastic price component, whereas the GESS model does.

In the framework of the American Agricultural Economics Association annual meetings, at Knoxville, Tennessee, July 31 to August 3, 1988, Martin and Crawford presented a study on producer price policies in Senegal. The country has been experiencing severe economic and food security problems for the last 10-15 years. Cereal production dropped sharply from 61 percent of self-sufficiency in 1974-76 to 39 percent of self-sufficiency in 1983-85. Rice imports rose from 100,000 metric tons to over 300,000 metric tons. Faced with declining agricultural production, the government announced a new agricultural policy in 1984, including the objectives of boosting domestic cereals production to 80 percent of self-sufficiency by the year 2000. The objective of Martin and Crawford's study was to examine the impact of alternative producer price policies on the composition of exports, the cereals self-sufficiency rates, costs to the government and consumers, and trade balances.

The three policies examined are:

1) An equal percentage increase in the prices of rice, millet/sorghum, and maize.
2) Establishment of a protected cereals market in West Africa by imposing tariff barriers and raising the consumer prices of rice and wheat, and the producer price of rice.
3) Implementation of economic (border) prices.

Martin and Crawford developed a linear programming model of the agricultural sector to examine the feasibility and economic cost of alternative policies for meeting the government's goals. In their linear programming model they elaborated 181 crop budgets in 11 production regions and constructed 13 typical farm models. In considering macro level implications they aggregated agricultural supply at both the regional and national level. Through the analysis and interpretation of the results, they concluded that none of the hypothesized policies offer an attractive trade-off between success in boosting cereals production and the cost of doing so. Moreover, price policy alone has limited potential for improving the cereals self-sufficiency rate. Even with a 100 percent increase in cereals prices, the cereals self-sufficiency rate only increased slightly, and at a substantial cost to the government and consumers.

Shultz (1983) investigated government interventions in agriculture in low-income countries and its effects on farming entrepreneurship. From his analysis, he concluded that government interventions to introduce new techniques and technology to modernize the agricultural sector, does not transform the agriculture sector into an efficient sector. Moreover, the governments of many countries seriously constrain the entrepreneurship of farmers and of housewifes and thereby reduces the efficiency of agriculture and the standard of living of farm families. He also introduced the question of economic dynamics of agricultural modernization from which we can derive two important inferences. First, economic disequilibria are inevitable and cannot be eliminated by law, by public policy, and surely not by rhetoric. Second, the function of farm entrepreneurs in perceiving, interpreting, and responding to new and better opportunities cannot be performed efficiently by governments. As an example of an effective government program Shultz revealed the case of the green revolution in India that has been giving substantial results. Shultz advised that this example is what is needed in low-income countries. The incentives to which farmers respond are the information that the farmers use in calculating their expected costs; including risks against the returns they expect to receive. The result of this calculation is an incentive to achieve economic gains and avoid losses. Shultz classified countries into those that overvalued (generally high income countries), undervalued (generally low income countries), or neither overvalued nor undervalued their agricultural production. In the case of overvalued agricultural production the producer incentives are too high to be optimal. Where it is undervalued, producer incentives are below optimum. In his article Shultz concentrates on the adverse production effects of policies in low-income countries that undervalued the agricultural production. Through this analysis some very important elements are distinguished, that is, the economic potential of agriculture in many low-income countries is large, but the economic opportunities that are required for farmers in these countries to realize this potential are far from favorable. Shultz believed that the primary cause of lack of optimum economic incentives is the government's intervention. The solution is input availability, and an efficient allocation of resources, with pricing efficiency, economic efficiency, and marketing efficiency.

Agricultural Price Analysis

Horton, Keer, and Dimitris (1988) undertook a study concerning food prices in developing countries. They reported that many past studies have shown that depressing farm prices has an adverse effect on net social welfare. They mention that these past studies used cross-country data to measure such effects. A study done by Peterson (1979) estimates that for a group of 27 developing countries, more favorable farm prices could have led to higher agricultural output. Several macro-models have tried to quantify the trade-offs in individual countries, when farm and consumer prices change. The objective of Horton, Keer and Dimitris's study is to use cross-country data to study the effects of increased consumer prices on consumers. It examines the correlation between real cereal prices and average calorie intake and infant mortality rate. Their study measures the effect on consumers of food prices and is therefore complementary to a number of studies using cross country evidence on supply response to relative prices (surveyed in Scandizzo, 1984). The methodology used is to estimate a type of aggregated demand function relating food intake to prices and incomes, using cross-country data. The problem reported for this kind of macro estimation or aggregate estimation is that it is necessary to take account of different patterns of different variables included in the model for different countries. Two different approaches are used to address this problem. The first approach use international comparison project (ICP) data, which provide both a purchasing power parity (ppp) index, and exchange rate and annual expenditure deflators for different expenditure categories (Kravis, Heston, 1982). The second approach was to use nominal exchange rates, consumer price indices, and GDP deflators for individual countries. The (ICP) approach allows for estimates of demand functions using pooled cross-country and time series data, while the non-ICP approach allows for estimates of cross country demand functions for individual years. In both approaches the least square method of estimation is used. The over all results suggest that there is some evidence that higher cereal prices are associated with higher infant mortality using cross-section data (world-wide data), but, little evidence exists of such a relation using time series data for individual countries. The cross-section derived elasticities are large and significant. This suggest that there indeed may be large responses of food intake of the poor to food price changes which are not picked up by aggregated average calorie intake data.

Through literature studies about food subsidies Schneider (1988) reported that food subsidy is a form of personal income transfer. However, food subsidies may have a consequences on the long-run welfare of the population. This transfer has an effect on budget equilibrium, the balance of payments, the composition of demand within the economy, and the rural-urban terms of trade.

Unlike the past studies in this area, the purpose of Schneider's study is to try to make policy makers aware of the implications of considered policies on food subsidies, and to illustrate how familiar supply and demand concepts can be used to analyze policy options. The methodology used is a partial equilibrium model in which the demand and supply functions are econometrically estimated. In terms of demand, the conceptual model assumes an economy consisting of five groups of consumers, which are characterized by their consumption patterns as subsistence, food transitional, goods transitional, middle-income, and high-income. In terms of supply, it is assumed that the agricultural sector produces for both the local food market and exports. Based on this analysis, the assessment criteria used to evaluate food subsidy programs are; targeting effect, their spill over effect, their growth potential, and their effect on consumer and producer prices. Schneider examined cases of subsidies on goods having no domestic production and goods with domestic production. In the case of subsidized import goods with no domestic production, the results is that a reduction of subsidy expenditure has an inflationary impact if it takes the form of a reduction of rationed quantities. A reduction of the subsidy rate has a deflationary impact on high income markets, a deflationary impact on non-substitutes in medium income markets, and either an inflationary or deflationary impact on low income markets, depending on whether the price elasticity of demand is greater or less than one. An increase in the price of subsidized food increases demand for substitutes regardless of the income effect. The major point of the analysis is the fundamental importance of the income elasticity of demand of the subsidized foods, particularly as it changes by income class. The effectiveness of targeting program benefits to low-income households and the effect of changes in subsidy policy on the composition of aggregate demand are primarily determined by the differential consumption patterns by income class. In addition whether the quantity of the subsidized food consumed is set by price (is marginal), or by rationing (is inframarginal) determines the effect of a change in subsidy policy on markets for other goods. Theoretically, it is possible to subsidize the consumption of low-income households through a dual price system without cost to either the government or producers, and with potential benefit to the government and producers at the expense of high income households.

Braverman, Hammer, and Jorgenson (1985) studied input subsidies to livestock producers in Cyprus. Their study expanded a general methodology designed to analyze agricultural pricing policies to include analysis of the livestock sector. The problems studied included: a) the consequences of several attempts to reduce the government deficits; b) the cost of living in the absence of subsidies; c) the effect of wage indexation on the government wage bill; d) the effect of input subsidies on the poor; e) the effect of input subsidies on agricultural production; f) and the effect of input subsidies on imports and farm income. The answer to these questions are very important and critical to the issues of efficiency, equity, practicality and political feasibility, in the framework of political economy debates. The methodology used is the multimarket method, a model which treats both the production structure of the agricultural sector and the demand system for its products in a consistent framework. The authors developed a set of demand and supply functions that included all the relevant variables in the system. Their model is constructed such that it can capture the basic behavior of farmers in Cyprus. Solving the system for different values of the policy will allow one to trace the effects of policy on the system, based on the substitutability and complementary among the commodities included in the system. The main policy question treated is the government cost in maintaining the subsidy for barley used as feed. The grain commission purchases barley grain from domestic farmers (with a premium over world prices) and from abroad, and sells to livestock producers at significant discounts. The subsidy in each of the markets is quite substantial, therefore it is probably not feasible to remove the subsidies in the short run. Thus the policy interventions to be simulated closed the gap between prices and world prices in stages. The recommendation made from this study was that the Cypriot government should increase consumer food grain prices and eliminate feed grain price subsidies in gradual stages. If this policy is implemented, the first implication is the discontinuation of pork and poultry imports since Cyprus would become self-sufficient in these goods. Second the policy allows free trade in these goods at initial prices.

Wtz and Scandizzo (1980) reviewed previous studies concerning the price distortions in agriculture and reported that for all studies, the net social losses appear to be substantial, both in absolute and relative terms. Real effects and foreign exchange losses, not reported were also estimated to be large. An example is the study done by Valdes (1973) about the policies of Chile. He estimated negative rates of protection averaging -.38 for wheat, -.35 for beef, -.30 for land and -.46 for wool. Because of these rates, the authors found that production was below equilibrium levels from three to ten percent for wheat, from 4.5 to 14.5 percent for beef, and from 6.8 to 23 percent for wool. The loss in foreign exchange earnings ranged from 24 to 39 million dollars, depending on the supply elasticities. Accordingly, Chile's agricultural trade deficit would have been reduced by 76 percent during 1951-55 and would have practically disappeared during 1956-60. The study evaluates the effects of the government intervention in agricultural commodity markets for a sample of developing countries. It also presents a review of the methodology for quantifying the effects of the distortions on prices, supply, demand, income, and foreign exchange. More specifically the paper seeks to investigate in sequence the following main issues:

1) The extent of price distortions induced by domestic agricultural policies.
2) The effect of price distortions on the quantities of each good produced.
3) The consequences of price distortions on the incomes of producer, consumers, and government revenues.

Before exploring these questions Wtz and Scandizzo first reviewed the broad framework of agricultural policy in developing countries. They, then, consider the appropriate way of quantifying the effects of these policies on the price system to determine the impact of the policy-affected prices on supply, demand, incomes and revenues. Concepts used in the study included the nominal rate of protection, partial equilibrium, and supply and demand elasticities. The analysis is based on 1973-1975 data. The own and cross price elasticities are from secondary data. The empirical results found indicate the gross real effects of the price distortions of the government's policy compared to where no government subsidies are involved. For example export and import subsidies were found to cause an expansion of trade amounting to the sum of the absolute production and consumption adjustments. This same methodology was applied for Pakistan, under the hypothesis of high demand and supply elasticities. The negative protection for wheat resulted in reduced production of 1599 thousand metric tons and increased consumption of 940 thousand metric tons. Thus, compared with a situation not influenced by price intervention, imports increased by 2539 thousand metric tons. Since, in actuality, total imports amounted to 1345 thousand metric tons, if all wheat subsidies were removed the study indicates Pakistan would become a wheat exporter. The net social losses in production and consumption critically depend on the extent of protection and on the elasticities. The welfare transfers in all cases are much larger than the respective welfare losses. Positive protection exists for three out of the twenty four cases considered. Producers incur welfare losses in twenty one cases. Even though not all major commodities were taken into consideration in the study, its results are indicative of how heavily agriculture is penalized in many developing countries. The sum of welfare losses for producers is substantial even in per-capita terms. Analogously, consumers make substantial welfare gains in twenty one out of twenty four cases. All the results are for small countries and the application or the use of these results should be done cautiously because the elasticities are obtained from other studies and the period considered is 1973-1975. An additional limitation is that the producer and the consumer price are the same.

Wtz's study is an important one from which some guidance can be used. The work used a partial equilibrium model which is the basic model used in this dissertation. Wtz used elasticities from secondary data, which is what this study intends to do for commodities where adequate time series data are not available. The Wtz's model is a deterministic model, whereas, the GESS model has a stochastic component.

Goldstein and Khan (1976) undertook a study concerning domestic price changes and the demand for imports. They report that most studies make the implicit assumption that elasticities of import demand with respect to relative prices and real domestic income are constant for all values of the two explanatory variables. This assumption is due to the use of a log-linear functional form for the import equation, which a convenient form for purposes of estimation. Another conclusion drawn from past studies is that the relative price elasticity of demand for imports will be large enough to overcome buyer inertia and the costs associated with switching supplies. The second interpretation is that the adjustment of import quantity to large price changes is more rapid than the adjustment to small changes. Under this interpretation the long-run (or equilibrium) elasticities of relative prices and real income would be independent of the size of the price changes, but the short run (or impact, elasticities) would be functionally related to the price change itself. The purposes of the study were to: a) provide new estimates of the aggregate import demand equation for twelve industrial countries, by using quarterly data on the relevant variables for the period 1955-1973; b) to examine empirically elasticities with respect to relative prices, and the speed at which actual imports adjust to desired level; and c) to determine if import adjustment speeds are independent of the size of the relative price changes. Unlike the previous studies using annual or semi-annual data, Goldstein and Khan's study using quarterly data is more precise in estimating the timing of the relationship involved concerning import demand. The twelve countries considered in this study are: Belgium, Denmark, France, Finland, Federal Republic of Germany, Italy, Japan, Netherlands, Norway, Sweden, United Kingdom, and United States. The methodology used is an econometric model with a double log functional form with the quantity of import demand as the dependent variable, and the ratio of import prices to domestic prices as explanatory variables. The rationalization of using the log-functional form for demand import is that this form allows imports to react proportionally to a rise and fall in the explanatory variables, assuming constant elasticities. The results are that import demand was responsive to relative prices for eight out of the twelve countries in the sample chosen. The magnitude of the price elasticities estimated were found to be generally similar to those price elasticities obtained in earlier studies. Real income changes were also found to exert a significant influence on aggregate import demand. Here it was found that the quarterly estimates of the income elasticity tend to be somewhat smaller than do the annual or semi-annual estimates. It was found also that there is no evidence that the price elasticities of demand for imports varied with the size of the relative price changes, or that importers adjust any faster when faced with larger than with "normal" relative price changes.

Braverman, Hammer, and Jorgensen (1987), through an analysis of the agricultural sector in Hungary, concluded the following concerning agricultural policy in Hungary. Most agricultural production in Hungary is produced at fixed prices set by the government. The absolute and relative prices of maize and wheat have differed in comparison to world market levels for the twenty years preceding 1983. For example wheat fell from protection of 113 percent of world prices in 1968 to 55 percent in 1983, while maize stayed at 85 percent of world price levels. Therefore, the objectives that the government may want to pursue with price policies are: a) foreign exchange earnings for the country as a whole; b) increased government revenues; c) maintenance of farm incomes, perhaps with a concern for the relative health of the large and small farms and; d) improvement of the cost of living as it is affected by the prices of consumer goods. A partial equilibrium model is used in which the supply and demand are estimated and programmed using "user friendly software". The analysis uses a multimarket approach in which substitution and complement effects are taken into considerations. Thus interaction between markets is observable. The model is structured to analyze the effects on agricultural production of changes in producer prices due to government policy. The agricultural sector is divided into large and small scale farm operations. Supplies of each commodity are assumed to be determined so as to maximize profits. One particular aspect of the model is that, the construction of the model requires base level values for all quantities and prices as well as all relevant sets of own and cross price elasticities. The model is elaborated as follows: supply is equated to demand for each commodity through the system of models. The solution is obtained by taking the derivatives of each equation relative to each commodity and solving for the price variation using the matrix inverse method. The results found for wheat and maize for the base year 1983 led to the recommendation to raise producer prices for wheat and maize. Given strong emphasis on government export earnings and hard currency foreign exchange, the results show also a higher priority for wheat prices than for maize. In this regard taking the maize price increase as an example, the increase in the maize price will lead to an increase in the supply of maize of eight percent and a decrease in the supply of wheat of 3.3 percent. On the factor demand side, livestock producers will use more wheat and less maize domestically. Due to the relatively low demand elasticities which were assumed, this effect is modest. The net effect of these two responses is to increase exports of maize substantially and to decrease those of wheat. In terms of government revenues generated by exports, it was found that the substitution effect was crucial. If the government were to pay a higher price for maize, the earnings per ton would be lower on maize exports.

Elasticities in Agricultural Studies

An important investigation through the literature of output prices response has been reported by Chang and Shumway in a paper presented at the annual meeting of the American Agricultural Economic Association (AAEA), Knoxville, Tennessee, August 1-3, 1988. This paper focuses on the sensitivity of supply elasticity estimates to model specification. More than 600 estimates of agricultural output supply elasticities from 190 studies were reported in a 1977 survey by Askari and Cummings. Most models used linear equations, a few were linear in logarithms, and a small number were estimated as a system of equations. From all these studies, a practical question has risen "do they lead to elasticity estimates that are significantly different from those obtained with simpler-single equation estimates?". The purpose of the study is to report an empirical investigation of the sensitivity of own price supply elasticities among the most popular model specifications appearing in the supply literature. Both single equation as well as systems of equations were estimated giving a total of twenty six models estimated for the same five output categories: feed grains, food grains, oil crops, other crops, and livestock. All models used the same annual data for the same geographic area and for the same time period (1951-1982). Model explanatory power, parameter significance, and consistency of results with theoretical expectations were examined. Distributed lag models, generalized least square estimation, Zellner seemingly unrelated least squares estimation, and non linear least squares estimation were used to derive the parameter estimates. The results are that in spite of the high R-squares values of .70 for the single equation estimates, few of their own price parameters (41 percent) were statistically significant. By contrast 75 percent of the own price parameters estimated by systems models were significant. Generally, most specifications yielded respectable goodness-of-fit statistics for each output category, but a large portion gave few significant own price parameter estimates. A number of elasticity estimates from alternative models fall within a 67 percent confidence interval of the simplest specifications and/or the system that fully maintained the theory. However, many did not. Thus it is concluded that, if the theory is correct, it is important to maintain it in the estimation of policy relevant relationships such as own price output supply elasticities. If, on the other hand, considerable uncertainty exists about the adequacy of the theory, then it may be more important to determine the distribution of estimates of primary interest from alternative plausible specifications.

Dax (1987) undertook a study focusing upon income elasticities. He defined the term "income elasticity of demand" in the traditional manner as "the quantitative measure of the relative variation of an individual's (or group of individuals) demand for certain commodities when his (their) income varies". Income elasticities can be of great interest for many purposes, interalia for applied economic policy:

- The government wants to estimate reactions in consumers' demand when it plans changes in the tax system;
- The government plans to subsidize certain subgroups of the population;
- The government is interested in forecasting long-term changes in the economic structure of the country.

Income elasticity can be calculated by estimating Engel curves or demand functions from time series price and consumption data, or from cross-section data of household consumption. The purpose of this study was to try to show the necessity and possible ways of integrating the whole income distribution into the calculations of income elasticities. The theoretical considerations are:

$$E_j^i(p,w^i) = \frac{\partial f_j^i(p,w^i)}{\partial w^i} \cdot \frac{w^i}{f_j^i(p,w^i)} \qquad (1)$$

Where f_j^i (p,w^i) is i'th demand function for j, w^i its budget (income), and p the price vector. E_j^i (p,w^i) is the income elasticity. It has been common practice to compute the value of the elasticity at a certain point of an estimated statistical Engel curve, for example at the mean or the median of the income distribution of the group of households, even though it is well known that the elasticity values may vary widely along the Engel curve. Therefore the computed value may not be a good representation for the income elasticity with respect to the whole group of households. Moreover, the method of measuring the income elasticity at only one point of the underlying income distribution leaves aside all considerations about changes in the relative dispersion of the income distribution with varying incomes. These changes, however, are important for the change of the market demand for commodities whose relative size should be expressed by the income elasticity.

Stone (1954, p 265) developed a formula for income elasticity of market demand for commodity j. Let G be the group of all consumers. Then

$$E_j = \frac{1}{\sum_{i \in G} f_j^i} \sum_{i \in G} \left\{ f_j^i \left(\frac{w^i}{f_j^i} \; \frac{\partial f_j^i}{\partial w^i} \right) \cdot \left(\frac{\sum_{i \in G} w^i}{w^i} \cdot \frac{\partial w^i}{\partial \sum_{i \in G} w^i} \right) \right\} \qquad (2)$$

In words, the market income elasticity is equal to the weighted average of the products of the individual income elasticities and the elasticities of the individual with respect to total income. The above formula can easily be simplified:

$$E_j = \frac{\overline{W}}{\overline{F}_j} \sum_{i \in G} \frac{\partial f_j^i}{\partial w^i} \cdot \frac{\partial w^i}{\partial \left(\sum_{i \in G} w^i \right)} \qquad (3)$$

with

$$\overline{F}_j = \frac{1}{\#G} \cdot \sum_{i \in G} f_j^i \; ; \quad \overline{W} = \frac{1}{\#G} \sum_{i \in G} w^i \qquad (4)$$

Which means that the market income elasticity j is a function of the sum of the slopes of the individual Engel curves which are weighted by the individual increments in income with respect to the total income of group G. In general, the value of the elasticity is dependent on the distribution of the increase in income over the group of households. There is just one exception, if all individual Engel curves are linear and have the same slope, $\frac{\partial f_j^i}{\partial w^i}$ is a constant for all i. In all other cases, one has to specify a distribution key. In terms of

$$\frac{\partial w^i}{\partial\left(\sum_{iEG} w^i\right)} \text{ or } \left[\left(\sum_{iEG} w^i\right) / \, w^i\right] \cdot \left[\partial w^i / \partial\left(\sum_{iEG} w^i\right)\right] \tag{5}$$

If the group of households can be considered as homogeneous, then all households have identical preferences and a common demand function f(p,wi), thus the income distribution of the group can be described by a density function rho(wi), and we can derive formulae which are more convenient for both empirical and theoretical groups. Therefore the demand function for the market can be defined for commodity j as $\bar{F}_j$ and mean income $\bar{w}$ as:

$$\begin{cases} \bar{F}_j = \bar{F}\ (p,\rho) = \int_0^\infty f_j(p,w)\ \rho\ (w)\ dw \\ \text{and } \bar{w} = \int_0^\infty w\rho(w)dw \end{cases} \tag{6}$$

which implies that the Income elasticity can be written as:

$$E_j = \int_0^\infty \frac{\partial f_j(P,w)}{\partial w}\ \rho(w)\ dw \cdot \frac{\bar{w}}{\bar{F}_j} \tag{7}$$

In the empirical work done 4,944 household's data are used. The data were collected in 1980 with a families expenditure survey (FES) in Great Britain. The goods included are; bread, offal, butter, margarine, tea, coffee, beer, wine and newspapers. The income distribution of the sample was approximated by a three-parameter log-normal distribution which was fitted by using the method of moments. The findings are that a specific functional form of the Engel curve does not yield high or low values of the elasticities. This means that it is not possible to find a common ranking for the different functional forms with respect to the values they yield. The working function always yields the highest elasticity values for the "necessary" goods (bread, offal, tea, margarine) but very low values for the "luxury" goods wine and beer. The main conclusions are that it is absolutely necessary to have an apriori hypothesis on the change of the relative dispersion of the income distribution. It is a well known fact that different functional specifications of the underlying Engel curve may lead to quite different values of the elasticities.

