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An Empirical Analysis of Demand Interrelationships: An Application to Selected Agricultural Commodities in Venezuela

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AN EMPIRICAL ANALYSIS OF DEMAND INTERRELATIONSHIPS:

AN APPLICATION TO SELECTED AGRICULTURAL

COMMODITIES IN VENEZUELA

by

Hector Luis Mata Brito

A thesis submitted in partial fulfillment
of the requirements for the degree

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ABSTRACT

An Empirical Analysis of Demand Interrelationships: An

Application to Selected Agricultural Commodities in Venezuela

by

Hector L. Mata Brito, Master of Science

Utah State University, 1970

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Department: Agricultural Economics

The primary objective of this study was to develop demand equations

at retail for selected Venezuelan food commodities. Commodities included

for analysis were rice, refined sugar, crude sugar, flour, potatoes, beef,

pork, black beans, corn, and powdered milk.

The basic statistical technique employed in the analysis was least

squares multiple regression. Although several mathematical forms for these

demand equations were evaluated, a log-log transform was found to be most

useful. Independent variables included own price, prices of substitutes and

complements, time and income. Observations were taken from Venezuelan

time series data over the period 1945-1965.

Development of these basic demand equations facilitated the treatment

of a second objective which was to evaluate the degree of complementarity

and substitution between each one of the commodities included in the model.

Further, it provided the necessary structural framework to give <u>exante</u>

examination to selected policy alternatives for Venezuelan agriculture. Alternatives examined included minimum price and import policies.

Interesting results and conclusions may be summarized as follows:

1. Difficult statistical problems are encountered in an attempt to estimate direct and cross elasticities of demand from time series data.

2. A less general approach utilizing principles of demand theory is advisable until further requirements are made in the data series.

3. A consistent demand model does provide useful insights into the interrelationships of commodity demands in terms of direction of change in price and quantity if not in terms of their magnitude.

4. Regional and social stratification of price, income and consumption data should improve the reliability of any subsequent analyses.

5. Additional household expenditure surveys of a cross-sectional nature would provide useful and necessary checks on the demand estimates obtained from time series data.

(83 pages)

INTRODUCTION

Since 1958 the Venezuelan Government has worked intensively toward

the displacement of imports of agricultural commodities through expanded

domestic production (Ministerio de Agricultura y Cria, 1967, 1968). To

the extent that these efforts are successful it will save foreign exchange

which is necessary for the development of both the agricultural and the

industrial sectors.

What can be said of the prices which might prevail in the market

place once the displacement of imports has taken place, of the effects

on prices if Venezuelan agricultural output continues growing at the current

rate and if the imports of food become unnecessary? These are quite

important questions which planners must answer in order to set agricultural

policy. This thesis intends to explore (empirically) some implications

about these questions which may be of use to the Venezuelan economy.

Purpose of Study

The main purpose of this study was to develop retail demand equations

for the major food commodities within the Venezuelan economy. Knowledge

of the demand relationships at both the farm and retail level provides an

important tool for the formulation of policy and for decision-making in

general. However, only the retail demands were treated empirically in the present thesis because of data insufficiencies, especially that of obtaining prices received by farmers or marketing margins for selected commodities.

Objectives

1. To develop demand equations at retail level for selected commodities for the Venezuelan economy.

2. To give a statistical evaluation to the degree of complementarity and substitution between commodities included in the model.

3. To demonstrate possible applications of the demand model.

    a. To evaluate the impact on prices of an immediate reduction of certain imports of food commodities.

    b. To show the implied price distortion which could result if current rates of output expansion continue for five or ten more years, on those commodities under the minimum price policy.

    c. To obtain projections of retail prices for years beyond the period of fit, that is, for the years 1970 and 1975, and to evaluate their implication at the farm level if data permit it.

Many other applications can be made from the developed demand model. However, this study only considered those already mentioned.

Since the empirical work in this thesis was based entirely on secondary

data, the quality of the study was not measured by the rigor of the field work and data manipulations. Rather it depended on a concise delimitation of important problem areas and an application of the estimated demand model to provide useful information about these areas.

Source of Data

National time series data necessary for this thesis was obtained from the annual publications of the following institutions in Venezuela: Central Bank of Venezuela, Ministry of Agriculture and Ministry of Development. In addition to these sources, other international sources were used since it was possible to obtain data from them.

The period of time under study included the years from 1945 to 1965. This time period was chosen mainly because of the limited availability of annual data for years prior to 1945. For example, the most important and reliable source of information of Venezuela, Informe Economico del Banco Central de Venezuela (Banco Central de Venezuela 1964, 1965, 1966), has been systematically publishing information of its economy only since 1950. Nevertheless, it is possible to obtain estimates of certain series for the years prior to 1945.

The information concerning the years 1966 through 1970 was not included since they were not available at the time this study was started.

Method of Procedure

The retail model, such as it was developed by G. E. Brandow (1961), states that the per capita consumption of each food or food group is a function of the prices of each food, prices of consumer goods and services other than foods, disposable personal income per capita, and changes in tastes and preferences which may occur over time. The relationship between the variables of the model can be expressed symbolically in the following fashion

$$q_1 = a_1 + b_{11}p_1 + b_{12}p_2 + \ldots + b_{1n}p_n + b_{1h}P_h + b_{1y}Y + b_1t_j$$

$$q_2 = a_2 + b_{21}p_1 + b_{22}p_2 + \ldots + b_{2n}p_n + b_{2h}P_h + b_{2y}Y + b_2t_j$$

$$q_n = a_n + b_{n1}p_1 + b_{n2}p_2 + \ldots + b_{nn}p_n + b_{nh}P_h + b_{ny}Y + b_nt_j$$

$$Q_h = a_h + b_{h1}p_1 + b_{h2}p_2 + \ldots + b_{hn}p_n + b_{hh}P_h + b_{hy}Y + b_ht_j$$

where

q_1 through q_n = per capita consumption of n items or groups of items.

p_1 through p_n = retail prices of n foods or groups of foods.

P_h = an index of consumer prices of goods and services other than foods.

Q_h = an index of per capita consumption of non-food goods and services.

Y = disposable personal income per capita.

t = trend term which picks up the influence of those independent variables not included in the model, will include also taste and preference of the consumers.

If each of the variables of the model are expressed in logarithms, the coefficients are elasticities and can be interpreted as showing the percentage changes in quantities resulting from given percent change in prices or income.

Multiple regression analysis

Stepwise multiple regression technique was used to obtain initial estimates of the coefficients in the model from the Venezuela time series data. The following statistics derived from the regression analysis were used to test the significance of variables within the model

1. Regression coefficient, b's

2. Simple partial coefficients of determination, r^2

3. Multiple correlation coefficient, R

4. Standard error of b's.

In addition to the above mentioned criteria, a Durbin Watson Statistic was computed to test for autocorrelated disturbances in the model.

Since data were treated in the logarithmic form, the coefficients derived from the multiple regression technique provided estimates of the demand elasticities for all variables considered. The present study, in contrast to the study realized by Brandow (1961) attempted to use most of its own estimates of demand elasticities. However, this was not possible in several cases.

Two conditions derived from the consumer theory of demand for the demand elasticities were used as a consistency check on the estimates derived from multiple regression analysis. These two conditions are stated as follows:

1. The homogeneity condition. This condition states that if both money income and prices change in the same proportion, the quantity demanded will remain unchanged (Henderson and Quandt, 1958). From this condition we can write that the sum of the direct price elasticity, and the cross price elasticity and the income elasticity in each equation is zero when consumer's preferences are constant, that is

$$b_{11} + b_{12} + \ldots + b_{1n} + b_{1h} + b_{1y} = 0$$

2. The symmetry relation. This condition states that the substitution effect on the ith commodity resulting from a change in the jth price is the same as the substitution effect on the jth resulting from a change in the ith price (Henderson and Quandt, 1958).

Construction of the retail model

Construction of the retail model requires the estimation of the full set of price and income elasticities of demand. These include direct price elasticities, cross price elasticities for food, cross price elasticities for goods and services other than food, and finally, income elasticity.

1. Direct price elasticity is defined as a proportional change in the consumption of a given commodity with a given change in the price of the

commodity. The general formula for direct price elasticity when the variables are treated in log form is

$$Eii = \frac{(\log qi)}{(\log pi)} = bii$$

If the change in consumption is less than proportional to the change in price, the demand is inelastic. If the change in consumption is greater than proportional to the change in price, the demand is elastic. Finally, if the change in consumption is equal to the change in price, the demand is termed unitary.

2. The cross-price elasticity is defined as a proportional change in the consumption of a given commodity associated with a given change in the price of a different commodity. Since each of the variables of the model are expressed in logs, the regression coefficients of prices of pj provide an estimate of this elasticity. That is,

$$Eij = \frac{(\log qi)}{(\log pj)} = bij$$

Products with high and positive cross elasticities denote that they are strong substitutes. On the other hand, products with small positive cross-elasticities approaching zero are not close substitutes. Finally, products which have nearly equivalent direct and cross-price elasticity coefficients but of a different sign, indicate that they are complementary products.

In order to determine complementarity and substitution between the different commodities of the model, it is necessary to evaluate both direct and cross-price elasticities of demand.

3. Cross-price elasticity for non-food. The Venezuelan economy does not have a complete index of consumers' price of goods and services other than food. For this reason it will not be used directly in the analysis. Instead these non-food cross-price elasticities will be set, each one at a fixed proportion of the corresponding income elasticity (Frish, 1959).

4. Income elasticity may be defined as a proportional change in the consumption of a commodity with a given change in the income of the consumers. The general formula for income elasticity in log form is

$$\eta = \frac{(\log q_i)}{(\log l)} = b_{iy}$$

Income elasticity can be either positive or negative. A negative income elasticity indicates that consumption decreases with an increase in income. Commodities with these characteristics are termed inferior goods. Most commodities have positive income elasticity of demand. It was expected that most of the Venezuelan commodities used in the model would have high positive income elasticities.

