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An economic study of the Brazilian cocoa prices in the international market

Aix do Canto Pereira

To the Graduate Council:

I am submitting herewith a thesis written by Aix do Canto Pereira entitled "An economic study of the Brazilian cocoa prices in the international market." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

James G. Snell, Major Professor

We have read this thesis and recommend its acceptance:

Charles Sappington, David W. Brown

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

March 10, 1970

To the Graduate Council:

I am submitting herewith a thesis written by Aix do Canto Pereira entitled "An Economic Study of the Brazilian Cocoa Prices in the International Market." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

James L. Snell
Major Professor

We have read this thesis
and recommend its acceptance:

Charles Sappington

David Brown

Accepted for the Council:

Hilton A. Smith
Vice Chancellor for
Graduate Studies and Research

AN ECONOMIC STUDY OF THE BRAZILIAN COCOA PRICES IN THE INTERNATIONAL MARKET

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

Aix do Canto Pereira

March 1970

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It has been a common pattern to express gratitude to those persons who helped to make an academic work possible by listing their names according to some criteria. To compose such a complete list would probably take time and also would fail to recognize some friendly people who indirectly gave their contribution for attaining the desired goal. The rational way seems to be to confine any acknowledgement to those who directly has some influence in all work which was developed and successfully completed. The task then is somewhat narrowed.

To begin with I wish to express a very special indebtedness to my wife, Regina, and daughter, Andrea, for their devotion and patience before and during the two years related to my graduate work. Without their help I realize that it would have been impossible to complete every stage of the job in which I was engaged. To Regina and Andrea, I offer this thesis as a symbol of my gratitude for everything they did all this time.

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Finally, I wish to say a word of eternal gratitude to my parents, Carvalho and Sylvia, for building in myself the basis for carrying out with responsibility and good will the tasks which I have faced in my life.

ABSTRACT

The objectives of this thesis were twofold. It was an attempt, first, to clarify the nature of economic relationship among various factors affecting the Brazilian cocoa price level in the world market, and secondly, to predict Brazilian cocoa prices in the international market.

The period covered by the study was from 1946 to 1966, and secondary data were used in the analysis.

Least square regression was applied to fit four linear structures to the data representing the variables assumed to be the most important economic factors in the determination of Brazilian cocoa prices. In the first equation the cocoa prices deflated by an appropriate price index appeared in relation with Brazilian cocoa production, the cocoa production from other areas, and the cocoa stock in consuming areas. In the second one, Brazilian cocoa production and cocoa inventories held by consuming countries appeared in relation with deflated Brazilian cocoa prices. In the remaining two structures the dependent variable was not deflated and the price index appeared as an extra variable. In this connection Brazilian cocoa price was stated as a function of Brazilian cocoa production, the rest of the world cocoa production, the level of cocoa stock held by consuming areas, and the price index. In the last structure Brazilian cocoa production, the cocoa stock level, and the price index were used as independent variables. The rationality for using such economic factors was based on the brief analysis of the world

cocoa economy carried out by this study. The following were the structures obtained by this analysis:

$$Y_1 = \underset{(0.01663)}{56.646 - 0.032891\ X_{2(t-1)}} \underset{(0.02961)}{+ 0.0082769\ X_3} \underset{(0.06271)}{- 0.011968\ X_{1(t-1)}}$$

$$Y_1 = \underset{(0.01622)}{43.296 - 0.041702\ X_3}$$

$$Y_1' = \underset{(0.01374)}{-14.553 - 0.04971\ X_{2(t-1)}} \underset{(0.22781)}{+ 0.90478\ X_4} \underset{(0.04739)}{- 0.04409\ X_{1(t-1)}} \underset{(0.02143)}{+ 0.012049\ X_3}$$

$$Y_1' = \underset{(0.01740)}{-2.7673 - 0.048754\ X_3} \underset{(0.26007)}{- 0.50215\ X_4} \underset{(0.06083)}{- 0.011009\ X_{1(t-1)}}$$

where:

Y_1 is the annual average wholesale New York spot price of Brazilian cocoa deflated by an appropriate price index; Y_1' is the simple annual average wholesale New York spot price of Brazilian cocoa; X_1 is the level of cocoa production in Brazil; X_2 is the production of cocoa beans in other areas; X_3 is the volume of cocoa beans in stock in consuming areas; and X_4 is the wholesale price index calculated by the Bureau of Labor Statistics.

On the basis of the statistical significance of the increases in the variations explained by the variables used in the equations, the structure below was selected as the one for attaining the objectives of the study:

$$Y_1' = -14.553 \underset{(0.01374)}{-0.04971 X_{2(t-1)}} \underset{(0.22781)}{+0.90478 X_4} \underset{(0.04739)}{-0.04409 X_{1(t-1)}} \underset{(0.02143)}{+0.012049 X_3}$$

$R^2 = 0.6281$ $\qquad$ $Se = 6.6990$

The ability of the model in predicting the Brazilian cocoa prices for 1967 and 1968 was considered reasonable. Inserting data into the equation above and solving for Y_1', the Brazilian cocoa price level was estimated at 22.46 cents while the actual price was 26.35 cents per pound in 1967, an underestimate of 3.89 cents; and at 23.39 cents while actual price in 1968 was 32.85 cents per pound, an underestimate of 9.46 cents per pound. In dealing with future forecasts caution must be taken since from the coefficient of determination of 0.6281 it may be inferred that more price variation could be explained by the effects of other variables not included in the analysis.

Further studying about the behavior of Brazilian cocoa price on a monthly basis would result in a refinement of the model achieved in the present study.

TABLE OF CONTENTS

CHAPTER PAGE

LIST OF TABLES

TABLE PAGE

TABLE PAGE

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The first chapter of this thesis presents the objectives of the study, the general line of approach toward them, data sources, review of literature, and finally the organization of the thesis.

I. OBJECTIVES OF THE STUDY

The objectives of this thesis are twofold. It is an attempt, first, to clarify the nature of economic relationships among various factors affecting the Brazilian cocoa price level in the world market by establishing a simple econometric model, and secondly, to predict Brazilian cocoa prices in the international market.

The reasons for developing such a study may be summarized by stressing some of the facts concerning the world cocoa economy and the Brazilian cocoa sector, and finally those facts related to the contributions which can be reached by attaining the objectives of this analysis.

Nowadays, cocoa occupies a central position in the economy of Ghana, Nigeria, Brazil, Ivory Coast, and other producing areas. With the exception of Brazil, where the major foreign exchange revenue source is coffee, cocoa is the most important crop linking the traditional economy with the modern sector in the producing countries.

In the last 21 years the West African countries produced about 67 percent of the world's cocoa production followed by countries in America, West Indies, and the combined areas of Asia and Oceania which in turn

contributed 26, 5, and 2 percent of the total cocoa production, respectively.

From Table 1 it can be seen that Africa's share in the world's cocoa production increased from 64.5 to 73.5 percent from the period 1946-47 to 1950-51 to 1962-63 to 1967-68. The share of the Americas, on the other hand, decreased from 27.9 to 20.7 percent in the same period. That of West Indies decreased from 6.6 to 3.5 percent, and finally, the share of Asia and Oceania together increased from 0.9 to 2.4 percent in this period. As a result, Africa emerged as the leading cocoa producer in the world due to increases in production in Ghana, Nigeria, the Ivory Coast, and the Cameroon.[1]

As far as the level of imports it may be cited that in the last 21 years the major importing countries were the United States, the United Kingdom, Germany Federal Republic, the Netherlands, France, and U.S.S.R., Germany Democratic Republic, and Czechoslovakia. Other countries around the world were responsible for minor imports. Table 2 shows the world net imports of cocoa beans by importing countries in the period specified above. From this table it can be seen that the five leading world consumers are the United States, Federal Republic of Germany, the Netherlands, the United Kingdom, and France. These nations imported about 27.3, 13.3, 9.9, 8.8, and 5.8 percent, respectively, of the total cocoa beans imported by consuming nations in the period 1962-66.

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[1]The leading cocoa exporters in the world were the same as the leading producing areas, namely countries in Africa and in America. Gill and Duffus, Cocoa Statistics, London, England, October, 1968.

Table 1. Average World Production of Cocoa Beans, Periods 1946-47 to 1950-51 and 1963-64 to 1967-68

Areas	Period[a] 1946-47 to 1950-51	Percent Over the Total	Period[a] 1963-64 to 1967-68	Percent Over the Total
	1,000 long tons		1,000 long tons	
Africa				
Ghana	237	33.6	439	33.2
Nigeria	100	14.2	237	18.1
Ivory Coast	44	6.2	129	9.7
Cameroom	42	5.9	86	6.5
Other	31	4.5	74	5.6
Total Africa	456	64.5	965	73.5
America				
Brazil	126	17.8	145	11.1
Ecuador	21	2.9	46	3.5
Venezuela	16	2.3	23	1.7
Other	34	4.8	35	2.7
Total Americas	197	27.9	270	20.7
West Indies				
Dominican Republic	29	4.2	31	2.5
Trinidad and Tobago	7	0.9	5	0.4
Other	10	1.5	12	0.8
Total West Indies	47	6.6	46	3.4
Asia and Oceania				
New Guinea	--	--	20	1.5
Other	7	0.9	12	0.9
Total Asia and Oceania	7	0.9	32	2.4
Total World	708	100.0	1,314	100.0

[a]Not adjusted for seasonality.

Source: Cocoa Statistics, Gill and Duffus, London, England, October, 1968, pp. 8-9.

Table 2. Average World Net Imports of Cocoa Beans, Periods 1946-50 and 1964-68

Consuming Areas	Period 1946-50	Percent Over the Total	Period 1964-68	Percent Over the Total
	1,000 long tons		1,000 long tons	
Western Europe				
Germany Fed. Republic	14	2.3	143	13.3
Netherlands	40	6.4	107	9.9
United Kingdom	117	18.6	95	8.8
France	52	8.4	63	5.9
Other	64	10.2	119	12.9
Total W. Europe	289	45.8	547	37.7
Eastern Europe				
U.S.S.R.	11	1.7	61	5.7
Germany Dem. Republic	--	---	15	1.4
Czechoslovakia	4	0.7	14	1.3
Other	5	0.7	39	3.6
Total E. Europe	20	3.1	129	12.0
America				
United States	263	41.8	295	27.3
Canada	19	3.1	17	1.7
Other	15	2.4	23	2.1
Total America	297	47.2	335	31.1
Australia & Oceania				
Australia	10	1.7	12	1.1
Other	3	0.4	3	0.3
Total Australia & Oceania	13	2.1	15	1.4
Asia & Asia Minor				
Japan	--	--	29	2.7
Other	3	0.5	15	1.4
Total Asia & Asia Minor	4	0.6	45	4.2
Africa				
South Africa	4	0.6	4	0.4
Other	3	0.5	2	0.2
Total Africa	6	1.1	6	0.6
Total World	629	100.0	1,078	100.0

Source: Cocoa Statistics, Gill and Duffus, London, England, October, 1968, pp. 22-23.

A dash indicates that import is under 1,000 tons.

In Brazil, cocoa beans is the third important product as far as the export sector is concerned, following coffee and sugar. In fact, cocoa has contributed an average of 4.9 percent to the formation of Brazil's exchange revenue in the last 21 years. This figure turns out to be of significance if it is considered that coffee shipments to overseas have contributed with 58.3 percent of the total foreign earnings in the period indicated above.[2] Insofar as the participation of cocoa beans in the Brazilian agriculture is concerned, it may be pointed out that on the average 0.2 percent has been its share in the total agriculture production which compared with that of coffee may show the degree of importance of cocoa within the agriculture context. Taking into account the income generated by the cocoa sector within the country's Internal Income, it may be stressed that its contribution amounts to about 1 percent which can be considered as an expressive figure if compared again with that of coffee which in turn averaged at 4.1 percent in the period 1946-66.