Marquez and McNeilly (1988) conducted a study about the income and price elasticities for non-oil exports of non-OPEC developing countries. Their purpose was to estimate income and price elasticities of non oil exports of developing countries to major industrial countries. This study is important in studying international linkages and trade policies, these elasticities are becoming increasingly important because of their role in the development of policies to deal with the existing debt crisis in developing nations. The literature offers a wide range of estimates for elasticities in question. For example, income elasticity estimates vary from .90 to 4.7. This variation is important to be considered because of the uncertainty it creates in the balance of payment projections associated with long term development plans and the debt remodeling agreements of many developing countries. The criticism made of past studies is that all use the OLS method of estimation which does not consider simultaneity bias, and assumes all countries have the same characteristics in terms of commodities exported from developing to developed countries. Therefore, the elasticities found to formulate specific policies will lead to uncertainty. Unlike the previous studies, the Marquez and McNeilly study used 2SLS to avoid the simultaneity biases. The problem encountered is the functional form of the model is based on the past studies done in the same area. The form frequently used is the trans-logarithmic functional form for import demand. This functional form is based on the well known Box-Cox test. The inspection of the results reveals several features of interest: first, the income elasticity for non-oil imports exhibits a good deal of cross-country variation ranging from -.17 for Japan to 2.2 for the United States; second, the income elasticity for manufactures ranges from .7 for Japan to 3.4 for Germany, and 3.0 for the U.S.A.; third, income elasticity for raw materials and food are substantially lower than those for manufactured goods; fourth, the estimate of income elasticity for imports of raw materials is negative. This result might be consistent with economic theory if domestic goods are perfect substitutes for imports or if developed countries are reducing their reliance on developing countries as a source of inputs); fifth, the price elasticities for food and raw materials have relatively large standard errors, and some of these elasticities are positive. The main conclusion from this study of estimating income and price elasticities of non-oil exports of non-OPEC developing countries to the major industrial countries, is that these elasticities have been the objective of increased attention in view of their importance for designing policies in response to the debt crisis. In spite of the importance of those elasticities, a review of literature reveals sharply divided views regarding their magnitudes. This study found that the lack of consensus stems from three sources; first, the use of multilateral trade flows aggregated across both countries and commodities; second, the omission of price effects; third, the reliance on ordinary least squares for parameter estimations.

Peterson (1988) inspected the literature related to long-run aggregate supply of agricultural products and reported that the aggregate supply response of agriculture is inelastic. The existence of an inelastic agricultural supply response is supported by conventional supply functions fitted to time series data. Peterson reports that most of the elasticities estimated conventionally fell in the range of .1 to .4. Peterson reported also that time series estimates understate the true supply response to expected price changes because much of the observed price variation is transitory, causing actual price to vary more than expected price. Cross-country observations should yield more accurate estimates of long-run supply elasticities because they reflect the response to differences in average levels of expected price. Therefore agricultural price policies based on relatively small estimated elasticities run the risk of underestimating their impact on output because policy changes tend to influence long-run expected levels of prices. The main purpose of the Peterson paper is to re-estimate aggregate agricultural supply functions from cross-country data using a more complete accounting of input prices. The procedure used is to estimate implicit output/input price ratios from the marginal products of a production function and then to use these prices to estimate an aggregate agricultural supply function. Data used for the estimations was from a cross section of 119 countries which encompass about 94 percent of the World's agricultural land. An important point to note is that the output of all agricultural products was measured as wheat equivalent (WEQ) per hectare. The procedure used for measuring WEQ is

$$WEQ_j = \sum_{i=1}^{n} \frac{P_i}{P_w} Q_{ij}$$

Where WEQ_j is wheat equivalent output in country j; P_w is the world market (export) price of wheat; P_i is the world market (export) price of commodity i; Q_{ij} is the physical quantity produced of commodity i in country j. The data used are

1982-84 annual averages of all agricultural commodities produced in each country considered. A Cobb-Douglas functional form was used. The results support the hypothesis that the long-run aggregate agricultural supply elasticity is in the neighborhood of one. Therefore policies which distort domestic agricultural prices either above or below the world market equilibrium have a greater impact on the production of food than is implied by the relatively small supply elasticities obtained from time series data. The results have relevance for both developed and developing countries. For developed countries, agricultural price supports will precipitate greater surpluses than predicted by the small supply elasticities obtained from conventional supply estimates. In less developed countries, policies which maintain artificially low output/input price ratios will reduce agricultural output more than what is expected from the low supply elasticities obtained from time series data. Moreover, the reduction of world market prices of agricultural commodities caused by subsidized exports of surplus by the developed countries, most likely retards the development of LDCs agriculture more than has been predicted.

Stochastic Models

Conway, Hallahan, Stillman, and Prentice (1990) undertook a study related to livestock prices and made comparisons between fixed and stochastic coefficient estimation procedures. Their study results indicate that the classical model of estimating livestock demand equations is not as accurate as stochastic modeling when it comes to price forecasting. To justify the superiority of the stochastic coefficients they used three different methods of estimations: Ordinary Least Squares (OLS), Maximum Likelihood (ML), and Autoregressive Integrated Moving Averages (ARIMA) as stochastic modeling. These methods are applied to estimate livestock demand relations. The deterministic model estimated with OLS and ML was specified as follows:

$$P_{it} = B_{oi} + B_{1i} \cdot BC_t + B_{2i} \cdot PC_t + B_{3i} \cdot CC_t + B_{4i} \cdot PCE_t + e_t$$

The subscript i represents beef, pork, or chicken equations; Pi represents real retail meat price for commodity i; BC represents beef per-capita consumption; PC represents pork per-capita consumption; CC represents chicken per-capita consumption; PCE represents real per-capita total consumption expenditures; e represents the error term. The stochastic model formulation on which ARIMA is used has the same structural functional form as the deterministic. Swamy and Tinsley's procedure was used to determine the stochastic coefficients. The result shows that an apparent forecast superiority exists for the stochastic coefficients model over a wide variety of criteria for quarterly beef and broiler price dependent demand equations. This superiority stems from the quarterly representation of stochastic coefficients to several forms of nonstationary processes and their probability to changing economic conditions. Moreover, the stochastic coefficients model performs exceptionally well in out-of-sample forecasting and has an increasing advantage the farther out the data time period it is used. The results suggest the probability of fairly stable consumer preferences for meats. Variation in the cross commodity and intercept coefficients suggest that the information contained in the quarterly model is not complete (intercept high). The stochastic coefficients estimation procedure can adjust, at least somewhat, for these problems.

Bigman (1987), conducted a study dealing with target subsidy programs. Through literature investigation, he confirmed that government interventions to secure an adequate supply of staple consumption items, such as food grain at affordable prices, are universal. Moreover, in developing countries the government is heavily involved in the marketing and distribution of staple food, and a large portion of the fiscal budget is committed to food subsidies. A result of these interventions is the creation of tension among different consumer groups, between producers and consumers, and between growth and equity issues. The primary goal of the government intervention in food distribution is to provide food security and cushion against inflation to urban consumers. The urban bias of these policies create an urban-rural conflict by shifting at least part of the burden onto the rural population. Another adverse effect of low food prices is a growing dependence on food imports and lower rates of agricultural growth. The purpose of the study is to analyze the trade-offs involved in a program targeted on low income consumers given production and price instability. The methodology used is a simulation analysis of the food grain sector in a developing country, specifically a model of the wheat sector in Pakistan and the actual distribution policies implemented by the government of Pakistan in the 1970's. The simulation model consists of: first, an econometric model specifying the demand and supply functions for the crop under consideration; second, the stochastic process describing the random fluctuation in the country's agricultural production, the world price of these products, and in non-agricultural incomes; and third, a set of policy rules that define the government practices under different contingencies. The simulation model formulated describes a discrete dynamic process of the economic system. The variables considered by type are; a) state variable, which includes the area allocated for cultivation, the level of stocks, the vacant storage capacity, and the quantities supplied and demanded; b) the random (weather) events, and their associated probability distributions; and c) policy actions variables determined according to the initial state of the system, the current random events, and a set of decision rules, for such variables as subsidy rates, import prices, etc. In the analysis Bigman considers the food grain sector to be a "closed" economy case. The main reason for considering a closed economy is to isolate the net effect of each policy and program. With free trade, the results will register the combined effect of the policy under consideration and of trade. The results of the simulation model show that both the mean and the coefficient of variation of the market price are rising as an effect of the program. The added demand of the target population, permitted by subsidy, bids up the price. Furthermore, by stabilizing the consumption of the target population, the program narrows the incidence of production instability to the non-beneficiary consumers only, thereby stabilizing their consumption. An example is given, under the subsidy program with target elasticity equal to .1, the market price rises on average by 4.3 percent. As a result, consumption of the non-beneficiary consumers declines by .6 percent and output rises by 1 percent. The disadvantage of the subsidy program is its distabilizing effect on the fiscal budget. In the program under consideration, once every 6.5 years government expenditures on the subsidy program also involve much higher deadweight losses. Over the long-run, the economic gains of the target group from the program would be smaller than those under a comparable income transfer program. The target subsidy program distabilizes not only the market price, but also the revenues of farmers. As a consequence, most of the additional consumption of the target population would have to come at the expense of the food consumption of the other consumers rather than the increase in output.

Trapp, Rogers, and Wilkins undertook a stochastic analysis of Liberian rice policy to determine how Liberia may achieve rice self-sufficiency in the long-run. The purpose of the study was to make policy recommendations to assure that Liberia will be secure in terms of rice supplies which are the main staple of the Liberian diet. The two alternative policies investigated are a rice reserve program and a rice security program. The program for rice reserve relies upon the world market to serve as the main form of rice reserves. However, the Liberian government must provide guaranteed financial security to always be able to buy the rice needed on the world market. The analysis determined the feasibility of generating these reserves with a rice import tax and from surplus revenue during the years of positive cash-flow from exportable cash crops including coffee, cocoa and palm oil, for which the trade balance is positive. To achieve the proposed recommendations for rice self-sufficiency two analytical models are employed together with a Liberian agricultural sector model which considered the supply and demand equations for nine categories of agricultural commodities (rice, coffee, cocoa, palm oil, meat and other crops). The core of the model is a set of three elasticity matrices. The model is designed to estimate the impact of changes in rice prices at the farm level. A Monte Carlo Trade Simulator (MCTS) was designed to estimate the amount of variation in the net trade balance for rice, coffee, and cocoa and was used in conjunction with the agriculture sector model. The MCTS is capable of determining the net trade balance and expected variation in the trade balance under alternative price conditions and production levels for rice, coffee, cocoa, and palm oil commodities. The major use of the MCTS model in this study is to envisage the level of financial or stock reserves required to assure adequate rice supplies under alternative world market conditions and Liberian agricultural policies. The approach in essence will achieve "rice security" rather than rice self-sufficiency. The findings is that the investment for achieving self-sufficiency in rice appears too costly or requires a long period to be achieved. Alternative, it was found feasible to assure adequate rice supply through import and a currency reserve program. This work by Trapp, regarding Liberian agricultural pricing policy, is relevant for formulating and understanding the purpose of the Generalized Econometric Spreadsheet Simulator (GESS) model which was used to analyze Liberian agricultural problems. The GESS model is the main model that is applied for Moroccan agricultural policy analysis. Of the literature reviewed the Trapp, Roger and Wilken's article it is the only article that included the stochastic component to analyze agricultural policy. Some differences do exist between Liberia and Morocco in terms of agricultural sectors and policies. However, the concept of GESS appears to fit both countries.

Summary

The literature reviewed dealt with many useful studies of agricultural policy. Most of the studies treated dealt with developing country's agricultural policy analysis problems. Thus they coincide with the interest of this dissertation. The work done by Donalt (1983) dealing with developing countries indicated that government interventions in developing countries have had a negative effect on consumers, producers and total social welfare in general. Scandizzo also undertook a study concerning the methodologies for measuring agricultural price intervention effects. Scandizzo's finding show that market interventions have moved the domestic terms of trade substantially against agriculture in many developing countries to the detriment of farmer's income, foreign exchange earnings and food production. Lutz and Saadat studied agricultural pricing policy and their effects on consumers, producers and government in seven developing countries (Argentina, Brazil, Mexican, Thailand, Indonesia, Egypt, and Kenya) and reach conclusion similar to Scandizzo. Martin and Crawford studied price policy in Senegal. They found that government interventions contributed to price distortion and had a negative effect on enhancing agricultural production. Other studies concerned the subsidy of either food, or input prices. Work in this area by Horton, Keer, Jorgenson (1985), Wtz and Scandizzo (1980) and others indicates that the agricultural sector was penalized, and the whole economic system experienced a loss by introducing subsidies for inputs and/or food. Therefore it was recommended that the best solution for boosting the economy is to let the market operates by it self as a competitive market.

Elasticity studies were done for agricultural commodities by Chang and Shumay (1988) and Marquez and McNeilly (1988) analyzing the sensitivity of price and income elasticities for agricultural products. Their findings were that elasticities of supply and demand for agricultural products vary from one study to an other depending on : a) the functional form used for the demand and supply equations estimate; b) the data used (cross-sectional or/and times series data); and c) the methodology used to estimate the parameters of the functions.

Stochastic studies were reviewed too. However few were done in the area of agricultural policy analysis. It suffices to reveal the work done by Conway and Hallahan (1990) but it is about livestock in which an autoregression integrated moving average (ARIMA) method was used. Trapp's study about agricultural policy in Liberia fits well with the analysis of Moroccan agricultural policy to be undertaken in this dissertation.

Based on the literature reviewed, two major methodologies were used. The first methodology is the partial equilibrium model in which supply and demand functions are estimated by OLS for major agricultural crops (wheat, barley, corn, . . . etc.). The second method is the input-output method in which all the sectors of the economy are considered, and the effects of any change in one sector effects the whole system. These changes are captured by the input-output model.

By and large, it can be confirmed that the review of the past studies are helpful and present a guide for considering agricultural pricing policy and government intervention. Many similar points exist between these past studies and the research being conducted about Moroccan agriculture. In particular, similarities exist for the policy formulation, the methodology and the interpretation of the results to be done. Research in Moroccan agricultural policy analysis conducted in the framework of this dissertation uses the GESS model. The GESS model is a partial equilibrium model, based on the concept of competitive equilibrium on which the cross effects of price changes are taken into account. The core of the GESS model is the same as that in the work done by Donalt (1988), Lutz (1988), Wtz and Scandizzo (1980), and Trapp (1985). However, the GESS model is unique from the studies reviewed as it simultaneously achieves the following three things:

a) GESS takes account of the cross effects among commodity price changes by assuming substitution and complement effects among agricultural commodities included in the model.

b) GESS includes a stochastic price component.

c) The whole system is treated and programmed using a "user friendly computer model" to conduct the deterministic and stochastic analysis.

CHAPTER IV

METHODOLOGY

Introduction

This chapter presents the methodology used to analyze Moroccan agricultural pricing policy and related issues. This methodology is based on the Generalized Econometric Spreadsheet Simulation (GESS) model as adopted for this study. Prior to applying the GESS model, a number of parameters are needed. These parameters are mainly the ratios between the different domestic commodity prices and world prices, the base year quantities and prices for supply and demand, and the cross and own price elasticities for supply and demand. From these parameters, the structure of the GESS model can be developed for the applications to be made here. The GESS model developed here contains fifteen commodities (tender wheat, hard wheat, barley, corn, beef, lamb, chicken, and the inputs for cereals and meat).

The literature review indicated two main methods which are used to model competitive market equilibrium. They were the partial equilibrium model and the input-output model. This dissertation deals with a single sector, agriculture. Thus the core of the GESS model is the partial equilibrium model as it was used in different past studies such as the study done by Tolley et al. 1982. The differences that arises in using the GESS models are: a) The GESS model includes more commodities relative to those found in the literature; b) GESS contains a stochasticness component designed to investigate the effect of price volatility, and the different pricing policies on the net trade balance for the commodities included in the model; c) the linkages among supply and demand quantities and prices, taxes and subsidies are considered; and d) the GESS model is programmed using LOTUS 1-2-3, in essence it uses "a user friendly software".

Organizationally, this chapter will be divided into four parts. First an overview of the estimation of econometric models of supply and demand for cereals and meat will be presented. Secondly, the structure of the GESS model and its programming using LOTUS 1-2-3 will be presented. Thirdly, the contents of the stochastic component of the model will be presented. The stochastic version of the GESS model will hereafter be referred to as the GESSS model or Generalized Econometric Stochastic Spreadsheet Simulator. Finally the data base used to develop the model will be described.

The GESS Model

The GESS model is designed to operate on a LOTUS 1-2-3 spreadsheet, or comparable spreadsheet and is "user friendly." A basic understanding of elasticities and supply and demand theory is helpful in understanding and interpreting the results of various policy scenarios tested.

The objectives of this section of the chapter are:

1 - to provide a general overview of the systems approach to modeling used in the case of Morocco.

2. - to provide a working knowledge of the concept of own and cross price elasticities and their use in econometric modeling.

3 - to illustrate a case development of the generalized econometric spreadsheet simulation model (GESS model) relative to Morocco.

4 - to present procedures for modeling stochastic events in the case of Morocco.

An Overview of Simulation Analysis

The verb "to simulate" is a term that has come into vogue recently in a number of scientific disciplines to describe the ancient art of model building. Although simulation has been applied to some extremely diverse forms of model building, ranging from renaissance paintings and sculpture to scale models of the cognitive process, it has come to mean something quite specific to both physical scientists and behavioral scientists. The modern use of the word traces its origin to the work of Von Newmann and Ulam in the late 1940's, when they coined the term "Monte Carlo analysis" to apply to a mathematical technique they used to solve certain nuclear-shielding problems that were either too expensive for experimental solution or too complicated for analytical treatment. Monte Carlo analysis involves the solution of nonprobabilistic mathematical problems by simulating a stochastic process that has moments or probability distributions satisfying the mathematical relations of the nonprobabilistic problem.

With the advent of high-speed computers in the early 1950's, simulation took on still another meaning because it became possible to experiment with mathematical models on a computer. For the first time the social scientists found that, like the physicists, they too could perform controlled, laboratory like experiments, they, however, used electronic computers rather than physical devices. With the invention of computer simulation, countless applications came into being, but an even greater number of practical and theoretical problems were also created by this innovation. Churchman (1968) defined simulation as "essentially a technique that involves setting up a model of a real situation and then performing experiments on the model." This definition of simulation is extremely broad, and may very well include seemingly unrelated things. A narrower definition of simulation that focuses upon economic simulation and that is restricted to experiments on logical and mathematical models only is "simulation is a numerical technique for conducting experiments on a digital computer, which involves certain types of mathematical and logical models that describe the behavior of a business or economic system (or some component thereof) over extended periods of real time."

Monte Carlo analysis is a simulation technique for problems having a stochastic or probabilistic basis, according to Hammersley and Handscomb (1964). Two different problems give rise to the use of this technique. First, many problems involve some kind of stochastic process. Consumer demand, production lead time, and total investment for the economy are examples of economic variables which may be considered to be stochastic in nature. Monte Carlo methods have been developed for simulating most of the well known probability distributions as well as any empirical distribution. Second, certain completely deterministic mathematical problems cannot be solved easily (if at all) by strictly deterministic methods. However, it may be possible to obtain approximate solutions to these problems by simulating a stochastic process whose moments, density function, or cumulative distribution function satisfy the functional relationships or the solution requirements of the deterministic problem.

Planning Computer Simulation Experiments

To plan simulation experiments that are applicable to economic and industrial systems, we must necessarily draw very heavily on the tools of mathematical statistics, numerical analysis, econometrics, computer programming, and experimental design. Many of the problems that we encounter in simulation are in reality classical problems in one or more of the aforementioned disciplines computer simulation. Experiments involve a procedure consisting of the following nine elements:

1 - Formulation of the problem

2 - Collection and processing of real world data

3 - Formulation of mathematical model

4 - Estimation of parameters of operating characteristics from real world data

5 - Formulation of a computer program

7 - Validation

8 - Design of Experiments

9 - Analysis of simulation data

The sequencing of these nine steps is displayed in Figure 13.

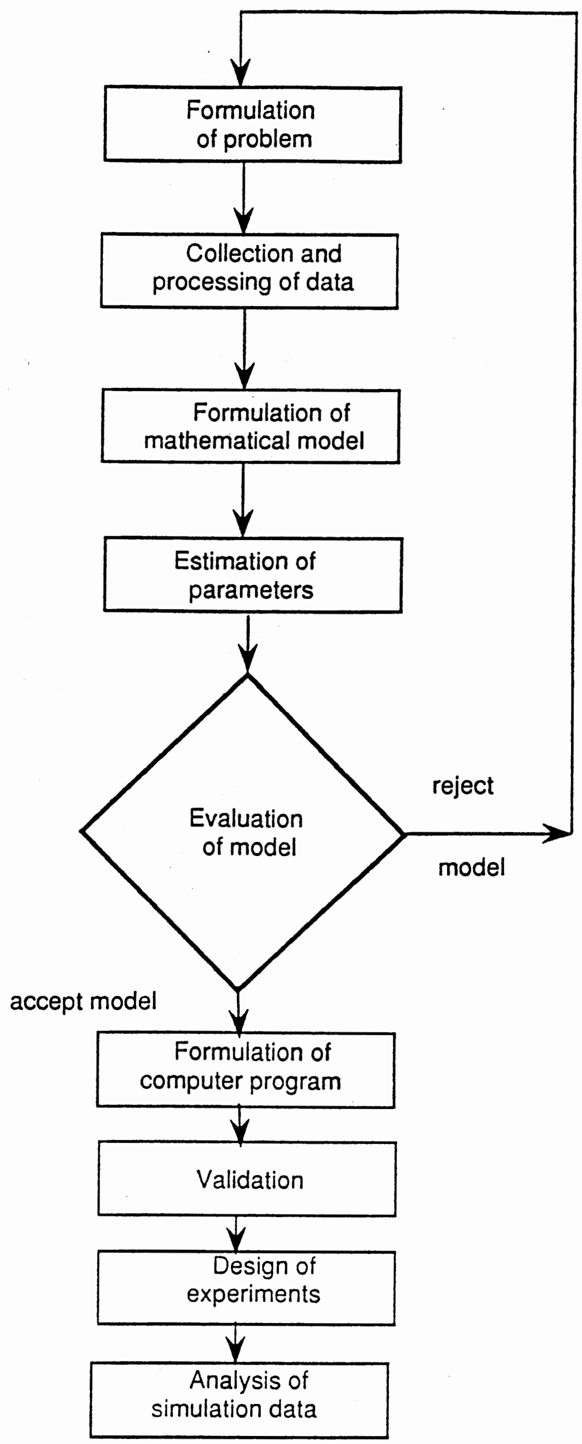

Figure 13. Flow Chart for Planning Simulation Experiments.

Model Structure

Morocco has a market structure similar to that depicted in figure 14.

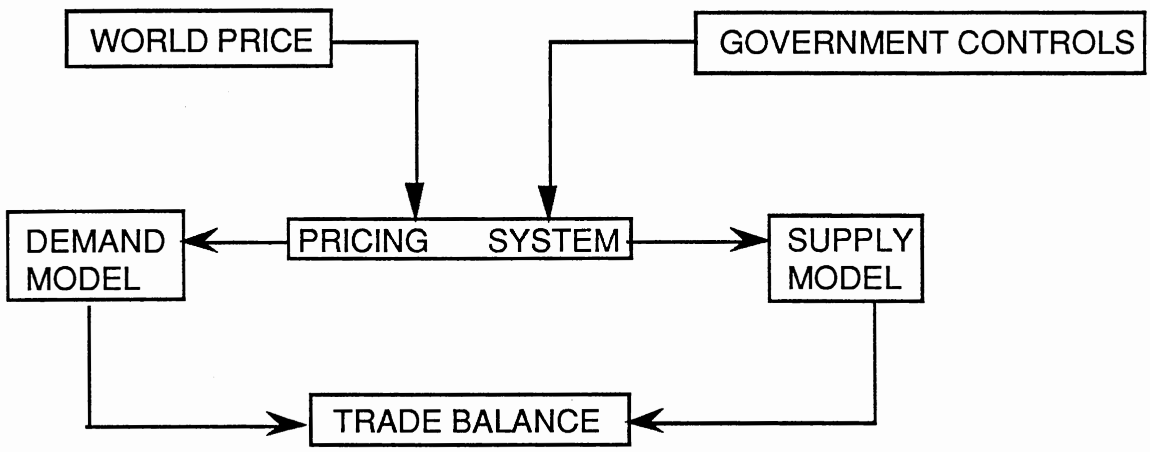

Figure 14. General Model Structure.

Morocco is a small open economy country. Agricultural prices are essentially determined by exogenous forces, i.e. either the government or the world market. As was reported by Trapp (1989), two key assumptions are evident in the structure depicted in figure 14. The first is that all prices are exogenously determined. As aforementioned, Morocco is a small country and cannot influence world market prices through either its consumption or production changes. Therefore Morocco becomes a price taker in the world market. For this reason Morocco has a policy of controlling agricultural prices, in particular for imported commodities such as tender wheat for which government intervention is important. Through price controls Morocco partially protects its producers and consumers from the instability of the world market.