Objective two was intended to evaluate the degree of complementarity and substitution between the commodities involved in the model. This objective was partially accomplished by evaluating both the direct and cross-price

elasticities of demand obtained from the multiple regression analysis. Once the direct and cross-price elasticities of demand were obtained, such as was already indicated in the analysis of objective one, the next step was to analyze the sign of the cross-price elasticity. If the sign of Eji is negative it implies that complementarity relationships existed between the commodities involved in the model.

On the other hand, a positive sign of Eji tells us that a substitution relationship exists between the various commodities. Commodities which are good substitutes have high and positive cross-price elasticity, while products with small cross-price elasticities approaching to zero are not close substitutes.

The analysis of this objective enabled us to know the effect of an increase or decrease in the price of a given commodity with respect to other commodities. That is, how much will the demand for corn or potatoes increase if the price of rice increases by a given percent.

Objective three attempted to demonstrate some applications of the complete demand model. In order to employ the model for forecasting or outlook work, it is necessary to have estimates of quantities to be disposed through commercial channels. The model was fitted using data for the period 1945 to 1965. Figures corresponding to the year 1945, 1950, 1955, 1960 and 1965 were used to test the predictive capabilities of the model.

This test and the application A, B, and C mentioned in the objectives

section above were analyzed using the following formula

$$[Q] = [b] \quad [P]$$

where

Q refers to the estimates of quantities to be disposed through the

market in the years 1970-1975.

b refers to the whole matrix of retail price elasticity coefficients.

P indicates the retail price.

This equation for price analysis may be rewritten in the following fashion

$$[P] = [b]^{-1} [Q]$$

The matrix [P] is treated as the endogenous variable while matrix [Q] was now assumed to be given exogenously. This formulation is accomplished in a manner analogous to that suggested by K. A. Fox (1968). Estimates of Q's for future years were taken from "Long Term Forecasts of the Supply and Demand of Agricultural and Livestock Products in Venezuela" (U.S.D.A., 1965). The matrix [b] estimated in the base period was inverted to provide conditional price estimates for projected years.

REVIEW OF THE DEVELOPMENT OF THE DEMAND CONCEPT AND
SOME CONSIDERATIONS IN THE DERIVATION OF THE
DEMAND CURVE FROM TIME SERIES DATA

Before attempting to derive demand elasticities from time series
data for selected Venezuelan agricultural commodities, it is necessary
to give a brief summary of the evolution of the theory of demand.

According to Professor Henry Schultz (1938), the statistical study of
demand was a creation of Professor Henry Moore. He attempted a statisti-
cal analysis of demand for various important commodities. Methods such
as the "relative changes" or "link relatives" and the "trend ratios" were
his own principle devised for handling time variables. On the other hand,
he is also known for being the first economist to derive statistical demand
curves and to measure the elasticity of demand for various commodities.

Augustin Cournot (1929) expressed the law of demand as being
that the sales or annual demand (D) is, for each article, a particular
function F(p) of the price p of such an article. In mathematical terms,
Cournot's law is

$$D = F(p)$$

A similar concept was developed independently by another Frenchman,
Jules Dupuit (1933) written during the 1840's.

Later on, Alfred Marshall defined the demand concept as follows:

The greater the amount to be sold, the smaller must be
the price at which it is offered in order that it may find
purchasers, or in other words, the amount demanded
increased with a fall in price. And again, the one uni-
versal rule to which the demand curve conforms is that
it is inclined negatively throughout the whole of its length.
(Marshall, 1920, p. 99)

In 1873, another Frenchman, Leon Walras (1900) expressed the demand

for a commodity as a function not only of its price, but also of all prices.

That is, purchasers will not buy a given commodity unless they know the

price of the commodity considered, as well as the prices of the related

commodities. This can be written in mathematical terms as follows

$$D = f(P_1, \ P_2 P_3 \ . \ . \ . \ P_n)$$

Where D refers to quantity demanded, P_1 the price of the commodity

considered and P_2 through P_n the prices of the related commodities.

In 1938, Henry Schultz, in his monumental study, stated that the

demand is not only a function of the price of the commodity in question but

also a function of the prices of related commodities, the size and distri-

bution of income and the period of time considered.

His law of demand can be expressed in the following fashion

$$Q = f(Y_1, \ Y_2, \ Y_3 \ . \ . \ . \ Y_n, \ R, \ t)$$

Where Q refers to the demanded commodity, Y_1 its own price, Y_2 through Y_n the prices of the related commodities, R the real income of the consumers and t, time. This catches the effects of all those factors which cannot be measured separately, but which change more or less slowly and smoothly.

In 1962, a book was written by Davidson, Smith and Willey. In their book, Economics: An Analytical Approach, they introduced a demand function similar to the one formulated by Henry Schultz 24 years ago. In mathematical terms, this demand function can be written as follows

$$Y = f(p_1, p_2 \ldots p_n, I, T)$$

This equation explains that the demand of the consumers for good number one is a function of its own price (p_1), the prices of the other goods $(p_2 \ldots p_n)$, the consumer's income (I), and his tastes (T). For example, the number of pounds of beef sold per year depends upon the price of beef (p), the price of pork (p), and the price of chickens (p), and so forth.

As has been seen, the quantity of a commodity is not only a function of price, but also of many other factors which directly or indirectly effect it. Factors relating the demand for selected agricultural commodities of the Venezuelan economy will be considered later in the next chapter.

Statistical Procedures

As it was already mentioned, the methods of the "relative changes"

or "link relatives", as sometimes it is called, and the "trend ratios", were

the main tools introduced by Moore (1914) for handling time variables.

These two methods, as well as the multiple correlation method, will be

briefly mentioned because of their influence on subsequent studies carried

out all over the world.

The method of relative change consists in finding the functional

relationship, not only between the absolute prices and absolute quantities,

but between the relative change in the price of the commodity and the

relative change in the quantity demanded.

Moore has explained the reasons why he selected this method in the

following words:

> By taking the relative change in the amount of the commodity
> that is demanded, instead of the absolute quantities, the
> effects of increasing population are approximately eliminated;
> and by taking the relative change in the corresponding prices
> instead of the corresponding absolute prices, the errors due
> to a fluctuating general price level, are partially removed.   If
> the observations should cover the period of a major cycle of
> prices, and the commodity under investigation should be a staple
> commodity . . . ., the above method of deriving the demand curve
> will give an extremely accurate formula summarizing the relation
> between variation in price and variation in the amount of the
> commodity that is demanded. (Moore, 1914, p. 69)

Using this method Professor Moore estimated for the first time the

demand curve for corn, hay, oats and potatoes.

The method of trend ratios consists of deriving the demand curve,

not from the absolute prices and corresponding absolute quantities, but from

the ratios of these prices and quantities to their respective trends.

The rationale of Moore's method, according to Professor Schultz,

rests on the following considerations:

> By taking the ratio of the actual (observed) prices to normal
> or trend prices, we eliminate, to a first approximation, the
> effect of the long term disturbing elements on the price of
> the commodity under consideration. Likewise by taking the
> ratio of the corresponding quantities to their trend, we
> eliminate approximately all the long time disturbing factors
> influencing the supply. (Schultz, 1938, p. 68)

Numerous economists, among them Edgeworth (1881), have considered this

method particularly useful for overcoming the main difficulties which lie in

the way of deriving statistical demand curves.

Before using the method of multiple correlation, Moore adjusted the

data for the influences of long term disturbing factors by the use of link

relatives or trend ratios. This adjustment enabled him to obtain an

appropriate expression for the demand functions.

As a first approximation, Moore selected a simple linear demand

function of the form

$$X_1 = \emptyset(Y_1 \ldots Y_n)$$
$$= a_o + a_{11}Y_1 + a_{12}Y_2 + \ldots a_{1n}Y_n$$

But if the simple linear function does not yield good results, he states,

we can do two things. First, we can include more factors in the hypothesis,

or, secondly, we can select a more general non-linear equation of the form

$$X_1 = \emptyset(Y_1 \ldots \ldots Y_n) = a_{oo} + a_{11}Y_1 + b_{11}Y_1^2 + \ldots \ldots + a_{12}Y_2$$
$$+ b_{12}Y_2^2 + \ldots \ldots + \ldots \ldots + \ldots \ldots + \ldots \ldots + \text{product terms}$$

Review of Literature

It is not the intention of this study to review all economic studies concerning demand analysis, but to choose a few which can be pertinent for the development of this thesis. Most of the literature herein reviewed will be concerned with studies carried out in the United States because of the unavailability of Venezuelan studies at the time this study was started.

The first study to be reviewed was made in 1938 by Henry Schultz. As he mentioned in the preface of his monumental study, demand functions were developed for sixteen agricultural commodities. Three out of sixteen were for Canadian agricultural commodities, and the rest for the United States. He derived two simple demand curves for each commodity. In the first case, he treated prices as the dependent variable. He experimented with the method of trend ratios, link relatives and multiple correlation to determine the effects of those methods on the elasticity of demand. Unadjusted and adjusted data were submitted to a parallel mathematical treatment. He analyzed demand curves in different ways. In the first, he considered the consumption of each of the sixteen commodities as a function of its own price and time; in the second analysis, he introduced income; and finally, he

expressed the demand for each commodity as a function of its own price,

prices of other goods, income and time. The Schultz study was based

on time series data. The time period under study was from 1875 to 1929.

The second study to be reviewed was made by Elmer J. Working

(1954). The study, initiated in 1946, had a major purpose of studying in

detail the economic factors which could affect the demand for meat. The

study was based on time series data and analyzed by standard methods of

multiple regression and correlation analysis. The following are the most

significant results obtained from that study: it was found that there were

differences between the short run and the long run elasticities of demand

for meat; that is, the demand in the short run at the retail level was found

to be somewhat inelastic, while in the long run, at the retail level, it was

found to be elastic. The second important result was that change in the

level of prices influence the demand for meat. Finally, it was found that

long-continued changes in real income affected the demand for meat more

than did equal changes which have persisted for shorter periods of time.

In addition to these conclusions, he found that the elasticity of demand for

beef and pork were not much different from unity. Quantity of meat

consumed, the general price level and the real income of the consumers

were the most important variables found by Working in his demand for meat

study.