With all these considerations in mind it may be concluded that the estimates of parameters of some economic factors affecting the marketing of a commodity internationally traded are very important to the producing country. The analysis of these economic relationships and their interactions influencing the cocoa prices and also establishing them is even more important to the producing area once in a nonstatic world, subject to structural changes, shifts of these parameters may

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[2] A more detailed discussion about those facts is developed in Chapter II in the section dealing with Brazilian cocoa economy.

guide new strategies for meeting the change situations devised.[3]

In dealing with the problem of estimating these parameters and even that of predicting them for years ahead the general assumption is that the relationships among the factors taken into account in the analysis should be the same as those which existed during the period under study. The price forecasting ability of the model to be proposed for Brazilian cocoa production for the international market may test the reliability of some of the economic relationships influencing the trade of this commodity.

II. PROCEDURE

As it was stated, this study is aimed to international market, but due to restrictions of data it was necessary to use data primarily concerned with the U. S. market. The U. S. cocoa consumption amounted to about 27.8 percent of the world cocoa production during the last 21 years.[4] To some extent this leaves the analysis to consider some of the factors affecting the cocoa price level in this country representing the normal pattern in the world cocoa market. It may also be stressed that about 39.8 percent of Brazilian cocoa production was imported by the U. S. in the period 1963-67.[5]

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[3] A theoretical model constructed to provide valid information about these parameters will be useful if and only if it is comprehensive in the sense that it does not abstract from the phenomena which are important to the problem under consideration.

[4] Cocoa Statistics, Gill and Duffus, London, England, October, 1968, pp. 4-5.

[5] Cocoa Statistics, FAO, Rome, Italy, 1965 and 1968.

This study pertains to the period 1946-66, leaving the years 1967 and 1968 as a means of testing the empirical validity of the model. The reasons for selecting this particular period are threefold. First of all, years before 1946 were not included. This period was characterized by unmeasurable and unusual economic factors which marked the late 1930's and early 1940's, with a recession 1937 followed by the Second World War and its influence upon production and international trade. Second, although some efforts were developed in order to establish an international cocoa agreement, they were not successful which let the analysis be extended throughout the period 1946-66. Finally, just after the event of World War II there were changes in price levels in the international cocoa market with related effects upon production; cocoa prices increased from the pre-established ceiling level by the U. S. Government of about 8.9 cents in 1945 to 11.5 cents per pound in 1946.

The observation period is defined in terms of years. Cocoa beans harvesting season begins in general in October and ends by February, being marketed fairly rapidly to the consuming areas. Insofar as the statistical analysis is concerned, ordinary least squares[6] procedure coupled with the stepwise method provided the means of computing a multiple regression equation that includes those variables assumed to be significant to the related problem.

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[6]Since there is only one endogenous variable in the model, the equation can be fitted by ordinary least square method.

III. SOURCES OF DATA

Data for the present study were provided by three main sources. These are as follows:

1. United Nations - Food and Agriculture Organization, which provides cocoa statistics and also some of the studies from the Cocoa Study Group in this organization.
2. Gill and Duffus Limited, London, a private organization dealing with cocoa market and business; one annual report issued in October, 1968, was largely used in the present study.
3. Anuário Estatístico do Brazil, Fundação IBGE, which provided the basic figures dealing with the cocoa in the Brazilian economy.

IV. RELATED STUDIES IN THE AREA

In reviewing the cocoa economy literature mention has to be made to two important studies concerned with the problem to be analyzed herein. They are an econometric study of the cocoa market during the period 1948-58,[7] and the newly written monograph by F. H. Weymar dealing with some econometric aspects of the world cocoa market.[8]

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[7]Reference to a study is made in W. A. Schutjer and E. J. Ayo, in Negotiating a World Cocoa Agreement: Analysis and Prospects, The Pennsylvania State University, College of Agriculture, Bulletin 744, October, 1967, p. 36. Unfortunately, no comments could be made about it due to time limitations and difficulties which were found in obtaining it.

[8]F. H. Weymar, The Dynamics of the World Cocoa Market, M.I.T. Press, Cambridge, Massachusetts, 1968.

Related to the second reference the author tries to "describe and explain the nature of the dynamics responses to the world cocoa industry to annual fluctuations in world cocoa production,"[9] by working out on a short-term rather than long-term basis. In doing so, the research is confined to a period 1953-63, and monthly data--some of them are computed therein--are used to explain the month to month variation of the "price-consumption subsystem." This is based on the inventory-price theory developed by the author in his monograph to study the behavior of the monthly price and consumption analysis of cocoa in the U. S. market.

Rather than trying to find points which could lead an analysis to clarify or to complete some aspects of the problem concerned herein, the Weymar's monograph is largely used in this thesis giving basis and guidance to attain the objectives which are proposed in this chapter. In this connection, this thesis attempts to use a more general and simple approach to the problem of finding some economic relationships affecting the international trade of Brazilian cocoa production and further forecasting the Brazilian cocoa prices on a long-term basis.

V. ORGANIZATION OF THE THESIS

Five subsequent chapters are utilized to present the contents of this study. Chapter II deals with various aspects of production and marketing sectors of cocoa economy, emphasizing first of all the production and the processing of cocoa beans for marketing; secondly, the

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[9] Ibid., p. 1.

geographical distribution of production; thirdly, the international trade of cocoa beans; and finally, the participation of cocoa production in the Brazilian economy. Chapter III presents some economic concepts of demand, supply, price fluctuations, marketing systems, and the extension of these concepts to the cocoa economy. Chapter IV presents the econometric model for predicting the Brazilian cocoa prices in the international market. Chapter V presents the empirical results and their analysis, and finally, Chapter VI summarizes the thesis.

CHAPTER II

THE WORLD COCOA ECONOMY

The purpose of this chapter is to present a review of the international cocoa economy with emphasis on the various aspects of production and marketing.

To provide a systematic framework this study will be divided into four parts as follows: the production of cocoa beans and their processing, the world cocoa production with emphasis on the geographical distribution of production, the international trade of cocoa beans, and the cocoa influence in the Brazilian economy. Although the major emphasis of this analysis will cover the period from 1946-66, references will be made to the years prior to 1946 to give the necessary background for interpretation of the evolution of the cocoa economy.

I. THE PRODUCTION OF COCOA BEANS AND THEIR PROCESSING

The Production of Cocoa Beans

Cocoa has many geographical origins and is usually named according to the port, region, or country from where it came. Formerly, cocoa beans coming from Ghana were known as "Accras," since they were shipped from that port; now the reference is simply to "Ghana Cocoa," perhaps with a description attached such as "Fair Fermented Ghana." Other examples are "Lagos Cocoa" which is named after the leading port city in Nigeria and "Bahia" which is cocoa produced in Bahia, the leading state cocoa producer in Brazil.

Theobroma Cacao, one of 20 species of the genus Theobroma, is the most important as far as manufacturing processes are concerned. Cocoa can be classified into three main varieties, each having different characteristics. They are known as:[10]

Criollo - regarded as the prime and flavor cocoa with red or yellow thin-walled, pointed, warty pods; large plump seed with white or pale purple fresh cotyledons, which give for producing special quality cocoa products.

Forastero - this forms the bulk of commercial cocoa; is characterized by smooth, mellon-shaped thick-walled, inconspicuously ridged and furrowed pods, which have rounded ends and are yellow when ripe; the seed is rather flat and dark purple when fresh, has a harsh flavor and is markedly bitter; various fruit types of this variety cultivated are: Amazon, Amelonado, Angoleta, Calabacillo, Cundearnor, Martina, and Sangretoro.

Trinitario - this is a mixed variety representing various degrees of mixture of Criollo and Forastero.

The finest and the most delicate of the cocoas are the Criollos (or natives) of South and Central America being grown in relatively small quantities. Ranking high in quality they are used to supply special

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[10] C. A. Krug and E. Quartey-Papafio, World Cocoa Survey, FAO, Rome, Italy, 1964, p. 2.

flavor grades for blending purposes.[11] The Forastero cocoa beans are the most widespread group used in world trade and they are cultivated in most of the important producing areas. In Ghana, for example, almost 100 percent of the cocoa tree population is made up of Forastero (Amelonado).[12] In Nigeria and the Ivory Coast the bulk of production also comes from cocoa belonging to this variety. In Brazil, although the Forastero variety is the major type being cultivated at present, plantations of Trinitario can be found. In the Dominican Republic and Trinidad Forastero and Trinitario are respectively cultivated to some extent.[13] The so-called Criollo is cultivated mainly in Cameroun, Colombia, Guatemala, Liberia, Madagascar, Mexico, Philippines, Rio Muni, and Venezuela.[14]

In general, it may be said that cocoa trees bear fruit three or four years after seeding. The pods are harvested intermittently throughout the year, but in most producing areas there are at least two distinct periods of heavy yield.[15] In West Africa the main harvest accounts for some 90 percent of annual production and the mid, or minor, crop for only 10 percent. On the other hand, Brazil's main and intermediate crops are of equal importance. Table 3 shows the principal cocoa harvesting periods in some of the most important producing areas throughout the world.

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[11] Cocoa, Merril Lynch, Pierce, Fenner and Smith, Inc., New York, 1966, p. 9.

[12] Krug and Quartey-Papafio, op. cit., pp. 9, 126, 139.

[13] Ibid., pp. 63, 89.

[14] Ibid., p. 207.

[15] V. D. Wickizer, Coffee, Tea and Cocoa, Stanford University Press, Stanford, California, 1951, p. 283.

Table 3. Cocoa Beans Harvesting Periods in Some Producing Areas

Areas	Main Crop	Mid Crop
Ghana	October-February	May-June
Nigeria	October-January	May-June
Ivory Coast	September-December	April-June
Brazil	September-January	Mid April-August
Dominican Republic	March-June	October-January

Source: Cocoa, Merril Lynch, Pierce, Fenner, and Smith, Inc., New York, 1966, p. 18.

The cocoa trees may go on producing for 40 years or more. Their economic life depends upon such variables as current prices and differences in yields of tropical plants of the same age.[16] In West Africa, for example, it was found that a number of fields were over 50 years old and still yielding,[17] and in the West Indies some trees were known to be over 100 years old. In Trinidad the optimum yield of a plantation comes after about 30 years, followed by a gradual decline.[18]

In general, it may be considered that the productivity of a good cocoa plantation is between one and two pounds of cured cocoa beans per tree per crop. It must be noted, however, that considering the potentialities of some producing areas the current yields in cocoa plantations are low.[19]

The Processing and Use of Cocoa Beans

To better understand the terms used throughout this study, a brief description of cocoa processing and use will be covered here.

Once the pod is harvested, the separation of the beans is accomplished in the curing, or fermenting, process. This is a very important part in preparing the beans for marketing since it is a principal factor in developing the color and flavor characteristics of the cocoa bean. The process of fermentation browns the white or purplish seed, reduces the natural bitterness and hardens the seed-skin to "shell," which can then be more easily removed at the factory. After two or

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[16] Ibid., p. 441.

[17] Ibid.

[18] Ibid.