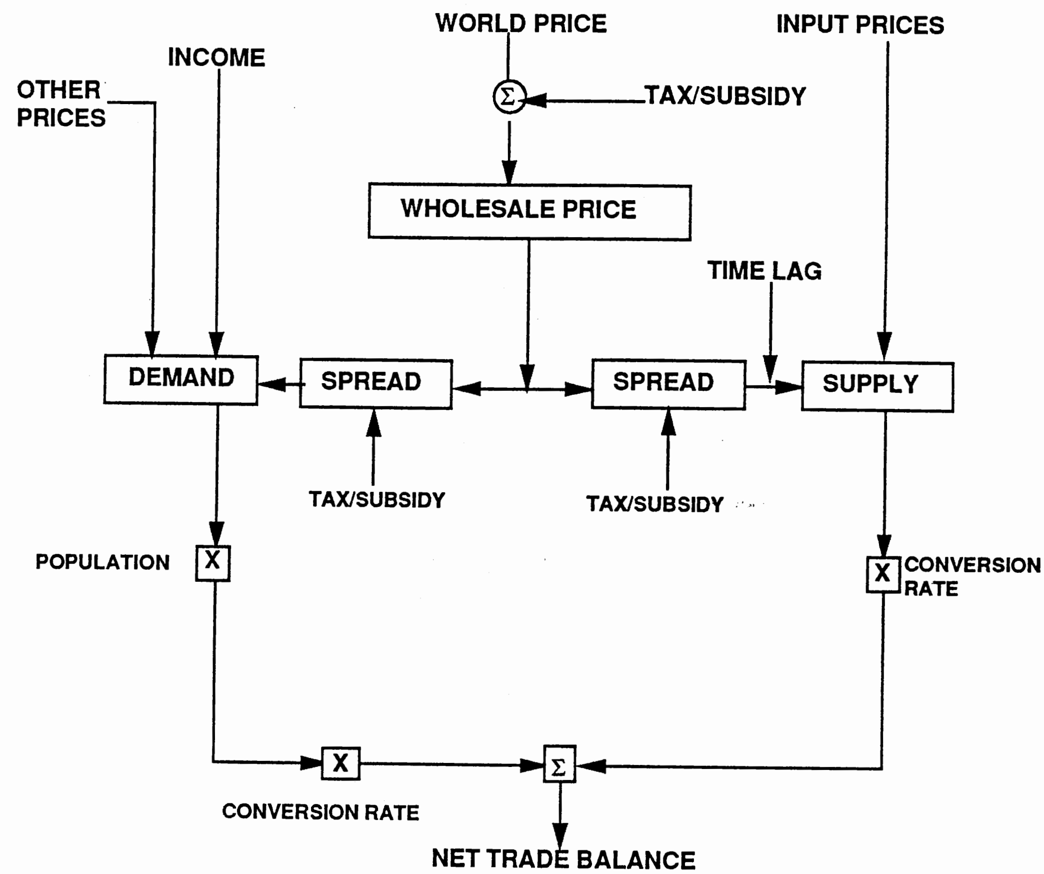

Figure 15. Detailed Model Structure.

Hence few price changes are available to base supply response parameter estimates upon.

Demand is modeled as per capita demand and is specified to be a function of its own price, the price of other substitute and complementary agricultural commodities, and per-capita income. Multiplication of per capita demand by population will give total retail demand.

The existence of other competing and complementary agricultural product prices in the demand model, and input prices in the supply model, raise a question with regard to modeling the total agricultural sector in Morocco. Figure 15, as Trapp reported in his study, only depicts the model structure for one commodity. However, for the fifteen commodities included in the Moroccan model, the same structure is valid with additional linkages through the common prices for substitute and complementary agricultural commodities. These linkages are straight forward since the prices are exogenous as aforementioned. Further detail about these linkage will be discussed in the following sections.

As reported by Trapp, in detailing the general model structure in the case of GESS, the above described general econometric model structure has several advantages and disadvantages. The assumption of exogenous prices is reasonably realistic, and is a major advantage because it avoids a great deal of complexity in the computerization and solution process.

A second advantage of the described model structure is the large number of policy variables it allows one to consider in a relatively simple model. For example in the Moroccan case, the impact of input subsidies, producer support prices, consumer price subsidies and taxes, and questions of self-sufficiency for staple agricultural commodities can be addressed.

A third major advantage of the described structure and spreadsheet program is the ease with which the model can be developed and implemented, providing either good time series data and/or cross section data exist with which to estimate demand and supply elasticities.

A fourth advantage or disadvantage, depending on the purpose of the analysis being conducted, is the focus of the model on short-term/annual responses to price and policy changes. In general the model is valid for looking at marginal changes in policy for one to several years into the future depending on the variability and the validity of the estimated econometric model. Drastic changes in prices policies, structural changes, and the long run impacts of such changes are not able to be adequately analyzed by GESS.

Theoretical Considerations

In the framework of Moroccan agricultural pricing policy analysis the GESS model is used as the tool to conduct analysis. The GESS model structure is based on the partial equilibrium concept in which the supply and demand equations for fifteen agricultural commodities form the heart of the model. The functional form of the demand and supply equations used is the double log function. The rationalization of using the double logarithmic form stems from the different studies reviewed which estimated agricultural demand and supply models. It suffices to mention work done by Boylan, Cuddy and O'Muircheartaigh 1980, Coursey and Nyquist 1988, Westley, Peterson 1988, Chand, and Kaul 1986, Khan and Ross 1977, Box and Cox 1964, and Dolby 1963. All these authors support and use double logarithmic functional forms for supply and demand equation estimation for agricultural commodities.

Based on this functional form, the supply and demand elasticities are the regression coefficients in the model. The presentation of the concept of elasticity and how elasticities are obtained from the functional form adopted will clarify this point.

Basic Setting for Supply Equations

As mentioned earlier, fifteen commodities are included in the model concerning the supply side. They are defined as follows:

1 - tender wheat (artizanal) with quantity symbolized as QS1 and price as PS1.

2 - tender wheat (miller) with quantity symbolized as QS2 and price as PS2.

3 - hard wheat with quantity symbolized as QS3 and price as PS3.

4 - barley with quantity symbolized as QS4 and price as PS4.

5 - corn with quantity symbolized as QS5 and price as PS5.

6 - beef with quantity symbolized as QS6 and price as PS6.

7 - lamb with quantity symbolized as QS7 and price as PS7.

8 - chicken with quantity symbolized as QS8 and price as PS8.

9 - milk official with quantity symbolized as QS9 and price as PS9.

10 - milk unofficial with quantity symbolized as QS10 and price as PS10.

11 - oil-cake with quantity symbolized as QS11 and price as PS11.

12 - pulp with quantity symbolized as QS12 and price as PS12.

13 - bran with quantity symbolized QS13 and price as PS13.

14 - forage with quantity symbolized as QS14 and price as PS14.

15 - fertilizer with quantity symbolized as QS15 and price as PS15.

All supply responses are specified to be a function of the prices of the fifteen commodities listed. For example, the tender wheat supply equation appears as follows:

PS1, PS2, PS3, PS4, PS5, PS6, PS14, PS15 are supply prices as defined above.

Knowing own and cross price elasticities for supply and given base year quantities and prices for the commodities included in the GESS model permits the supply equations of the model to be directly developed instead of estimated.

Basic Setting for Demand Equations

Demand equation are specified for most of the fifteen commodities modeled. Demand equations are not considered for some of the commodities because of missing data.

In addition to the price and quantity definitions given in the discussion of supply, the demand models also include the variable per capita income which is symbolized as "I".

As mentioned earlier the functional form for demand equations is also a double logarithmic function as depicted below:

The tender wheat demand equation is:

$$QD1 = f(PD1, PD2, Pd3, PD4, PD5, PD6, PD7, PD8, PD9, PD10, I) \quad (5)$$

The tender wheat functional form demand equation:

$$QD1 = B1 \cdot (PD1^{r1}) \cdot (PD2^{r2}) \cdot (PD3^{r3}) \cdot (PD4^{r4}) \cdot (PD5^{r5}) \cdot (PD6^{r6}) \cdot (PD7^{r7}) \cdot (PD8^{r8}) \cdot (PD9^{r9}) \cdot (PD10^{r10}) \cdot (I^{r}) \quad (6)$$

or alternatively in double logarithmic function:

$$LOG(QD1) = LOG(B1)+r1 \cdot LOG(PD1)+r2 \cdot LOG(PD2)+r3 \cdot LOG(PD3)+ r4 \cdot LOG(PD4)+r5 \cdot LOG(PD5)+r6 \cdot LOG(PD6)+r7 \cdot LOG(PD7) +r8 \cdot LOG(PD8)+r9 \cdot LOG(PD9)+r10 \cdot LOG(PD10)+r \cdot LOG(I) \quad (7)$$

From equation (6) the demand intercept B1 for tender wheat can be obtained easily assuming that the demand elasticities and the base year demand quantity QD1 and prices are known.

$$B1 = (QD1)/[(PD1^{r1})\cdot(PD2^{r2})\cdot(PD3^{r3})\cdot(PD4^{r4})\cdot PD5^{r5})\cdot (PD6^{r6})\cdot(PD7^{r7})\cdot(PD8^{r8})\cdot(PD9^{r9})\cdot (PD10^{r10})\cdot(I^{r})] \quad (8)$$

Where r1 is own price elasticity of demand for tender wheat and r2, r3, r4, r5, r6, r7, r8, r9, and r10, are respectively cross price elasticities of tender wheat (A) with respect to tender wheat (M), hard wheat, barley, corn, beef, lamb, chicken, official milk, and unofficial milk. Finally, r is the income elasticity of tender wheat.

The above procedure for deducing supply and demand equations from own and cross price elasticities allows the heart of the GESS model to be summarized in a matrix of supply and demand elasticities. Thus, using the equations listed above for demand and supply and a spreadsheet containing these relationships, the entire set of relationships required for the system of econometric models for fifteen commodities can be generated from two matrices and a set of base year prices and quantities. This approach, as explained and applied by Trapp, not only facilitates the implementation of a system of econometric models into a computer program, but also facilitates the specification of elasticities/parameters of the system.

The use of supply and demand elasticity matrices as the core of the modeling approach facilitates the incorporation of previous research results done about Moroccan agriculture, in particular the research by the World Bank 1988 (Eliraki). More detail about the elasticities and data used will be given in but it is not a problems since each table can be displayed on one computer screen.

The heart of the model's operation is involved in the calculation of the values in columns H to J, which are dependent on the policies considered in the study. For example, Table 1 and Table 2 are relative to supply and demand quantities. The cells in these tables are calculated by using equations (2) and (6). Using a LOTUS 1-2-3 notation, cell H10 (Table 1) representing supply quantity for tender wheat (A) is calculated by the following equation:

```
H10 = $AD10•(H$54^$M10)•(H$55^$N110)•(H$56^$010)•(H$57^$P10)
      •(H$58^$Q10)•(H$67^$ZZ10)•(H$68^$AA10)                  (9)
```

Where cell H10 contains the projection or the supply quantity relative to the policy proposed for scenario #1. AD10 contains the constant term for supply model. H54, H55, H56, H57, H58, H67, H68 contain respectively supply prices for tender wheat (A), tender wheat (M), hard wheat, barley, corn, forage, and fertilizer as in the case of equation (2), but programmed in LOTUS 1-2-3. M10 contains the own price elasticity for tender wheat (A). N10, O10, P10, Q10, Z10, AA10, contain respectively cross price elasticities for tender wheat (M), hard wheat, barley, corn, forage, and fertilizer. The symbol "•" and "^" denote multiplication and raising to a power. The cells I to J are calculated in the similar fashion to equation (9) and can be programmed by using the command "COPY". This is why the symbol "$" is added to the cells above indicating the "COPY" should change only selected row and column designations.

AD10 contains the intercept coefficient for the tender wheat (A) supply model and is programmed using equation (4):

$$AD10 = (G10/[(G54\string^M10)\bullet(G55\string^N10)\bullet(G56\string^O10)\bullet(G57\string^P10)\bullet(G58\string^Q10)\bullet (G67\string^Z10)\bullet(G68\string^AA10)] \quad (10)$$

Where cell G10 contains the base year supply quantity for tender wheat (A) and G54, G55, G56, G57, G58, G67, G68 respectively contain the base year supply prices for tender wheat (A), tender wheat (M), hard wheat, barley, corn, forage, and fertilizer. The cells M10, N10, O10, P10, Q10, Z10, AA10 contain supply elasticities as defined for equation (9).

Likewise, use of the demand elasticities in conjunction with base year retail prices and quantities can be used in a similar manner to generate projections for demand for any given policy assumption. For example cell H31 (Table 2) computes the demand for tender wheat (A) as follows:

$$H31 = AD31\bullet(H\$74\string^\$M31)\bullet(H\$75\string^\$N31)\bullet(H\$76\string^\$O31)\bullet(H\$77\string^\$P31) \bullet(H\$78\string^\$Q31)\bullet(H\$79\string^\$R31)\bullet(H\$80\string^\$S31)\bullet(H\$81\string^T31)\bullet (H\$82\string^\$U31)\bullet(H\$83\string^\$V31)\bullet(H\$88\string^\$AA31) \bullet(H\$89\string^\$AB31). \quad (11)$$

Where cell H31 contains demand projection or computed result obtained for policy scenario #1 . AD31 contains the constant term for the soft wheat (A) demand equation. H74, H75, H76, H77, H78, H79, H80, H81, H82, H83, H88, H89 contain respectively the demand prices for tender wheat (A), tender wheat (M), hard wheat, barley, corn, beef, lamb, chicken, official milk, unofficial milk, fertilizer, per capita income. M31 contains the own price elasticity of demand for tender wheat while N31, O31, P31, Q31, R31, S331, T31, U31, V31, AA31, contain respectively the cross-price elasticity of demand for tender wheat (A) with respect to tender wheat (M), hard wheat, barley, corn, beef, lamb, chicken, official milk, fertilizer. AB31 contains the income elasticity for tender wheat.

AD31 contains the calculated tender wheat demand intercept calculated as follows.

$$AD31 = (G31)/[G74^{\wedge}M31)\cdot(G75^{\wedge}N31)\cdot(G76^{\wedge}O31)\cdot(G77^{\wedge}P31)\cdot G78^{\wedge}Q31) \cdot(G79^{\wedge}R31)\cdot(G80^{\wedge}S31)\cdot(G81^{\wedge}T31)\cdot(G82^{\wedge}U31)\cdot(G83^{\wedge}V31)\cdot(G88^{\wedge}AA31) \cdot(G89^{\wedge}AB31)] \quad (12)$$

where cell G74, G75, G76, G77, G78, G79, G80, G81, G82, G83, G88, G89 contain respectively the base year demand prices for tender wheat (A), tender wheat (M), hard wheat, barley, corn, beef, lamb, chicken, official milk, unofficial milk, fertilizer and per-capita income. The cells M31, N31, O31, P31, Q31, R31, S31, T31, U31, V31, AA31, AB31 have the same definition as in equation (11).

In computing supply and demand in the GESS model, farm and retail prices are considered as exogenous. Farm and retail prices, as aforementioned, are linked to the world prices through the wholesale prices using the ratios presented in tables 10, 11, and 12. These price linkages are detailed in the following equations.

Cell H54 (Table 3) contains soft wheat (A) farm price and is computed by equation (3) below:

$$H54 = (H184\cdot(H227/100))\cdot((100+H118)/100) \quad (13)$$

where cell H184 contains the wholesale price for tender wheat (A) (Table 9), and H227 contains the farm/wholesale price margin (farm price as a percent of a wholesale price, see Table 11). H118 contains farm level taxes (-) and subsidies (+) as a percent of base year supply prices (See Table 6).

Cell H74 (Table 4) contains a retail price, and is computed by equation (14) below:

$$H74=(H184\bullet(H249/100))\bullet((100+H143)/100) \quad (14)$$

where cell H249 contains a retail price/wholesale price margin (retail price as a percent of wholesale prices; see Table 12). H143 contains retail price level taxes (-) and subsidies (+) as a percent of base year demand prices (See Table 7).

Cell H184 (Table 9) contains the soft wheat (A) wholesale price and is computed by equation (15) below:

$$H184 = (H163\bullet(H206/100))\bullet((100+H271)/100) \quad (15)$$

where cell H163 contains world price of soft wheat (A) (Table 8). H206 contains the wholesale/world price margin (wholesale price as a percent of world price; See Table 10).

Prices linkages are assured between farm, retail, wholesale and world prices in the GESS models by equations (13), (14), and (15). The starting point of these linkages is with the world prices entered in rows 163 to 177 as shown in Table 8. Wholesale prices as represented in equation (15), are calculated from world prices, given the ratios of wholesale prices to world prices found in rows 206 to 220 as shown in Table 10, and given any import/export taxes and subsidies indicated in rows 271 to 285 as shown in Table 13.

Farm and retail level prices are related to the wholesale prices, and wholesale prices in turn are related to world prices. For this reason it is important to briefly describe the logic of equation (15), which computes the wholesale price. In the first term of equation (15) the world price H163 is multiplied by the percentage value that the wholesale price is of world price as reported in cell H206. Since cell H206 is reported in percentage terms it must be converted to a decimal by dividing by 100. Thus, the first term of the equation calculates the wholesale price given the world price.

The second term of the equation (15) modifies the wholesale price calculated by the first term based on the effect of any tax or subsidy imposed on international trade. This modification is complicated by the fact that the impact of a tax or subsidy upon the domestic wholesale price is different depending on whether the commodity in question is an import or export. For example, a tax on an export will act like an increase in the cost of exporting and will cause the domestic wholesale price to be lowered relative to the world price. On-the-other hand, a tax on an import will be an increase in importation cost. This cost will be passed on by the importer by raising the domestic wholesale price. In the case of taxes (entered with a negative sign) the basic assumption is that all commodities listed are export commodities. However, in the case of imports the sign of a tax rate variable should be reversed to indicate an import commodity. A similar argument exists in the case of a subsidy. The net trade balance for the commodity in question is contained in cell C96:

$$C96 = H10\text{-}H31 \qquad (16)$$

Where H10 and H31 are respectively supply and demand quantities for tender wheat. Positive values for a commodity denote a positive trade balance, or net exportation. A negative values denotes a net import.

Given the wholesale price, the farm level and retail level prices (in this analysis retail price = wholesale price) can be calculated. Equation (13) shows the calculation of the farm price for tender wheat, while equation (14) shows the calculation of the retail price for tender wheat.

With the above described system of interlinked prices, the effect of any world price change or price policy change will be passed through the entire system, i.e. any world price or policy variable change made in rows 163 to 291 will results in changes in the whole system.

In summary, the concepts presented here for the GESS model, in the case of Morocco, are meant to be an illustration of the methodology used in the framework of this dissertation. However, this methodology description concerns only the deterministic model, the stochastic concepts that will be included in this work will be treated in the next section.

Theoretical Consideration for Stochastic Modeling.

The GESS model developed in the framework of this study for Moroccan agricultural pricing policy includes a stochastic component. This stochastic component added focuses on prices. The agricultural commodity prices are considered as stochastic because of the different factors involved in their determinations. These factors are government intervention, world market price fluctuations, and weather variations. Thus, domestic prices are the result of different forces acting on them, which justifies the use of the concept of stochasticness in this study. Many methods exist for generating random variables. In this model the direct transformation method and the correlated random events method will be used. Details for these two methods are given in the next two sections.

Direct Transformation Techniques

The direct transformation method is the simplest method of generating a desired random number distribution. This method is based on the formula that transforms directly a series of uniform 0-1 random variants into another distribution. For example, the basic formula to obtain any uniform distribution desired, given that R represents a 0-1 uniform random variable, is given by equation (17) for the case where a uniform distribution between 1 and 10 is desired instead of 0-1.

$$X = 1+(10-1)*R \tag{17}$$

By using the Lotus 1-2-3 it is easy to program equation (17). R in equation (17) is a random number between 0 and 1 and can be obtained from the Lotus 1-2-3 by using the operand @RAND.

In most cases the GESS stochastic model requires normally distributed random variables. Normally distributed random variables can be generated from two 0-1 uniform random variables R1 and R2 as follows:

X1=(-2*LN(R1))^.5*(COS(2@PI*R2)) (18)

X2=(-2*LN(R1))^.5*(SIN(2*@PI*R2)) (19)

where, LN is defined as log base e and @PI is the Lotus function for generating the value of "pie". A normal (0,1) distributed random variable can be further transformed into any other desired normal distribution, XD, by the following formula:

$$XD = STDX*X+EX \tag{20}$$

where, EX is the expected mean, STDX is the expected standard deviation, and X is a normal (0,1) random variable.

TABLE 1

FARM LEVEL SUPPLY (QL)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
10	(1)	Soft Wheat {A}	6313670.00	6267139.32	14309308.61	7950742.88
11	(2)	Soft Wheat {M}	9658000.00	9586822.17	21888901.79	12162224.94
12	(3)	Hard Wheat	12745000.00	12742971.47	13523290.87	12911213.77
13	(4)	Barley	24143000.00	24294410.78	11234850.47	19847601.04
14	(5)	Corn	3049500.00	3043877.21	6243693.67	3535305.33
15	(6)	Beef	2119410.00	2120280.83	1523054.84	2120280.83
16	(7)	Lamb	1935750.00	1954126.41	2345225.93	1954126.41
17	(8)	Chicken	1757100.00	1757821.96	1118996.32	1757821.96
18	(9)	Milk {OFF}	8008000.00	8015679.61	7800711.54	8015679.61
19	(10)	Milk {UNOFF}	313200.00	313586.23	542538.06	313586.23
20	(11)	Oil-Cake	0.00	0.00	0.00	0.00
21	(12)	Pulp	0.00	0.00	0.00	0.00
22	(13)	Bran	1370.00	1370.00	1370.00	1370.00
23	(14)	Forage	125.00	125.68	133.98	120.74
24	(15)	Fertilizer	0.00	0.00	0.00	0.00

TABLE 2

RETAIL LEVEL DEMAND (QL)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
31	(1)	Soft Wheat {A}	6313670.00	6313670.00	1267988.53	2846118.41
32	(2)	Soft Wheat {M}	26980000.00	26980000.00	5444874.99	12162224.94
33	(3)	Hard Wheat	12745000.00	12745000.00	57336938.91	38226101.23
34	(4)	Barley	24253000.00	24253000.00	101063685.72	102196196.22
35	(5)	Corn	4704500.00	4704500.00	13051988.79	14867874.43
36	(6)	Beef	2144240.00	2144240.00	3550996.12	2163013.69
37	(7)	Lamb	1935750.00	1935750.00	1465495.30	1952698.27
38	(8)	Chicken	1757143.00	1757143.00	1631571.49	1757143.00
39	(9)	Milk {OFF}	469800.00	469800.00	481855.17	473913.29
40	(10)	Milk {UNOFF}	313200.00	313200.00	167062.40	341727.95
41	(11)	Oil-Cake	0.00	0.00	0.00	0.00
42	(12)	Pulp	0.00	0.00	0.00	0.00
43	(13)	Bran	0.00	0.00	0.00	0.00
44	(14)	Forage	0.00	0.00	0.00	0.00
45	(15)	Fertilizer	0.00	0.00	0.00	0.00

TABLE 3

FARM PRICE (DH/QL)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
54	(1)	Soft Wheat {A}	190.00	187.17	284.50	187.17
55	(2)	Soft Wheat {M}	200.00	197.02	310.08	308.44
56	(3)	Hard Wheat	215.00	212.66	98.56	212.08
57	(4)	Barley	153.00	150.92	73.94	150.92
58	(5)	Corn	176.00	176.00	115.25	176.00
59	(6)	Beef	1381.00	1381.00	496.32	1381.00
60	(7)	Lamb	1593.00	1593.00	810.45	1593.00
61	(8)	Chicken	1068.00	1068.00	442.95	1068.00
62	(9)	Milk {OFF}	213.00	213.00	130.96	213.00
63	(10)	Milk {UNOFF}	173.00	173.00	145.02	173.00
64	(11)	Oil-Cake	130.00	130.00	130.00	130.00
65	(12)	Pulp	100.00	100.00	100.00	100.00
66	(13)	Bran	75.00	75.00	137.00	75.00
67	(14)	Forage	153.00	153.00	130.00	153.00
68	(15)	Fertilizer	101.00	101.00	101.00	101.00

TABLE 4

RETAIL PRICE (DH/QL)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
74	(1)	Soft Wheat {A}	125.00	125.00	190.00	125.00
75	(2)	Soft Wheat {M}	129.00	129.00	200.00	308.44
76	(3)	Hard Wheat	315.00	315.00	146.00	315.00
77	(4)	Barley	198.00	198.00	97.00	198.00
78	(5)	Corn	197.00	197.00	129.00	197.00
79	(6)	Beef	3211.00	3211.00	1154.00	3211.00
80	(7)	Lamb	3540.00	3540.00	1801.00	3540.00
81	(8)	Chicken	1695.00	1695.00	703.00	1695.00
82	(9)	Milk {OFF}	411.00	411.00	252.69	411.00
83	(10)	Milk {UNOFF}	303.00	303.00	254.00	303.00
84	(11)	Oil-Cake	130.00	130.00	130.00	130.00
85	(12)	Pulp	100.00	100.00	100.00	100.00
86	(13)	Bran	75.00	75.00	137.00	75.00
87	(14)	Forage	153.00	153.00	130.00	153.00
88	(15)	Fertilizer	101.00	101.00	101.00	101.00