In 1961 a study was made by G. E. Brandow at the Pennsylvania

Agricultural Experiment Station. In that study, the author reviewed all of

the better known demand analyses for food in the United States. His matrix

of elasticities and cross elasticities of demand was developed from these

analyses following suggestions given by Frish (1959). As he mentioned in

his study, most of the direct price elasticities of demand, as well as some

of the larger cross elasticities, were based on time series analysis. How-

ever, the smaller cross elasticities found in his matrix were estimated by

Brandow on an arbitrary basis (Fox, 1968).

The Brandow complete model includes five parts. The first one

deals with retail demand. The principal components of this part are the

direct price elasticity, cross-price elasticity for food or food groups,

non-food cross-price elasticity and income elasticity. The elements on

the major diagonal are direct price elasticities of demand. The second

part, derived from the retail model, deals with demand for domestic

food use at the farm level. The third part describes the demand at the

export and industrial level. The fourth part is a combination of the second

and the third. It shows total demand for food and cotton at the farm level

of marketing. Finally, the fifth part deals with demand for feed grains

and oilseeds. The Brandow model shows, for instance, that the direct

price elasticity for beef is -.95. This means that an increase in the price

of beef by 1 percent would reduce the consumption of beef by .95 percent.

It also shows that if the prices of the other 23 foods increased by 1 percent,

the consumption of beef would tend to increase .32490 percent. Finally, it

shows that a 1 percent increase in the price of all the 24 foods would reduce

beef consumption by .62510 percent. Another important conclusion reached

by Brandow is that if the price of all foods increased by 1 percent, consump-

tion of all foods decreased by .34137 percent. Cross elasticities of demand

for individual foods with respect to non-food prices were estimated by

Brandow at .33 percent of the corresponding income elasticity.

In 1965 a study titled "Long Term Forecasts of the Supply and Demand

of Agricultural and Livestock Products in Venezuela" was prepared by the

Consejo de Bienestar Rural de Venezuela under a contract with the Economic

Research Service of the U. S. Department of Agriculture. The main purpose

of this study was to establish projections of the importation demand for

the years of 1965, 1970 and 1975 for selected agricultural commodities.

Secondary objectives were to project growth of the Venezuelan economy

and finally, to project demand and supply for selected agricultural commod-

ities.

Two models were used in analyzing the twenty-two commodities

included in the above mentioned study. The first one used time series

analysis while the second one used the results of the national survey of

family income and expenses carried out in Venezuela in 1962. The first model

used the years 1945 to 1961 as the reference period with 1945 serving as the

base year. The data necessary for the second model was collected from the

whole country which was divided into eight homogeneous areas and the families

were stratified into three major groups; rural, intermediate and urban. A total

of 4,000 families was selected from the mentioned groups using a two-stage sampling technique. The least square method was used on the data collected from the sample. Income and price elasticity derived from log-log relationships were computed for both rural and urban zones. Little difference was found in the price elasticity of the two zones for products such as rice, powdered milk, natural milk, corn, black beans, etc. However, it was found that the rural zone had lower negative price elasticity than the urban zone for eggs, pasteurized milk, other beans, and beef. This means that an increase in the price of those commodities would tend to decrease consumption less in a rural zone than in an urban zone. Finally, products such as oats, potatoes, butter, cassava, fresh fish and domestic white cheese had lower negative price elasticity in the urban than in the rural zone. In this case, an increase in the price of those commodities would cause rural consumption to decrease more slowly than urban consumption. In the case of income elasticity just one product, crude sugar, had negative income elasticity, while the rest had positive income elasticities.

STATISTICAL ANALYSIS

As indicated in the introduction, multiple regression technique

was used on Venezuelan time series data to obtain estimates of the

elasticities of demand. The period under study was from 1945 to 1965.

This study did not include data prior to 1945 or after 1965 because of the

unavailability of these data at the time this thesis was begun.

Elasticities of demand were obtained for six Venezuelan agricultural

commodities. Commodities included were milled rice, refined sugar,

crude sugar, flour, potatoes, beef, pork, black beans, corn and

powdered milk. These commodities were selected not only because they

constitute the basic diet of the Venezuelan people but also because of their

increasing participation in the formation of the Venezuelan gross agricultural

product.

A Priori Variable Selection

A priori, variables will be apparent per capita consumption, retail

prices, disposable personal income per capita and time.

Apparent per capita consumption

In order to determine the annual apparent per capita consumption of

each of the ten commodities included, national figures relating to

domestic production were added to imports. The amounts which go in the

international markets were subtracted from that total. The resulting

figure, known as apparent consumption, was divided by the total population

for each year. Total per capita consumption was not used because of

existing difficulties in estimating the changes in inventories as well as

the amounts of crops which go for seed.

Retail prices

Retail prices for the ten agricultural commodities included in the

model are reported annually by the General Statistics Division of the

Ministry of Development. These retail prices for Caracas City were

taken because of the lack of data for the period 1945 to 1955. In other

words, retail prices for the whole country have been published by the

Ministry of Agriculture and Livestock only since 1956.

Disposable personal income per capita

This variable was obtained by dividing the national disposable personal

income of each year by the total population for each year. It was necessary

to estimate the figures corresponding to disposable personal income for the

period 1945-1949 because they were not directly available at the time this

study was begun. The rest of the figures were taken from the Compendio

Estadistico de Venezuela, Ministry of Development (1968).

Time

Trend term was included to account for possible changes in tastes, preferences, and range of choice.

Deflation Process

Before price series were submitted to the mathematical treatment, it was necessary to deflate the price series in order to put them in terms of a base value of the Bolivar. The deflating process is normally accomplished by dividing the price series by the consumer price index. In the present thesis, two price indices were used to deflate the price series. In the first case, the raw food price index was used to deflate the price series of the following commodities: potatoes, beef, pork and black beans. In the second case, a manufactured food price index was used in the process of deflating commodities such as rice, sugar, crude sugar, flour, corn and powdered milk.

The main reason why this deflating process was followed was because the Venezuelan economy does not have a usable consumer price index for the period under study.

The disposable income series was adjusted or converted into what is termed real income. This process was accomplished by dividing that series by the wholesale price index of Venezuelan economy. The adjustment in disposable income is ordinarily deflated by the consumer price index. However, this procedure was used because the Venezualan economy does not have a usable consumer price index for the full period.

Multiple Correlation Analysis of Demand

The model used in this study specifies that the quantities demanded

of each of the ten agricultural commodities is a function not only of the

price of each particular commodity as shown in Table 1, but also of the

prices of other commodities shown in Table 2, income shown in Table 3

and time. Commodity prices included as explanatory variables in this

study were milled rice, refined sugar, crude sugar, flour, potatoes,

beef, pork, black beans, corn and powdered milk. The general equation

used in each of the ten commodities was

$$\log Qi = a + b_{i1} \log p_1 + b_{i2} \log p_2 + \ldots + b_{in} \log p_n + b_{iy} \log Y$$

$$+ b_i \log b_j$$

where

   Qi = apparent per capita consumption

   p_i = retail prices of the ten commodities

   Y = disposable personal income per capita

   t = trend term (tastes, preferences)

Once the data were prepared, they were analyzed by the stepwise

multiple regression method. This method has the characteristics of

computing the multiple linear and non-linear regression in a stepwise manner,

inserting at each step either a forced variable or a program selected variable.

Table 1. Deflated retail prices

	Milled Rice Bs/Kgrs	Refined Sugar Bs/Kgrs	Crude Sugar Bs/Kgrs	Flour Bs/Kgrs	Potatoes Bs/Kgrs	Beef Bs/Kgrs	Pork Bs/Kgrs	Black Beans Bs/Kgrs	Corn Bs/Kgrs	Powdered Milk Bs/Kgrs
1945	0.85	0.75	0.83	0.74	0.88	1.44	2.66	0.59	0.37	9.53
1946	0.79	0.69	.86	.57	.67	1.62	2.08	.64	.47	8.69
1947	0.72	0.69	.82	.58	.55	1.57	2.08	.66	.43	6.72
1948	0.74	0.71	1.00	.67	.49	2.19	3.08	.91	.37	6.09
1949	0.77	0.72	.88	.53	.43	2.13	2.93	.63	.41	4.95
1950	0.71	0.71	.83	.52	.34	2.00	2.77	.57	.41	4.08
1951	0.75	0.69	.73	.50	.35	1.95	2.86	.64	.45	4.84
1952	0.99	0.70	.76	.62	.38	2.05	2.99	.72	.42	4.84
1953	1.00	0.69	.87	.54	.39	2.18	3.14	.65	.32	5.10
1954	0.94	0.66	.84	.50	.35	2.25	3.05	.68	.33	4.93
1955	0.94	0.66	.95	.53	.37	2.23	2.90	.69	.40	4.50
1956	0.83	0.64	1.14	.61	.42	2.10	2.85	.62	.37	4.17
1957	0.79	0.64	.94	.62	.38	2.19	2.94	.64	.35	4.31
1958	0.85	0.65	.98	.59	.56	2.21	2.93	.66	.32	4.16
1959	0.97	0.63	.89	.62	.41	2.44	2.86	.71	.37	3.95
1960	0.96	0.63	.90	.68	.38	2.64	2.96	.71	.40	4.08
1961	1.01	0.62	.82	.67	.43	2.64	2.88	.67	.45	3.97
1962	1.02	0.62	.94	.66	.33	2.71	2.91	.66	.39	3.92
1963	1.00	0.61	.96	.60	.39	2.47	2.87	.69	.38	4.15
1964	1.06	0.59	.97	.57	.39	2.21	2.72	.72	.43	4.01
1965	0.98	0.58	.96	.57	.34	2.31	2.75	.66	.38	4.37

Source: Based on publications of the General Statistics Division, Ministry of Development, Caracas, Venezuela.