[19] Ibid., p. 443.

three days of curing, the beans must be dried. Drying in the sun continues to be the most direct, effective, and convenient method when the harvest takes place during the dry season. However, it often takes from one to two weeks for this process, whereas mechanical drying may be accomplished in less than a day. The dried beans are the raw cocoa or cocoa beans of the international market. They are now ready to be bagged and transported to cocoa buying, or shipping, centers where the beans are graded. The grading provides the basis for the buying and selling operations in the open market.

The grading systems in most of the principal producing areas are based primarily on the quality of fermentation. Secondary factors include the appearance of the dried beans, the degree of bean imperfection and the amount of foreign matter mixed with the beans. It should be noted that the grading system is not as exacting or perfected as the grading system developed for use in the coffee industry.[20]

The raw cocoa may then be stored. This requires storage facilities with atmospheric conditions necessary to preserve the bean's quality. Although some doubts persist as to the effects of prolonged storage, it is believed that beans can be kept for many months if they are properly dried to a low moisture content and the temperature is held constant at a range of between 25 to 30°C.[21]

Upon arrival at the chocolate factory the cocoa beans are cleaned, roasted, ground, and then pressed.

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[20] Wickizer, op. cit., p. 301.

[21] Cocoa, p. 21.

In cleaning the beans, foreign matter such as stones, sticks and dust are removed. The intensity of such a process depends upon the grade of the cocoa beans. The cleaned beans are then roasted, the length of roasting time being dependent on the ultimate use of the bean. For some products roasting is primarily to help in the later removal of the shells, whereas for other products the roasting is desired to develop certain flavor, color, and aroma characteristics.

The roasted beans are then broken into particles called "nibs," which also contains the "shells," during the grinding process. The shells and nibs are then separated by appropriate machines. The shells are a by-product and are used in the manufacture of cattle feed. At this time one of the more important parts of the entire process occurs: the blending of nibs of different varieties. This blending gives the desired mixture for the kind of final product to be produced.

By grinding the blended material, a smooth brown liquid known as "cocoa liquor" is obtained. It is made up of about 55 percent of cocoa butter (the fat content) and 45 percent powder. The fineness to which particle size is reduced depends on the requirements of the particular product in view. Usually the higher the quality of the product the smaller must be the particle size.

At this point the manufacture of "cocoa powder" and/or "chocolate" begins. "Cocoa powder" consists of cocoa liquor from which some of the fat has been reduced--from 55 to about 20-25 percent--depending upon whether it is to be used for drinking or as a mix for ice cream, cake, or milk. The material is presented in a finely divided form so that it can be suspended in water or milk as beverage. Most dutched cocoa powders

are alkalized to improve their color, flavor and apparent solubility in water. The cocoa butter so extracted can be regarded as a by-product in powder manufacture, but in reality cocoa butter is the more valuable part of the bean and relative demands for the two parts are such that in times of excess supply of cocoa beans, it is the powder which ends up as a by-product in the extraction of cocoa butter for chocolate manufacture.

As far as the production of chocolate, it may be stressed that this product consists of finely ground cocoa nibs which are sweetened with sugar and have had enough added fat to enable the resultant paste to be moulded into blocks. The need of adding extra cocoa butter to cocoa liquor in the process is what gives rises to cocoa powder as a by-product. Cocoa butter is quite solid at ordinary room temperature, but melts just below body temperature so that it softens readily in the mouth. It is this unique property of melting at a particular temperature which makes cocoa butter practically indespensable in the manufacture of high chocolate candy and thus makes other vegetable fats imperfect substitutes. Its other contributions include reduction of viscosity in the chocolate, and the ability to resist rancidity; but these functions can be performed by other factors, whose usage by the industry thus increases in times of high bean prices.

The chocolate obtained by adding butter to liquor (perhaps more properly called "chocolate material") is then made into chocolate candy or used as a covering or icing by other food industries.

II. THE PRODUCTION OF COCOA BEANS WITH EMPHASIS ON THE GEOGRAPHICAL DISTRIBUTION, PERIOD 1900 TO 1966

The basic aim of this study is to show the evolution of cocoa production from 1900 to the year 1966 giving insight into the patterns of production as well as analysis of factors which affected those patterns.

For the present the whole period will be divided into four main periods, as follows:

1. The period from 1900-01 to 1938-39
2. The World War II period
3. The period from 1945-46 to 1958-59
4. The period from 1959-60 to 1966-67

The Period from 1900-01 to 1938-39

In analyzing this period it may be useful to refer to Table 4 which provides the basic figures for these years. It can be noted that the world cocoa production increased from about 135,000 long tons in 1900-01/1904-05 to 797,000 long tons by the end of 1938-39, an increase of about 600 percent in total production. Logically, a decrease in the price level would be expected, but such was not the case until the early 1920's; perhaps the high prices were a result of the increased demand for cocoa during World War I. The war also affected the crop movements to the markets, keeping artificially high prices until the end of 1920, when prices finally started decreasing. Production, as well as the level of exports, kept expanding during this time even though at a somewhat slower rate.

Table 4. Production in the Major Producing Countries, Five Years Average from 1900-01 to 1934-35 and Yearly from 1934-35 to 1938-39

Areas	1900-01 to 1904-05	1905-06 to 1909-10	1910-11 to 1914-15	1915-16 to 1919-20	1920-21 to 1924-25	1925-26 to 1929-30	1930-31 to 1934-35	1935-36	1936-37	1937-38	1938-39
	----------	----------	----------	1,000 long tons	----------	----------	----------	----------	----------	----------	----------
Africa											
Ghana	2	15	50	148	177	225	237	285	300	240	298
Nigeria	---	2	5	15	32	48	64	94	104	98	116
Ivory Coast	---	---	---	---	6	14	32	46	48	50	54
Cameroom	1	2	5	3	4	8	17	24	25	29	31
Total Africa	26	50	97	163	249	325	386	483	512	456	539
America											
Brazil	21	29	36	53	55	69	88	124	114	138	137
Ecuador	20	27	39	41	34	18	19	19	21	19	15
Venezuela	12	15	17	18	21	17	19	17	18	20	15
Total America	62	79	101	124	125	123	146	186	183	208	198
West Indies											
Dominican Republic	10	15	20	22	22	21	23	23	19	24	30
Trinidad & Tobago	18	20	23	27	27	25	19	16	12	16	7
Total West Indies	41	49	57	62	60	57	52	51	44	52	49
Asia & Oceania											
New Guinea	---	---	---	---	---	---	---	---	---	---	---
Total Asia & Oceania	5	7	8	7	7	8	10	7	9	11	10
Total World	135	185	263	356	441	514	594	727	748	727	797

Table 4. (Continued)

Areas	1900-01 to 1904-05	1905-06 to 1909-10	1910-11 to 1914-15	1915-16 to 1919-20	1920-21 to 1924-25	1925-26 to 1929-30	1930-31 to 1934-35	1935-36	1936-37	1937-38	1938-39
	1,000 long tons										
Average Wholesale Spot Price "Accra" New York-Cents Per Pound	---	---	11.2[a]	12.6[a]	9.4[a]	12.0	6.5	5.0	6.9	8.4	5.2
Total Exports (thousand long tons)	118	161	242	880	420	500	552	680	712	646	723

[a]United States unit value of imports.

A dash indicates that production is under 1,000 tons. Production was not adjusted for seasonality.

Source: Cocoa Statistics, Gill and Duffus, London, England, October, 1968, pp. 6-9.

At the turn of the century, the Americas and West Indies producing areas contributed about 80 percent of the total world supply of cocoa leaving 20 percent for Africa, Asia, and Oceania. In 1926 the entire producing picture changed and Ghana alone accounted for 43 percent of total production. By the end of the 1938-39 season, the Ghana crop exceeded 250,000 long tons of cocoa beans. Parallel to this, increases in production by Nigeria and other African countries also rose and by the beginning of the Second World War, Africa itself accounted for almost 70 percent of the total world supply of cocoa beans.[22] On the other hand, a price decline which was observed after 1920 affected the production in the other areas greatly reducing their production.

The results of the facts mentioned are also reflected in one of the more important aspects as far as the cocoa industry manufacturer is concerned. This was a marked change in the quality of cocoa beans which came into the world market, mainly because of the restrictions of the Caribbeans and Central Americas markets which were the main source of the favor grades needed for high quality chocolate.[23]

The lowering of prices during this period also discouraged new plantings in some African countries and reduced attention to the care of cocoa farms as a whole. In the American continent the production remained almost without any increase during this period. In Brazil the impact of low prices on planting began to be felt even though labor cost

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[22]Such a tremendous increase in the African countries production was due primarily to clearing 1.5 to 2.2 million hectares of tropical forest. Cocoa, A Review of Current Trend in Production, Price and Consumption, Bulletin 27, FAO, Rome, Italy, November, 1955, p. 9?.

[23]Wickizer, op. cit., p. 289.

was low.[24] Production remained relatively stable in Asia and Oceania since their efforts were concentrated on rice, tea, rubber, sugar, and not cocoa production.

The World War II Period

It must be noted at this time that in absolute terms prior to the beginning of the war there was a steady increase in the total world cocoa production. Since then the impact of this event was noted once the level of production fell from 736,000 long tons in the period 1934-35 to 1937-38 to 637,000 long tons of cocoa beans in the period 1939-40 to 1943-44, a decrease in production of about 11 percent. The decline in production continued until the 1947-48 crop year. The reasons for such a reduction may be attributed first of all to the fact that the war needs provided a new source of local jobs with higher wages. This led to a relative shortage of labor for the rest of the economy, with consequent rise in the cost of producing cocoa beans. Next, the agricultural community shifted resources to attend to the necessity of producing more food stuff to attend the increased demand for food during the war. Finally, there was disruption of the cocoa trade along with a general decline in cocoa price levels (Table 5).[25] Although some governments did in fact provide price support for cocoa, among those were both West Africa and Brazil.

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[24] Cocoa, A Review of Current Trend in Production, Price and Consumption, p. 13.

[25] Ibid., p. 33.

Table 5. Production in the Major Producing Countries, Five Year Average from 1939-40 to 1959-60 and Yearly from 1960-61 to 1966-67

Areas	1939-40 to 1943-44	1944-45 to 1948-49	1949-50 to 1953-54	1954-55 to 1958-59	1959-60	1960-61	1961-62	1962-63	1963-64	1964-65	1965-66	1966-67
	----------	----------	----------	----------	1,000 long tons							
Africa												
Ghana	226	225	255	236	317	433	410	422	436	557	410	376
Nigeria	98	96	124	112	155	195	191	176	216	294	182	267
Ivory Coast	29	33	54	66	61	95	80	101	97	145	148	148
Cameroom	29	41	49	58	63	73	84	76	86	90	78	84
Total Africa	409	423	481	518	651	859	816	840	903	1,162	853	953
America												
Brazil	144	115	132	160	198	122	116	111	123	116	173	173
Ecuador	14	17	26	32	34	41	37	38	35	48	35	53
Venezuela	16	16	19	19	18	17	19	20	21	22	23	24
Total America	181	178	216	265	312	247	237	238	233	241	284	308
West Indies												
Dominican Republic	22	27	32	33	39	34	33	37	41	32	28	28
Trinidad & Tobago	7	5	8	8	7	6	6	6	5	5	5	5
Total West Indies	37	41	50	50	57	50	48	53	55	49	43	43
Asia & Oceania												
New Guinea	3	2	3	3	7	7	11	14	17	21	18	21
Total Asia & Oceania	8	7	8	12	19	19	22	27	29	33	29	32
Total World	637	669	755	845	1,039	1,175	1,123	1,158	1,220	1,485	1,209	1,336

Table 5. (Continued)

Areas	1939-40 to 1943-44	1944-45 to 1948-49	1949-50 to 1953-54	1954-55 to 1958-59	1959-60	1960-61	1961-62	1962-63	1963-64	1964-65	1965-66	1966-67
	1,000 long tons											
Average Wholesale Spot Price "Accra" New York Cents Per Pound	7.1	20.8	32.3	39.5	36.6	28.4	22.6	21.0	25.3	23.4	17.3	29.1
Total Exports (thousand long tons)	557	572	688	704	737	882	999	1,019	1,024	1,016	1,285	1,092

Production was not adjusted for seasonality.