TABLE 5

NET PHYSICAL TRADE BALANCE (1000 QL)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
96	(1)	Soft Wheat {A}	0.00	-46.53	13041.32	5104.62
97	(2)	Soft Wheat {M}	-17322.00	-17393.18	16444.03	0.00
98	(3)	Hard Wheat	0.00	-2.03	-43813.65	-25314.89
99	(4)	Barley	-110.00	41.41	-89828.84	-82348.60
100	(5)	Corn	-1655.00	-1660.62	-6808.30	-11332.57
101	(6)	Beef	-24.83	-23.96	-2027.94	-42.73
102	(7)	Lamb	0.00	18.38	879.73	1.43
103	(8)	Chicken	-0.04	0.68	-512.58	0.68
104	(9)	Milk {OFF}	7538.20	7545.88	7318.86	7541.77
105	(10)	Milk {UNOFF}	0.00	0.39	375.48	-28.14
106	(11)	Oil-Cake	0.00	0.00	0.00	0.00
107	(12)	Pulp	0.00	0.00	0.00	0.00
108	(13)	Bran	1.37	1.37	1.37	1.37
109	(14)	Forage	0.13	0.13	0.13	0.12
110	(15)	Fertilizer	0.00	0.00	0.00	0.00

TABLE 6

FARM LEVEL (PRODUCER TAXES (-) AND SUBSIDIES (+) AS A PERCENT OF BASE YEAR SUPPLY PRICES)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
118	(1)	Soft Wheat {A}	1.49	0.00	0.00	0.00
119	(2)	Soft Wheat {M}	1.49	0.00	0.00	54.22
120	(3)	Hard Wheat	1.09	0.00	0.00	0.00
121	(4	Barley	1.36	0.00	0.00	0.00
122	(5)	Corn	0.00	0.00	0.00	0.00
123	(6)	Beef	0.00	0.00	0.00	0.00
124	(7)	Lamb	0.00	0.00	0.00	0.00
125	(8)	Chicken	0.00	0.00	0.00	0.00
126	(9)	Milk {OFF}	0.00	0.00	0.00	0.00
127	(10)	Milk {UNOFF}	0.00	0.00	0.00	0.00
128	(11)	Oil-Cake	0.00	0.00	0.00	0.00
129	(12)	Pulp	0.00	0.00	0.00	0.00
130	(13)	Bran	0.00	0.00	0.00	0.00
131	(14)	Forage	0.00	0.00	0.00	0.00
132	(15	Fertilizer	0.00	0.00	0.00	0.00

TABLE 8

WORLD PRICE (DH/QL)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
163	(1)	Soft Wheat {A}	190.00	190.00	190.00	190.00
164	(2)	Soft Wheat {M}	200.00	200.00	200.00	200.00
165	(3)	Hard Wheat	146.00	146.00	146.00	146.00
166	(4)	Barley	97.00	97.00	97.00	97.00
167	(5)	Corn	129.00	129.00	129.00	129.00
168	(6)	Beef	1154.00	1154.00	1154.00	1154.00
169	(7)	Lamb	1801.00	1801.00	1801.00	1801.00
170	(8)	Chicken	703.00	703.00	703.00	703.00
171	(9)	Milk {OFF}	252.69	252.69	252.69	252.69
172	(10)	Milk {UNOFF}	254.00	254.00	254.00	254.00
173	(11)	Oil-Cake	130.00	130.00	130.00	130.00
174	(12)	Pulp	100.00	100.00	100.00	100.00
175	(13)	Bran	137.00	137.00	137.00	137.00
176	(14)	Forage	130.00	130.00	130.00	130.00
177	(15)	Fertilizer	101.00	101.00	101.00	101.00

TABLE 9

WHOLESALE PRICE (DH/QL)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
184	(1)	Soft Wheat {A}	125.00	125.00	190.00	125.00
185	(2)	Soft Wheat {M}	129.00	129.00	200.00	129.00
186	(3)	Hard Wheat	315.00	315.00	146.00	315.00
187	(4)	Barley	198.00	198.00	97.00	198.00
188	(5)	Corn	197.00	197.00	129.00	197.00
189	(6)	Beef	3211.00	3211.00	1154.00	3211.00
190	(7)	Lamb	3540.00	3540.00	1801.00	3540.00
191	(8)	Chicken	1695.00	1695.00	703.00	1695.00
192	(9)	Milk {OFF}	411.00	411.00	252.69	411.00
193	(10)	Milk {UNOFF}	303.00	303.00	254.00	303.00
194	(11)	Oil-Cake	130.00	130.00	130.00	130.00
195	(12)	Pulp	100.00	100.00	100.00	100.00
196	(13)	Bran	75.00	75.00	137.00	75.00
197	(14)	Forage	153.00	153.00	130.00	153.00
198	(15)	Fertilizer	101.00	101.00	101.00	101.00

TABLE 11

FARM/WHOLESALE PRICE MARGIN (FARM PRICE AS A PERCENT OF A WHOLESALE PRICE)(DH/QL)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
227	(1)	Soft Wheat {A}	152.000	152.000	152.000	152.000
228	(2)	Soft Wheat {M}	155.039	155.039	155.039	155.039
229	(3)	Hard Wheat	68.254	68.254	68.254	68.254
230	(4)	Barley	77.273	77.273	77.273	77.273
231	(5)	Corn	89.340	89.340	89.340	89.340
232	(6)	Beef	43.008	43.008	43.008	43.008
233	(7)	Lamb	45.000	45.000	45.000	45.000
234	(8)	Chicken	63.009	63.009	63.009	63.009
235	(9)	Milk {OFF}	51.825	51.825	51.825	51.825
236	(10)	Milk {UNOFF}	57.096	57.096	57.096	57.096
237	(11)	Oil-Cake	100.000	100.000	100.000	100.000
238	(12)	Pulp	100.000	100.000	100.000	100.000
239	(13)	Bran	100.000	100.000	100.000	100.000
240	(14)	Forage	100.000	100.000	100.000	100.000
241	(15)	Fertilizer	100.000	100.000	100.000	100.000

TABLE 12

RETAIL/WHOLESALE PRICE (RETAIL AS A PERCENT OF WHOLESALE PRICE)(DH/QL)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
249	(1)	Soft Wheat {A}	100.00	100.00	100.00	100.00
250	(2)	Soft Wheat {M}	100.00	100.00	100.00	100.00
251	(3)	Hard Wheat	100.00	100.00	100.00	100.00
252	(4)	Barley	100.00	100.00	100.00	100.00
253	(5)	Corn	100.00	100.00	100.00	100.00
254	(6)	Beef	100.00	100.00	100.00	100.00
255	(7)	Lamb	100.00	100.00	100.00	100.00
256	(8)	Chicken	100.00	100.00	100.00	100.00
257	(9)	Milk {OFF}	100.00	100.00	100.00	100.00
258	(10)	Milk {UNOFF}	100.00	100.00	100.00	100.00
259	(11)	Oil-Cake	100.00	100.00	100.00	100.00
260	(12)	Pulp	100.00	100.00	100.00	100.00
261	(13)	Bran	100.00	100.00	100.00	100.00
262	(14)	Forage	100.00	100.00	100.00	100.00
263	(15)	Fertilizer	100.00	100.00	100.00	100.00

TABLE 13

IMPORT/EXPORT TAXES (-) AND SBSIDIES (+)
(AS A PERCENT OF FARM LEVEL)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
321	(1)	Soft Wheat {A}	0.00	0.00	0.00	0.00
322	(2)	Soft Wheat {M}	0.00	0.00	0.00	0.00
323	(3)	Hard Wheat	0.00	0.00	0.00	0.00
324	(4)	Barley	0.00	0.00	0.00	0.00
325	(5)	Corn	0.00	0.00	0.00	0.00
326	(6)	Beef	0.00	0.00	0.00	0.00
327	(7)	Lamb	0.00	0.00	0.00	0.00
328	(8)	Chicken	0.00	0.00	0.00	0.00
329	(9)	Milk {OFF}	0.00	0.00	0.00	0.00
330	(10)	Milk {UNOFF}	0.00	0.00	0.00	0.00
331	(11)	Oil-Cake	0.00	0.00	0.00	0.00
332	(12)	Pulp	0.00	0.00	0.00	0.00
333	(13)	Bran	0.00	0.00	0.00	0.00
334	(14)	Forage	0.00	0.00	0.00	0.00
335	(15)	Fertilizer	0.00	0.00	0.00	0.00

TABLE 14

PRODUCTION COST

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
348	(1)	Soft Wheat {A}	0.00	0.00	0.00	0.00
349	(2)	Soft Wheat {M}	0.00	0.00	0.00	0.00
350	(3)	Hard Wheat	0.00	0.00	0.00	0.00
351	(4)	Barley	0.00	0.00	0.00	0.00
352	(5)	Corn	0.00	0.00	0.00	0.00
353	(6)	Beef	0.00	0.00	0.00	0.00
354	(7)	Lamb	0.00	0.00	0.00	0.00
355	(8)	Chicken	0.00	0.00	0.00	0.00
356	(9)	Milk {OFF}	0.00	0.00	0.00	0.00
357	(10)	Milk {UNOFF}	0.00	0.00	0.00	0.00
358	(11)	Oil-Cake	0.00	0.00	0.00	0.00
359	(12)	Pulp	0.00	0.00	0.00	0.00
360	(13)	Bran	0.00	0.00	0.00	0.00
361	(14)	Forage	0.00	0.00	0.00	0.00
362	(15)	Fertilizer	0.00	0.00	0.00	0.00

TABLE 15

GOVERNEMENT COST AND REVENUE (1000 DH)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
321	(1)	Soft Wheat {A}	17874.00	0.00	0.00	0.00
322	(2)	Soft Wheat {M}	28780.84	0.00	0.00	7252401.24
323	(3)	Hard Wheat	29867.91	0.00	0.00	0.00
324	(4)	Barley	50236.75	0.00	0.00	0.00
325	(5)	Corn	0.00	0.00	0.00	0.00
326	(6)	Beef	0.00	0.00	0.00	0.00
327	(7)	Lamb	0.00	0.00	0.00	0.00
328	(8)	Chicken	0.00	0.00	0.00	0.00
329	(9)	Milk {OFF}	0.00	0.00	0.00	0.00
330	(10)	Milk {UNOFF}	0.00	0.00	0.00	0.00
331	(11)	Oil-Cake	0.00	0.00	0.00	0.00
332	(12)	Pulp	0.00	0.00	0.00	0.00
333	(13)	Bran	0.00	0.00	0.00	0.00
334	(14)	Forage	0.00	0.00	0.00	0.00
335	(15)	Fertilizer	0.00	0.00	0.00	0.00

TABLE 16

NET MONETARY RECEIPTS (VALUE OF MARKET SURPLUS) (1000,000 DH)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
348	(1)	Soft Wheat {A}	410.39	383.81	3830.04	1132.37
349	(2)	Soft Wheat {M}	-1548.82	-1591.62	5698.28	0.00
350	(3)	Hard Whea t	-1274.50	-1304.80	-7038.28	-9303.06
351	(4)	Barley	-1108.22	-1135.60	-8972.53	-17239.46
352	(5)	Corn	-390.07	-391.06	-964.13	-2306.76
353	(6)	Beef	-3958.25	-3957.05	-3341.93	-4017.33
354	(7)	Lamb	-3768.91	-3739.63	-738.67	-3799.63
355	(8)	Chicken	-1101.77	-1101.00	-651.33	-1101.00
356	(9)	Milk {OFF}	1512.62	1514.25	899.79	1512.56
357	(10)	Milk {UNOFF}	-40.72	-40.65	36.25	-49.29
358	(11)	Oil-Cake	0.00	0.00	0.00	0.00
359	(12)	Pulp	0.00	0.00	0.00	0.00
360	(13)	Bran	0.10	0.10	0.19	0.10
361	(14)	Forage	0.02	0.02	0.02	0.02
362	(15)	Fertilizer	0.00	0.00	0.00	0.00

TABLE 17

NET MONETARY TRADE BALANCE (1000 DH)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
374	(1)	Soft Wheat {A}	0.00	-8840.83	2477850.82	969878.65
375	(2)	Soft Wheat {M}	-3464400.00	-3478635.57	3288805.36	0.00
376	(3)	Hard Wheat	0.00	-296.17	-6396792.61	-3695973.57
377	(4)	Barley	-10670.00	4016.85	-8713397.02	-7987813.73
378	(5)	Corn	-213495.00	-214220.34	-878270.07	-1461901.41
379	(6)	Beef	-28653.82	-27648.88	-2340244.24	-49313.72
380	(7)	Lamb	0.00	33095.91	1584394.85	2572.07
381	(8)	Chicken	-30.23	477.31	-360340.34	477.31
382	(9)	Milk {OFF}	1904835.30	1906775.86	1849409.14	1905736.47
383	(10)	Milk {UNOFF}	0.00	98.10	95370.82	-7148.00
384	(11)	Oil-Cake	0.00	0.00	0.00	0.00
385	(12)	Pulp	0.00	0.00	0.00	0.00
386	(13)	Bran	187.69	187.69	187.69	187.69
387	(14)	Forage	16.25	16.34	17.42	15.70
388	(15)	Fertilizer	0.00	0.00	0.00	0.00

Equations (18), (19) and (20) were programmed in Lotus 1-2-3 to generate normally distributed random value for the General Econometric Stochastic Spreadsheet Simulation (GESSS) Model.

Correlated Random Events Method

Taking account of correlated prices in agriculture is rational, because of the strong substitutability and complementary among agricultural commodities. McCalla and Timothy (1985) clearly explained the existence of multicommodity price linkages between agricultural commodity prices for which they gave the following general propositions. First, price variability in one market is linked by intercommodity relationships (cross elasticities of supply, cross elasticities of demand, and input output coefficients) to price variations on other commodity markets. Second, the magnitude of price movements in one market for given disturbances depends on the slopes of all countries' supply and demand functions in that market and the magnitude of the cross elasticity terms. Third, substitution and input/output relationships, whether in production, consumption or both, cause prices in the connected markets to move in the same direction. The greater the degree of substitution, the more stable both markets will be. Conversely, complementary relationships cause relative price differences between markets to widen. In fact, any analysis should simultaneously take all of these relationships into account.

The correlated events techniques is the most suitable method for policy analysis in the case of correlated exogenous world prices. This method allows the simulation of random but correlated prices. The general theory for this method is developed by Naylor et al. in "Computer Simulation Techniques" Chapter 4. The method is presented below.

Assuming a n dimension random vector of prices X with expected values E(X) = m, and that price vector X has a variance-covariance matrix V,

$$V = E[(X-m) \bullet (X-m)'] = \begin{bmatrix} v_{11}\, v_{12} \cdots\cdots\cdots v_{in} \\ \vdots \qquad\qquad \vdots \\ v_{n1} \cdots\cdots\cdots v_{nn} \end{bmatrix} \qquad (21)$$

where, v_{ii} denotes the variance of the ith price, and v_{ij} denotes the covariance between ith and jth price of the random price vector.

The generation of a correlated random normal vector of prices X, given the mean price vector m and variance-covariance V is given by:

$$X = CZ + m \qquad (22)$$

$$V = C'C \qquad (23)$$

where, Z is a vector of independent standard normal (0,1) variables, C is a unique lower triangular matrix obtained from V by the so-called "Square Root Method" which provides a set of recursive formulas for the computation of the elements of C as follows:

$$C_{i1} = v_{i1}/(v_{11})^{\wedge}.5 \qquad 1 \leq i \leq n \qquad (24)$$

$$C_{ii} = (v_{ii} - \sum_{k=1}^{i-1} (C_{ik})^{\wedge}2)^{\wedge}.5 \qquad 1 \leq i \leq n \qquad (25)$$

$$C_{ij} = (v_{ij} - \sum_{k=1}^{j-1} (C_{ik} {*} C_{jk}))/C_{jj} \qquad 1 < j < i < n \qquad (26)$$

Since C is a lower triangular matrix, $C_{ij}=0$ for all $j > i$. After obtaining the elements of C, all components of X can be obtained from Z as weighted sums:

$$X_i = \sum_{i=1}^{n} (C_{ij} \cdot Z_i) + m_i \qquad 1 \leq i \leq n \qquad (27)$$

As applied here, the variance-covariance matrix was computed for fifteen commodity world prices (considered as stochastic in the GESSS model). m is the mean vector of these fifteen commodity prices; C is computed from the equations (23) to (25); Z is a vector of independent Normal (0,1) random variables is generated by Lotus 1-2-3 by using the @RAND function and transformations described in equations (18) to (20). Programming of equations (21) and (22) in Lotus 1-2-3 are straightforward. The connection of random price vector X to GESSS is through in Table 8.

Data Base

The data base for the development of the GESS model consists of time series data for domestic agricultural commodity prices and quantities, world prices for agricultural commodities; a set of supply and demand elasticity matrices; and a set of specified taxes and subsidies for agricultural inputs/outputs.

In Morocco, data for agricultural commodities is collected by many sources, but there is not (if at all) a unique publisher. Hence, conflicting data exists for the same commodity in terms of prices and quantities. Because of this conflict, an action of collecting data and building a data bank was undertaken by the D.P.A.E. in order to homogenize data and to lessen or eliminate the differences among the same kind of data. Therefore, the time series data used in GESSS is a result of data coming from many sources. The time series used are from the period 1969 to 1985. These data were used for estimating the own and cross price elasticities of demand and supply for cereals and meat through the econometric models previously presented. As was mentioned, the GESS model requires base year quantities and prices. For the present study the average of three years (1983--85), was used as the base period. Using an average of three years was felt to be more representative since it eliminated single year abnormalities.

The international market prices used are those data published by The Bureau of Statistics of the International Monetary Fund. The demand and supply elasticities were developed from two sources. For seven commodities (tender wheat, hard wheat, barley, corn, beef, lamb, and chicken) own and cross price elasticities are obtained by direct estimation using the available time series data (1969--85). Elasticities for the remaining commodities, (those for which the time series data is missing) are those found in other studies done about Moroccan agriculture, in particular work done by Karim and the World Bank (1988). Consumer and producer taxes and subsidies data is a problem because they are not published officially. The only subsidy statistics found in Moroccan agricultural published data are those of fertilizer for cereals and mechanization. A conversion is needed for fertilizer because the subsidy is given in terms the quantity of selected seeds purchased. However, for mechanization, the subsidy is given in terms of fuel, tractors, and agricultural tools purchased. Since machinery and tools are used on many crops over a multiple year life, calculation of the magnitude of the mechanization subsidy for a given crop in a given year is difficult if not impossible. Furthermore, the purchase of agricultural engines is done individually and is done by a minority of farmers, thus the subsidy for mechanization is insignificant.

CHAPTER V

PRESENTATION AND INTERPRETATION OF THE RESULTS

Introduction

This chapter presents a set of results (with interpretations) derived from the application of the GESSS Model for selected agricultural pricing policy issues in Morocco. The chapter is divided into three parts. In the first part of the chapter a review of historical price and quantity ratios will be presented. Ratios considered are: wholesale/farm price ratios, farm level price ratios between commodity prices; retail level price ratios between different product prices, and consumption/production quantity ratios. In the second part of the chapter supply and demand elasticities used in the GESSS model will be reviewed. Finally, the last section of this chapter, GESSS deterministic and stochastic results will be presented and discussed.

Price Ratios

Prior to presentation of the GESSS model results, a useful background perspective can be derived from reviewing key price relations in the Moroccan economy. The ratios reviewed will be analyzed by estimating time trends and coefficients of variation of the ratios. Interpretation of the trend for various ratios will provide information about the changing production efficiency for cereals (tender wheat, hard wheat, barley, corn), and meat (beef, lamb, chicken) as well as information about shifts in demand between major food products.

Table 18, presents wholesale/farm price ratios for cereals and meats. Regressing each ratio on time, it is noticed that for cereals, the regression coefficients of the time trend variables are all negative and significantly different from zero at the five percent level, except for hard wheat. For the meats (beef, lamb and chicken) all the time trend variables are insignificant at the five percent level. These results indicates that the cereal ratios are decreasing gradually over time, which in turn indicates that the cost of processing cereals is decreasing, indicating increased efficiency in cereal processing operations.

The magnitude of the coefficients of variation for cereals are all less than 20 percent except that of soft wheat with 25 percent. The large magnitude of the coefficients of variation for tender wheat indicates that wholesale and farm relationship for tender wheat has been unstable. Upon further review it is noted that tender wheat ratios can be divided into two distinct periods. The first period is from 1969 to 1977, in which the wholesale/farm ratio is greater than unity, which means that the wholesale price was greater than farm price. Theoretically a wholesale/farm price ratio greater than one would be expected. Over the 1978-85 time period, the wholesale/farm price ratios for soft wheat were all less than unity. This result means that the farm price is greater than the wholesale price which is a theoretical discrepancy. However, the tender wheat equation is significantly downward sloping with respect to time as it is for other commodity ratios mentioned earlier.

The discrepancy depicted in the price ratios for tender wheat is due, for the large part, to the intensive government intervention in this market for input and output prices. The government intervention in the tender wheat market is

TABLE 18

WHOLESALE TO FARM PRICE RATIOS

Year	Soft Wheat	Hard Wheat	Barley	Corn	Beef	Lamb	Chicken
1969	1.371	1.425	1.600	1.565	2.557	2.277	1.533
1970	1.205	1.286	1.519	1.500	2.577	2.275	1.518
1971	1.214	1.383	1.500	1.500	2.568	2.420	1.554
1972	1.350	1.391	1.484	1.484	2.510	2.448	1.489
1973	1.056	1.776	1.393	1.403	2.452	2.321	1.487
1974	1.059	1.841	1.379	1.343	2.382	2.295	1.422
1975	1.058	1.315	1.371	1.358	2.174	2.109	1.409
1976	1.072	1.402	1.385	1.206	1.974	1.880	1.592
1977	0.780	1.087	1.329	1.333	2.104	2.078	1.644
1978	0.853	1.243	1.333	1.326	2.225	2.099	1.769
1979	0.816	1.150	1.326	1.322	2.122	2.066	1.892
1980	0.644	1.562	1.299	1.299	2.121	2.040	2.146
1981	0.663	1.384	1.293	1.292	2.325	2.222	1.587
1982	0.815	1.771	1.319	1.310	2.326	2.222	1.587
1983	0.760	1.204	1.296	1.297	2.326	2.222	1.587
1984	0.632	1.265	1.293	1.296	2.326	2.222	1.587
1985	0.709	1.260	1.294	1.284	2.326	2.222	1.587
Average	0.945	1.403	1.377	1.360	2.317	2.201	1.611
Std	0.239	0.213	0.091	0.094	0.174	0.139	0.175
C.V	25%	15%	7%	7%	8%	6%	11%

motivated by the high demand for this commodity. The literature reviewed found that government intervention in many LDCs has led to artificially low retail prices.

The time trends of the wholesale to farm price ratios for beef, lamb, and chicken, respectively, are negative, but insignificant with respect to time, which means that the meat ratios may be considered as independent of time based on the t-test at the five percent level of significance. The non-existence of a significant time trend for meat price ratios indicates processing techniques and cost for meat did not change significantly from 1969 to 1985. The magnitude of the coefficients of variations for the meat wholesale/farm price ratios vary from 6 percent for lamb to 11 percent for chicken. The coefficients of variation for meat wholesale/farm price ratios are all less than those found for food grains, but not less than those found for feed grains. Thus it can be concluded that wholesale to farm price spreads, overtime, have been more volatile for food grains than for livestock.