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Table 2. Apparent per capita consumption of selected agricultural commodities

Years	Milled Rice (Kgrs)	Refined Sugar (Kgrs)	Crude Sugar (Kgrs)	Flour (Kgrs)	Potatoes (Kgrs)	Beef (Kgrs)	Pork (Kgrs)	Black Beans (Kgrs)	Corn (Kgrs)	Powdered Milk (Kgrs)
1945	4.04	9.03	11.45	13.71	3.33	13.18	2.98	5.84	69.00	1.42
1946	5.56	12.86	16.31	16.13	5.62	14.11	3.26	5.98	70.56	2.78
1947	10.54	12.73	16.93	19.99	6.57	12.99	3.23	6.05	71.39	3.91
1948	3.16	17.65	18.88	20.64	8.35	13.77	3.85	4.71	47.43	5.59
1949	5.57	19.34	17.31	18.60	11.65	14.16	4.85	6.46	69.65	6.00
1950	7.29	18.01	15.67	23.26	13.30	14.47	4.62	8.36	64.12	6.35
1951	7.57	19.03	15.55	24.90	13.54	13.45	3.77	8.44	62.89	5.14
1952	5.77	17.46	15.06	23.54	10.99	13.06	3.65	8.02	63.69	6.12
1953	5.76	20.94	13.79	24.29	11.24	13.40	4.03	8.43	58.97	6.42
1954	5.62	19.04	11.01	24.94	13.22	13.14	3.97	7.52	55.27	6.51
1955	4.39	24.32	11.29	29.90	11.59	13.37	3.73	7.10	51.66	6.79
1956	3.67	26.89	10.63	30.17	12.50	13.29	3.91	8.90	54.88	6.74
1957	4.06	13.50	10.04	25.91	17.41	14.37	4.26	8.80	51.21	7.14
1958	9.26	22.04	9.31	30.36	11.94	15.95	4.47	9.19	51.82	7.79
1959	9.53	34.24	7.60	24.10	14.66	16.44	4.48	7.15	46.92	8.15
1960	10.46	25.94	5.95	29.25	18.82	16.56	4.41	7.86	58.82	8.14
1961	8.68	28.30	5.87	31.99	10.75	17.64	4.14	5.74	59.67	7.75
1962	9.03	31.23	5.37	28.48	15.40	17.59	4.54	4.01	71.16	7.36
1963	10.61	28.29	5.43	30.95	13.64	18.05	4.47	4.31	52.84	7.44
1964	12.75	32.94	5.04	43.76	14.32	18.26	4.38	4.44	73.54	6.93
1965	14.86	38.31	5.26	44.60	15.46	18.48	4.10	4.28	64.39	7.75

Sources: Long term forecasts of the supply and demand of agricultural and livestock products in Venezuela. Data for 1945-1961 taken from respective tables or calculated from data provided in study. Data for 1962-1965 taken from Annuario Estadistico Agropecuario 1965.

Table 3. Per capita disposable income deflated by the wholesale price
index, 1945-1965

Years	Per capita Disposable Income[a]	Wholesale Price Index (Base: 1938=100)	Real Income
1945	1,060	124.5	851
1946	1,116	135.8	822
1947	1,168	154.1	758
1948	1,228	172.5	712
1949	1,292	172.3	750
1950	1,373	172.6	795
1951	1,422	179.9	790
1952	1,459	177.6	822
1953	1,532	172.0	891
1954	1,629	175.1	930
1955	1,653	177.1	933
1956	1,761	176.4	998
1957	1,849	172.0	1,075
1958	1,955	175.1	1,116
1959	2,238	176.2	1,270
1960	2,149	173.9	1,236
1961	2,143	176.9	1,211
1962	2,114	175.0	1,208
1963	2,244	177.3	1,266
1964	2,488	183.9	1,353
1965	2,581	189.0	1,366
1966	2,599		

Sources: Compendio Estadistico de Venezuela, Ministerio de Fomento.
a = estimated, 1945-1949.

In the first case, those variables considered important by the researcher are the first ones to enter the regression, while in the second case, the computer selects those variables which have the highest partial correlation with the dependent variables, as the next ones to enter the regression. This method is very useful for assessing the contribution of each independent variable.

Model Number One

In a first approximation, regression was computed on the non-linear model. The basic idea behind this approximation was to gain some knowledge about the data. In this regression no variables were forced.

At this stage, certain criteria such as the F value, multiple correlation coefficients and standard error of b's were used in order to test the significance of variables within the model. In addition, partial correlation elements and the Durbin Watson statistic was used in order to test for multi-colinearity and autocorrelation.

The F value is a statistical measure which gives the researcher an idea about the degree of association that exists between the variables within this type of model. It is commonly said that significant association exists if the F statistic obtained from the regression exceeds a predetermined critical tabular value. Otherwise, it is said that no significant association exists. In the first sets of regression, the predetermined critical tabular

values were $F(12, 8, .95) = 3.28$ and $F(12, 8, .99) = 5.67$. Since the F statistic obtained from the regression of milled rice, black beans and corn does not exceed the predetermined critical value, it can be concluded that no association exists between the variables in each of the mentioned regressions. On the other hand, regression on crude sugar, flour, potatoes and milk were significant at the 1 percent level. As can also be seen in Table 4, milled rice, black beans and corn showed the lowest multiple correlation coefficients, R, meaning that the proportion of variation of the dependent variable explained by the independent variables is low. The direct price elasticities on crude sugar, beef, and corn showed a positive sign. These results are at variance with contemporary demand theory. The rest of the commodities showed a negative own price elasticity. It was also found that the standard error of the b_{ii} is quite high. A coefficient is generally considered significant if its value is at least twice its corresponding standard error. In the present case, high values of the estimates of standard error may mean that the mathematical model is inadequate; that is, a linear or polynomial form may give a better fit.

On the other hand, estimates of income elasticities on crude sugar, flour, corn and powdered milk showed negative income elasticity. A negative income elasticity on crude sugar was also found in a study prepared in 1965 by the Consejo de Bienestas Rural de Venezuela under

Table 4. Model number one; non-linear model; regression coefficients and their statistics

Regression of	F Value	Multiple Correlation Coefficients	Direct Price Elasticities (bii)	Standard Error of (bii)	Income Elasticities (biy)	Standard Error of (biy)
Milled Rice	2.23	.77	-.0361	1.3516	1.9878	2.3220
Refined Sugar	5.34*	.88	-.5197	6.3374	.0166	1.4045
Crude Sugar	24.37**	.97	.3168	.4756	-.9750	.8313
Flour	10.20**	.93	-.1705	.3904	-.6466	.7849
Potatoes	25.07**	.97	-.1191	.2870	2.2410	.7226
Beef	4.38*	.86	.4735	.3093	.6228	.5209
Pork	5.12*	.88	-.1647	.3732	.6875	.4820
Black beans	1.40	.67	-.5460	.9233	.9428	1.7221
Corn	1.13	.62	.3508	.5104	-.4321	.9569
Powdered Milk	8.57**	.92	-.9584	2.0357	-.1180	2.2723

*Significant at .95 percent level.
**Significant at .99 percent level.

a contract with the Economic Research Service of the U. S. Department of Agriculture. The remaining commodities which showed negative income elasticities are not readily explained. It has been found that income elasticity for foods in the developing countries is quite high approaching to one. This conclusion, reached by John Mellor and others (1969), tends to confirm that the estimates of income elasticities for flour, corn and powdered milk are not valid. As in the case discussed before, the standard error of the income elasticities are also quite high and none of the coefficients on income are significant. Estimates of cross-price elasticity showed very large values and unexpected signs.

Those unexpected signs on direct price, cross-price and income elasticities of demand may be due to two factors. It may be due to a high degree of inter-correlation, meaning that the independent variables are themselves interrelated. In this case, the partial coefficients of correlation can give us an idea about the degree of inter-correlation between the independent variables. In order to handle this problem, the following criteria was used. Multicollinearity was considered to exist if correlation elements were greater than .70. Three out of seventy-eight unique correlation elements were found to be above the predetermined value. This indicated that a limited degree of inter-correlation existed between independent variables.

The other factor which may cause the unexpected sign is the so-called confounding factor. This case occurs when certain non-significant variables

are included in the model. This case can easily be seen in the present study where some variables contribute a low percentage in the explanation of the dependent variable.

In order to test for autocorrelated disturbances in the model, the Beta coefficients obtained from the stepwise regression were entered into the Durbin Watson statistic program to calculate the δ value. At the given level of significance and the appropriate sample size, N, a computed δ is indicative of positive autocorrelation if it falls below the critical value of K, and is indicative of negative autocorrelation if it exceeds the corresponding critical value of K'; if it falls between the two critical values, no evidence of autocorrelation is present (Fox, 1968). In this study, no autocorrelation was present at both .01 and .05 percent levels of probability with nine degrees of freedom. The Durbin Watson values varied from 1.98 to 3.11. The lower and upper limits for the critical value of K at 5 percent level of probability was (1.1524 - 3.3476), while both limits for the critical value of K at 1 percent level of probability was (0.7974 - 3.7025). As can be seen, in both cases the obtained δ values fell between the critical limits. This indicated that no significant autocorrelated disturbances were present in the model.

Model Number Two

Once the first set of regressions were analyzed, the next step consisted

of running a second set of regressions in which six variables were selected

as the first ones to enter the regression. Selected variables were time,

income, own prices, the two strongest substitutes and the strongest comple-

ment. The remaining variables were selected by the computer and brought

into the regression in accordance with the magnitude of their respective

partial correlation coefficients. At this stage, regressions were computed

in both linear and non-linear models. Some of the results obtained from

these models are shown in Tables 5 and 6 respectively.

An examination of the computed F values for the non-linear regression

model indicated that milled rice, black beans and corn were not significant

at either .95 or .99 level. This indicated that no significant association

existed between these variables. The critical values used were $F_1(14, 6,$

$.95) = 3.93$ and $F_2(14, 6, .99) = 7.48$. On the other hand, the same

commodities showed the lowest multiple correlation coefficient varying

from .48 to .51. This means that the proportion of variation of the

dependent variable explained by the independent variables is low. As in

the first regression, direct price elasticities were found to be positive

on crude sugar, beef, corn and powdered milk. Pork also showed a

positive direct price elasticity. Of the remaining direct price elasticities

just potatoes and black beans appeared to be significant with respect to their

standard error. The income elasticities for crude sugar, beef and black

beans were the only ones that appeared to be significant with respect to their

standard errors.