Source: Cocoa Statistics, Gill and Duffus, London, England, October, 1968, pp. 6-9.

Another reflection of the war occurred by 1942 when the United States Government established a ceiling price of 8.9 cents per pound on cocoa beans in order to stabilize the cost of living in that country.[26] This ceiling continued until 1946 when the price controls were finally removed.

Another major reason for the decline in production was the increased incidence of disease and pests, especially "Swollen Shoot" in most West African countries. Although the disease was first recognized in 1936,[27] its impact on supply of cocoa was not generally felt until after the war. Research of damage on production carried out in Ghana,[28] where the disease was most widespread, estimated that on the average one million trees were killed annually between 1932-39, and five million per year from 1939-45. In the total it was believed that in Ghana a total of 50 million cocoa trees were affected by the middle of 1948.[29]

The Period from 1945-46 to 1958-59

The combined effects of the war, disease, and low prices were reflected in the low per capita supplies during the 1940's and the early and mid 1950's. Average world production of the two crop years following the war--1945-46 and 1946-47--was almost 600,000 long tons, about 135,000 long tons below the two-year average which preceded the war--1936-37 to

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[26] Cocoa Statistics, Gill and Duffus, p. 35.

[27] Wickizer, op. cit., p. 294.

[28] Ibid., p. 295.

[29] Ibid., p. 374.

1937-38.[30] Because population level in the consuming areas had gone up considerably after the end of the war, this meant an even lower per capita supply. This led to increases in prices, which occurred in the 1940's and early 1950's, and may be pointed out as the main factor for the strong upward trend in cocoa production.

The Period from 1959-60 to 1966-67

In this period there was a tremendous increase in the world cocoa production. A new era in cocoa production started in 1960, when over a million long tons were produced. In 1961 production rose to 1,175,000 long tons and since then up to the 1966-67 crop year there have been increases as a result of the plantings by cocoa producers in the 1950's, and to several programs which were, and have been, carried out in the field of research and experimentation.

Recent projections of cocoa production indicate that by 1970 under favorable economic and social conditions production may be somewhere between 1,400,000 and 1,500,000 long tons[31] which is above those projections of consumption which estimate that at a price of 30 cents per pound total demand may be slightly above 1,250,000 long tons.[32]

One of the most important aspects of the cocoa production is the concentration of production in a small number of countries. Table 6

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[30]It may be cited herein that the unfavorable weather conditions played an important role for this reduction, namely in West Africa. Wickizer, op. cit., p. 280.

[31]Agricultural Commodities Projections for 1970, FAO Commodity Review, Rome, Italy, 1962, p. II 43.

[32]Ibid., p. II 41. These estimates exclude the Sino Soviet Area.

Table 6. Concentration of World Cocoa Production, Period 1910-11 to 1964-65

Period	Number of Countries Producing Cocoa (1)	Average World Production 1,000 long tons	Number of Countries Producing 80 Percent of World Total (2)	Percentage of the Countries Producing 80 Percent of the World Cocoa Production (2) Over (1)
1910-11 to 1914-15	26	263	7	27.5
1915-16 to 1919-20	28	356	6	21.4
1920-21 to 1924-25	30	441	7	23.3
1925-26 to 1929-30	30	514	7	23.3
1930-31 to 1934-35	30	594	7	23.3
1935-36 to 1939-40	31	736	7	23.4
1940-41 to 1944-45	30	623	4	13.3
1945-46 to 1949-50	31	677	7	23.4
1950-51 to 1954-55	34	764	7	20.5
1955-56 to 1959-60	34	892	8	23.8
1960-61 to 1964-65	34	1,232	7	20.5

Source: Cocoa Statistics, Gill and Duffus, London, England, October, 1968, pp. 6-9.

indicates that in the period 1910-11 to 1914-15 on the average about seven countries were responsible for 80 percent of the world's production. As one can see, the percentage of countries accounting for such a large share in the world's cocoa production did not change to a great extent. This is true although shifts in production occurred among the producing countries. The reduction which was observed in the period 1935-36/1939-40 to 1940-41/1944-45 may be attributed to the effect of low prices of cocoa in the 1930's and the conditions of the Second World War on the nonmajor producing areas.

Based on the statistical data of production and that of time in the period of this brief analysis--1900-01 to 1966-67--it may be seen from the equations which were fitted to them[33] that there was an increase in world production of about 15,600 long tons of cocoa beans per year, which corresponds to an increment in production of about 3.1 percent yearly.

III. ANALYSIS OF VARIATION IN PRODUCTION

In analyzing the factors influencing the cocoa beans production, they should be viewed from two aspects: the price and the physical factors.[34]

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[33]The equation for a straight line has the form Y = 519.82 + 15,574 x (origin 1934) and that for a logarithimic line has the shape of log Y = 2.34739 + 0.013308 x (origin 1934).

[34]W. A. Schutjer and E. J Ayo, Negotiating a World Cocoa Agreement: Analysis and Prospects, Bulletin 744, The Pennsylvania State University, October, 1967, p. 6.

Concerning the first factor, it is considered as having long- and short-term effects upon production. In the long run it has been found that cocoa production reacts after 13 years to any price change in the world market.[35] Related to the short-term effects of prices in production, the referred study points out three kinds of relationships with them: the influence of prices on harvesting cocoa trees, that on cultural practices carried out by farmers in producing areas, and finally, that on the care of processing cocoa beans for final marketing.

In the countries of Western Africa there was little relationship between prices and the amount of cocoa beans harvested, basically because harvesting costs were low, and also because this product was the main source of income due to lack of opportunities for off-farm employment. However, conditions have changed in Nigeria and Ghana since 1956, where planting has been carried out in distant places--increasing, as a result, the cost of harvesting and also substantially increasing the availability of alternative employment opportunities.[36]

A relationship between price and cultural practices used in the cocoa field was found to exist. In fact, the same study indicates that:[37]

> During the period of low prices, farms tend to be neglected, especially the less accessible plots. Neglect of cocoa farms was especially prevalent during the Second World War, when there were additional opportunities for off-farm wage employment. In Ghana and Nigeria, for example, many farms were neglected during the war years--they were described as abandoned. The rise in cocoa price following the Second World War, coupled with a decline in urban and military employment opportunities, resulted in better attention being given to the abandoned farms.

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[35] Ibid., p. 7.

[36] Ibid.

[37] Ibid., p. 8.

As far as the effects of prices in processing cocoa beans for marketing, it must be recalled that the processing by itself has great effect on the quality of the product for the final market. In this connection it may be expected that variations in the level of prices paid to producers will induce the farmers to pay less or more attention to the processing and even to the care during the storage operations. This is true in Cameroom and Nigeria where increases in the price level induced native farmers to improve fermentation and drying, and production of "superior" grade has doubled or tripled.[38]

Related to the physical factors, variations in production may result from the aging of trees, the availability of suitable land, the prevalence of diseases and pests, technological changes, and finally, the weather.[39]

As it was cited in the first part of the study, in many cocoa producing areas yields are low as a result of the advanced age of cocoa farms and plantations. Tables 7, 8, and 9 show the age distribution of cocoa trees in Gold Coast, Nigeria, and Ivory Coast.

The availability of suitable land for cocoa was one of the main factors in the expansion of production verified in Africa. If the production of cocoa beans is compared among different countries in this area, it may be noted that in Ghana, Nigeria, and Ivory Coast, where cocoa was established at different times, some decreasing in the rate of increases in the level of cocoa output began to occur. This is deemed to

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[38] Cocoa, A Review of Current Trends in Production, Price, and Consumption, p. 37.

[39] Schutjer and Ayo, op. cit., p. 8.

Table 7. Age Distribution of Cocoa Trees in Gold Coast, 1953

Age Groups	Percentage
Less than 7 years	10
7 to 15 years	17
15 to 30 years	40
Over 30 years	33

Source: Cocoa, A Review of Current Trends in Production, Price, and Consumption, Bulletin 27, FAO, Rome, Italy, November, 1955, p. 22.

Table 8. Age of Cocoa Trees in Nigeria, 1953

Age Groups	Percentage
Less than 5 years	7
5 to 10 years	21
10 to 25 years	41
25 to 40 years	31
Over 40 years	--

Source: W. A. Schutjer and E. J. Ayo, Negotiating a World Cocoa Agreement: Analysis and Prospects, Bulletin 744, The Pennsylvania State University, College of Agriculture, October, 1967, p. 23.

Table 9. Age Distribution of Cocoa Trees in Ivory Coast, 1953

Age Groups	Percentage
Less than 5 years	10
5 to 10 years	14
10 to 25 years	45
25 to 40 years	31
Over 40 years	--

Source: W. A. Schutjer and E. J. Ayo, Negotiating a World Cocoa Agreement: Analysis and Prospects, Bulletin 744, The Pennsylvania State University, College of Agriculture, October, 1967, p. 24.

be due to the lack of further suitable land. As a matter of fact, cocoa was first established in Ghana in the late nineteenth century followed by Nigeria and then by the Ivory Coast which leads to the conclusion that:[40]

> The slackening effect was observed in Ghana as early as 1910; a more pronounced slackening occurred in Nigeria after about 1920; some slight slackening in the Ivory Coast was observed in the course of twenties; thus, it was in the oldest producing areas that the slackening in the rate of increase in production was first noticed.

Diseases have had greater influence than pests on production of cocoa beans.[41] It may be cited that the most damaging diseases influencing cocoa production are the Swollen Shoot, the Black pod, Trunk canke, and Witches broom. The first two are common in West Africa, causing great decreases in production. The last two kinds of diseases are found either in West Africa or Brazil, Colombia, Equador, and the West Indies.

As examples of insects affecting the level of cocoa production, it may be stated herein that "capsids"[42] are considered the most damaging insects in Nigeria and Ghana. "Azteca ants," generally found in Brazil, and "thrips" are also factors upon the volume of cocoa production.

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[40] Ibid., p. 9. There, however, potential areas suitable for cocoa in many countries including Brazil, Cameroom, Colombia, etc., but the utilization of these areas is often handicapped by several factors, including lack of labor and transport facilities. Krug, op. cit., p. 200.

[41] Wickizer, op. cit., p. 293.

[42] Ibid.

Technological changes (the use of adequate fertilization, improved varieties, new planting systems, and improved processing methods of the cocoa beans) and the weather conditions influence yields and total cocoa production. An excessive rain or excessive drought in the growing season can cause losses in production by encouraging the development of pests and diseases.

IV. THE TRADE OF COCOA BEANS, PERIOD 1900 TO 1966

The world cocoa absorption and economic factors affecting the international trade of cocoa (namely income and prices) should be analyzed under identical periods of time; in other words, from 1900 to 1938, the Second World War period, the period from 1946 to 1959, and, finally, from 1960 to 1966.

Whatever framework may be used herein, two important developments took place in the last few years:[43] first of all, the recovery and growth of European consumption, and second, a change in the long trend of the United States imports and consumption of cocoa products.