Price Ratios Between Commodities

Table 19, presents the farm and wholesale price ratios of tender wheat/hard wheat, tender wheat/barley, tender wheat/corn, hard wheat/barley, hard wheat/corn, barley/corn, beef/lamb, beef/chicken, and lamb/chicken. The ratio of one farm commodity price to another is referred to as the $farm_i/farm_j$ price ratio and likewise the ratio of two wholesale prices is referred to as $wholesale_i/wholesale_j$. For example tender wheat (staple crop) which is highly demanded is compared to the other cereals. The ratios of tender wheat/hard wheat prices at the farm level are all less than one, meaning that the farm price for hard wheat is greater than that of tender wheat. The same result is found for

TABLE 19

FARMi/FARMj AND WHOLESALEil/WHOLESALEj PRICE RATIOS

Year	Soft/Hard		Soft/Barley		Soft/Corn		Hard/Barley		Hard/Corn		Barley/Corn		Beef/Lamb		Beef/Chicken		Lamb/Chicken	
	Farm	Retail	Farm	Retail	Farm	Retail	Farm	Retail	Farm	Retail	Farm	Retail	Farm	Retail	Farm	Retail	Farm	Retail
1969	0.88	0.84	1.750	1.500	1.522	1.333	2.00	1.78	1.739	1.583	0.870	0.889	0.671	0.753	0.414	0.690	0.617	0.916
1970	0.89	0.77	1.444	1.146	1.300	1.044	1.63	1.49	1.467	1.356	0.900	0.911	0.714	0.809	0.444	0.755	0.622	0.931
1971	0.89	0.78	1.400	1.133	1.400	1.133	1.47	1.44	1.567	1.444	1.000	1.000	0.757	0.804	0.475	0.785	0.627	0.977
1972	0.87	0.84	1.290	1.174	1.290	1.174	1.48	1.39	1.484	1.391	1.000	1.000	0.773	0.793	0.496	0.836	0.641	1.054
1973	1.10	0.66	1.213	0.919	1.067	0.803	1.10	1.40	0.968	1.225	0.879	0.873	0.774	0.817	0.528	0.870	0.682	1.064
1974	1.08	0.62	1.172	0.900	0.971	0.766	1.09	1.46	0.900	1.234	0.829	0.851	0.742	0.770	0.559	0.936	0.753	1.216
1975	0.75	0.60	1.113	0.859	1.030	0.802	1.48	1.42	1.373	1.330	0.925	0.934	0.744	0.767	0.574	0.886	0.772	1.156
1976	0.79	0.61	1.327	1.028	1.015	0.902	1.67	1.69	1.279	1.488	0.765	0.878	0.764	0.802	0.749	0.929	0.980	1.157
1977	0.87	0.62	1.176	0.690	1.149	0.672	1.35	1.11	1.322	1.078	0.977	0.974	0.769	0.778	0.788	1.008	1.025	1.295
1978	0.86	0.59	1.173	0.750	1.067	0.686	1.37	1.28	1.247	1.169	0.910	0.915	0.784	0.831	0.811	1.020	1.035	1.228
1979	0.81	0.58	1.198	0.737	1.144	0.706	1.48	1.28	1.411	1.227	0.956	0.958	0.774	0.795	0.923	1.036	1.193	1.303
1980	0.95	0.39	1.150	0.570	1.066	0.528	1.20	1.45	1.117	1.343	0.927	0.927	0.775	0.806	1.-21	1.009	1.317	1.252
1981	0.88	0.42	1.109	0.568	0.970	0.498	1.26	1.35	1.101	1.180	0.875	0.876	0.793	0.830	0.626	0.917	0.789	1.104
1982	0.99	0.46	1.383	0.855	1.150	0.716	1.39	1.87	1.159	1.568	0.832	0.838	0.843	0.883	1.172	1.718	1.390	1.946
1983	0.83	0.52	1.111	0.651	1.034	0.606	1.34	1.25	1.248	1.160	0.931	0.931	0.807	0.845	1.238	1.814	1.534	2.147
1984	0.86	0.43	1.233	0.603	1.217	0.594	1.43	1.40	1.414	1.381	0.987	0.985	0.880	0.921	1.277	1.871	1.451	2.032
1985	0.73	0.41	1.190	0.652	1.034	0.571	1.63	1.59	1.420	1.394	0.987	0.985	0.867	0.907	1.293	1.894	1.492	2.088
Average	0.884	0.597	1.261	0.867	1.143	0.796	1.441	1.450	1.307	1.326	0.915	0.925	0.778	0.818	0.788	1.116	0.995	1.345
Std	0.098	0.144	0.158	0.252	0.152	0.236	0.219	0.189	0.209	0.142	0.065	0.051	0.050	0.056	0.302	0.405	0.329	0.410
C.V	11%	24%	13%	29%	13%	30%	15%	13%	16%	11%	7%	6%	6%	6%	38%	36%	33%	30%

the ratio of tender wheat and hard wheat at the wholesale level. This result is the same for the other ratios aforementioned.

Time trend equations estimated (regression of each ratio on time) indicate that all farm price ratios are independent of time at the five percent level of significance. The independence of farm price ratios from time indicate that the farmers use the same techniques for all production, and/or that technological development has not been more rapid in one commodity versus another.

The wholesale price ratio time trend coefficients with respect to time were significant at the five percent level of significance. The dependance of the wholesale price ratios upon time, especially in the case of cereals indicate either the relative demand has shifted between commodities or governments subsidies have been heavier for some products.

The variation of the price ratios is expressed in terms of the coefficient of variations. Table 19 reports the coefficients of variation for each ratio. The $farm_i/farm_j$ ratio coefficients of variation for all cereals are less than 20 percent. However, the magnitude of the coefficients of variations for the wholesale price ratios are greater than 20 percent for soft/hard wheat, soft/barley, and soft/corn. The large magnitude of the coefficients of variation of the ratios involving soft wheat is believed to be mainly due to the price distortion caused by the government intervention in soft wheat price determination. The coefficients of variation for other wholesale price ratios fall below 20 percent indicating reasonably stable price relations between the products.

Considering meat price ratios, beef is compared to lamb, and beef and lamb are compared to chicken. The wholesale and farm price ratios for beef and lamb both indicate the price of lamb is greater than the price of beef. The regressions of the farm and wholesale price ratios for beef and lamb on time indicate that both ratios are independent of time at the five percent level of significance. The beef/chicken, and lamb/chicken farm and wholesale price ratios indicate higher farm and wholesale prices for chicken than for beef or lamb at the beginning of the time period (1969-1985). But these ratios become greater than one starting at the end of the 70's and beginning of the 80's, indicating chicken prices fell below beef and lamb prices. This was also seen in figures 9, 10, and 12 in Chapter II. This phenomena is mainly due to the low level of technology used in chicken production till the end of the 70's. Since then improved technology has become available leading to lower cost of chicken production. The regression of both the wholesale and farm price between beef and chicken and lamb and chicken show positive and significant regression coefficients for the time variable which indicates that the farm and retail prices for chicken have declined, overtime, with respect to lamb and beef prices. This result is likely due to the recent improvements in chicken production efficiency.

The coefficients of variation for the beef/lamb wholesale and farm ratios are both six percent. This low magnitude indicates that production and demand relations between beef and lamb have been stable. However, the coefficients of variation for the beef/chicken and beef/lamb ratios are all greater than 30 percent, which is a large variation. These results show that beef and lamb on one hand, and chicken on the other hand have different production techniques and processing operation resulting in larger variations between their farm price ratios and between their wholesale price ratios.

Consumption/Production Ratios

Table 20, presents the consumption/production ratios for cereals and meat. These ratios show the degree of self-sufficiency for each commodity. For

TABLE 20

CONSUMPTION/PRODUCTION QUANTITY RATIOS

Year	Soft Wheat	Hard Wheat	Barley	Corn	Beef	Lamb	Chicken
1969	1.306	1.000	1.000	1.004	1.003	1.000	1.000
1970	1986	1.000	1.000	1.013	1.003	1.000	1.000
1971	2.293	1.006	1.000	1.028	1.001	1.000	1.000
1972	1.760	1.000	1.000	1.030	1.000	1.000	1.000
1973	3.430	1.000	1.045	1.156	1.000	1.000	1.000
1974	2.731	1.000	1.000	1.081	1.007	1.001	1.000
1975	4.700	1.042	1.059	1.098	1.020	1.000	1.000
1976	2.984	1.000	1.000	1.000	1.015	1.000	1.000
1977	6.106	1.117	1.020	1.237	1.024	1.027	1.000
1978	4.758	1.000	1.007	1.204	1.037	1.002	1.000
1979	4.219	1.000	1.006	1.345	1.003	1.000	1.000
1980	4.621	1.000	1.005	1.363	1.010	1.000	1.000
1981	9.207	1.182	1.207	3.127	1.001	1.000	1.000
1982	3.242	1.014	1.077	1.613	1.048	1.000	1.000
1983	3.460	1.000	1.003	1.704	1.047	1.000	1.000
1984	4.207	1.005	1.073	1.517	1.038	1.000	1.000
1985	2.794	1.000	1.005	1.543	1.012	1.000	1.000
Average	3.753	1.022	1.030	1.357	1.016	1.002	1.000
Std	1.825	0.049	0.052	0.496	0.016	0.006	0.000
C.V	49%	5%	5%	37%	2%	1%	0%

example the tender wheat ratios are all greater than one. This indicates that consumption is greater than production. Notable also is the fact that the ratios are unstable from year to year. The time trend equation of the consumption/production ratio on time for tender wheat shows that the regression coefficient with respect to time is positive, but insignificantly different from zero at a 5 percent level of confidence. This upward sloping phenomena of tender wheat ratio (despite its insignificance) is probably due to excess demand, which is, in part, caused by population growth and lagging production growth. The other consumption/production ratios, (hard wheat, barley, corn, beef, lamb, chicken) are all around one. When regressed on time, the regression coefficients with respect to time for the ratios are insignificantly different from zero at the 5 percent level. This implies that the production is almost equal to consumption with only small differences between them each year.

The magnitude of the coefficients of variations (C.V.s) for the tender wheat and corn consumption/production ratios, are respectively 49 percent and 37 percent. These C.V.s are large indicating a large variation between consumption and production. The large variation in the soft wheat ratios are mainly due to government intervention in determining supply and demand prices, which in turn affect production and consumption. Variation in the corn consumption/production ratio can be explained by the fact that corn has a small and unstable market which is sensitive to production and consumption variations. The coefficients of variation for hard wheat, barley, beef, lamb, and chicken consumption/production ratios are less than six percent. These low C.V. magnitudes indicate a stable relation between production and consumption.

TABLE 21

ECONOMETRIC ESTIMATION OF DEMAND EQUATIONS FOR CEREALS

Parameters Estimates	Equations: Soft Wheat	Hard Wheat	Barley	Corn
Intercept	-.0370	.07000	-.741	-.17000
Tender W Price	-.0057	.00601	.012	.00185
(t)	(-1.380)	(2.11)	(1.85)	(1.84)
(E)	(-0.914)	(1.26)	(1.65)	(1.32)
Hard W Price	.0026	-.00077	.0047	.00067
(t)	(1.40)	(-.61)	(1.649)	(1.505)
(E)	(0.72)	(-.28)	(1.145)	(0.841)
Barley Price	.0045	.0023	-.0031	-.000052
(t)	(.996)	(.751)	(-.439)	(-.0047)
(E)	(.870)	(.600)	(-.520)	(.0450)
Corn Price	.0043	-.0056	-.0071	-.0013
(t)	(-.9000)	(-1.698)	(-.950)	(-1.143)
(E)	(-.9210)	(-1.580)	(-1.31)	(-1.267)
Income	.00024	.00047	.00016	.000041
(t)	(1.84)	(.524)	(.7827)	(1.306)
(E)	(1.27)	(.330)	(.7320)	(0.983)
R^2	.839	.754	.664	.547
STD	.148	.103	.232	.036
n obs	17	17	17	17
deg fd	11	11	11	11

Notice that figures without parentheses are regression coefficients with respect to the price of the commodity, and those between parentheses stand for student t-test symbolized (t), and elasticity symbolized (E). W stands for wheat, R^2 stands for coefficient of determination, STD stands for standard error, "n obs" stands for number of observations, and "deg fd" stands for degrees for freedom.

TABLE 22

ECONOMETRIC ESTIMATION OF DEMAND EQUATIONS FOR MEAT

Parameters Estimates	Equations			
	Beef	Chicken		Lamb
Intercept	.167	-.056		.213
Beef Price	-.0000202	.0000093	Lamb/Beef	-.021
(t)	(-.439)	(.441)		(-.180)
(E)	(-.052)	(.024)		(-.382)
Chicken price	.000016	-.0000103		-------
(t)	(.947)	(-1.339)		-------
(E)	(.039)	(-0.025)		(.274)
Lamb Price	.000054	-.0000026	Lamb/Chk.	0.14
(t)	(1.136)	(.120)		(0.606)
(E)	(0.169)	(.008)		(-.108)
Income	-.000042	.0000214	Income	-.0001
(t)	(-2.234)	(2.496)		(-2.110)
(E)	(-.2070)	(0.105)		(-2.084)
R2	.665	.879		.29
STD	.016	.007		.019
n obs	17	17		17
deg fd	12	12		13

Note, the notation in table 22 is the same as that in table 21.

The goodness of fit of some of the models selected is not as strong as is statistical desirable. But in terms of economic theory, the selected models presented in table 21, and table 22, respectively, for cereals and meat serve for the purpose assigned for this dissertation. Moreover, the elasticities found for cereals and meat show a certain similarity in magnitude with respect to those found in the literature reviewed about Morocco and other developing countries.

A discussion of the demand elasticities found and used will clarify the demand situation in cereals and meat found in this study. The magnitude of the cereals own price demand elasticities varies from |-.28| for hard wheat to |-1.267| for corn. This interval of demand own price elasticities for cereals can be divided into two categories. Those elasticities less than unity, including soft wheat, hard wheat, and barley, and those greater than one, including only corn. The commodities with own price elasticity values less than one are inelastic commodities.

Cereals are the basic staple of the Moroccan diet, thus it is consistent with theory that they would have relatively low elasticities of demand. The own price elasticity |-1.267| of demand for corn is greater than unity. This may be due to its use in consumer diets as well as a livestock feed. Also, the total use of corn is not large and small changes in demand constitute a large percent of the market. This may explain in part the high elasticity of corn.

Cross-price elasticities of demand for cereals vary in magnitude from |-.045| for corn with respect to barley to |-1.58| for hard wheat with respect to corn. This is a large interval. The |-.045| cross elasticity for corn with respect to barley is very small and may be considered as insignificant since the regression coefficient of the price of corn in the barley demand model is also insignificant. The cross price elasticities of corn with respect to other cereals are low with a mixture of signs because corn is a minor crop that is used for livestock feed as well as food. Thus the motive for its demand are mixed both for human and animal use and lead to an unclear relation between commodities. However, soft wheat, hard wheat, and barley are major crops, hence their cross price elasticities are relatively larger than those of corn. The computed cross elasticities were deemed to serve for the purpose of the agricultural policy analysis in this study.

The income elasticities estimated for cereals are all relatively high, their magnitude vary from .333 to 1.277 (see table 21). The most important results here is that the signs of the income elasticities for cereals are all positive. This implies that as income increases the quantity demanded increase too. This is consistent with per-capita income in Morocco being relatively low and consumers demanding more staple foods as income rises before switching to other more expensive non-staple products, such as meat.

Considering meat demand, the own price elasticities estimated have the anticipated sign, but the magnitudes are questionable. This uncertainty in the magnitude of the own price elasticities is shown also in figure 8 (chapter II) representing the quantities of meat consumed as a function of time. A possible explanation is that, in developing countries per-capita income is low and meat is not affordable for everybody. Generally only high income individuals consume meat. These individuals may not be sensitive to price changes. This may explain the low elasticity estimates for meat. However, the chicken model may be the most meaningful in terms of economic theory and the Moroccan market, because chicken meat is affordable for a family with an average income.

The demand cross price elasticities estimated for meat have theoretically inconsistent signs in several cases, especially for chicken with respect to lamb, and lamb with respect to beef. These unanticipated signs are due, in part, to the small poorly functioning meat market. Another sign problem evolves also in the case of income elasticities for beef and lamb. They have negative signs. Again these signs may be explained by the small and poorly functioning market too. Because of the numerous theoretical problems with estimation results for beef demand, the estimated elasticities found here were not used in the GESSS model. Instead, the own and cross price elasticities reported in the 1988 World Bank study are used.

Supply Equation Results and Elasticities for Supply

Econometric supply models are estimated for seven commodities (soft wheat, hard wheat, barley, corn, beef, lamb, chicken). Tables 23 and 24 report the results of fitting equations to data of cereals and meat production on own, substitute, complement, and input prices. The ordinary least squares method of estimation is used to determine the parameter estimates. Own price elasticities conform to supply theory. Based on the student t statistics test, the goodness of fit of the models is satisfactory in terms of economic theory. The magnitude of elasticities estimated conform to the Moroccan markets, and are consistent with those found in the studies done in LDC's.

Cereals own price elasticities vary from .121 for hard wheat to .533 for soft wheat. This elasticity interval shows an inelastic supply market for cereals, meaning that for a one percent variation of own price, their is less than a one percent variation in production. The slow supply adjustment is generally due to the time it takes to produce an agricultural commodity and an inability of producers to rapidly reorganize their farms.

The magnitude of cross-price elasticities estimated varies .0301 for hard wheat with respect to soft wheat, to |-.911| for tender wheat with respect to

TABLE 23

ECONOMETRIC ESTIMATION OF SUPPLY EQUATIONS FOR CEREALS

Parameters Estimates	Equations: Soft Wheat	Hard Wheat	Corn		Barley
Intercept	-1848818	4428146	522536		-392324
Soft W Price	28982.95	4129.34	10466.09	B/T	10120477
(t)	(.336)	(.114)	(1.265)	(t)	(1.734)
(E)	(.533)	(.030)	(0.331)	(E)	(-.449)
Hard W Price	16961.05	14650.57	-13293.67	B/H	-8652746
(t)	(.323)	(.566)	(-2.092)	(t)	(-1.945)
(E)	(.353)	(.121)	(-0.476)	(E)	(0.331)
Corn	3401.63	-30062.17	7494.45		----------
(t)	(.039)	(-.815)	(.826)		----------
(E)	(.050)	(-.151)	(.215)	(E)	(-.144)
Barley	-59993.24	-21872.05	-8042.16	B/C	2981472
(t)	(-.448)	(-.408)	(-.667)	(t)	(.535)
(E)	(-.911)	(-.127)	(-.210)	(E)	(.263)
Fertilizer	119573.19	-------	8592.58		---------
(t)	(1.061)	-------	(1.013)		---------
(E)	(1.421)	-------	(0.175)		---------
Q(t-1)		-.0616	.0885		-.0991
(t)		(-.488)	(1.265)	(t)	(-1.17)
R2	.596	.937	.982		.961
STD	1613130	777028	166890		1318580
n obs	16	16	16		16
dg fd	9	9	8		10

Notice that (t) and (E) have the same meaning as in Table 21, b/t, b/h, and b/c stand respectively for barley/tender wheat, barley/hard wheat, and barley/corn.

TABLE 24

ECONOMETRIC ESTIMATION OF SUPPLY EQUATIONS FOR MEAT

Parameters Estimates	Equations		
	Beef	Lamb	Chicken
Intercept	3964897	-2657679	-276092
Beef	7630.05	-4089.079	1078.69
(t)	(3.433)	(-1.12)	(.671)
(E)	(2.318)	(-2.01)	(.620)
Lamb	-6154.65	31114.72	-106.41
(t)	(-3.39	(1.132)	(-.082)
(E)	(-2.37)	(1.970)	(-.077)
Chicken	-941.36	1680.33	917.25
(t)	(-1.405)	(1.570)	(2.423)
(E)	(0.0362)	(1.104)	(0.668)
Oil-cake	-23439.44	36151.39	--------
(t)	(-3.639)	(4.423)	--------
(E)	(-0.810)	(12.051)	--------
Pulp -12758.81	-46677.99	--------	
(t)	(-2.023)	(-5.654)	--------
(E)	(0.226)	(-1.310	--------
Bran 168.845	39033.65	1330.863	
(t)	(2.650)	(3.401)	(.2155)
(E)	(0.224)	(0.921)	(.0414)
Forage	200042.71	-7887.28	--------
(t)	(2.685)	(-1.882	--------
(E)	(0.744)	(-0.476)	--------
Corn	-11811.54		
(t)	(-1.346)		
(E)	(-0.481)		
Q(t-1)	------------	1.0286	--------
(t)	------------	(.44)	--------
R2	.901	.920	.9305
STD	139765.97	164174.313	145443.17
n obs	16	15	16
deg fd	7	6	11

barley. The negative cross price elasticity indicates that barley and soft wheat are competing crops. This is true in rainfed areas with an annual rainfall of greater than 400mm/year. In fact, soft wheat is a relatively new crop in Morocco, and farmers present a certain inertia to produce it. This inertia is mainly due to the farmers ignorance of soft wheat yield potential, its plantation conditions, and its stages of growth as well. This is why soft wheat and barley have an opposite sign. The cross-price elasticity for hard wheat with respect to tender wheat is .0301. First of all, its magnitude is low, but the sign is valid because hard wheat is resistant to the drought, whereas tender wheat is not . Thus, they compliment each other rather than compete. For this reason they do not compete for the same land especially in arid areas.

The magnitude of own price elasticities for meat varies from .666 for chicken to 2.318 for beef. The chicken industry is new in Morocco and risky in terms of production, because chicken production needs a large amount of fixed and over-head capital. On the other hand the production does not take as long a time period as beef or lamb production. From the mid 70's up to the beginning of the 80's many private investments were made in the chicken industry which led to increasing supply and decreasing prices. Besides, the Moroccan consumer is aware of the constituencies of processed feed for chicken, that is, hormones are added to chicken feed. Compared to chicken fed traditionally (no processed feed), there is a significant differences in taste and health between these two kind of chickens. Therefore, the chicken market has shown a slowdown in demand which has influenced supply since the mid 80's. These factors justify the inelastic market.

Beef's own-price elasticity (2.318) is high. Beef does not appear to be sold in a steady flow, rather it is sold when forage is short or income is needed.

Hence, it's market is very thin and volatile which accounts for its high supply elasticity.

The meat cross-price elasticity magnitudes vary from |-.036| for beef with respect to chicken to |-2.37| for beef with respect to lamb. The signs for the cross-price elasticities of beef with respect chicken, lamb with respect to beef, and chicken with respect to beef are negative and meaningful. They imply that there is a substitution effect in production, as the price of one meat increases there is a shift in production from other meats to the production of the high priced meat. This shift requires that the fixed capital used in meat production is convertible. In Morocco, the meat industry is different from that of developed countries in the way the investment is done. Generally, in LDC's the fixed capital in meat industry is not huge and producers produce at the same time on the same farm beef, chicken, and lamb. Therefore to switch from one activity to the other does not create much difficulty. The cross-price elasticity (-2.37) of lamb with respect to beef is relatively high because the two production processes are the most similar and easiest to switch between. Moreover, the cross-price elasticity (-.036) for chicken with respect to beef is smaller because the two production activities are less alike.

Among the meat cross price elasticities, however, there are unanticipated positive signs, particularly those of cross elasticities of lamb with respect to chicken, and the cross elasticity of chicken with respect to lamb which may be due to the unreliable data. Furthermore, the chicken cross price elasticities with an unanticipated sign may be explained by the use of advanced technology which increased chicken supply irregardless of its price situation.

Input prices are also included in the meat production equations. Inputs included are; oil-cake, pulp, bran, forage, and corn for beef. The same inputs are used for lamb production, except corn. For chicken, the only input data available is bran. Anticipated signs and the magnitude of the elasticities for these inputs are not satisfactory as shown in Table 24. Other functional forms; linear models with a one period lag in prices, two period lagged prices, a log linear model, trans-log linear model, etc. were tried, but the anticipated signs of the regression coefficient for the input prices of meat production are contradictory with respect to economic theory. Therefore, the own and cross price elasticities of meat used in the GESS are those found in the study done by Eliraki, 1988.

Supply and Demand Elasticity Matrices

Tables 25 and 26 reports the demand and supply elasticity matrices used in the GESS model. The demand and supply own and cross price elasticities for cereals used in the GESS model are those computed through the demand econometric models developed for soft wheat, hard wheat, barley, and corn, and are depicted respectively in Table 21 and Table 23. Meat demand and supply own and cross price elasticities were computed but are not used in GESS because of the unreliable signs in cross price elasticities and problems in the magnitude of the own price elasticities. They and all other remaining demand and supply own and cross elasticities used in GESS are from the World Bank study done by Eliraki, 1988. An overview of the magnitude and the significance of the elasticities in the supply and demand matrices is given below.