Table 5. Model number two; non-linear model; regression coefficients and their statistics

Regression of	F Value	Multiple Correlation Coefficients	Direct Price Elasticities (bii)	Standard Error of (bii)	Income Elasticities (biy)	Standard Error of (biy)
Milled Rice	2.47	.51	-.2681	.9620	1.5147	1.0208
Refined Sugar	10.23**	.81	-3.9439	2.5903	-.1784	.5405
Crude Sugar	49.06**	.95	.4683	.3200	-1.7684	(.3618)
Flour	12.63**	.84	-.5066	.3894	.4494	.4003
Potatoes	40.42**	.94	-.8383	.2259	.3368	.2973
Beef	11.56**	.83	.5129	.2193	.5533	(.1419)
Pork	9.66**	.80	.0542	.2212	.1744	.1513
Black Beans	2.21	.48	-1.4122	.6218	-1.4945	(.6567)
Corn	2.45	.51	.3585	.3111	.1942	.3344
Powdered Milk	24.03**	.91	.7843	.9503	1.4847	.8120

*Significant at .95 percent level.
**Significant at .99 percent level.

Table 6. Model number two; linear model; regression coefficients and their statistics

Regression of	F Value	Multiple Correlation Coefficients	Direct Price Elasticities (bii)	Standard Error of (bii)	Income Elasticities (biy)	Standard Error of (biy)
Milled Rice	3.35	.58	-.2644	7.2906	1.4201	.01287
Refined Sugar	8.46**	.78	-.5881	78.6376	.4399	.0207
Crude Sugar	39.97**	.94	.0187	3.7749	4.0757	.0063
Flour	12.83**	.84	-.4551	17.4508	-.5879	.0188
Potatoes	17.43**	.88	-.5402	5.6404	-1.7670	.0080
Beef	13.53**	.85	.0327	1.4189	.2734	.0044
Pork	7.00*	.75	.1503	.3747	.7326	.0014
Black Beans	1.58	.40	-.1406	5.4306	-.0224	.0082
Corn	1.95	.45	.3358	51.6458	-.3990	.0418
Powdered Milk	20.64**	.89	.4696	.1245	-1.3930	.0017

*Significant at .95 percent level.
**Significant at .99 percent level.

Similar results were obtained from the linear model. Regressions on milled rice, black beans and corn were not significant at .95 percent level of probability. Refined sugar, crude sugar, flour, potatoes, beef and powdered milk were found to be significant at .99 level of probability. Critical values used were $F_1(14, 6, .95) = 3.93$ and $F_2(14, 6, .99) = 7.48$. The multiple correlation coefficients varied from .40 to .75 indicating that the explained variability on the dependent variable explained for the independent variable was low. At this stage no multiple regression coefficients were found to be significant with respect to their standard errors. The income elasticities obtained from the linear model appear to be significant with respect to their standard errors. However, as was indicated above, the negative signs and extreme range on those values are not readily explained.

Cross-price elasticities computed on both linear and non-linear models showed high values and unexpected signs. For such reasons, no attempts were made to analyze them in detail. It was thought that the degree of multicollinearity existing between the independent variables, and more importantly, the problem of confounding, were probably responsible for these unexpected signs.

At this point, it is wise to say that the country of Venezuela is not a developed one. For such a reason it is assumed that its data are also underdeveloped. Some data are not available, while others are only for

recent years. This limitation on Venezuela's data directly affects the results obtained in this section.

Model Number Three

The next step in the development of this discussion consisted of running a new set of regressions, both linear and non-linear, in which own prices, income and time were selected to be the first ones to enter the regression, the remaining variables being selected by the computer in accordance with their partial correlation coefficients. The general equation for the linear model was

$$Qi = a + bi1p1 + biyY + bitj$$

while the general equation used in the non-linear model is indicated as follows

$$\log Qi = a + bi1 \log p1 + biy \log Y + bi \log tj$$

where

Qi = apparent per capita consumption.

pi = own prices of the ten commodities.

Y = disposable personal income per capita.

t = trend term.

As can be seen in Table 7, regression on crude sugar, flour,

Table 7. Model number three; non-linear model; regression coefficients and their statistics

Regression of	F Value	Multiple Correlation Coefficients	Direct Price Elasticities (bii)	Standard Error of (bii)	Income Elasticities (biy)	Standard Error of (biy)
Milled Rice	3.76	.39	-.3620	.1342	1.3545	.7142
Refined Sugar	18.34*	.76	-1.7826	.2435	.0131	.5383
Crude Sugar	92.59**	.94	.1943	.2904	-2.1983	.2039
Flour	28.86**	.83	-.3641	.1169	.3390	.2535
Potatoes	52.07**	.90	-.7463	.2663	-.1349	.3184
Beef	20.13*	.78	.3086	.1946	.5511	.1110
Pork	8.10	.58	-.4907	.2340	.0838	.1608
Black Beans	3.07	.35	-1.2363	.5931	-1.0052	.4048
Corn	3.45	.37	.6407	.2527	.2046	.2025
Powdered Milk	47.18**	.89	1.5218	.7609	2.3450	.5310

*Significant at .95 percent level.
**Significant at .99 percent level.

potatoes and powdered milk was found to be significant at . 99 percent

level of probability; that is, a high degree of association existed between

the variables included in the non-linear model. The critical F value at

. 99 percent level of probability was $F_1 (17.3, .99) = 26.87$. The multiple

correlation coefficient of the non-significant equations varied from . 35

to . 78. The critical F value at . 95 percent level of probability was

$F_2 (17.3, .95) = 8.65$. Regression equations on milled rice, pork, black

beans and corn indicated that a low degree of association existed.

Coefficients of regression on own prices for milled rice, refined

sugar, flour, potatoes, pork, and black beans appeared to be significant.

The standard errors of these estimates are approximately one-half or less

of their corresponding coefficient of regression. Coefficients on crude

sugar, beef, corn and powdered milk showed positive signs. These

unexpected signs may be due to multicollinearity and confounding factors

as indicated above.

At this point, no analysis will be made on cross-prices and income

elasticities of demand since they appeared to be in conflict with demand theory

and the Venezuelan reality. It was assumed that no autocorrelated disturbance

existed in the model. This was confirmed by the Durbin Watson statistics

test. The results on the linear model, as can be seen in Table 8, did

not vary significantly from prior results. For that reason, no additional

comment will be made on them.

Table 8. Model number three; linear model; regression coefficients and their statistics

Regression of	F Value	Multiple Correlation Coefficients	Direct Price Elasticities (bii)	Standard Error of (bii)	Income Elasticities (biy)	Standard Error of (biy)
Milled Rice	5.84	.50	-.3096	7.1387	1.0552	.2722
Refined Sugar	18.34*	.76	-.4249	68.5031	.0161	.0133
Crude Sugar	74.31**	.92	.0318	3.5734	-5.2318	.0041
Flour	24.83*	.81	-.2692	14.4232	-.1149	.0128
Potatoes	25.65*	.81	-.5694	5.9552	1.5664	.0089
Beef	23.31*	.80	.0111	1.2014	.6142	.0032
Pork	5.17	.47	.3707	.3987	-.2447	.0014
Black Beans	1.93	.25	-.1452	5.4458	-2.2968	.0050
Corn	2.83	.33	.6077	.3977	.2016	.0230
Powdered Milk	34.20**	.85	.5430	.1246	-.9751	.0017

*Significant at .95 percent level.
**Significant at .99 percent level.

After examining the results of the various regressions, it was thought that those ones obtained from the reduced model were the better ones. Estimates of direct price elasticities were obtained for milled rice, refined sugar, flour, potatoes, pork and black beans. Estimates of these commodities are shown in Table 9.

Estimates of direct price elasticities based on time series data were found to be greater than those obtained on cross-sectional data for the same commodities. The latter were obtained from a study conducted in Venezuela in 1965 by the Economic Research Service of the U. S. Department of Agriculture.

E. J. Working (1954), Geoffrey S. Shepherd (1963) and some other economists have pointed out that long run direct price elasticities are greater than those based on short run data.

Adaptation of the Model

Since usable estimates of cross-price, income elasticities, as well as estimates of direct price elasticities for crude sugar, beef, corn and powdered milk, were not obtained from the statistical analysis, it was decided to follow Brandow's approach. This approach consists of taking estimates of direct price, cross-price and income elasticities of demand from other studies. In order to accomplish this objective, three estimates of income elasticities for milled rice, refined sugar, crude sugar, flour,

Table 9.   Estimates of direct price elasticities

Commodities	Direct Price Elasticities	
	Time Series Data	Cross Sectional Data
Milled Rice	-.36203	-.21721
Refined Sugar	-1.78267	-.33708
Flour	-.36415	-.27640
Potatoes	-.74632	-.56158
Pork	-.49072	-.22944
Black Beans	-1.23637	-.47543

potatoes, beef, pork, black beans, corn and powdered milk, as well as estimates of direct price elasticities for crude sugar, beef, corn and powdered milk were taken from a study conducted in 1965 by the Consejo de Bienestas Rural de Venezuela, under contract with the Economic Research Service of the U. S. Department of Agriculture. The rest of the direct price elasticities for milled rice, refined sugar, flour, potatoes, pork and black beans were supplied by this study.

The food price elasticity matrix shown in Table 10 was constructed using the following steps: (1) direct price elasticities were assigned to the main diagonal of the table; (2) estimation of income elasticity for food; (3) computation of the cross elasticity for non-foods; (4) computation by the symmetric relation, the cross elasticities showing the effects of food prices on purchases of non-food goods and services.