The Period 1900 to 1938

In analyzing this period, it may be noted that the United States imports increased more rapidly than those countries with the European continent. As Table 10 shows, the share of the United States in world imports of cocoa beans rose from about 19 percent in the period 1900-01 to about 33 percent in the period 1937-38, just prior to the Second World

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[43] Cocoa, p. 44.

Table 10. World Net Imports of Cocoa Beans, Five Year Average from 1900 to 1934, and Yearly from 1935 to 1938

Areas	1900 to 1904	1905 to 1909	1910 to 1914	1915 to 1919	1920 to 1924	1925 to 1929	1930 to 1934	1935	1936	1937	1938
	1,000 long tons										
Western Europe											
Germany	21	32	50	12	73	72	83	74	75	71	78
Netherlands	9	13	25	21	33	44	49	61	66	52	74
France	19	22	26	40	39	36	40	43	47	41	42
United Kingdom	19	22	27	59	47	57	64	92	108	86	128
Other	38	23	33	42	41	45	52	60	50	44	57
Total W. Europe	87	116	162	175	214	255	289	330	346	294	379
Eastern Europe											
Czechoslovakia	---	---	---	---	5	7	9	13	12	10	10
U.S.S.R.	2	3	4	2	2	4	2	5	7	11	15
Other	---	---	1	2	4	10	12	15	16	15	18
Total E. Europe	2	3	5	3	11	21	23	33	35	36	43
America											
United States	23	39	61	104	151	183	191	267	271	266	197
Canada	1	1	2	6	6	7	9	11	16	11	11
Other	1	1	1	2	4	11	9	9	10	10	12
Total America	24	52	65	132	161	201	209	287	297	287	220
Australia & Oceania											
Australia	1	1	1	2	4	4	5	6	7	7	6
Other	---	---	---	---	1	1	1	2	1	1	2
Total Australia & Oceania	1	1	1	2	5	5	6	8	8	8	8

Table 10. (Continued)

Areas	1900 to 1904	1905 to 1909	1910 to 1914	1915 to 1919	1920 to 1924	1925 to 1929	1930 to 1934	1935	1936	1937	1938
	1,000 long tons										
Asia & Asia Minor											
Japan	---	---	---	---	---	---	1	2	2	1	1
Other	1	1	1	2	2	2	1	2	1	1	2
Total Asia & Asia Minor	1	1	1	2	2	2	2	4	3	2	3
Africa											
South Africa	---	---	---	---	---	---	1	1	1	1	2
Other	---	---	---	---	---	---	---	---	---	---	---
Total Africa	---	---	---	---	---	---	1	1	1	1	2
Total World	115	162	234	313	413	484	529	663	690	628	655

Source: Cocoa Statistics, Gill and Duffus, London, England, October, 1968, pp. 20-23.

War. The European share of world supplies, on the other hand, decreased from 79 to 57 percent in the same length of time. Even on a per capita basis the rise in the United States consumption during this period was higher than any other country.[44]

The outstanding economic characteristics of this period, after 1920, was the decline in cocoa prices, the rise in the per capita income in most consuming countries, and the increase in the supply of cocoa beans.[45] As a result, the consumption of cocoa and cocoa products increased.

The World War II Period

The patterns of imports which were observed in the previous years did not change to a large degree although the per capita real income in all consuming countries kept rising. However, by looking at the consuming areas individually it can be seen that there were changes in the level of imports (Table 11). At the beginning of World War II the U. S. took 33 percent of the total imports, but at the end of this event this share rose to 45 percent--1946-47 average. On the other hand, European countries as a whole decreased their level of imports from 57 to 45 percent with the exception of United Kingdom whose imports increased from 16 to 18 percent of total cocoa beans imported in this period. The level of prices increased from 6.8 cents per pound--1937-38 average--to 8.9 cents in 1942 when this ceiling was established by the United States Government.

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[44] Cocoa, p. 45.

[45] Ibid., p. 54.

Table 11. World Net Imports of Cocoa Beans, Five Year Average from 1939 to 1958, and Yearly from 1960 to 1966

Areas	1939 to 1943	1944 to 1948	1949 to 1950	1954 to 1958	1959	1960	1961	1962	1963	1964	1965	1966
	----------	----------	----------	----------	----------	1,000 long tons	----------	----------	----------	----------	----------	----------
Western Europe												
Germany Fed. Rep.	33	---	52	87	102	112	123	135	132	141	162	146
Netherlands	19	20	53	62	74	82	107	101	98	104	116	115
France	34	30	56	51	55	56	58	68	64	59	62	63
United Kingdom	140	107	112	100	77	92	85	108	111	74	78	102
Other	23	52	72	88	103	116	126	132	131	144	145	145
Total W. Europe	263	209	345	390	411	458	499	544	536	622	563	571
Eastern Europe												
Germany Dem. Rep.	---	---	2	6	15	12	13	14	14	14	15	18
Czechoslovakia	2	4	3	7	9	12	15	12	13	13	14	19
U.S.S.R.	5	8	15	21	26	49	15	45	53	65	87	56
Other	3	3	4	11	36	22	22	35	35	39	54	43
Total E. Europe	10	15	23	44	66	95	65	96	115	131	170	136
America												
United States	247	270	252	213	205	238	336	279	275	260	348	312
Canada	17	21	15	12	12	15	16	16	15	18	23	16
Other	13	17	15	17	12	11	17	18	15	22	28	32
Total America	276	308	282	244	229	264	269	313	305	300	399	360
Australia & Oceania												
Australia	9	11	8	9	10	13	15	8	12	14	12	12
Other	3	3	2	2	3	3	3	4	3	3	4	4
Total Australia & Oceania	12	14	10	11	13	16	18	12	15	17	16	16

Table 11. (Continued)

Areas	1939 to 1943	1944 to 1948	1949 to 1950	1954 to 1958	1959	1960	1961	1962	1963	1964	1965	1966
	---------- 1,000 long tons ----------											
Asia & Asia Minor												
Japan	2	---	2	4	8	9	15	23	30	32	25	37
Other	2	2	3	3	6	8	8	10	8	14	22	23
Total Asia & Asia Minor	4	3	4	7	14	17	23	33	38	46	47	60
Africa												
South Africa	5	4	3	3	3	5	3	6	2	6	3	4
Other	1	3	2	1	1	1	2	2	1	2	2	2
Total Africa	6	7	5	5	4	6	5	8	3	8	5	6
Total World	575	557	671	701	737	856	979	1,006	1,012	1,024	1,200	1,149

Source: Cocoa Statistics, Gill and Duffus, London, England, October, 1968, pp. 20-23.

The Period from 1946 to 1959

Changes began to appear in the level of consumption in the major importing countries. The per capita income in five of those countries rose by 46 percent, but the average total production of cocoa beans in relation to the total population declined in these areas;[46] if it is assumed that in some of the consuming areas the income elasticity for cocoa is positive,[47] the result was a great pressure for increasing cocoa price level. This fact coupled with a negative income elasticity in the U. S. had a significant influence on the level of imports in the United States. The share of its imports, which was about 45 percent at the end of the period 1946-47, dropped to 28 percent in 1958-59, and even on per capita basis the level of consumption declined. The increasing price level exerted additional and even more complicated influences in the American market, inducing manufacturers to develop new formulas to reduce the quantity of cocoa products in the final consumer products and also to develop new substitutes for cocoa butter and cocoa flavor.[48] The level of imports in Europe on the other hand rose from 45 to 65 percent in the same period, but the United Kingdom's share of the total decreased from 18 to 11 percent. The United Kingdom's per capita consumption, however, was greater than that in U. S. A. In 1958 the cocoa price reached the highest peak of 44.3 cents per pound decreasing thereafter.

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[46] Ibid., presumably U. S. A., U. K., Germany Federal Republic, France, and the Netherlands.

[47] J. R. Behrman, "Cocoa: A Study of Demand Elasticities in the Five Leading Consuming Countries," Journal of Farm Economics, Vol. 47, 1965, p. 416. For the period 1950 to 1961 the following income elasticity coefficients were estimated: France = 0.22, Germany Federal Republic = 0.77, Netherlands = 0.13, United States = -1.97, and United Kingdom = -0.35.

[48] Cocoa, p. 51.

The Period from 1960 to 1966

The entire picture of the international trade changed to some extent in this period compared to those of pre-war (1900 to 1938) and post-war periods. The United States level of imports which were about 33 and 45 percent in 1935-38 and 1946-47, respectively, dropped to 29 percent over the total cocoa beans traded in 1965-66, even though there were increases in the level of income and decreases in the level of prices. As a result, the European countries emerged as leading areas of the consumption of cocoa and cocoa products. In the same periods indicated before, as a matter of comparison, the U. S. level of imports increased from 57 and 45 percent to 61 percent of the total imports verified in 1965-66. However, the United Kingdom share of the total decreased from 16 and 18 percent to 8 percent of the world imports in 1965-66. Consequently, Germany Federal Republic and the Netherlands emerged as leading consuming areas in Europe.

Based on the statistical data of imports and that of time in the period 1900-66, it may be seen from the equations which were fitted to them[49] that there was an increase in world import of about 12,700 long tons of cocoa beans per year or an increase of about 3.0 percent yearly.

When compared with the increase which was observed in production--3.1 percent per year--in the same period of time, it may be seen that variation in imports are closely related to that of production. The main factors which can explain such a relationship may be pointed out as being that first, producing areas have not done any substantial manufacturing

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[49]The equation for a straight line has the form Y = 446,710.4 + 12,715 x (origin 1934), and that for a logarithimic line has the shape of log Y = 2.294387 + 0.0128104x (origin 1934).

in cocoa beans;[50] second, they have not had any technical storage condition for preserving the raw cocoa beans; and finally, the low level of cocoa beans and cocoa products consumption in producing areas.

V. COCOA IN THE BRAZILIAN ECONOMY, PERIOD 1946 TO 1966

To begin with, it must be said that cocoa beans, together with cotton, sugar, rubber, and coffee, constitue the most important agricultural product insofar as the export sector of the Brazilian economy is concerned.[51] As a matter of fact, coffee has been the major source of income as well as foreign exchange revenue for the entire economy, although some efforts have been made to diversify the agriculture structure of the rural areas.[52] In this sense cocoa beans and the above-mentioned products have made some contributions to the export sector, and since cocoa is the major concern of this study, reference should be made to its participation and performance within the Brazilian economy. To attain such a task, comparisons should be made with other products, especially

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[50] Of the major producing countries such as Ghana, Nigeria, Brazil, Ivory Coast, and Cameroon, only Brazil has been doing any substantial grinding. Cocoa Statistics, Gill and Duffus, London, England, October, 1968, pp. 10-13.

[51] Projections of Supply and Demand for Agricultural Products of Brazil, F.G.V., Brazil, July, 1968.

[52] The main cause for this dependence upon coffee as a source of internal income and namely of exchange revenue seems to be found on the agricultural policy followed in the period--1947 to 1960-- which overvalued the exchange rate to avoid declines in the level of international coffee prices, and also the adoption of the doctrine that "the country exports only the surplus which is left over after domestic market for the commodity has been adequately supplied even if the internal prices are lower than world market prices." N. H. Leff, Economic Policy Making and Development in Brazil, 1947-1964, Columbia University, New York, 1968, p. 81.

coffee to have some idea of what the figures to be dealt with may represent. In analyzing the figures it must be kept in mind that the coffee production has been comprised to 20 states in Brazil, especially São Paulo, Paraná, Minas Gerais, and Espírito Santo where the economic structure differs to some extent from the other areas, but 95 percent of the cocoa production has originated from Bahia.