Table 25 presents the supply elasticity matrix in which the magnitude of own price elasticities for cereals varies from .121 for hard wheat to .53 for tender wheat. These cereals own price elasticities are those computed through the supply econometric estimations reported in Table 23. The magnitude for the

TABLE 25

SUPPLY ELASTICITIES

	DH(1)	DH(2)	DH(3)	DH(4)	DH(5)	DH(6)	DH(7)	DH(8)	DH(9)	DH(10)	DH(11)	DH(12)	DH(13)	DH(14)	DH(15)
(1) Soft Wheat(A)	0.533	0.533	0.353	-0.91	0.05	0	0	0	0	0	0	0	0	-0.02	1.421
(2) Soft Wheat(M)	0.533	0.533	0.353	-0.91	0.05	0	0	0	0	0	0	0	0	-0.02	1.421
(3) Hard Wheat	0.03	0.03	0.121	-0.15	-0.04	0	0	0	0	0	0	0	0	-0.01	0.01
(4) Barley	-0.449	-0.44	0.331	0.263	-0.14	0	0	0	0	0	0	0	0	-0.01	0.01
(5) Corn	0.331	0.331	-0.47	-0.21	0.215	0	0	0	0	0	0	0	0	-0.03	0.175
(6) Beef	0	0	0	-0.03	-0.18	0.62	-0.22	0	-0.1	-0.09	0	-0.01	-0.02	-0.03	0
(7) Lamb	0	0	0	-0.69	0	-0.29	0.88	0	-0.13	-0.12	0	-0.02	-0.16	0	0
(8) Chicken	0	0	0	-0.03	-0.34	0	0	0.66	0	0	-0.09	0	-0.06	0	0
(9) Milk (OFFI)	0	0	0	-0.07	0	-0.24	-0.24	0	0.9	-0.27	0	0	-0.16	-0.01	0
(10) Milk (UNDOFF)	0	0	0	-0.09	-0.01	-0.39	-0.14	0	-0.49	0.8	0	-0.01	-0.19	-0.01	0
(11) Oil-Cake	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(12) Pulp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(13) Bran	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(14) Forage	-0.08	-0.09	-0.11	-0.12	-0.04	0	0	0	0	0	0	0	0	0.3	0
(15) Fertilizer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 26

DEMAND ELASTICITIES

	DH (1)	DH (2)	DH (3)	DH (4)	DH (5)	DH (6)	DH (7)	DH (8)	DH (9)	DH (10)	DH (11)	DH (12)	DH (13)	DH (14)	DH (15)	Income
(1) Soft Wheat(A)	-0.914	-0.91	0.72	0.87	-0.92	0.01	0.01	0.01	0.02	0.01	0	0	0	0	-0.01	1.27
(2) Soft Wheat(M)	-0.914	-0.91	0.72	0.87	-0.92	0.01	0.01	0.01	0.01	0.01	0	0	0	0	-0.12	1.27
(3) Hard Wheat	1.26	1.26	-0.28	0.6	-1.58	0.01	0.01	0.01	0.01	0.01	0	0	0	0	-0.12	0.333
(4) Barley	1.65	1.65	1.145	-0.52	-0.31	0.01	0.01	0.01	0.01	0.01	0	0	0	0	-0.06	0.732
(5) Corn	1.32	1.32	0.841	0.04	-0.26	0.01	0.01	0.01	0.01	0.013	0	0	0	0	-0.06	0.983
(6) Beef	0.01	0.01	0.02	0.01	0	-0.72	0.25	0.01	0.08	0.01	0	0	0	0	-0.01	0.27
(7) Lamb	0	0.01	0.01	0.01	0	0.29	-0.21	0.1	0.05	0	0	0	0	0	0	0.43
(8) Chicken	0	0	0.01	0.01	0	0.15	0.13	-0.24	0.06	0	0	0	0	0	0	0.69
(9) Milk (OFFI)	0.01	0.01	0	0	0	0.09	0.05	0.05	-0.42	0.01	0	0	0	0	0	0.69
(10) Milk (UNDOFF)	0.06	0.1	0.08	0.05	-0.02	0.12	0.05	0.04	0.1	-0.49	0	0	0	0	0	0.69
(11) Oil-Cake	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(12) Pulp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(13) Bran	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(14) Forage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(15) Fertilizer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note that soft wheat (A) represents soft wheat sold in rural markets without price, or quantity control. Soft wheat(M) represents a soft planted under contracts to be delivered to the mills for four. Milk(OFF) represents milk under contracts delivered to the cooperatives for dairy products. Milk(unoff) represents milk with no price, nor quantity control.

supply own price elasticities for meat vary from .62 for beef to .88 for lamb. Milk supply own price elasticity is .9 which is relatively high with respect to the other commodities. The supply own price elasticities for meat and milk are those found in the World Bank study done in 1988.

The demand elasticity matrix is depicted in Table 26. The magnitude of the own price elasticities varies from | -.28| to |-1.267| for cereals and from |-.21| to |-.72| for meat. Milk demand's own price elasticity is -.05 which is very low, but could be about correct because of the low per-capita consumption. The own price demand elasticities for cereals are computed through the demand equations reported in Table 21. A key point to notice is that demand elasticities for meat are very low while supply elasticities are somewhat larger. This relationship is consistent to that found in the reviewed literature presented in Chapter III. It implies that meat is inelastic in terms of demand, whereas supply is relatively more elastic. This implies that the demand quantities are not responsive to the prices, but the quantities supplied are. The demand and supply cross price elasticities used for meat and milk are those found by the World Bank study.

Income elasticities are included in the demand elasticity matrix. Their magnitude varies from .33 to 1.27 for cereals, and from .27 to .69 for meat. The magnitude of income elasticities for cereals and meat conform to those found in the literature reviewed. The income elasticities reflect cereal and meat markets in developing countries since the cereal income elasticities are greater than those of meat because of the low per-capita income.

The GESS Model Results

The purpose of this study is to analyze Moroccan agricultural pricing policy and price volatility and their effects on producers, consumers, cost and revenue of government intervention, and supply and demand for soft wheat, hard wheat, barley, corn, meat, lamb, and chicken. The method adopted, as described in Chapter IV, is the GESS model. Two applications of the GESS model are undertaken, a deterministic and a stochastic application. In the deterministic application three policy cases have been considered. They are: a) removal of all input subsidies; b) free trade; and c) self-sufficiency for soft wheat. The stochastic application reconsiders the first two policy options i.e., removal of input subsidies and free trade. These two applications are treated below.

The GESS Deterministic Results

The deterministic version of the GESS model was used to analyze the effect of selected price policies. Before starting the analysis of the results, it is worthy to analyze the base situation with which the model operates. All base prices and quantities are the average of three years (1983-1985).

Table 36 reports the wholesale/world price margin (wholesale as a percent of world price). For example the tender wheat wholesale price under the base year situation, represents 66 percent of world price, which is far below the world price. This is due to the intensive government intervention between the domestic and world market. This price distortion is shown also in other commodity prices, but in these cases the domestic prices are higher than the world prices.

Table 31 represents net physical trade balances. Under the base year situation it can be noticed that there exists a significant deficiency in production relative to demand for soft wheat, barley, corn, beef, and chicken. This under production may be due, in part, to the small fraction of farmers with large land holdings, who are benefiting from the input subsidies. This appears to be particularly true for soft wheat and barley. However, supply is equal to demand for hard wheat and lamb and their prices are determined by market forces. Milk production is far beyond the demand. The government cost incurred in input subsidies are reported in Table 39.

In terms of policy analysis, three cases will be considered. Scenario#1 is for the case of zero input subsidies. In scenario#2, retail and whole sale prices are set equal to world price. In scenario#3 the effects of a self-sufficiency pricing policy for milled soft wheat are considered.

Scenario#1: Zero Input Subsidies

In Morocco, a major form of government intervention is embodied in agricultural input subsidies (selected seeds, and fertilizer). The policy alternative considered here is to eliminate all input subsidies. Theoretically they are considered as inefficient because government intervention leads to price distortion, and as a consequence a loss in total social welfare. The results of removing input price subsidies are shown under the column for scenario number one in fifteen tables (Table 27 to Table 41) developed from the GESS model. The following discussion will report the results of Tables 29, 30, 31, 39, 40, and 41, which provide us respectively with the farm price, retail price, the physical net trade balance, government costs, domestic net monetary receipts

TABLE 27

FARM LEVEL SUPPLY (QL)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
10	(1)	Soft Wheat {A}	6313670.00	6267139.32	14309308.61	7950742.88
11	(2)	Soft Wheat {M}	9658000.00	9586822.17	21888901.79	12162224.94
12	(3)	Hard Wheat	12745000.00	12742971.47	13523290.87	12911213.77
13	(4)	Barley	24143000.00	24294410.78	11234850.47	19847601.04
14	(5)	Corn	3049500.00	3043877.21	6243693.67	3535305.33
15	(6)	Beef	2119410.00	2120280.83	1523054.84	2120280.83
16	(7)	Lamb	1935750.00	1954126.41	2345225.93	1954126.41
17	(8)	Chicken	1757100.00	1757821.96	1118996.32	1757821.96
18	(9)	Milk {OFF}	8008000.00	8015679.61	7800711.54	8015679.61
19	(10)	Milk {UNOFF}	313200.00	313586.23	542538.06	313586.23
20	(11)	Oil-Cake	0.00	0.00	0.00	0.00
21	(12)	Pulp	0.00	0.00	0.00	0.00
22	(13)	Bran	1370.00	1370.00	1370.00	1370.00
23	(14)	Forage	125.00	125.68	133.98	120.74
24	(15)	Fertilizer	0.00	0.00	0.00	0.00

TABLE 28

RETAIL LEVEL DEMAND (QL)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
31	(1)	Soft Wheat {A}	6313670.00	6313670.00	1267988.53	2846118.41
32	(2)	Soft Wheat {M}	26980000.00	26980000.00	5444874.99	12162224.94
33	(3)	Hard Wheat	12745000.00	12745000.00	57336938.91	38226101.23
34	(4)	Barley	24253000.00	24253000.00	101063685.72	102196196.22
35	(5)	Corn	4704500.00	4704500.00	13051988.79	14867874.43
36	(6)	Beef	2144240.00	2144240.00	3550996.12	2163013.69
37	(7)	Lamb	1935750.00	1935750.00	1465495.30	1952698.27
38	(8)	Chicken	1757143.00	1757143.00	1631571.49	1757143.00
39	(9)	Milk {OFF}	469800.00	469800.00	481855.17	473913.29
40	(10)	Milk {UNOFF}	313200.00	313200.00	167062.40	341727.95
41	(11)	Oil-Cake	0.00	0.00	0.00	0.00
42	(12)	Pulp	0.00	0.00	0.00	0.00
43	(13)	Bran	0.00	0.00	0.00	0.00
44	(14)	Forage	0.00	0.00	0.00	0.00
45	(15)	Fertilizer	0.00	0.00	0.00	0.00

TABLE 29

FARM PRICE (DH/QL)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
54	(1)	Soft Wheat {A}	190.00	187.17	284.50	187.17
55	(2)	Soft Wheat {M}	200.00	197.02	310.08	308.44
56	(3)	Hard Wheat	215.00	212.66	98.56	212.08
57	(4)	Barley	153.00	150.92	73.94	150.92
58	(5)	Corn	176.00	176.00	115.25	176.00
59	(6)	Beef	1381.00	1381.00	496.32	1381.00
60	(7)	Lamb	1593.00	1593.00	810.45	1593.00
61	(8)	Chicken	1068.00	1068.00	442.95	1068.00
62	(9)	Milk {OFF}	213.00	213.00	130.96	213.00
63	(10)	Milk {UNOFF}	173.00	173.00	145.02	173.00
64	(11)	Oil-Cake	130.00	130.00	130.00	130.00
65	(12)	Pulp	100.00	100.00	100.00	100.00
66	(13)	Bran	75.00	75.00	137.00	75.00
67	(14)	Forage	153.00	153.00	130.00	153.00
68	(15)	Fertilizer	101.00	101.00	101.00	101.00

TABLE 30

RETAIL PRICE (DH/QL)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
74	(1)	Soft Wheat {A}	125.00	125.00	190.00	125.00
75	(2)	Soft Wheat {M}	129.00	129.00	200.00	308.44
76	(3)	Hard Wheat	315.00	315.00	146.00	315.00
77	(4)	Barley	198.00	198.00	97.00	198.00
78	(5)	Corn	197.00	197.00	129.00	197.00
79	(6)	Beef	3211.00	3211.00	1154.00	3211.00
80	(7)	Lamb	3540.00	3540.00	1801.00	3540.00
81	(8)	Chicken	1695.00	1695.00	703.00	1695.00
82	(9)	Milk {OFF}	411.00	411.00	252.69	411.00
83	(10)	Milk {UNOFF}	303.00	303.00	254.00	303.00
84	(11)	Oil-Cake	130.00	130.00	130.00	130.00
85	(12)	Pulp	100.00	100.00	100.00	100.00
86	(13)	Bran	75.00	75.00	137.00	75.00
87	(14)	Forage	153.00	153.00	130.00	153.00
88	(15)	Fertilizer	101.00	101.00	101.00	101.00

TABLE 31

NET PHYSICAL TRADE BALANCE (1000 QL)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
96	(1)	Soft Wheat {A}	0.00	-46.53	13041.32	5104.62
97	(2)	Soft Wheat {M}	-17322.00	-17393.18	16444.03	0.00
98	(3)	Hard Wheat	0.00	-2.03	-43813.65	-25314.89
99	(4)	Barley	-110.00	41.41	-89828.84	-82348.60
100	(5)	Corn	-1655.00	-1660.62	-6808.30	-11332.57
101	(6)	Beef	-24.83	-23.96	-2027.94	-42.73
102	(7)	Lamb	0.00	18.38	879.73	1.43
103	(8)	Chicken	-0.04	0.68	-512.58	0.68
104	(9)	Milk {OFF}	7538.20	7545.88	7318.86	7541.77
105	(10)	Milk {UNOFF}	0.00	0.39	375.48	-28.14
106	(11)	Oil-Cake	0.00	0.00	0.00	0.00
107	(12)	Pulp	0.00	0.00	0.00	0.00
108	(13)	Bran	1.37	1.37	1.37	1.37
109	(14)	Forage	0.13	0.13	0.13	0.12
110	(15)	Fertilizer	0.00	0.00	0.00	0.00

TABLE 32

FARM LEVEL (PRODUCER TAXES (-) AND SUBSIDIES (+) AS A PERCENT OF BASE YEAR SUPPLY PRICES)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
118	(1)	Soft Wheat {A}	1.49	0.00	0.00	0.00
119	(2)	Soft Wheat {M}	1.49	0.00	0.00	54.22
120	(3)	Hard Wheat	1.09	0.00	0.00	0.00
121	(4)	Barley	1.36	0.00	0.00	0.00
122	(5)	Corn	0.00	0.00	0.00	0.00
123	(6)	Beef	0.00	0.00	0.00	0.00
124	(7)	Lamb	0.00	0.00	0.00	0.00
125	(8)	Chicken	0.00	0.00	0.00	0.00
126	(9)	Milk {OFF}	0.00	0.00	0.00	0.00
127	(10)	Milk {UNOFF}	0.00	0.00	0.00	0.00
128	(11)	Oil-Cake	0.00	0.00	0.00	0.00
129	(12)	Pulp	0.00	0.00	0.00	0.00
130	(13)	Bran	0.00	0.00	0.00	0.00
131	(14)	Forage	0.00	0.00	0.00	0.00
132	(15)	Fertilizer	0.00	0.00	0.00	0.00

TABLE 33

RETAIL LEVEL (CONSUMER TAXES (-) AND SUBSIDIES (+) AS A PERCENT OF BASEYEAR DEMAND PRICES)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
143	(1)	Soft Wheat {A}	0.00	0.00	0.00	0.00
144	(2)	Soft Wheat {M}	0.00	0.00	0.00	139.10
145	(3)	Hard Wheat	0.00	0.00	0.00	0.00
146	(4)	Barley	0.00	0.00	0.00	0.00
147	(5)	Corn	0.00	0.00	0.00	0.00
148	(6)	Beef	0.00	0.00	0.00	0.00
149	(7)	Lamb	0.00	0.00	0.00	0.00
150	(8)	Chicken	0.00	0.00	0.00	0.00
151	(9)	Milk {OFF}	0.00	0.00	0.00	0.00
152	(10)	Milk {UNOFF}	0.00	0.00	0.00	0.00
153	(11)	Oil-Cake	0.00	0.00	0.00	0.00
154	(12)	Pulp	0.00	0.00	0.00	0.00
155	(13)	Bran	0.00	0.00	0.00	0.00
156	(14)	Forage	0.00	0.00	0.00	0.00
157	(15)	Fertilizer	0.00	0.00	0.00	0.00

TABLE 34

WORLD PRICE (DH/QL)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
163	(1)	Soft Wheat {A}	190.00	190.00	190.00	190.00
164	(2)	Soft Wheat {M}	200.00	200.00	200.00	200.00
165	(3)	Hard Wheat	146.00	146.00	146.00	146.00
166	(4)	Barley	97.00	97.00	97.00	97.00
167	(5)	Corn	129.00	129.00	129.00	129.00
168	(6)	Beef	1154.00	1154.00	1154.00	1154.00
169	(7)	Lamb	1801.00	1801.00	1801.00	1801.00
170	(8)	Chicken	703.00	703.00	703.00	703.00
171	(9)	Milk {OFF}	252.69	252.69	252.69	252.69
172	(10)	Milk {UNOFF}	254.00	254.00	254.00	254.00
173	(11)	Oil-Cake	130.00	130.00	130.00	130.00
174	(12)	Pulp	100.00	100.00	100.00	100.00
175	(13)	Bran	137.00	137.00	137.00	137.00
176	(14)	Forage	130.00	130.00	130.00	130.00
177	(15)	Fertilizer	101.00	101.00	101.00	101.00

TABLE 35

WHOLESALE PRICE (DH/QL)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
184	(1)	Soft Wheat {A}	125.00	125.00	190.00	125.00
185	(2)	Soft Wheat {M}	129.00	129.00	200.00	129.00
186	(3)	Hard Wheat	315.00	315.00	146.00	315.00
187	(4)	Barley	198.00	198.00	97.00	198.00
188	(5)	Corn	197.00	197.00	129.00	197.00
189	(6)	Beef	3211.00	3211.00	1154.00	3211.00
190	(7)	Lamb	3540.00	3540.00	1801.00	3540.00
191	(8)	Chicken	1695.00	1695.00	703.00	1695.00
192	(9)	Milk {OFF}	411.00	411.00	252.69	411.00
193	(10)	Milk {UNOFF}	303.00	303.00	254.00	303.00
194	(11)	Oil-Cake	130.00	130.00	130.00	130.00
195	(12)	Pulp	100.00	100.00	100.00	100.00
196	(13)	Bran	75.00	75.00	137.00	75.00
197	(14)	Forage	153.00	153.00	130.00	153.00
198	(15)	Fertilizer	101.00	101.00	101.00	101.00

TABLE 36

WHOLESALE/WORLD PRICE MARGIN (WHOLESALE PRICE AS A PERCENT OF WORLD PRICE)(DH/QL)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
206	(1)	Soft Wheat {A}	65.79	65.79	100.00	65.79
207	(2)	Soft Wheat {M}	64.50	64.50	100.00	64.50
208	(3)	Hard Wheat	215.75	215.75	100.00	215.75
209	(4)	Barley	204.12	204.12	100.00	204.12
210	(5)	Corn	152.71	152.71	100.00	152.71
211	(6)	Beef	278.25	278.25	100.00	278.25
212	(7)	Lamb	196.56	196.56	100.00	196.56
213	(8)	Chicken	241.11	241.11	100.00	241.11
214	(9)	Milk {OFF}	162.65	162.65	100.00	162.65
215	(10)	Milk {UNOFF}	119.29	119.29	100.00	119.29
216	(11)	Oil-Cake	100.00	100.00	100.00	100.00
217	(12)	Pulp	100.00	100.00	100.00	100.00
218	(13)	Bran	54.74	54.74	100.00	54.74
219	(14)	Forage	117.69	117.69	100.00	117.69
220	(15)	Fertilizer	100.00	100.00	100.00	100.00

TABLE 37

FARM/WHOLESALE PRICE MARGIN (FARM PRICE AS A PERCENT OF A WHOLESALE PRICE)(DH/QL)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
227	(1)	Soft Wheat {A}	152.000	152.000	152.000	152.000
228	(2)	Soft Wheat {M}	155.039	155.039	155.039	155.039
229	(3)	Hard Wheat	68.254	68.254	68.254	68.254
230	(4)	Barley	77.273	77.273	77.273	77.273
231	(5)	Corn	89.340	89.340	89.340	89.340
232	(6)	Beef	43.008	43.008	43.008	43.008
233	(7)	Lamb	45.000	45.000	45.000	45.000
234	(8)	Chicken	63.009	63.009	63.009	63.009
235	(9)	Milk {OFF}	51.825	51.825	51.825	51.825
236	(10)	Milk {UNOFF}	57.096	57.096	57.096	57.096
237	(11)	Oil-Cake	100.000	100.000	100.000	100.000
238	(12)	Pulp	100.000	100.000	100.000	100.000
239	(13)	Bran	100.000	100.000	100.000	100.000
240	(14)	Forage	100.000	100.000	100.000	100.000
241	(15)	Fertilizer	100.000	100.000	100.000	100.000

TABLE 38

RETAIL/WHOLESALE PRICE (RETAIL AS A PERCENT OF WHOLESALE PRICE)(DH/QL)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
249	(1)	Soft Wheat {A}	100.00	100.00	100.00	100.00
250	(2)	Soft Wheat {M	100.00	100.00	100.00	100.00
251	(3)	Hard Wheat	100.00	100.00	100.00	100.00
252	(4)	Barley	100.00	100.00	100.00	100.00
253	(5)	Corn	100.00	100.00	100.00	100.00
254	(6)	Beef	100.00	100.00	100.00	100.00
255	(7)	Lamb	100.00	100.00	100.00	100.00
256	(8)	Chicken	100.00	100.00	100.00	100.00
257	(9)	Milk {OFF}	100.00	100.00	100.00	100.00
258	(10)	Milk {UNOFF}	100.00	100.00	100.00	100.00
259	(11)	Oil-Cake	100.00	100.00	100.00	100.00
260	(12)	Pulp	100.00	100.00	100.00	100.00
261	(13)	Bran	100.00	100.00	100.00	100.00
262	(14)	Forage	100.00	100.00	100.00	100.00
263	(15)	Fertilizer	100.00	100.00	100.00	100.00

TABLE 39

GOVERNEMENT COST AND REVENUE (1000 DH)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
321	(1)	Soft Wheat {A}	17874.00	0.00	0.00	0.00
322	(2)	Soft Wheat {M}	28780.84	0.00	0.00	7252401.24
323	(3)	Hard Wheat	29867.91	0.00	0.00	0.00
324	(4)	Barley	50236.75	0.00	0.00	0.00
325	(5)	Corn	0.00	0.00	0.00	0.00
326	(6)	Beef	0.00	0.00	0.00	0.00
327	(7)	Lamb	0.00	0.00	0.00	0.00
328	(8)	Chicken	0.00	0.00	0.00	0.00
329	(9)	Milk {OFF}	0.00	0.00	0.00	0.00
330	(10)	Milk {UNOFF}	0.00	0.00	0.00	0.00
331	(11)	Oil-Cake	0.00	0.00	0.00	0.00
332	(12)	Pulp	0.00	0.00	0.00	0.00
333	(13)	Bran	0.00	0.00	0.00	0.00
334	(14)	Forage	0.00	0.00	0.00	0.00
335	(15)	Fertilizer	0.00	0.00	0.00	0.00
		Total	126,759.50	0.00	0.00	7,252,401.24

TABLE 40

NET MONETARY RECEIPTS (VALUE OF MARKETSURPLUS) (1000,000 DH)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
348	(1)	Soft Wheat {A}	410.39	383.81	3830.04	1132.37
349	(2)	Soft Wheat {M}	-1548.82	-1591.62	5698.28	0.00
350	(3)	Hard Wheat	-1274.50	-1304.80	-7038.28	-9303.06
351	(4)	Barley	-1108.22	-1135.60	-8972.53	-17239.46
352	(5)	Corn	-390.07	-391.06	-964.13	-2306.76
353	(6)	Beef	-3958.25	-3957.05	-3341.93	-4017.33
354	(7)	Lamb	-3768.91	-3739.63	-738.67	-3799.63
355	(8)	Chicken	-1101.77	-1101.00	-651.33	-1101.00
356	(9)	Milk {OFF}	1512.62	1514.25	899.79	1512.56
357	(10)	Milk {UNOFF}	-40.72	-40.65	36.25	-49.29
358	(11)	Oil-Cake	0.00	0.00	0.00	0.00
359	(12)	Pulp	0.00	0.00	0.00	0.00
360	(13)	Bran	0.10	0.10	0.19	0.10
361	(14)	Forage	0.02	0.02	0.02	0.02
362	(15)	Fertilizer	0.00	0.00	0.00	0.00
		Total	-11,268.12	-11,363.24	-11,242.30	-35,171.48

TABLE 41

NET MONETARY TRADE BALANCE (1000 DH)

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
374	(1)	Soft Wheat {A}	0.00	-8840.83	2477850.82	969878.65
375	(2)	Soft Wheat {M}	-3464400.00	-3478635.57	3288805.36	0.00
376	(3)	Hard Wheat	0.00	-296.17	-6396792.61	-3695973.57
377	(4)	Barley	-10670.00	4016.85	-8713397.02	-7987813.73
378	(5)	Corn	-213495.00	-214220.34	-878270.07	-1461901.41
379	(6)	Beef	-28653.82	-27648.88	-2340244.24	-49313.72
380	(7)	Lamb	0.00	33095.91	1584394.85	2572.07
381	(8)	Chicken	-30.23	477.31	-360340.34	477.31
382	(9)	Milk {OFF}	1904835.30	1906775.86	1849409.14	1905736.47
383	(10)	Milk {UNOFF}	0.00	98.10	95370.82	-7148.00
384	(11)	Oil-Cake	0.00	0.00	0.00	0.00
385	(12)	Pulp	0.00	0.00	0.00	0.00
386	(13)	Bran	187.69	187.69	187.69	187.69
387	(14)	Forage	16.25	16.34	17.42	15.70
388	(15)	Fertilizer	0.00	0.00	0.00	0.00
		Total	-1812209.81	-1784973.79	-9393008.19	-10323282.53

TABLE 42

SELF-SUFFICIENCY SUPPLY AND DEMAND PRICES

			G Base Year	H SCEN#1	I SCEN#2	J SCEN#3
400	(1)	Soft Wheat {A}	145.85	145.78	41.30	71.31
401	(2)	Soft Wheat {M}	308.37	308.24	89.87	308.44
402	(3)	Hard Wheat	280.71	279.90	4757.02	4188.02
403	(4)	Barley	182.63	180.35	1464.16	1465.65
404	(5)	Corn	259.66	259.99	208.72	510.85
405	(6)	Beef	2192.12	2191.45	1468.96	2205.76
406	(7)	Lamb	1856.82	1840.78	613.44	1855.58
407	(8)	Chicken	1208.03	1207.47	761.77	1207.47
408	(9)	Milk {OFF}	30.63	30.61	19.58	30.81
409	(10)	Milk {UNOFF}	214.04	213.84	72.00	228.79
410	(11)	Oil-Cake	0.00	0.00	0.00	0.00
411	(12)	Pulp	0.00	0.00	0.00	0.00
412	(13)	Bran	0.00	0.00	0.00	0.00
413	(14)	Forage	0.00	0.00	0.00	0.00
414	(15)	Fertilizer	0.00	0.00	0.00	0.00

(difference between total farm revenue and total consumption expenditure), and net monetary net trade balance.