The following procedure was used to estimate cross elasticities for foods. First, expenditure weights for each of the ten commodities, all food and non-foods, were computed. All food includes only the ten commodities; it does not include every food. That is the main reason why expenditure weight for all food is lower than the expenditure weight for non-foods. Once expenditure weights were computed, non-food cross-price elasticities were set each equal to .67 times the corresponding income elasticity. The value used to compute non-food cross-price elasticity, that is .67, was obtained by dividing non-food cross-price elasticity expenditure weight by

Table 10. Price and income elasticities of demand at retail: percentage changes in quantities demanded resulting from one percent changes in prices or income, 1945-1965

Quantities Demanded of	Retail Prices of					
	Milled Rice	Refined Sugar	Crude Sugar	Flour	Potatoes	Beef
Milled Rice	-0.36203	0.05969	0.01304	0.00684	0.00417	0.01433
Refined Sugar	0.10076	-1.78267	0.13390	0.18164	0.06491	0.37559
Crude Sugar	0.05136	0.11323	-0.95554	0.09089	0.03326	0.18784
Flour	0.00026	0.00058	0.00039	-0.36415	0.00206	0.00170
Potatoes	0.02089	0.04600	0.03119	0.04939	-0.74632	0.07380
Beef	0.00018	0.00041	0.00027	0.00044	0.00014	-0.37622
Pork	0.00818	0.01805	0.01223	0.01938	0.00649	0.03997
Black Beans	0.05428	0.11966	0.08111	0.12845	0.04306	0.26456
Corn	0.02267	0.05002	0.03391	0.05370	0.01801	0.11059
Powdered Milk	0.00305	0.00672	0.00455	0.00723	0.00241	0.01488
Expenditure Weights	0.00664	0.01463	0.00992	0.01571	0.00527	0.03235

Quantities Demanded of	Retail Prices of						
	Pork	Black Beans	Corn	Powdered Milk	All Foods	Non Foods	Income
Milled Rice	0.00577	0.00827	0.04101	0.00237	-.20654	.08286	.12368
Refined Sugar	0.13284	0.06576	0.34122	0.06051	-.32554	.13060	.19494
Crude Sugar	0.06681	0.03538	0.18244	0.03041	.16392	-.06576	-.09816
Flour	0.00168	0.00235	0.00644	0.00050	-.34819	.13969	.20850
Potatoes	0.02655	0.01525	0.07809	0.01201	-.39315	.15773	.23542
Beef	0.00654	0.00137	0.00099	0.00084	-.36504	.14645	.21859
Pork	-0.49072	0.01432	0.07115	0.00426	-.29669	.11903	.17766
Black Beans	0.09268	-1.23637	0.15642	0.03066	-.26549	.10651	.15898
Corn	0.03895	0.01534	-0.62262	0.01394	-.05165	.02072	.03093
Powdered Milk	0.00523	0.00210	0.01085	-0.43033	-.37331	.14977	.22354
Expenditure Weights	0.01133	0.00449	0.23590	0.00525	0.12923	0.87077	1.00000

all food expenditure weight, as in Brandow's study (1961). Once the direct
price elasticity, non-food cross-price elasticity and income elasticity were
computed for each row, the total of the food cross elasticities for each row
could be found; since the sum of all coefficients in each row should be
equal to zero (the homogeneity condition), the sum of the food cross-
elasticities in each row was designated Ri. That is, direct price elasticity
+ non-food price elasticity + income elasticity + Ri = 0. Hence, Ri = direct
price elasticity - non-food cross-price elasticity - income elasticity.

The individual cross-price elasticities in the first column were obtained
using the following procedure. The expenditure weight for each commodity
was multiplied times the number of commodities being analyzed. The
resulting figure known as the weighted mean was multiplied times the ratio
between the individual residual (Ri) and the summation of the total residuals
$(\sum_{c=1}^{10} Ri)$. In this manner, individual cross-price elasticities were chosen so
that their values were in proportion to the Ri and their weighted sum was the
desired amount. Once the first column was completed, the symmetric relation
was used to calculate the coefficients in the first row. Individual cross-price
elasticities in the second column were obtained using the same procedure.
Likewise, row two was computed by symmetry. Repetition of the column-
row steps completed Table 10 (Brandow, 1961).

SELECTED APPLICATIONS OF THE DEMAND MODEL

In accordance with objective three, this section gives discussion to some potentially useful applications of the demand model. However, before any applications were made it was considered necessary to give some assessment or to test the predictive capability of this model. This test and the applications described below were addressed to the three parts of objective three. Specifically these were to

a. Evaluate the impact on prices of a reduction of certain imports of food commodities.

b. Show the implied price distortion which could result if current rates of output expansion continue for five or ten more years on those commodities under the minimum price policy.

c. Obtain projections of retail prices for years beyond the period of fit, that is, for the years 1970 and 1975, and to evaluate their implication at the farm level if data permit it.

A graphic illustration of these applications are shown in Figure 1. Line segments DD and SS represent the estimated demand and supply schedules respectively for any one of the ten commodities. Line segment $S_1 S_1$ depicts a possible import reduction on black beans, corn and powdered milk. A reduction in the supply available for consumption for two other commodities included on the minimum price policy; that is,

black beans and corn are also represented by $S_1 S_1$. Given a typical demand

relationship these supply reductions will bring about price increases. Finally,

line segment $S_2 S_2$ represents possible supply increases for milled rice and

potatoes which may result from the minimum price policy. These supply

increases will cause price decreases. In the analysis which follows, per-

centage changes in supply and price in applications A and B are relative

to the supply estimates obtained from U.S.D.A. and to projected prices

which are consistent with these projected supply estimates. Comparisons

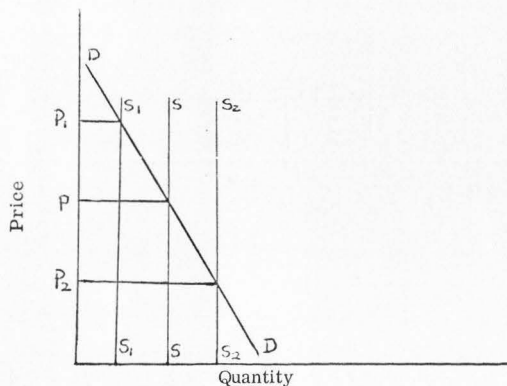are made in each of the two projected years, 1970 and 1975.

Figure 1. Graphic presentation of Applications A and B.

Equations Used in Objective Three

The basic formulation of the demand model was expressed symbolically

in the following fashion

$$q_1 = a_1 + b_{11}P_1 + b_{12}P_2 + \ldots + b_{1n}P_n + b_{1h}P_h + b_{1y}Y + b_1 t_j$$

$$q_2 = a_2 + b_{21}P_1 + b_{22}P_2 + \ldots + b_{2n}P_n + b_{2h}P_h + b_{2y}Y + b_2 t_j$$

$$q_n = a_n + b_{n1}P_1 + b_{n2}P_2 + \ldots + b_{nn}P_n + b_{nh}P_h + b_{ny}Y + b_n t_j$$

where

q_i through q_n = per capita consumption of n items or groups of items

P_i through P_n = retail prices of n foods or groups of foods

P_h = an index of consumer prices of goods and services other than foods

Y = disposable personal income per capita

t = trend term which includes taste and preferences of consumers as

well as the influence of those variables not included specifically

which may be changing with the passage of time

The above relationship may be rewritten in matrix algebra notation

as follows

$$
\begin{bmatrix} Q_1 \\ Q_2 \\ \cdot \\ \cdot \\ Q_n \end{bmatrix}
=
\begin{bmatrix} b_{11} b_{12} \cdots b_{1n} \\ b_{21} b_{22} \cdots b_{2n} \\ \cdot \quad \cdot \quad \quad \cdot \\ \cdot \quad \cdot \quad \quad \cdot \\ b_{n1} b_{n2} \cdots b_{nn} \end{bmatrix}
\begin{bmatrix} P_1 \\ P_2 \\ \cdot \\ \cdot \\ P_n \end{bmatrix}
+
\begin{bmatrix} b_{1y} & b_1 \\ b_{2y} & b_2 \\ \cdot & \cdot \\ b_{ny} & b_n \end{bmatrix}
\begin{bmatrix} Y_1 Y_2 \cdots Y_{21} \\ T_1 T_2 \cdots T_{21} \end{bmatrix}
$$

or in a more general formula

$$[Q] = [b][P] + [c][YT]$$

where

 [Q] is a matrix of quantities

 [b] is a matrix of demand elasticities

 [P] is a matrix of prices

 [c] is a matrix of income elasticity and trend term coefficients

 [YT] is a matrix of income and time

 The latter equation was solved for the vector [P] , relying on the reversability of the demand relationship (Fox, 1968).

$$\hat{[P]} = [b]^{-1} [Q] - [c] [YT]$$

 This form of the equation was used in each of the applications described in objective three.

Predictive Capabilities of the Model

 Price and quantity data for all ten commodities corresponding to the years 1945, 1950, 1955, 1960 and 1965 were selected for this purpose. Operations necessary to evaluate [P] under alternative supply condition [Q], plus adjustments for income and time [YT] were performed in an IBM 360-44 computer. Results suggested that the model didn't predict satisfactorily; that is, the predicted values for prices for the years 1945, 1950, 1955, 1960 and 1965 were substantially less than the observed values in seven of the ten commodities.

It was thought that this lack of predictive capability was due to the following factors. First, since Brandow's approach was followed, estimates of income elasticities for the ten commodities, as well as estimates of direct price elasticities for crude sugar, beef, corn and powdered milk were taken from the U. S. Department of Agriculture (1965). This information, in addition to our own estimates of direct price elasticities, enabled us to compute cross-price elasticities. This synthetic technique obviously increased the error in prediction. The second and more important factor may be attributed to the interaction between disposable personal income per capita and time which was .94. Since the income elasticities of demand were taken from the U. S. Department of Agriculture (1965), the trend term estimated in the statistical model which also included income as an explanatory variable, didn't take full account of the loss in explanatory power between these statistical estimates of the income elasticities and those which were incorporated into the model from independent studies.

Given these circumstances, the following adjustment was employed

$$[Q] \quad - \quad [b] \quad [P] \quad + \quad [c] \quad [YT] \quad = K$$

where demand and income elasticities were taken from Table 10. Hence

$$[\hat{P}] \quad = \quad [b]^{-1} \quad [Q] \quad - \quad [c] \quad [YT] \quad - \quad [K]$$

where

$$K = \quad [a] \quad + \quad [R]$$

[a] is a matrix of intercept coefficients

[R] is a matrix of residuals

K was calculated for the most recent year, 1965, and combined with a composite of the intercept, trend and income terms in the projection work. In order to do this it was necessary to assume that this part of the unexplained variability (R) was not random, but had consistent sign and magnitude over the period of analysis and projection. Some alternatives to this procedure include a simple regression of price and quantity or of an annual estimate of K on time. However these alternatives were not pursued because of a less desirable economic basis in the first case and because of time and budget limitations in the latter.