For this reason attempts to evaluate the contribution of cocoa beans to the entire economy may be meaningless in terms of impact on any one group or region,[53] but it gives some idea of its overall national importance.

Formation of Internal Income

One of the elements which stresses the importance of cocoa production within the Brazilian economy is the fact that 0.4 percent was the average participation of cocoa in the Internal Income of this country in the period 1946 to 1966, Table 12. The importance of this figure becomes even greater when compared to that of coffee, the most important agricultural product within the sector which contributed 4.1 percent to the Brazil's Internal Income in the same period.

Taking into consideration not only the income directly generated by cocoa production but also that originated from other sectors of the cocoa marketing system, the contribution to the Internal Income may amount to a 1 percent, which may be viewed as a significant figure within

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[53]The comparison could result in better overview of its importance if it was made with the geographical region where the State of Bahia is comprised.

Table 12. Participation of Cocoa Beans and Coffee in Internal Income, Period 1946-66

Year	Internal Income (1)	Coffee Production Value (2)	Cocoa Beans Production Value (3)	Participation of Coffee Production Value over Internal Income	Participation of Cocoa Production Value over Internal Income
	NC$			Percent	
1946	---*	5.3	0.4	---*	---*
1947	140.2	5.5	0.7	3.9	0.5
1948	158.5	6.4	0.6	4.0	0.4
1949	181.6	8.5	0.6	4.7	0.3
1950	214.4	15.9	1.0	7.4	0.5
1951	254.5	16.6	0.9	6.5	0.4
1952	293.3	19.0	0.9	6.5	0.3
1953	300.3	21.4	1.7	5.9	0.5
1954	455.9	29.8	3.7	6.5	0.8
1955	579.1	41.5	3.3	7.2	0.6
1956	733.6	30.5	2.5	4.2	0.3
1957	871.9	47.0	3.5	4.6	0.4
1958	1,056.2	48.6	4.6	4.6	0.4
1959	1,418.5	64.7	7.1	4.6	0.5
1960	1,902.8	77.5	8.0	4.1	0.4
1961	2,822.2	103.4	10.0	3.7	0.4
1962	4,406.8	158.2	12.8	3.6	0.3
1963	7.725.3	181.8	21.0	2.4	0.3
1964	14,766.1	294.4	47.7	1.9	0.3
1965	24,261.9	797.7	66.8	3.2	0.3
1966	33,729.5	604.7	97.7	1.7	0.3

*Not available.

Source: Anuário Estatístico do Brazil, Fundação IBGE, Brazil, 1967.

the considerations stated before. Table 12 shows the cocoa participation in Brazil's Internal Income.

From Table 12 it can also be seen that the participation of cocoa in the Internal Income grew to some extent, taking as a base its contribution in 1948 of 0.3 percent of the value of Internal Income. The increases which were observed reflected increases in farm price levels more than increases in the level of production or even in the area under cultivation.

Insofar as the participation of cocoa in the Internal Income of the individual Brazilian States is concerned, it must be emphasized that from 1960 to 1964, for which data are available, income from cocoa corresponded to about 18.2 percent of the Internal Income of the agricultural sector of the State of Bahia.[54] Unfortunately lack of additional information counteracts further comments about the effects upon the economic structure of the state.

Formation of Foreign Exchange Revenue

The importance of the cocoa sector within the general context of the economy cannot be measured only in terms of its participation in the country's Internal Income. The average of 4.9 percent in the formation of Brazil's exchange revenues for the period under observation is indicative that as a single commodity, and in an economy where coffee is the major source of revenue, it was and is a potential factor in Brazil's importing capacity.

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[54]The agricultural sector for this comparison included livestock, forest, and crops since lack of information does not allow more details of the contribution of each item within agriculture.

If the data presented in Table 13, particularly those of column 4, are broken down into two columns, in other words, if the computation is carried out over the total value of export minus coffee contribution, it can be seen that the importance of cocoa is even greater. In this connection its share reached the average of 12.3 percent over the total export considered herein.

The upward trend in the international cocoa prices, reaching the highest peak of 55.7 cents per pound in 1954, made the cocoa participation in the total Brazilian export value to increase as well, declining afterwards with decreases in the level of international price for this product.

Incidentally, the upward and downward movements coincided with the Brazilian exchange policy adopted in the post-war periods. From 1947 to 1952 this policy was characterized by a fixed and over-valued[55] exchange rate. During this period the cocoa exports decreased at a rate of 0.07 percent per year. From 1953 to 1960 even though there was some maladjustment between internal and external prices, the exchange rate showed less rigidity and the level of exports decreased at this period at a rate of 0.02 percent per year. From 1961 to 1966, although the level of production kept rising in absolute terms, the level of cocoa beans exports decreased a great extent as a result of the increasing level of internal "grindings." The level of export of cocoa products, such as cake, powder, and butter, increased somewhat but not sufficient in the aggregate to increase the cocoa participation in total Brazilian export value.

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[55]Leff, op. cit., pp. 80-81.

Table 14. Cocoa Beans and Coffee Participation Over Brazilian Agricultural Area, Production, and Value, Period 1946-1966

Year	Production of Cocoa Beans Over Total Agricultural			Participation of Coffee Over Total Agricultural		
	Area	Production	Value	Area	Production	Value
	Percent					
1946	1.4	0.1	1.6	16.2	1.6	21.3
1947	1.8	0.1	2.5	14.4	1.6	20.0
1948	1.8	0.1	1.8	14.9	1.7	20.0
1949	1.8	0.1	1.6	15.1	1.8	22.4
1950	1.6	0.2	2.1	14.8	1.7	32.9
1951	1.7	0.1	1.7	15.4	1.7	31.7
1952	1.6	0.1	1.4	15.2	1.6	29.9
1953	1.9	0.1	2.1	14.4	1.5	26.7
1954	2.0	0.2	3.7	15.1	1.3	29.8
1955	1.9	0.2	2.6	15.5	1.8	32.3
1956	1.9	0.2	1.8	15.9	1.1	22.5
1957	1.8	0.2	2.0	16.7	1.7	27.0
1958	2.2	0.2	2.4	18.2	1.9	25.6
1959	2.1	0.2	2.6	18.3	2.3	24.0
1960	2.0	0.2	2.1	17.7	2.0	21.1
1961	1.9	0.2	2.0	17.1	2.0	21.1
1962	1.9	0.1	1.3	17.0	1.9	16.8
1963	1.8	0.1	1.5	15.5	1.4	12.7
1964	1.7	0.2	1.0	13.0	1.6	11.4
1965	1.7	0.2	1.5	11.6	2.6	18.1
1966	1.7	0.2	1.8	10.7	1.9	11.0

Source: Anuário Estatístico do Brazil, Fundação, IBGE, Brazil, 1956, 1958, 1960, 1967.

Note: Brazilian total agriculture includes production of crops of rice, bananas, potatoes, beans, oranges, manioc corn, wheat, sugarcane, tobacco, castor beans, coffee, cocoa, cottonseed, which constituted the bulk of Brazilian agricultural production.

which are small, however, in the aggregate. Lack of data concerning with the age of cocoa trees and the kind of ownership in the sector avoids any further comment and analysis.

Share of the Brazilian Cocoa in the International Market

Although some comments were previously made about this subject, a more particular overview of the Brazilian cocoa participation in the international market in the period 1946 to 1966 will be made at this time.

As it was stated before, after World War II the international cocoa market has two clear periods, provided that the level of production is considered in the whole world. The first period was from 1946 to 1959, when the total production was unable to attain the one million long tons level, being on the average about 760,000 long tons. The second period was from 1960 to 1966, when the average was about 1,200,000 long tons.

The first period had as its main feature a substantial increase in the cocoa price level in the international market, rising from the pre-established ceiling of 8.9 cents per pound to 35.4 cents at the end of 1959, attaining the highest peak of 55.7 cents in 1954 and decreasing thereafter. In this same period Brazil's share in total world export increased from 17.5 in 1946-50 to 18.1 percent of the total world export in 1955-59, which may be considered as a small increment in the amount of cocoa beans being shipped to consuming areas (Table 15). Such a small development in the performance of Brazilian cocoa trade may be attributed to the tremendous reduction of the level of United States imports--a

Table 15. Brazilian and World Cocoa Beans Net Exports, Period 1946 to 1966

Year	Net Exports			Brazil's Export As A Percent of the World's Export	Other Areas' Export As A Percent of the World's Export
	Brazil (1)	Other Areas (2)	World (3)		
	-------1,000 long tons -----			---------- Percent ----------	
1946	128	502	630	20.3	79.7
1947	97	473	570	17.0	83.0
1948	72	510	582	12.4	87.6
1949	130	582	712	18.3	81.7
1950	130	600	730	17.8	82.2
1951	95	570	665	14.3	85.7
1952	57	554	611	9.3	90.7
1953	107	615	722	14.8	85.2
1954	119	563	682	17.4	82.6
1955	120	568	688	17.4	82.6
1956	137	613	750	18.3	81.7
1957	108	666	774	13.9	86.1
1958	102	526	628	16.2	83.8
1959	78	659	737	10.6	89.4
1960	123	759	882	13.9	86.1
1961	103	896	999	10.3	89.7
1962	54	965	1,019	5.3	94.7
1963	68	956	1,024	6.6	93.7
1964	74	942	1,016	7.3	92.7
1965	90	1,195	1,285	7.0	93.0
1966	111	981	1,092	10.2	89.8

Source: Cocoa Statistics, Gill and Duffus, London, England, October, 1968, pp. 18-19.

decrease from 83.3 to 37.8 percent of the total world imports in the periods 1946-50 to 1955-59, respectively.

In the next period, from 1960 to 1966, there was a remarkable decline in the share of Brazilian cocoa beans in the international trade. In fact, from the period 1960-61 to 1965-66 their participation decreased from 12.0 to 8.5 percent, respectively. This decline in the level of Brazilian share coincides with the decrease which was observed in the international cocoa price, which was 35.4 cents in 1959 and 23.0 cents per pound at the end of 1966. The United States share of the world imports rose from 31.3 to 45.0 percent in the period cited as references.

Interesting to observe at this point is the fact that in the first period the cocoa production increased from 123,000 long tons in 1946-50 to 160,000 long tons in 1955-59; however, in the next period there was a declining in production from 160,000 to 140,000 long tons from 1960-61 to 1965-66, respectively (Table 16). The differences between the figures concerned with production and those of exports may be explained by the amount of cocoa beans being "grinded" both for internal consumption and for exports--cocoa butter, powder, and cake.

CHAPTER III

ECONOMIC THEORY AND THE COCOA ECONOMY FRAMEWORK

In the preceding chapter a broad overview of cocoa production and trade patterns as well as the main factors affecting the international market and production of cocoa beans was given. This chapter will endeavor to give a brief review of some economic concepts in order to provide a rationale for analyzing certain relationships in the cocoa economy as well as to give a basis for the econometric model of the Brazilian cocoa price behavior in the international market to be proposed in the next chapter.