Before starting the policy analysis, it is worthy to explain how the output subsidy is computed and expressed in terms of units of output produced (DH/QL). As explained in Chapter II, concerning a description of Moroccan agriculture, the government intervenes in terms of input subsidies for seeds, fertilizer and mechanization for major commodities. But, the only published data for subsidies are those of seeds and fertilizer. The subsidy computation is as follows; The government subsidizes seeds for soft wheat by the DH40/QL, hard wheat DH20/QL, and Barley DH80/QL; for fertilizer the subsidy is about DH2.67/QL for all cereals. To translate the figures above into units of subsidy per unit of output produced (DH/QL), the quantity of seeds and fertilizer used per hectare for each commodity and yield per hectare are needed. With this complement of information and simple multiplication and division operations, the subsidy per unit produced is obtained. This output subsidy is computed because it is more convenient in introducing it into GESS. It gives a more accurate estimate of response since the input elasticities are not very accurate and in many cases are not available.

Table 31 presents the net physical trade balances for the agricultural commodities (soft wheat(A), soft wheat(M), hard wheat, barley, corn, beef, lamb, chicken, and milk(off), milk(unoff)). Under scenario # 1 it can be noticed that the physical net trade balance is negative for soft wheat, hard wheat, corn, and beef, meaning that the demand for these commodities is greater than their production. However, barley, lamb, chicken, and milk do have a positive physical net trade balance. Comparing this policy to that of the base year (subsidies included) we may say that there is an improvement of the situation in terms of production for barley, beef, lamb, chicken, and milk, but undesirable results for soft wheat, hard wheat, and corn, because of the reduction in their production.

Barley presents an interesting case. Barley had a negative physical net trade balance under the base year policy in which input subsidies are included. However, barley's balance of trade becomes positive when input subsidies are removed. This change occurs despite the fact that barley's own farm level price fell when subsidies to barley were removed. This result can be explained as follows: farm prices (Table 29) for soft wheat(A), soft wheat(M), and barley in the base year policy are respectively DH190/QL, DH200/QL, and DH153/QL. However, under scenario#1 soft wheat(A), soft wheat(M), and barley farm prices are respectively DH187.17/QL, DH197.02/QL, and DH150/QL. Under zero input subsidy the farm prices for soft wheat(A), soft wheat(M)[1], and barley decreased, but barley is related to soft wheat(A), and soft wheat(M) by negative supply cross price elasticities (Table 25). Therefore, as farm prices for soft wheat(A), and soft wheat(M) decrease, barely production increases. This means that the farmers who had been growing soft wheat(A), and soft wheat(M) switched to barley production as input subsidies were eliminated.

Table 41 reflects the net monetary trade balances which is the difference between the export earning and the import expenses, it is obtained by multiplying the net physical trade balances by the corresponding world prices. Under zero input subsidies soft wheat, hard wheat, corn, and beef present a deficit which is expressed in terms of import expenses, whereas, corn, lamb, chicken, and milk have a positive net monetary trade balance. However, the

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[1]Note that Soft wheat(A) represents a soft wheat sold in rural market without any price, or quantity control. Soft wheat(M) represents a soft wheat planted under contract to be delivered to mills for flour. Milk(off) represents milk under contracts delivered to the cooperatives for dairy products. Milk(unoff) represents milk with no price, nor quantity control.

total net monetary trade balance is negative which creates an import expense for the government and net foreign exchange outflow.

Table 39 reports the government intervention costs for three commodities (soft wheat, hard wheat, and barley). Under scenario#1 there are no cost for the government since the policy adopted is zero input subsidies. Instead the government has saved the cost spent on the subsidies.

Table 40 presents the domestic net monetary receipts where net monetary receipts are defined as the difference between farm receipts and consumer expenditures. Under the zero input subsidy the total domestic net monetary receipts is more deficient than under the base year situation. This is the case even though the monetary balance of trade improved. This is due to the domestic prices of cereals falling. In the case of barley, barley's net physical and monetary balance of trade rose, but due to the decline in its farm level price its net monetary receipts fell. Retail prices remained unchanged for all commodities.

Meat and milk are not subject to subsidy of any kind, but they are affected by the zero input subsidies for cereals. The net physical trade balance for beef is negative under both policies (base year, and zero input subsidy), but, under zero input subsidy policy there is a slight increase in beef production. Lamb shifts from self sufficiency in the base year to an excess supply under zero input subsidy policy. Chicken switches from a negative net trade balance in the base year situation to an excess supply under the no subsidy policy. Milk has a positive net trade balance in both policies, but there exists an increase in milk production under the zero input subsidy policy. The effect of the zero input subsidy on meat and milk is mainly due to the interaction of meat and milk production through the input elasticities, since cereals are inputs to meat production, specifically barley and corn are inputs for beef, lamb and chicken production (see Table 25).

Comparison of the base year policy with input subsidies, and the zero input subsidy policy, indicates that the government does not incur any cost under zero input subsidy (Table 39). Instead the government saves the amount of input subsidies expenses. The net physical trade balances under the zero input subsidy policy show better results than those of the base year policy for barley (which shifts from import to overproduction), lamb, beef, and milk. Production of soft wheat, hard wheat, and corn decline thus causing their physical balances of trade to decline also.

Consumers are not assumed to be affected by the zero input subsidy because the retail prices are assumed unchanged, i.e. exogenous.

Scenario#2: Wholesale Price Equal to World Price with Zero Input Subsidies

This policy option is selected to see what will be the results with respect to the base year policy (in which there is a difference between wholesale and world prices) if domestic prices were to be brought in line with world prices. By setting domestic prices equal to the world price a free/open trade situation is essentially represented. Likewise setting all domestic prices equal to world prices effectively removes all subsidies. The effects of this policy, if it were adopted, are depicted in fifteen tables (Table 27 to Table 41) in the scenario#2 column. The discussion here will focus on Tables 29, 30, 31, 39, 40, and 42 reflecting respectively the domestic supply prices, the domestic demand prices, the net physical trade balances, the government costs, the domestic net monetary receipts (value of domestic market surplus), and the net monetary trade balances.

In Table 31 results of the physical net trade balances for agricultural commodities are reported. Under scenario#2 the results indicate that soft wheat(A), soft wheat(M), lamb, milk (off), and milk(unoff) have positive net physical trade balances, whereas, hard wheat, barley, corn, beef, and chicken have negative net physical trade balances. The positive net trade balances of soft wheat, lamb, and milk are due to the effect of the open trade policy and the interaction among commodities through cross price elasticities (Table 25, and Table 26). Open trade results in the decline of all farm commodity prices except soft wheat. Lamb presents an interesting case, despite its farm price declining, its production increases. With free trade the price of lamb becomes 810.45DH/QL, whereas under the base year policy lamb farm price is 1593DH/QL (Table 29). Lamb production is related to beef, chicken, and input prices through cross price elasticities and negative input price elasticities. Therefore as farm prices for beef and chicken go down with the negative supply cross price elasticities lamb production increases. Practically we may say that there is a substitution effect in favor of lamb production. For the other commodities which experience a decline in physical trade balance, the decline in their own supply price dominates the cross supply elasticities and their production and trade balances decline.

Table 30 scenario#2 reports retail prices which are equal to world prices, but less than those of base year expect for soft wheat(A), and soft wheat(M). As the demand prices go down the consumers purchase more, depending on the demand elasticities. The excess demand phenomena is well seen under the scenario#2 in hard wheat, barley, corn, beef, and chicken. Retail prices, like farm prices, are lower with free trade for all commodities except soft wheat.

Therefore, under the scenario#2 the consumer gains and the producer loses in all commodities except soft wheat.

Table 41 reports the net monetary trade balances. The results indicate that deficits occur in hard wheat, barley, corn, beef, and chicken. These deficit occur because of falling retail prices that increase demand, and falling farm prices that decrease production. The balance of trade improved for soft wheat and lamb, but not by enough to offset the declines in hard wheat, barley, corn, beef and chicken. Thus the impact of free trade upon the Moroccan balance of trade is to quadruple the net monetary trade deficit.

Table 40 reflects the domestic net monetary receipts (value of domestic market surplus) which is the difference between the production values and the consumption expenses. Under the open trade policy the results show that all the net monetary balances are negative except for two commodities, soft wheat and milk. Hence, the total of net monetary balance is negative. The positive net monetary balances for the categories of soft wheat and milk are, essentially, due to the decreases of retail prices which surpass the decreases in farm prices. In total the net monetary receipts realized with free trade are slightly less than those realized in the base period.

Scenario#3: Self-Sufficiency in Soft Wheat (M) Through Pricing Policy

Soft wheat is Morocco's largest food crop. Currently Morocco is not self-sufficient in soft wheat. Approximately 64 percent of Morocco's milled soft wheat consumption was imported during the base year. Retail level soft wheat prices are currently heavily subsidized in Morocco. Retail prices during the base period were 129 DH/QL versus a farm level price of 200 DH/QL. This heavy subsidy contributes to Morocco's lack of self-sufficiency because of the stimulus it provides to consumption. The analysis to be conducted here will determine the impact of reverting to a competitive market situation for soft wheat (M). Permitting a free market in soft wheat (M) will lead to self-sufficiency in soft-wheat where self-sufficiency is defined as a zero balance of trade. It will also of course lead to higher retail level soft wheat prices and less soft wheat consumption. Likewise it should lead to higher farm prices and more production of soft wheat. In order to consider whether a policy of self sufficiency in soft wheat (M) is desirable, the level of these free market consumption and production quantities and their associated market price must be known as a first step in considering the benefits and costs of such a policy.

Given that the supply and demand equations for soft wheat (M) are defined by the elasticities present in the GESS model, the equilibrium price for soft wheat (M) can be mathematically determined. This is done by setting the supply equation ($Q_s = a \cdot P^{e11} \cdot P^{e12} \ldots P^{e1n}$ where the e_{ij}'s are the own and cross supply elasticities) equal to the demand equation ($Q_d = a \cdot P^{e11} \cdot P^{e12} \ldots P^{e11n}$ where in this case the e_{ij}'s are own and cross demand elasticities) and solving for price. Since the intercepts of the supply and demand equation used are defined by the base year conditions, the equilibrium price will be representative of the conditions present in the base year. A set of self-sufficiency prices for each commodity for the base year of the GESS model has been calculated and reported in column g of Table 42. The self-sufficiency price for wheat was found to be 308.44 DH/QL. This is 54.22 percent above the base year farm price and 139.1 percent above the base year retail price.

Once the equilibrium price has been mathematically calculated for soft wheat (M) it can be inserted in the GESS model and the equilibrium quantity for soft wheat (M), simulated. This insertion is done by placing a subsidy on the base year farm price of 54.22 percent and a tax on the base year retail price of 139.1 percent. Changing the price of soft wheat (M) in the model to its equilibrium level will affect not only the supply and demand quantities of soft wheat (M), but also the supply and demand quantities of all other commodities in the model due to existence of cross effects of the soft wheat price through various cross elasticities of supply and demand. These cross effects have relevance in determining the desirability of changing to a self-sufficiency policy in soft wheat (M). It is quite possible that obtaining self-sufficiency in soft wheat will hinder the balance of trade for other commodities.

Column J for scenario #3 in table 31 presents the net physical trade balances resulting from the wheat self-sufficiency pricing policy. Soft wheat (M), as planned, is converted from a deficit trade balance to a zero or self-sufficient balance. The trade balance for soft wheat (A), which is complementary crop to soft wheat (M) is changed from a zero balance to a surplus balance and Morocco becomes a net exported of soft wheat (A). However the trade balance for all other grains and beef is worsened compared to the base year. This occurs for two reasons. First, the higher retail prices for soft wheat (M) cause the consumption of other commodities to rise to replace the reduced level of soft wheat (M) consumed. For example the consumption of hard wheat, barley and corn increases significantly. Secondly, the higher farm prices received for soft wheat (M) leads to increased soft wheat (M) production, partly through the reduction in production of competitive crops, specifically barley production is reduced significantly. Production of other complementary crops and livestock enterprises is increased slightly. In some cases this increase in production was large enough to slightly improve their net physical balance of trade.

Table 41 reports the estimated effect of the soft wheat self-sufficiency pricing policy on the net monetary trade balance. The total balance of trade is worsened by the wheat self-sufficiency pricing policy. The total deficit is increased from 1.81 billion DH to 10.32 billion DH. Thus, these results indicate that attempting to obtain self-sufficiency in one commodity through pricing policy, while not controlling prices and/or trade in all other commodities is self defeating in this case of the total effect upon the trade balance.

The determination of a pricing policy that would lead to all commodities having zero (self-sufficient) balances of trade simultaneously could be undertaken using the GESS model. However, the process is a complex one given the many cross effects present in the model's structure and a unique solution can not be computed in using the GESS model. Injection of the set of equilibrium prices reported in Table 42 will not lead to simultaneous self-sufficiency for all commodities since each of these prices was calculated assuming all other prices were held constant. A simultaneous equation iterative solution algorithm such as the Gauss-Sidel elgorithm would be needed to find the set of prices that would lend to simultaneous self-sufficiency in all commodities. Likewise it should be noted that self-sufficiency in wheat can be achieved with a variety of tax and subsidy combinations different from the one calculated here, i.e. a slightly greater farm subsidy and lower retail tax would lead to self-sufficiency at a large quantity level. Thus the combinations of taxes and subsidies that would lead to simultaneous self-sufficiency for all commodities is nearly infinite.

The GESSS Stochastic Results

In this dissertation, emphasis is placed on analyzing agricultural pricing policy using stochastic prices. Based on the structure of GESSS, as reported in the methodology chapter, the domestic farm, retail, and wholesale prices are related to the world prices through the ratios presented earlier in this chapter. World prices are considered stochastic because Morocco is a small open economy country and depends on the international market to fulfill supply shortages for major agricultural commodities. As a consequence, any shock in the world market is transmitted integrally into the domestic market. However, as was reported in the studies done by Mateus (1988) about Morocco, the government intervenes in fixing producer and consumer prices. But this does not eliminate the effect of international market variation in the sense that this variation is transmitted into the government budget required to operate the government intervention program.

Three policy alternatives will be considered. The first policy alternative is the base year situation which will be considered as a reference policy with which the adopted policies will be compared. The second alternative policy considers zero input subsidies. The third alternative policy is the case where zero input subsidies are combined with stochastic world prices set equal to domestic wholesale prices. The results of these policy options are depicted in twelve tables (Tables 43 to Table 54).

The stochastic simulations conducted were done as follows. The World prices, for the agricultural commodities included in the GESSS, are simulated 100 times, using the upper triangular matrix of coefficients (Table 55) obtained from the variance covariance matrix of the world prices as was explained in the methodology chapter. The average, standard deviation, minimum, maximum, and coefficient of variation of 100 simulation runs for net physical trade balance, domestic farm price, domestic retail price, domestic net monetary receipts (value of domestic market surplus), and net monetary trade balance are calculated under the two policy alternatives considered. The results of the simulations under these two policy alternatives are reported in twelve tables

(Tables 43 to Table 54), and their interpretation is given in the following sections.

First Policy Alternative: Stochastic World Price with Zero Input Subsidies

Under this policy alternative, the effect of world price stochasticness is calculated for net physical trade balance, world price, domestic farm price, domestic retail price, net monetary trade balance, and domestic net monetary receipts and reported respectively in tables 43 through 48.

The magnitude of the coefficients of variation (C.V) of world prices (Table 44) for cereals varies from 22 percent for barley to 25 percent for soft wheat and hard wheat, and for meat from 19 percent for chicken to 34 percent for lamb, and 31 percent for milk. The magnitude of these coefficients of variation is attributable to the degree of international market instability. The magnitude of the coefficients of variation indicate that the world market for these commodities is unstable, and any price prediction policy should consider the magnitude of these C.V's which, accordingly, and may lead to unsatisfactory results.

Table 43 reports the net physical trade balances. It indicates that all commodities have a negative value for their minimum balance except for milk. The maximum net physical trade balances are all positive except those of corn and soft wheat(M). However, the average physical trade balance of the 100 simulation runs are negative for soft wheat (M), hard wheat, barley, corn, and lamb, but positive for soft wheat (A), beef, chicken, and milk. The magnitude of the coefficients of variation of net physical trade balances for cereals varies from

TABLE 44

WORLD PRICE (DH): ZERO INPUT SUBSIDIES

	Soft Wheat(A)	Soft Wheat(M)	Hard Wheat	Barley	Corn	Beef	Lamb	Chicken	Milk (Off)
Base Year	190.00	200.00	146.00	97.00	129.00	1154.00	1801.00	703.00	252.69
Average	192.59	202.72	147.99	97.09	131.13	1200.42	1807.11	709.25	260.40
St. Dv.	48.39	50.94	37.19	21.27	29.52	261.39	615.99	135.83	80.72
Minimum	70.28	73.98	54.01	47.89	54.51	519.22	404.83	328.30	75.79
Maximum	287.86	303.01	221.19	149.60	193.71	1757.69	3160.49	1089.16	425.20
C.V.	25%	25%	25%	22%	23%	22%	34%	19%	31%

TABLE 45

FARM LEVEL PRICE (DH): ZERO INPUT SUBSIDIES

	Soft Wheat(A)	Soft Wheat(M)	Hard Wheat	Barley	Corn	Beef	Lamb	Chicken	Milk (Off)
Base Year	190.00	200.00	215.00	153.00	176.00	1381.00	1593.00	1068.00	213.00
Average	190.49	200.51	215.55	151.06	178.90	1436.55	1598.40	1077.49	218.62
St. Dv.	47.87	50.39	54.16	33.09	40.27	312.81	544.85	206.36	67.77
Minimum	69.52	73.18	78.67	74.51	74.36	621.35	358.08	498.76	63.63
Maximum	284.72	299.70	322.18	232.76	264.29	2103.44	2795.48	1654.65	356.98
C.V.	25%	25%	25%	22%	23%	22%	34%	19%	31%

TABLE 46

RETAIL PRICE (DH): ZERO INPUT SUBSIDIES

	Soft Wheat(A)	Soft Wheat(M)	Hard Wheat	Barley	Corn	Beef	Lamb	Chicken	Milk (Off)
Base Year	125.00	129.00	315.00	198.00	197.00	3211.00	3540.00	1695.00	411.00
Average	126.70	130.76	319.29	198.18	200.25	3340.16	3552.01	1710.07	421.85
St. Dv.	31.84	32.86	80.23	43.42	45.08	727.31	1210.78	327.50	130.77
Minimum	46.24	47.72	116.53	97.76	83.24	1444.72	795.73	791.56	122.78
Maximum	189.38	195.44	477.24	305.37	295.83	4890.77	6212.17	2626.06	688.82
C.V.	25%	25%	25%	22%	23%	22%	34%	19%	31%

TABLE 47

NET MONETARY TRADE BALANCE (1000,000 DH):
ZERO INPUT SUBSIDIES

	Soft Wheat(A)	Soft Wheat(M)	Hard Wheat	Barley	Corn	Beef	Lamb	Chicken	Milk(Off)	Total
Base Year	0.00	-3464.40	0.00	-10.67	-213.50	-28.65	0.00	-0.03	1904.84	-1812.41
Average	28.88	-3382.59	-40.70	-80.06	-209.52	160.34	-49.13	18.86	2079.20	-1474.72
St. Dv.	355.39	1185.95	561.50	533.90	64.00	484.31	735.43	173.35	929.51	5023.34
Minimum	-763.27	-6143.19	-1552.83	-938.41	-348.97	-731.44	-1203.96	-346.57	236.61	-11792.03
Maximum	1121.56	-114.15	1246.13	1512.39	-61.29	1901.69	2201.46	543.39	4184.55	12535.75
C.V.	1230%	-35%	-1380%	-667%	-31%	302%	-1497%	919%	45%	-341%

TABLE 48

DOMESTIC NET MONETARY RECEIPTS (1000,000 DH):
ZERO INPUT SUBSIDIES

	Soft Wheat(A)	Soft Wheat(M)	Hard Wheat	Barley	Corn	Beef	Lamb	Chicken	Milk(Off)	Total
Base Year	410.39	-1548.82	-1274.50	-1108.22	-390.07	-3958.25	-3768.91	-1101.77	1505.81	-11234.34
Average	417.04	-1515.60	-1233.73	-1001.56	-384.51	-3737.00	-3800.10	-1083.61	1651.79	-10687.29
St. Dv.	280.83	840.13	907.30	748.44	101.72	886.84	1231.29	343.55	759.50	6099.60
Minimum	-194.47	-3437.03	-3842.09	-2609.65	-596.95	-5546.62	-6099.86	-1784.66	157.10	-23954.22
Maximum	1320.93	902.22	723.57	942.92	-150.77	-1399.62	-1164.65	-174.41	3378.62	4378.81
C.V.	67%	-55%	-74%	-75%	-26%	-24%	-32%	-32%	46%	-57%

TABLE 49

NET PHYSICAL TRADE BALANCE (1000 QL): WORLD PRICE EQUAL TO WHOLESALE PRICE

	Soft Wheat(A)	Soft Wheat(M)	Hard Wheat	Barley	Corn	Beef	Lamb	Chicken	Milk (Off)
Base Year	0.00	-17322.00	0.00	-110.00	-1655.00	-24.83	0.00	-0.04	7538.20
Average	13193.53	16744.61	-51202.83	-91549.87	-6749.75	-1970.33	782.15	-471.30	7141.46
St. Dv.	2109.64	3755.34	28314.25	18687.85	1075.88	493.71	432.97	189.17	1239.98
Minimum	8757.03	8460.54	-220695.23	-182382.15	-11516.75	-3374.89	-835.47	-855.61	3194.57
Maximum	22544.55	32843.54	-17191.71	-57994.01	-5011.38	-969.98	1754.39	435.93	9436.24
C.V.	16%	22%	-55%	-20%	-16%	-25%	55%	-40%	17%