Application A

Evaluation of the impact on prices of an immediate reduction of certain imports of food commodities

It has been a main concern of the Venezuelan Government to become self-sufficient in agriculture. Controls on imports have been used in an effort to stimulate domestic production of pork, dairy products and eggs. However, commodities selected for this analysis were black beans, corn and powdered milk. These commodities were selected because they are considered basic foods in the Venezuelan diet. Further, a large proportion

of corn and black bean production comes from its smaller subsistence farms where productivity is low. Every year large quantities of black beans and corn must be imported to meet domestic demand. To the extent that import restriction increases agricultural prices and incomes, some increase in domestic production can be expected from these farms.

Given the demand model, Application A in objective three was accomplished by reducing the assumed level of imports for the years 1970 and 1975. Impact on commodity prices associated with these exogenously induced import changes provided the focal point of interest.

Any government policy which restricts imports will have some effect on consumer prices. In the short-run this policy will cause an increase in consumer prices while in the long-run, prices should tend to decrease if the volume of domestic production increases by a sufficiently large amount. In the short-run the policy of import reduction will save some foreign exchange necessary for the development of both the agricultural and the industrial sectors. However, the ultimate advisability of such import restriction rests on the extent to which comparative production advantage may be developed within the country.

Procedure

Projected quantities of commodities subject to the import experiment were obtained using the following procedure. First, the import percentage

of the estimated total supply available for consumption in 1970 and 1975

was calculated from the U. S. Department of Agriculture (1965). Second,

imports for these years were assumed to be reduced by 20 percent and 45

percent respectively. Finally, the import portion of supply available per

capita was multiplied times the proposed reduction for 1970 and 1975.

This reduction was subtracted from the estimated per capita supply avail-

able for consumption for those years. Table 11 shows this projected

per capita supply available for consumption as well as predicted prices

for black beans, corn and powdered milk which were associated with these

quantities.

Table 11. Projected per capita supply available for consumption and
predicted prices for selected commodities for the years 1970
and 1975

Commodities	1970		1975	
	(Kgrs)	(Bs/Kgrs)	(Kgrs)	(Bs/Kgrs
Black beans	9.54	.37	8.77	.45
Corn	61.83	.39	57.14	.45
Powdered Milk	13.65	.28	12.62	.49

Sources: Long term forecasts of the supply and demand of agricultural
and livestock products in Venezuela. Projections calculated
from data provided in the study.

Predicted prices obtained for black beans, corn and powdered milk

for the years 1970 and 1975 were compared with those obtained without

import reduction.

It was found that the proposed reduction of 20 percent and 40 percent on import of black beans for years 1970 and 1975 will increase prices by a 5.71 percent and 15.38 percent respectively with respect to prices obtained for the same commodities without import reduction. On the other hand, quantities of black beans decreased by 4.41 percent and 10.23 percent during the same period.

Predicted prices for corn will increase by an 11.43 percent and 32.35 percent respectively. These price increases were associated with 5.28 and 13.28 percent decreases in supply for the same years.

The predicted price of powdered milk increased by 21.74 and 53.12 percent respectively during the same two years. These price increases were associated with 7.52 and 17.14 percent decreases in supply.

These predicted prices may appear to be too low, especially that of powdered milk. This becomes obvious if we compare its observed per unit price of 4.37 Bolivars, in 1965, with the predicted price of .28 cents in 1970. However, these results may be entirely reasonable since the per capita supply available for consumption in 1970 and 1975 was estimated by the U.S.D.A. study (1965) to increase by 298.00 and 267.00 percent respectively.

Given these results, it appears that the impact of import reduction is entirely consistent with demand theory. That is, given a typical demand relationship, as supply of a commodity shifts to the left (import reduction)

its price will increase. The extent of this price increase depends on the quantity elasticity within the prevailing range of price and quantity for that commodity.

Application B

This application was intended to show the implied price distortion which could result if current rates of output expansion on milled rice, potatoes, black beans and corn continue for five or ten more years. These commodities have been under the minimum price policy since 1961 (Stredel, 1969). One of the main objectives of this policy was to stimulate domestic production of those commodities considered as basic to the Venezuelan diet. Considerable effort has been made by the Venezuelan Government in order to move toward self-sufficiency in those products under the minimum price policy. The government is providing and improving existing facilities for agricultural credit, transportation, and marketing. Productivity and future land use for agricultural production will depend largely on the emphasis placed by the government on specific crops. An effective minimum price policy which results in efficient import substitution provides an important means of supplying this emphasis. However, evidence provided by United States agriculture illustrates that retention of a minimum price policy in the face of rapidly expanding agricultural output may be ill advised.

Procedure

Projected quantities to be available for consumption for the years 1970

and 1975 of those commodities under the minimum price policy and subject

of this analysis were obtained using the following procedure. First, an

annual rate of growth for each of the four commodities was calculated as

indicated in Appendix A. Results show that milled rice and potatoes grew

at an annual rate of 6.39 and 7.46 percent respectively during the period

1945-1965. On the other hand, it was found that black beans and corn

experienced a negative annual rate of increase of 1.48 and 0.33 percent

respectively during the same period. Once these annual rates of growth

were found, the next step consisted of a projection of the total supply

available for consumption for the years 1970 and 1975. It is important to

note that these figures may be underestimated since the rate of growth

in domestic production is greater than the rate of growth in total supply

available for consumption. Table 12 shows projected per capita supply

available for consumption as well as predicted prices for milled rice,

potatoes, black beans and corn for the years 1970 and 1975.

As indicated in Table 12, predicted prices for milled rice were found

to be 84.67 percent below the prices which would result if U.S.D.A. supply

estimates are realized in 1970 and by 93.42 percent below estimates based

on their figures for 1975. This reduction may be attributed to supply

Table 12. Projected per capita supply available for consumption and
predicted prices for selected commodities under the minimum
price policy for the years 1970 and 1975

Commodities	1970		1975	
	(Kgrs)	(Bs/Kgrs)	(Kgrs)	(Bs/Kgrs)
Milled Rice	20.08	0.44	27.66	0.20
Potatoes	22.19	0.23	32.13	0.16
Black Beans	3.97	0.64	3.66	0.71
Corn	63.43	0.34	62.17	0.34

Sources: Long term forecasts of the supply and demand of agricultural
and livestock products in Venezuela and Anuario Estadistico
Agropecuario, 1966.

increases which exceed those of the U.S.D.A. by 94.95 and 163.42 percent

respectively for the years 1970 and 1975.

Potatoes also showed reductions in predicted price of 37.84 and 60.00

percent for the same two years. This reduction in predicted prices may

be attributed to supply increases which exceed those of the U.S.D.A. by

38.68 and 89.00 percent respectively for the years 1970 and 1975.

Predicted prices for black beans showed increases of 82.86 and 82.05

percent respectively for the years 1970 and 1975. These increases in

predicted prices may be attributed to decreases in supply which were 60.22

and 62.54 percent below the estimates of supply provided by the U.S.D.A.

for 1970 and 1975.

Finally, predicted prices for corn for the same years were

less than U.S.D.A. estimates by 2.86 percent in 1970. In 1975, the two

estimates were identical. Estimates of supply were 2.83 and 7.44 percent

below the estimates of the U.S.D.A. for 1970 and 1975.

As in Application A, the results obtained for milled rice, potatoes

and black beans were entirely consistent with demand theory. That is,

for a given typical demand relationship, as supply of a commodity shifts

to the right (milled rice, potatoes), its price will decrease. Conversely,

as supply shifts to the left (beans) the price of that commodity should

increase. One exception to this was found in the price response of corn.

In 1970 a 2.83 percent reduction in supply was accompanied by a 2.86

percent decrease in price. Similar results were obtained in 1975 when

a 7.44 percent reduction in supply was accompanied by a no percent

change in price. A rationale for this exception may be provided by giving

consideration to the inclusion of cross effects in the model. That is, it is

possible that the rather large increases in supply of other commodities

which are adequate substitutes for corn results in their substitution for

corn.

As in Application A, for milled rice, black beans and potatoes, the

extent of the price change will depend upon the quantity elasticity within

the prevailing range of price and quantity for those commodities.

Application C

The main purpose of this application was to give assessment to possible

retail prices which will prevail in Venezuelan markets if the per capita supplies of selected commodities as projected by the U.S.D.A. study (1965) are realized in 1970 and 1975.

The above mentioned study projected per capita supply available for consumption for the indicated years; however, it didn't show probable market clearing prices. Figures shown in Table 13 were used in the demand model for this purpose. They were taken from the respective tables in the U.S.D.A. study or calculated from data provided in that study.

The procedure used to predict probable prices was exactly the same as was used previously in testing the model and in predicting price change in applications A and B. Therefore results will be presented without elaboration of procedure.

Predicted prices for the ten commodities for the years 1970 and 1975 are shown in Table 13. There is no way to know whether or not these prices will prevail in the market place for the designated years. It is possible that these prices underestimate or overestimate the real prices. However, given the demand model, these prices are consistent with per capita supply as projected by the U.S.D.A. study (1965) for the years 1970 and 1975.

Table 13. Projected per capita supply available for consumption and predicted prices for the years 1970 and 1975

Commodities	1970 (Kgrs)	1970 Bs/Kgrs	1975 (Kgrs)	1975 Bs/Kgrs
Milled Rice	10.30	2.87	10.50	3.04
Refined Sugar	31.93	0.63	27.93	0.73
Crude Sugar	4.68	1.00	4.36	1.10
Flour [1]	39.27	1.04	44.09	0.96
Potatoes	16.00	0.37	17.00	0.40
Beef	20.97	1.78	21.23	1.89
Pork	4.60	2.40	4.92	2.38
Black Beans	9.98	0.35	9.77	0.39
Corn	65.28	0.35	67.17	0.34
Powdered Milk	14.76	0.23	15.23	0.32

[1] The conversion coefficient of wheat to flour which was used is 0.70 which appears for Venezuela in the publication, "Coefficients of Normas", FAO, Rome, 1958.