I. ECONOMIC CONSIDERATIONS ABOUT PRICE DETERMINATION AND PRICE MOVEMENTS

Theoretically, prices are determined by the economic forces which govern the demand and supply structure of a product in a given market. A demand curve may be defined as a schedule showing the quantities which will be taken in the market at all possible prices at a given time, while other factors like prices of other commodities, consumer's money income, and so on remain constant.[57] Supply schedule of a product is

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[57] C. E. Ferguson, Microeconomic Theory, R. D. Irwin Company, 1966, p. 39. From the foregoing statement it may be concluded that, in general, the demand curve slopes downward to the right. One possible circumstance under which this concept does not hold relates to a situation of strong anticipatory demand, or speculation if consumer's view an initial rise in price as a signal for further increases. As a result, they will, in general, increase their purchases to counteract the anticipated increase.

defined as the various quantities of good which sellers will place on the market at all possible alternative prices, other things being equal.[58] The total supply is primarily a function of the past prices of the product, and also the prices of other products which the firm can produce, the prices of factors of production, and state of the arts. In general, the slope of the supply function is upward to the right, in other words, its slope is positive; the higher the price, the greater the quantity sellers will be willing to place on the market and the more sellers entering the market.

If market demand remains constant whereas costs of production are reduced, prices in a competitive market will fall; consequently, output will increase less than if price had remained at its previous level, and the quantity demanded will increase somewhat above its previous level. Shifts in the market demand curve due to changes in other factors affecting the demand function will also influence market prices and, hence, the quantities produced by suppliers.

The concept of price determination as stated may be viewed as a static one. Under real conditions, however, shifts in both supply and demand functions of a given product may occur. As a result, the price, and consequently the production, may also move from the equilibrium point supposed to exist in a static world. These shifts may occur due to changes over time in any of the variables affecting either the supply or the demand function. To estimate the effects that those variables

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[58] R. L. Kohls, Marketing of Agricultural Products, MacMillan Company, New York, 1968, p. 135.

may have upon price and production specific economic parameters are widely used, namely the price, income, and cross elasticity coefficients calculated on the grounds of past behavior of economic variables affecting particular markets.

Assuming, however, that no structural changes occur in factors such as consumers' income, tastes and preferences, prices of other products, the level of technology, the price of inputs, and the price of other products a firm can produce, how can one explain the prive movements in agricultural economy? How may one explain the departures from an equilibrium point expressing the amount of a given commodity that producers are willing to supply and the amount of the same commodity which consumers are willing to take out of the market at a given price level?

The Cobweb Theorem developed by Mordecai Ezekiel explains the commodity price-output sequences in agriculture by making use of the traditional concepts of supply and demand schedules. The Cobweb analysis is a semi-dynamic type of analysis where the relevant demand and supply relations do not shift during the time span under consideration.

Before further explaining the Theorem, it must be stressed that it takes two concepts of supply related in the time sequence to make the analysis function:[59] (1) the supply relation concept which describes those quantities of a commodity that producers plan to supply at varying prices; and (2) the supply relation which describes at the close of the

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[59]W. W. Cochrane, Farm Prices: Myth and Reality, University of Minnesota Press, Minneapolis, 1964, p. 63.

growth or production period those quantities of a commodity that producers stand ready to offer on the market at varying prices. Since it is assumed that most agricultural products are perishable, and that in general producers have poor storage facilities, it is assumed that the second supply relation is highly or perfectly inelastic.

Depending upon the elasticity of both demand and supply functions, the Cobweb Theorem can be viewed under three aspects pertaining to price movements: (1) "continuous fluctuation," where the coefficients of elasticity of both functions are equal in absolute terms; (2) "divergent fluctuation," where the elasticity of supply is greater than that of demand; and (3) "convergent fluction," the reverse situation of the second case, with supply less elastic than demand.

In the first case, the continuous fluction, Figure 1, helps to understand the patterns of price and production movements.

Assume that Q_1 is the amount of commodity supplied to consumers. This quantity generates a relatively low price at P_1, but at this price level producers will be willing to offer a relatively small amount of a product at Q_2 in the next period. This short supply intercepts the

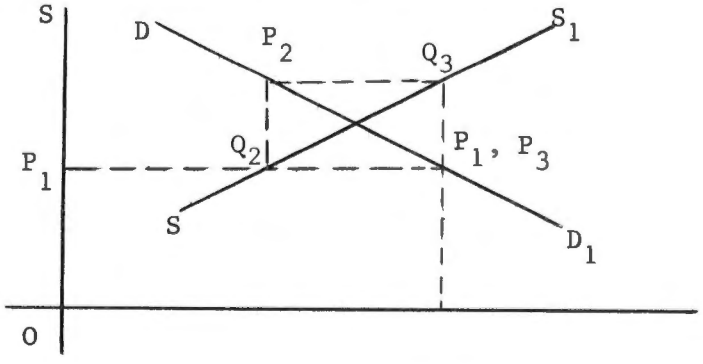

Figure 1. The continuous price fluctuations.

demand curve DD' at P_2 price level (higher than the previous one) which, on the other hand, calls forth a corresponding low price P_3. Note that P_3 is equal to P_1, the price level observed in the first period, and the same pattern is re-established without attaining any equilibrium point.

The divergent fluction aspect of the Theorem may be explained by Figure 2. Note that now the supply elasticity is greater than that of demand.

Beginning with the level of production Q_1, the corresponding price P_1 is attained, which is the price that consumers are willing to pay at this level of output. This in turn generates a desire on the part of the production sector to supply the amount Q_2 in the second period. At this level of production price P_2 is attained in the market which will induce producers to offer the amount Q_3 of the commodity for consumption during the third period. However, such a production will depress the price to P_3 which in turn reduces the level of output to Q_4 in the fourth period, and so on. Under these conditions the situation may continue to

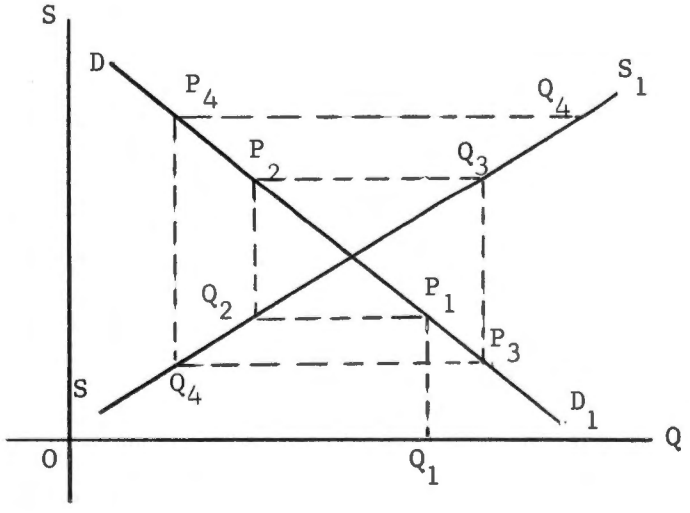

Figure 2. The divergent price fluctuation.

follow this pattern until price falls to zero and production is completely abandoned.

In dealing with the last aspect of the Cobweb Theorem, in which the reversed situation may be observed, it may be said that this is only the case which behaves in the manner assumed by the equilibrium theory. The price and production levels converge even faster to the equilibrium point if the supply curve is markedly less elastic than the demand curve.

The Theorem explained above helps one to understand the short production and short price movements. The longer cycles which may likely happen to some commodities are explained by extending the same principles used before; they may not follow, however, the same regular pattern of price variability. There are at least three generic reasons which account for this: (1) a change in the demand for the commodity to be studied during the growing season, (2) the influence of technological advance changing the schedule of intentions of production, and (3) the influence of many factors beyond the producers' control such as weather, and so on, which may not help the planned output to be realized. Summarizing, it may be said that "the equilibrium price is that price toward which actual price will tend to move."[60]

II. THE COCOA PRICE FLUCTUATIONS--THE LONG, INTERMEDIATE, AND SHORT TERMS

One of the main characteristics of the world cocoa economy is the well-known widespread price fluctuations in the international market.

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[60] Kohls, op. cit., p. 189.

Following the economic theory such movements may be classified under three categories:[61] long term, intermediate term, and short term. The short-term fluctuations, reflecting variations in price occurring from hour to hour, day to day, and even week to week, may be viewed as a result of the speculative forces which happen to prevail in the world's cocoa markets. Regarding the long-term price movements and based upon the theory developed in the prior section, it may be said that the dynamics of cocoa price fluctuations follow the traditional Cobweb line of reasoning. Although response to price changes varies considerably from one producing area to another, this general pattern is implied by Weymar:[62]

> (1) A period of low prices, such as the 1930's and early 1940's, causes a decline in new planting; (2) after substantial delay required to clear the pipeline of maturing trees, production begins to level off and perhaps decline (e.g., the production plateau lasting from 1939 to 1955); (3) with the normal growth consumption begins to outpace production, causing inventories to fall; (4) cocoa prices climb (e.g., the late 1940's and most of the 1950's), bringing a revival in new planting, and starting the second half of the cycle.

The length of the period between peaks and troughs is primarily a function of the average time from the new plantings to the peak production of cocoa trees. As stated in Chapter II, 13 years has been the average time required for significant changes in the level of production in the world market. As may be expected, this figure varies from country to country. A recent empirical study carried out for the Brazilian cocoa production points out that "there exists a cocoa price cycle of an average length of 14 years, thought to be due to a Cobweb-like

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[61] Weymar, op. cit., p. 6.

[62] Ibid., p. 6.

relationships between price and production."[63] Other studies on the grounds of production hypothesis suggest different time lags. Bateman, for example, indicates a period varying from 8 to 14 years for Ghanian long-run responses to cocoa price changes. A ten-year lag period is suggested by Wehner for Nigeria,[64] and Viton, indicates a lag og eight years by using three-year moving averages.[65]

The intermediate-term fluctuations in cocoa prices, consumption and production represent the response of cocoa industry system to annual variations in the world production of cocoa beans. A crop shortage may cause inventories and expectations regarding future inventories to fall, increasing, as a result, the level of prices. After adjustments lag, consumption and consumption expectations decline to a level close to the short crop. However, not before inventories have been further depleted, the continuous price increasing forces consumption to be reduced below the production rate. As a result the inventory decline is reversed and the price now begins to fall. However, the consumption rate does not end its decline until after an adjustment lag. At this stage the inventory level is well up from its through and increasing even further. The

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[63] J. S. Weiss, A Spectral Analysis Approach to Brazilian Cocoa Supply Structure, a paper presented at FAO Technical Working Party on Cocoa Production and Protection, Rome, Italy, September, 1966, p. 4.

[64] References are made by J. S. Weiss in his paper to M. J. Bateman, "Aggregate and Regional Supply Functions for Ghanian Cocoa, 1946-62," Journal of Farm Economics, Vol. 42, pp. 384-401; and H. G. Wehner, Jr., "The Cocoa Marketing Board and Economic Development in Ghana," unpublished Dissertation, University of Michigan.

[65] Cocoa: A Review of Current Trend in Production, Price and Consumption, p. 37.

level of price continues to decline; the consumption begins to increase due to the low level of prices and the second half of cycle begins again.

Figure 3 may help to visualize the entire structure mentioned in the preceding lines.

III. MARKETING ORGANIZATION AND OPERATION

Considerations about the role of demand and supply structure in determining the price of commodity were developed in the preceding sections, but the notion of market has not yet been developed herein.

Marketing can be defined as being "the performance of all business activities in the flow of goods and services from the point of initial agricultural production until they are in the hands of the ultimate consumer."[66] From the definition it can be said that one of the important characteristics of the market is its dynamic behavior. In bringing the product to the consumer sector a series of actions usually takes place in some normal pattern. From this it may be concluded that some sort of coordination is required in connecting the production sector to the consumption sector. Between the two sectors is the "marketing system" composed of business firms engaged in physical and technological activities, and also of those organizations whose activities involve the mechanics of establishing the selling prices as well as the arrangements, contacts, and organizations which provide an orderly flow of the production.