TABLE 50

WORLD PRICE (DH): WORLD PRICE
EQUAL TO WHOLESALE PRICE

	Soft Wheat(A)	Soft Wheat(M)	Hard Wheat	Barley	Corn	Beef	Lamb	Chicken	Milk (Off)
Base Year	190.00	200.00	146.00	97.00	129.00	1154.00	1801.00	703.00	252.69
Average	185.57	195.34	142.60	96.26	127.67	1152.16	1718.44	706.20	245.74
St. Dv.	44.10	46.42	33.88	20.75	29.17	266.05	532.53	126.58	73.53
Minimum	59.25	62.37	45.53	34.02	42.96	263.32	141.54	377.30	41.99
Maximum	295.95	311.52	227.41	159.32	206.72	1783.21	2882.31	1015.14	410.44
C.V.	24%	24%	24%	22%	23%	23%	31%	18%	30%

TABLE 51

FARM LEVEL PRICE (DH): WORLD PRICE
EQUAL TO WHOLESALE PRICE

	Soft Wheat(A)	Soft Wheat(M)	Hard Wheat	Barley	Corn	Beef	Lamb	Chicken	Milk (Off)
Base Year	190.00	200.00	215.00	153.00	176.00	1381.00	1593.00	1068.00	213.00
Average	85.07	89.55	96.27	73.37	114.06	495.53	773.30	444.97	127.35
St. Dv.	20.22	21.28	22.88	15.82	26.06	114.43	239.64	79.76	38.11
Minimum	27.16	28.59	30.74	25.93	38.38	113.25	63.69	237.73	21.76
Maximum	135.67	142.81	153.53	121.44	184.69	766.93	1297.04	639.63	212.71
C.V.	24%	24%	24%	22%	23%	23%	31%	18%	30%

TABLE 52

RETAIL PRICE (DH): WORLD PRICE EQUAL TO WHOLESALE PRICE

	Soft Wheat(A)	Soft Wheat(M)	Hard Wheat	Barley	Corn	Beef	Lamb	Chicken	Milk (Off)
Base Year	125.00	129.00	315.00	198.00	197.00	3211.00	3540.00	1695.00	411.00
Average	56.59	58.40	142.60	96.26	127.67	1152.16	1718.44	706.20	245.74
St. Dv.	13.45	13.88	33.88	20.75	29.17	266.05	532.53	126.58	73.53
Minimum	18.07	18.64	45.53	34.02	42.96	263.32	141.54	377.30	41.99
Maximum	90.24	93.13	227.41	159.32	206.72	1783.21	2882.31	1015.14	410.44
C.V.	24%	24%	24%	22%	23%	23%	31%	18%	30%

TABLE 53

NET MONETARY TRADE BALANCE (1000,000 DH): WORLD PRICE EQUAL TO WHOLESALE PRICE

	Soft Wheat(A)	Soft Wheat(M)	Hard Wheat	Barley	Corn	Beef	Lamb	Chicken	Milk(Off)	Total
Base Year	0.00	-3464.40	0.00	-10.67	-213.50	-28.65	0.00	-0.03	1904.84	-1812.41
Average	2506.77	3348.92	-6493.11	-8476.94	-844.09	-2181.37	1450.01	-330.09	1843.17	-9176.73
St. Dv.	400.83	751.07	1200.78	829.77	159.32	457.92	950.28	128.95	801.91	5680.82
Minimum	1663.83	1692.11	-10308.05	-10059.81	-1140.42	-3230.95	-122.00	-581.07	142.73	-21943.63
Maximum	4283.47	6568.71	-3909.58	-6203.80	-410.26	-828.66	4078.60	260.56	3865.49	7704.52
C.V.	16%	22%	-18%	-10%	-19%	-21%	66%	-39%	44%	-62%

TABLE 54

DOMESTIC NET MONETARY RECEIPTS (1000,000 DH):
WORLD PRICE EQUAL TO WHOLESALE PRICE

	Soft Wheat(A)	Soft Wheat(M)	Hard Wheat	Barley	Corn	Beef	Lamb	Chicken	Milk(Off)	Total
Base Year	410.39	-1548.82	-1274.50	-1108.22	-390.07	-3958.25	-3768.91	-1101.77	1505.81	-11234.34
Average	3870.95	5677.74	-7117.79	-8737.53	-929.09	-3211.47	-749.48	-628.11	898.20	-10926.58
St. Dv.	582.23	1059.60	1091.40	883.77	166.76	554.72	380.94	153.97	403.34	5276.75
Minimum	2660.78	3394.02	-10762.95	-10391.35	-1237.34	-4275.40	-1669.63	-929.52	58.13	-23153.27
Maximum	6469.38	10300.34	-4887.28	-6259.12	-459.00	-1049.20	27.11	-27.40	1919.55	6034.38
C.V.	15%	19%	-15%	-10%	-18%	-17%	-51%	-25%	45%	-48%

TABLE 55

COEFFICIENT MATRIX FOR WORLD PRICES

	Hard Wheat	Barley	Corn	Beef	Lamb	Chicken	Milk
Hard Wheat	5.05	3.89	10.47	-0.45	12.47	7.59	29.19
Barley	0.00	5.96	7.01	-0.64	9.55	10.24	12.18
Corn	0.00	0.00	11.65	-0.74	10.25	7.95	22.28
Beef	0.00	0.00	0.00	101.41	-48.09	57.95	258.47
Lamb	0.00	0.00	0.00	0.00	181.48	-86.34	551.41
Chicken	0.00	0.00	0.00	0.00	0.00	109.15	96.07
Milk	0.00	0.00	0.00	0.00	0.00	0.00	83.65

24 percent for corn to 1230 percent for soft wheat, and for meat from 441 percent for beef to 2654 percent for chicken, and 18 percent for milk.

The ranges of the coefficients of variation in net physical trade balances for meat and cereals are much larger than those of world prices. The reason for this large variation in net physical trade balances is attributable to two factors. First changes in world prices effect both supply and demand which collectively change the balance of trade. Secondly, many of the balances of trade being dealt with are close to zero and hence small relative to total supply and demand. Thus small percentage shifts in supply and/or demand can result in large percentage changes in the physical balance of trade. In cereals, soft wheat (A) with a C.V. magnitude of 1230 percent is the most sensitive to the world price changes, whereas corn is the least with C.V. magnitude of 24 percent. The coefficients of variation for meat are all high, implying that meat is very sensitive to the world price volatility.

The effects of the world price stochasticness on domestic farm and retail prices are reflected in Tables 45 and 46. Since the changes in world prices are transmitted directly into domestic farm and retail prices the resulting coefficients of variations for domestic prices are the same as those for world prices. The identical variation between world prices on one hand, and the domestic prices on another hand, is due to the linkages of domestic prices to the world prices through the price ratios explained in the methodology chapter.

Comparing the results of world price volatility effects on net physical trade balances to the base year situation (Table 43), it can be noticed that, on average, the world price volatility has a slightly depressing effect on soft wheat(A), soft wheat(M), hard wheat, barley, and lamb and a slight positive effect on all other commodities. These are not the same basic effects that were in the deterministic case when subsidies were removed. Given the large standard deviations generated by the stochastic simulations none of these variations could be concluded to be significant. In effect the stochastic impacts of the world market have over-powered the deterministic effect of the subsidy removal.

This implies that removing all domestic input subsidies does not significantly influence Morocco's balance of trade given the instability present in world market prices. What is of significance to note is the magnitude of the coefficients of variation for each commodity's trade balance and the coefficient of variation for the total trade balance. It is significant to note that the total monetary balance of trade (Table 47) has a coefficient of variation of over 300 percent, which is quite large.

The domestic net monetary receipts (value of domestic market surplus), reported in Table 48, indicate that all commodities have negative average domestic net monetary receipts, except for soft wheat(A) and milk. The magnitude of the coefficients of variation for cereals varies from 26 percent for corn to 75 percent for barley. For meat the C.V magnitudes vary from 24 percent for beef to 32 percent for lamb and chicken.

In summary, this stochastic simulation points out several significant implications. First, the input subsidy program carried out in Morocco has relatively little impact on the Moroccan economy relatively to the potential impact of random world prices. Secondly, the magnitudes of volatility in Moroccan agricultural prices and trade balances that free trade would lead to are quite large. Thus it is not surprising that Morocco currently has policies in place to protect its economy from this instability.

Second Policy Alternative: Stochastic World Prices With Zero Input Subsidies Coupled with Wholesale Prices Equal to World Prices

Under this policy alternative, wholesale prices are set equal to world prices with world prices are stochastic. Minimums, maximums, standard deviations, averages, and coefficients of variation of the net physical trade balance, world price, domestic farm price, domestic retail price, and domestic net monetary receipts are reported respectively in tables 49 through 54.

Table 49 reflects the net physical trade balances for soft wheat(A), soft wheat(M), hard wheat, barley, corn, lamb, beef, chicken, and milk. The results of 100 simulation runs indicate that soft wheat(A), soft wheat(M), lamb, and milk, on average, show the positive net physical trade balances, whereas, hard wheat, barley, corn, beef, and chicken have negative balances. These results mean that for the commodities with negative net physical trade balances the consumption on average is greater than production, and vice-versa for the commodities with a positive net physical trade balances. The minimum and the maximum net physical trade balances are negative for hard wheat, barley, corn, and beef, whereas the minimum balances for soft wheat(A), soft wheat(M), and milk indicate overproduction even in the worst years. Lamb and chicken have negative minimum net physical trade balance, but their maximums are positive. The magnitude of the coefficients of variation of net physical trade balances for cereals vary from 16 percent for soft wheat(A) to 55 percent for hard wheat; for meat it varies from 25 percent for beef to 55 percent for lamb. For milk it is 17 percent . It can be noticed that the coefficients of variation for cereals are all less or equal to 22 percent, which appears to be an acceptable variation range, except that of hard wheat which is 55 percent. With regard to meats, lamb with the largest C.V. of 55 percent is equal in volatility to hard wheat. Each of the physical trade balances reported has a large degree of variation. However, in this case the simulated average balances are significantly different from the base year. The shifts are similar to those observed in the deterministic analysis. Thus opening the Moroccan economy to free trade would not only create increased volatility, it would also significantly shift the balance of trade for many of Morocco's agricultural commodities.

Tables 50, 51, and 52, present respectively the results for world prices, domestic farm prices, and domestic retail prices. The magnitude of the coefficients of variation for the world, the domestic farm and retail prices are equal for each price and vary for cereals from 22 percent for barley to 24 percent for hard wheat and soft wheat. For meat the coefficient of variation varies from 18 percent for chicken to 31 percent for lamb. Finally, the coefficient of variation is 30 percent for milk price. The existence of identical coefficients of variation at all price levels is due to the direct linages between world prices and domestic price implemented in constructing GESSS.

The net monetary trade balances reported in table 53 presents the same results as the net physical trade balances in terms of exports and imports. However, the imports and exports here are expressed in monetary value. Soft wheat(A), soft wheat(M), lamb, and milk show an excess supply which may be expressed in foreign exchange earnings since commodity surplus are assumed to be exported. Whereas, hard wheat, barley, corn, beef, and chicken present an excess demand which should be covered by import amounts with expenses as reflected in table 53. With free trade and stochastic prices the net monetary trade balance on average is negative. The coefficient of variation is 62 percent. This is less than in the previous case where only subsidies were removed. This change is not due to the volatility of each commodity trade balance changing (indeed the standard deviations of each trade balance remained similar) but is due to the average trade balances being significantly different with free trade.

The domestic net monetary receipts (values of domestic market surpluses) reported in table 54 show that, on average, the value of market surpluses are positive for soft wheat(A), soft wheat(M), and milk. These three commodities have positive balances of trade, hence their supply levels exceed their demand which leads to a positive domestic net monetary balance. Net monetary receipts are negative for hard wheat, barley, corn, beef, lamb, and chicken. These results reflect the level of domestic farm and retail prices which have large spreads (retail/farm prices) for the commodities with the negative average values of market surpluses. This means that farm prices are low relative to the retail prices for the commodities with deficits in their market surplus values. Likewise these commodities are all import commodities for which domestic demand exceeds domestic supply.

Relative to the base year, a policy of free trade would favor soft wheat(A), soft wheat(M), lamb, and milk. They would become export commodities. However, hard wheat, barley, corn, beef, and chicken show undesirable results in that both net monetary trade balances and values of the domestic market surpluses decline.

In summary, analysis of the effect of world price volatility combined with policies of no input subsidy and free trade indicate that while world price volatility overshadows the impact of input subsidies, it does not overshadow the basic changes the deterministic model showed free trade would create. The stochastic simulation indicated that free trade would significantly lower the balance of trade for Morocco, i.e. the deficit balance of trade would increase by nearly 500 percent with a coefficient of variation of only 62 percent. While the standard deviation of the trade balance under free trade is only 62 percent in absolute terms it is greater than the base line actual trade deficit. Hence free trade would result in considerable balance of trade instability.

Concluding Comments

Through the GESS model developed, analysis of two alternative policies were undertaken, free trade (zero input subsidies), and wholesale prices equal to world prices coupled with free trade. The impacts of these two policy alternatives were implemented and analyzed in envisaging the GESS deterministic model and the GESS stochastic model. The effects of the two policy alternatives were measured by estimating changes in the following policy indicators: net physical trade balance, world prices, domestic supply and demand prices, the net monetary trade balance, and the value of market surpluses.

The major results found are that, in the case of GESS deterministic model, the net physical trade balances and the net monetary trade balances present a promising results with a decrease in monetary trade balance deficit under free trade with respect to the base year situation. The same results are known also for the values of the market surpluses. However, the second policy alternative wholesale prices equal to the world prices combined with free trade indicate that the total net monetary trade balance deficit increases compared to the base year policy. Therefore the scenario#1 cuts down the net monetary trade balance deficit leading to less foreign exchange needs, and improvement of the agricultural sector production, but scenario #2 does not.

In the case of stochastic model, the net physical and monetary trade balances were shown to have high degrees of volatility under both policy alternatives with free trade. The impact of world price volatility that would occur under free trade was shown to overshadow the affects of subsidy removal. However the basic shifts in production and consumption that would occur with free trade are not overshadowed by the world price instability that would come with free trade. However, the instability caused by free trade may be to great to be politically acceptable.

The results found can help to shape future Moroccan agricultural pricing policy, and to modify and correct current pricing policy. This work is an application economic and scientific concepts to Moroccan agricultural pricing policy which, if it is followed up, will help policy makers to base their decisions on founded tools. This work is not an end in its self, but is a starting step toward a creditable tool to be used in agriculture, and other sectors as well.

CHAPTER VI

SUMMARY AND FUTURE RESEARCH POSSIBILITIES

Objectives, Methodology, and Results

The study undertaken in the framework of this dissertation is intended to analyze Moroccan agricultural pricing policy. There is a discrepancy between the agricultural production potential, and the current production in the Moroccan agricultural sector. The shortages in agricultural commodity supply may stem from many sources. Among these sources may be misallocation of resources, inefficiency of the agricultural pricing system, market inefficiency, technical inefficiency, and no investment monitoring. This study focuses on agricultural pricing policy and its potential use, and upon the effect of agricultural pricing volatility upon producers, consumers, and government. Through the literature reviewed, many studies were found of agricultural pricing policies for LDCs. They confirmed that most LDC governments intervene in agricultural price determination. Also in most cases they distort the market equilibrium resulting in the misallocation of resources and hence inefficient investments and underproduction.

Given the problems facing the Moroccan government in administering agricultural price policy there exists a need to develop tools for aiding in price policy decision. The General Econometric Spread Sheet (GESS) modeling approach was applied to Morocco to provide such a tool. This method is mainly based on the partial equilibrium concept in which supply and demand equations, for major commodities are used to describe the agricultural market structure. In this study the supply and demand equations used were developed from price elasticities for supply and demand of agricultural commodities. The General Econometric Spreadsheet Simulator (GESS) model was used to organize the estimated supply and demand equations into a price policy analysis model. Moreover, two GESS model options were developed, a deterministic and stochastic option. These two model options were used to analyze the effect of selected pricing policies and of world price volatility upon key economic variables.

The major results obtained from this study is first of all the experience on applying and manipulating economic concepts in the case of the Moroccan agricultural sector. Moreover, through the GESS deterministic model, under the policy option, zero input subsidy, the production increased for barley, lamb, chicken, and milk, for these commodities a producer gain in quantities by an overproduction with respect to the base year situation. The values of market surpluses for barley, lamb, chicken and milk are negative, which means that the producer monetary situation is not improved. The net monetary trade balances are positive for the above commodities leading to foreign exchange earnings if the surpluses will be for export. Soft wheat, hard wheat, corn, and beef present an excess demand showing a negative net physical trade balances. These commodities with an excess demand indicate that the demand prices are low with respect to those of base year. Under the policy option zero input subsidies, the government did not incur any cost, instead it saved the amount designed to the input subsidies. The net monetary trade balance and net monetary receipts both indicators show a deficit in their overall balance, but indicate a deficit reduction with respect to the base year policy.

Under scenario #2 the results may be considered as promising in terms of net physical and monetary trade balances than those of the base year policy for soft wheat, lamb, and milk. But, hard wheat, barley, corn, beef, and chicken show undesirable results, that is, production could not cover consumption. Their net monetary trade balances are negative indicating more deficit and appealing to import and need in foreign exchange. The overall net monetary trade balances and value of market surpluses, under this scenario #2, present more deficit than those of the base year policy.

The deterministic results obtained from the two policy options adopted, zero input subsidies on one hand, and wholesale prices equal to world prices coupled with zero input subsidies on other hand show different results with respect to the base year policy in which the government intervenes. Zero input subsidy policy indicates a promising result in terms of two policy indicators the total of the net monetary trade balances and the total of the value of market surpluses with respect to the base year and scenario#2 policies. Besides, the base year policy shows better results than those of scenario #2 in terms of two policy indicators the total of the net monetary trade balances and the total of the value of the market surpluses.

The GESS stochastic results were obtained by randomly generating the world prices, using normal distribution, and introduced into GESS model are measured by the coefficients of variations of 100 simulation runs for the commodities included in the GESS model. Under zero input subsidies the average of net physical trade balances of 100 simulation runs for soft wheat (M), hard wheat, barley, corn and lamb are negative so do their monetary trade balances. The volatility of world prices are high and has a depressing effect on the above commodities indicating a need in foreign exchange to cover the shortage in production for the mentioned commodities. However, soft wheat

(A), beef, chicken, and milk have a positive average net physical and monetary trade balances reflecting a promising result of these commodities and a gain in foreign exchange earning if the surpluses are designed for exportation. The overall average net monetary trade balances is negative meaning that there is a need in foreign exchange to cover the net monetary trade balance deficit.

Under the second policy alternative, wholesale prices equal to world prices combined with zero input subsidies the world prices volatility is measured by the coefficient of variation of the policy variable net physical trade balances, net monetary trade balances, value of market surpluses, and the domestic prices. The effect of this policy shows, in average, a positive net and monetary trade balance for soft wheat, lamb, and milk. A positive net monetary trade balance reflect an excess production in terms of monetary value and a gain in foreign exchange earnings, hard wheat, barley, corn, beef, and chicken present an excess demand and a negative net monetary trade balance. The negative net physical and monetary trade balance indicate that for the concerned commodities the production fall short and the excess demand should be covered by import appealing for the foreign exchange. The volatility of world prices is well expressed and high in net physical and monetary trade balance leading to the government interventions, especially in soft wheat for which a C.V is too large. The overall average net monetary trade balance is negative indicating a need in foreign exchange to cover the net monetary trade balance deficit. Therefore under this current policy the situation is worsened with respect to the base year situation since the deficit in monetary balance increases.

The world price volatility combined with two main policy alternatives (zero input subsidies, and wholesale equal to world price coupled with zero input subsidies) indicate that zero input subsidy policy gives a promising results since the overall average of the net monetary trade balance is greater than both those of scenario#2 and base year policy. Under secenario #2 the total of the averages of the net monetary trade balances shows that the balance is negative and the deficit increases with respect to the other policy alternatives. These results indicate that zero input subsidies policy is more promising that the base year and scenario#2 policies.

Method Limitations, and Future Research Possibilities

The GESS model is used to analyze the current agricultural pricing policy in Moroccan agricultural sector by considering selected agricultural pricing policies. From the analysis done some guidance for agricultural policy has emerged. The core of the GESS model is the partial equilibrium concept based on competitive equilibrium market as it is used in a variety of studies mentioned in the reviewed literature. Partial equilibrium theory is mainly based on Ceteris Paribus assumption. Moreover, in developing the GESS model we make use of the base year data to determine the supply and demand equations given supply and demand own and cross price elasticities. This approach will not lead to the exact same results as using directly estimated time series supply and demand equation, however the difference should be minimal and are more than compensated for by the computational advantage provided by the GESS framework. In addition, some elasticities, especially those of meat supply, used in GESS model, are those of the past studies done about Morocco. These also may be considered as a model limitation with respect to those elasticities all determined from the time series data of the agricultural commodities employed in the model. However the alternative when no data or estimates exist is to ignore the key commodities entirely.

The implementation of the results obtained from this study should be done with consideration of the quality of data. The data are a resultant of many sources, and may lack the degree of compatibility in definition sought. Nevertheless, the results obtained from this study give an indication about the agricultural pricing policy, its trend, and a guidance for policy formulation. However, all the model weaknesses should be taken into consideration.

Future research possibilities are an open question for which many possible answers exist. Considering the stage the model is, currently developed to additional actions that could be undertaken include: a) development of a simultaneous solution capability to determine self-sufficiency supply and demand prices for all commodities simultaneously; b) development of a stochastic domestic supply and demand prices component; and c) expansion of the model to consider multi-year forecasts and hence the analysis of the dynamics of pricing policy and stochastic variable.

A simultaneous solution for supply and demand prices will give a solution taking account of different interactions (substitution and complement effects) among commodities reflecting an equilibrium among different markets. Nevertheless, the reaction to the solution (self-sufficiency supply and demand prices) will depend on the level of the prices in agricultural sector. Accordingly, the prices might be distorted or might not represent the practical prices because these prices are computed by considering the agricultural sector by its self without introducing other sectors in the economy. As it is well known, the prices in agriculture sector depend on those of other sectors included in the Moroccan economy and vice-versa.

Stochastic domestic supply and demand prices will provide the price volatility effect on consumer, producer, government and the general welfare by considering the price fluctuations caused by the domestic market forces and weather. This option may show how the different markets react toward unexpected price variation measured by the price stochasticness.

Multi-year projection analysis would be a powerful tool for policy analysis. This tool could forecast the future of a policy formulation in agricultural commodity prices rather than having to rely on ad-hoc determination. Anticipating the outcomes, the results from a multi-year analysis will depend mainly on the quality of data. Nevertheless, the results may be better than unfounded price determination. Risk analysis method can be connected to GESS stochastic model in order to select the policy variables the most likely to happen.

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VITA

Ahmad Baijou

Candidate for the Degree of

Doctor of Philosophy

Thesis: A STOCHASTIC AGRICULTURAL PRICE ANALYSIS MODEL OF THE MOROCCAN AGRICULTURAL SECTOR

Major Field: Agricultural Economics

Biographical:

Personal Data: Born in Takhiamt, Aoufous, Errachiddia, Morocco, January 1, 1954. The son of Lahcen Baijou and Khadija bent Hammou.

Education: Graduated from Erfoud, Errachiddia High School, Errachiddia, Morocco, in June 1973) received Diplome D'Agronomie Generale from Institut Agronomique et Veterinaire Hassan II, Rabat, Morocco, in July, 1978; received Diplome D'AGronomie Engineer from Institut Agronomique et Veterinaire Hassan II Rabat, Morocco, in July, 1980; received Master of Science Degree in Agricultural Economics from Oklahoma State University, Stillwater, Oklahoma, United States of America, in May, 1989; completed requirements for the Degree of Doctor of Philosophy at Oklahoma State University, Stillwater, Oklahoma, United States of America, in December, 1990.

Professional Experience: Establishment of computer software package for management of Moroccan forest 1979 to 1980. Contribution in estimation of the timber volume of Ardenne forest in Belgium 1979 to 1980. In charge of the sampling survey; elaboration of the questionnaires, and data processing for Moroccan integrated agricultural development projects in the frame work of ex-post project appraisal and evaluation from 1980 to 1985. Build up of software packages serving for processing the integrated development project data to assess the efficiency of execution of the operations planned in the framework of Moroccan agricultural projects 1981 to 1984. Contribution in the development of a regional input-output model for Azilal province from 1984 to 1986. Contribution in a study concerning domestic agricultural commodities trade among Moroccan regions 1984 to 1986.

Elaboration of a sampling survey techniques for the integrated agricultural project in Morocco 1981 to 1985.