Sources: Long term forecasts of the supply and demand of agricultural and livestock products in Venezuela. Data for 1970-1975 and projections taken from respective tables or calculated from data provided in the study.

A part of Application C under objective three was concerned with making some inferences about farm level prices based on the results obtained for retail prices in Applications A and B. It was not possible to make a complete quantitative evaluation of these implications at the farm level since usable series of producer prices could not be obtained.

It was thought that a suitable alternative to direct estimation of the farm level demand might be provided by incorporating margin estimates determined in independent studies. In exploring this possibility, a study by the Facultad de Economica of the Instituto de Investigaciones Economicas, (1969) was located in which a technique for estimating margins was discussed using cross sectional data from the Andes region. These margins were calculated at different levels of the marketing channel; that is, between producer-wholesaler, retailer-wholesaler and producer-retailer levels. The margin between the producer-retailer level was considered the most important one for the purpose of this analysis. Between these two levels in the marketing channel, margins were calculated for twenty-five agricultural products. The margins for four of the ten commodities considered in this thesis were available from that study.

These margins may be misleading for the following reasons. First, only regional estimates were available. Second, they were calculated at one point in time and therefore associated with one level of quantities and prices. Third, reliability of the data source may be questioned since these

data were obtained from "Camioneros", wholesalers and retailers. In

many cases a truthful answer by these individuals could have been

detrimental to their business interests since knowledge of their operations

could encourage both competition and governmental scrutiny. However,

this is the only available information on margins which will permit

inferences about prices at the farm level as they may be influenced by

changes in prices at the retail level.

Inferences of this type were drawn for the four commodities included

in the current study for which estimates of the margins were available.

In order to accomplish this, it was necessary to assume that such

margins were a constant proportion of their respective retail price.

Margins taken from the independent source were as follows: crude sugar,

21 percent; potatoes, 58 percent; black beans, 45 percent; and corn, 73

percent.

Results obtained for black beans and corn using margins with

Application A (import experiment), indicates that producers will get

approximately 6.28 and 5.87 percent of the increases in retail prices for

1970 and 17.79 and 14.34 percent respectively for the increases in retail

prices for the year 1975. On the other hand, analysis made by applying

margins to Application B (minimum price) for potatoes, black beans and

corn indicates that producer prices for potatoes and corn may be reduced

by 15.89 and 0.77 percent respectively for the year 1970 while prices for

black beans may increase by 45.57 percent during the same year. Finally,

producers may experience a reduction in the potato price of 25.20

percent in 1975. An increase in the producer prices of approximately

45.13 percent may be expected on black beans during 1975. No increase

is indicated for the price of corn at the producer level in 1975 since the price

at retail level was not affected by the minimum price policy.

SUMMARY AND CONCLUSIONS

Objectives of this study were to develop demand equations at retail

level for selected commodities for the Venezuelan economy; to evaluate

the degree of complementarity and substitution between each one of the

commodities included in the model; to evaluate the impact on prices of an

immediate reduction of certain imports of food commodities; to show the

implied price distortion which could result if current rates of output

expansion continue for five or ten more years on those commodities

under the minimum price policy; to obtain projections of retail prices

for years beyond the period of fit, that is, for the years 1970 and

1975, and to evaluate their implication at the farm level if data permit it.

Time series data were used to obtain estimates of direct price

elasticities. The period under study included the years from 1945 to 1965.

This time period was chosen mainly because of the limited availability

of annual data for years prior to 1945. Information concerning the years

from 1966 through 1970 was not included since they were not available

for all commodities treated at the time this study was begun.

Data used in this study were gathered from the annual publications

of the Ministry of Development, the Ministry of Agriculture and Livestock,

and the Central Bank of Venezuela.

Commodities included in this study were milled rice, refined sugar, crude sugar, flour, potatoes, beef, pork, black beans, corn and powdered milk. Milled rice, potatoes, black beans and corn were included because they have been the object of a minimum price policy. Black beans, corn and powdered milk were included because of their relative importance as imported commodities.

Data were analyzed using a stepwise multiple regression technique. This technique was applied on both linear and non-linear models.

Estimates of direct price elasticities were obtained from the statistical analysis for milled rice, refined sugar, flour, potatoes, pork and black beans. No usable estimates of direct price elasticity were obtained for crude sugar, beef, corn and powdered milk.

Estimates of cross-price and income elasticities showed unexpected signs and extreme range on their values. In most cases, they contributed only marginally to the R^2 of the model and with but few exceptions, their regression coefficients were found to be statistically non-significant.

Multicollinearity provided no serious problems except between the time and income variables. This correlation was .94.

In tests at both .95 and .99 percent level of probability, no evidence of autocorrelated disturbances was found to be present in the model.

Brandow's approach to demand estimation and projection was followed. This approach consists of taking elasticity estimates from independent studies in addition to the ones developed in the present study.

These are used to construct a complete matrix of elasticities for impact and projection of commodity prices or consumption.

Results obtained from the initial test showed that the model didn't predict satisfactorily; that is, the predicted values for prices for the years 1945, 1950, 1955, 1960 and 1965, were substantially less than the observed values for seven of the ten commodities. This lack of predictive capability may be attributed to the interaction between disposable personal income per capita and time which was .94. Since the income elasticities of demand were taken from the U. S. Department of Agriculture study (1965), the trend term estimated in the statistical model which also included income as an explanatory variable didn't take full account of the loss in explanatory power between these statistical estimates of the income elasticities and those which were incorporated into the model from independent studies.

Given the above circumstances, an adjustment was made which consisted in subtracting a constant (K) from the equation solved for the vector [P] . The constant (K) was calculated for the most recent year, 1965, and combined with a composite of the intercept, trend and income terms in the projection work. In order to do this it was necessary to assume that this part of the unexplained variability (R) was not random, but had consistent sign and magnitude over the period of analysis and projection.

It was found that predicted prices for black beans, corn and powdered

milk may increase by 5.71, 11.43 and 21.74 percent respectively with respect to prices obtained for the same commodities without import reduction for the year 1970, and by 15.38, 32.35 and 53.12 percent respectively during 1975. These price increases were associated with 4.41, 5.28 and 7.52 percent decreases in the quantities of all three commodities respectively. On the other hand, decreases of 10.23, 13.28 and 17.14 percent in the quantities of the same commodities for the years 1975 contributed to the increases in price for that year. Given these results, it appears that the impact of import reduction is entirely consistent with demand theory.

Predicted prices for milled rice and potatoes were shown to be decreased by 84.67 and 37.84 percent respectively during the year 1970. This reduction in prices may be attributed to supply increases which exceed those of the U.S.D.A. by 94.95 and 38.68 percent respectively during the same year. Predicted prices for the same commodities were shown to be decreased by 93.42 and 60.00 percent respectively during 1975. These reductions in prices are associated with increases in supply by 163.42 and 89.00 percent during the same year. Predicted prices for black beans showed increases of 82.86 and 82.05 percent respectively for the years 1970 and 1975. These increases in predicted prices may be attributed to decreases in supply which were 60.22 and 62.54 percent below the levels of supply estimated in the ERS study for 1970 and 1975. Finally, predicted corn prices for the

same years were less than U.S.D.A. estimates by 2.86 percent in 1970.
In 1975, the two estimates were identical. Estimates of supply were 2.83
and 7.44 percent below the estimates of the U.S.D.A. for 1970 and 1975.

Recommendations

Given the lack of reliability of the data from the period 1945-1955,
the same study should be carried out using more recent information. Data
from the period 1956 up to the present should provide a considerable
improvement. However this shortened time series would seriously
limit available degrees of freedom in any statistical analysis. In future
work, it may be desirable to add new commodities to the model and to drop
others depending primarily upon the alternatives being evaluated.

The outlook work which would be facilitated by an improved demand
model would benefit both producers and consumers. Knowledge of demand,
supply, and prices for agricultural commodities would serve as a valuable
aid to decision makers.

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Appendix A

Annual Rate of Increase and Projected
Per Capita Consumption for Milled Rice, Potatoes, Black Beans and Corn
For Years 1970 and 1975

Per Capita Consumption 1965 = Per Capita Consumption 1945 $(1 + r)^{21}$

Milled rice annual rate of growth

$$14.86 = 4.04 \ (1 + r)^{21}$$

where

$$r = .06394$$

projected per capita consumption for 1970 and 1975.

Per Capita
Consumption 1970 = 4.04 $(1 + .06394)^{26}$

$$x = 20.08 \ \text{Kgrs}$$

Per Capita
Consumption 1975 = 4.04 $(1 + .06394)^{31}$

$$x = 27.66 \ \text{Kgrs}$$

Potatoes annual rate of growth

$$15.46 = 3.33 \ (1 + r)^{21}$$

where

$$r = .07466$$

potatoes projected per capita consumption for 1970-1975.

Per Capita
Consumption 1970 = 3.33 $(1 + .07466)^{26}$

$$x = 22.19 \text{ Kgrs}$$

Per Capita
Consumption 1970 = 3.33 $(1 + .07466)^{31}$

$$x = 32.13 \text{ Kgrs}$$

Black beans annual rate of growth

$$4.28 = 5.84 (1 + r)^{21}$$

where

$$r = -.01475$$

projected per capita consumption for 1970-1975.

Per Capita
Consumption 1970 = 5.84 $(1 - .01475)^{26}$

$$x = 3.97 \text{ Kgrs}$$

Per Capita
Consumption 1975 = 5.84 $(1 - .01475)^{31}$

$$x = 3.66 \text{ Kgrs}$$

Corn annual rate of increase

$$64.39 = 69.00 \ (1 \div r)^{21}$$

where

$$r = -.0033$$

projected per capita consumption for 1970-1975.

Per Capita
Consumption 1970 = 69 $(1 - .0033)^{31}$

$$x = 63.43 \text{ Kgrs}$$

Per Capita
Consumption 1975 = 69 $(1 - .0033)^{31}$

$$x = 62.17 \text{ Kgrs}$$

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