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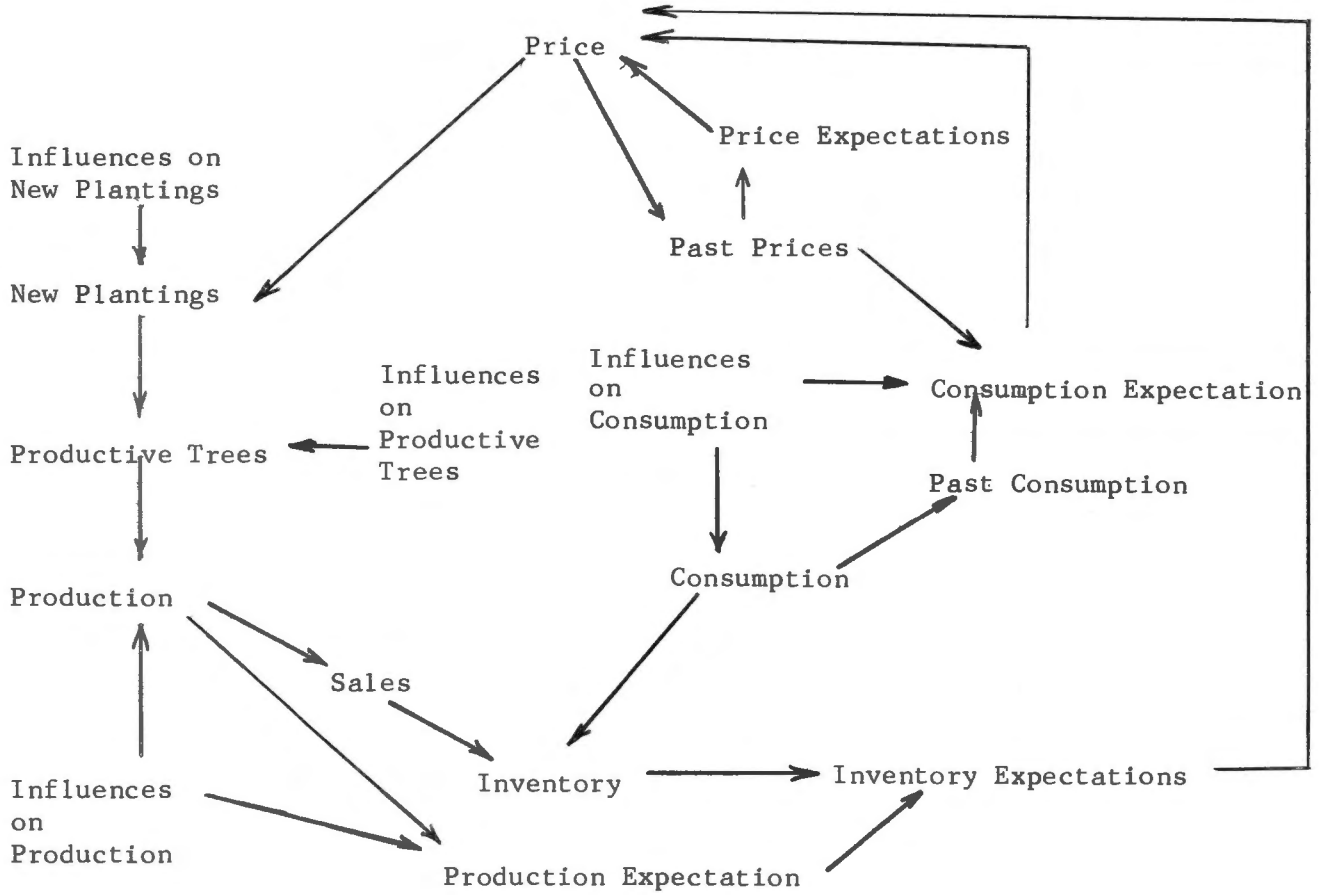
[66] Kohls, op. cit., p. 9.



SOURCE: H. F. Weymar, The Dynamics of the World Cocoa Market, M.I.T. Press, Cambridge, Massachusetts, 1968.

Figure 3. Interactions among price, production and consumption in cocoa economy.

The organization of the marketing may vary according to the type of product to reach the consumers' sector. For each commodity various agencies have been arranged in different ways, which constitute what are called the "marketing channels." Marketing channels are divided into two categories:[67] centralized and decentralized channels. In the first case the bulk of production is commercialized in large central and terminal markets by those engaged in the business of a particular product. A decentralized channel is characterized by the fact that such establishments are not used in selling and buying operations; instead, businessmen make their purchase directly from the producing points.

From this idea of marketing channels the concept of "market" comes about. In economic analysis the term "market" refers to that area or space wherein all the buyers and sellers are highly sensitive to the transactions made by each other.[68] It is in this market that the demand and supply forces are met and prices are determined for all commodities going to consumption. In this connection the area of a market may be determined by the commodity under consideration, the degree of communication between buyers and sellers, and the physical characteristics of the product itself which permits its movement among buyers and sellers. Used in this sense, then, markets may be classified into local, regional, national, or international in extent.

In general, and this is true for most of the commodities internationally traded, the buying and selling operations take place in

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[67] Ibid., p. 31.

[68] Ibid., p. 150.

terminal markets or exchange centers where the trade is largely carried out either on a cash or future basis (through its legal instrument: future contract).

As far as prices are concerned, there is no difference between cash and future quotations by the time the contract is due. Most of the difference between them in the period prior to maturity is due to the amount of the costs of holding the commodity. However, the level of prices in both operations do not follow the same pattern of fluctuations since situations may arise changing the expectations concerned with future transactions.

In the determination of price for selling and buying operations it may be said that future quotations do not establish the cash basis for negotiations but have some effect on it. The real contribution of future trading, to both production and consumption sector, may be that "of lessening both the seasonal fluctuation of prices and the extent of price change from one season to another."[69]

IV. THE COCOA MARKET PROCESS IN PRODUCING AREAS

Because the economies of several cocoa producing areas depend on the trade of cocoa beans as a major source of their foreign exchange revenue and also because the bulk of production comes from numerous small holders[70] as shown in Tables 17, 18, and 19, some kind of government

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[69] Ibid., p. 343.

[70] The only exception seems to be Brazil, Venezuela, Ecuador, and much of the Caribbean area. Wickizer, op. cit., p. 276.

Table 17. The Distribution of Cocoa Holdings in Gold Coast

Size	Percent of Holdings	Total Area	Percent of Total Area in Cocoa Beans
Hectares		1,000 hectares	
Less than 0.5	71.0	149.7	20.6
0.5 to 2.0	20.8	287.3	39.4
2.0 to 4.0	8.0[a]	271.1[a]	37.2
4.0 to 10.0	0.2[b]	20.2[b]	2.8

[a]From 2.0 to 10.0 hectares.

[b]10 hectares and over.

Source: A Review of Current Trends in Production, Price, and Consumption, FAO Rome, Italy, November, 1955, p. 17.

Table 18. The Distribution of Farms and Cocoa Cultivations by Size in Nigeria

Size	Total Farm Land		Cocoa Land	
	Percent of Farmers	Percent of Total Area in Farms	Percent of Farmers	Percent of Total Area in Cocoa Beans
Hectares				
Less than 1.0	3	0.2	50.0	17
1.0 to 2.0	10	2.0	25.0	20
2.0 to 4.0	27	8.0	18.5	30
4.0 to 8.0	30	20.0	5.0	19
8.0 and over	30	70.0	1.5	14

Source: A Review of Current Trends in Production, Price, and Consumption, FAO Rome, Italy, November, 1955, p. 17.

Table 19. The Distribution of Cocoa Farms by Size in Ivory Coast

Size	Percent of Farmers
Hectares	
Less than 0.5	0.5
0.5 to 2.0	19.0
2.0 to 10.0	79.0
10.0 to 40.0	1.0
40.0 and over	0.5

Source: A Review of Current Trends in Production, Price and Consumption, FAO Rome, Italy, November, 1955, p. 19.

intervention in the trade sector is quite understandable. The direct participation of the government began during World War II when organizations were set up in the major producing areas. In West Africa the British Government undertook to control the sources of cocoa supply, soon after the war started, to insure growers against loss of markets. In Brazil official control was introduced in 1938, even though the Instituto de Cacau da Bahia was created in 1931.[71] Since the World War II, however, many modifications have been introduced and adapted in the marketing systems of the producing areas.

In Ghana, the largest cocoa producer in the world, all of the product is purchased by the "Ghana Agricultural Produce Marketing Board" or its subsidiary the "Cocoa Marketing Company, LTD." These buyers have the prerogative of selling Ghana's cocoa to the world market. Each season the board fixes the price to be paid to the farmers with differentials provided for certain grades. This in turn protects the farmer from price fluctuation in the international market.[72]

In Nigeria each geographical region has its own Board. The "Western Region Board" is the most important of these since the bulk of Nigeria's production comes from this region. The Boards set the price support for each cocoa season.

In the formerly French areas of Africa "Stabilization Funds" were set up by the government in the 1950's. At the beginning of each season they fix the prices for the farmers and an equivalent price to the

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[71] Wickizer, op. cit., p. 341.

[72] Cocoa, p. 19.

exporters. Sales to the world market, however, are negotiated by private exporters. When the international price level is higher than that previously established, they must rebate all or part of the difference to that fund or vice-versa.

In Brazil[73] during World War II, the Brazilian Cocoa Institute was in charge of all purchases of beans from producers and sales into the international market. In the cases of areas distant from the Institute's branches, independent buyers usually resold the beans as their own to this organization. However, after 1947 the Institute ceased part of this operation leaving to private enterprise the biggest part of all business transactions. As a matter of fact, the Institute's participation in all business transactions decreased from about 26 percent in 1948 to 2 percent in 1964. The Cooperatives' share on the other hand increased from about 11 percent to 17 percent in the period above.

One particular point must be emphasized; presently, all the transactions are submitted to the Bahian Cocoa Commerce Commission (CCCB), a private commission composed of representatives of all exporting organizations dealing with cocoa business. The basic function of the CCCB has been to prevent rebating and other illegal transactions by requiring each one of them to be made at a price no less than slightly below the going prices. The Commission is officially recognized by the Bank of Brazil,[74] even though this Bank "rubberstamp" each transaction

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[73]The description of the marketing process in Brazil is based upon recent study carried out by J. S. Weiss in an unpublished Master's thesis entitled "A Spectral Analysis Approach to Brazilian Cocoa Supply Structure," University of Florida, 1966.

[74]The Government Credit Institution in Brazil.

for foreign markets. From each foreign contract the Government deducts a pre-established level of percent so-called "retenção cambial."[75] After obtaining the Bank of Brazil approval of the transaction, an embarkation permit is issued completing the exportation process.

In 1965 when the cocoa prices were very low, the Planning Executive for the Economic and Rural Development of Cocoa Culture (CEPLAC) was put in charge of establishing a minimum farmer price. Although this has not been primarily the official purpose of this Commission, it was apparently chosen since it was the federal organization and with a number of experienced administrative personnel connected with the Bank of Brazil.

Other organizations such as the Commission of Economic Planning (CPE), an independent planning agency of the State of Bahia, the Institute of Economic and Finance of the University of Bahia, a research division, and the Superintendency of Development of the Northeast Region (SUDENE) has been interested in planning the development of the region.

As far as industrialization of cocoa beans in Brazil is concerned, the low rate of its expansion is perhaps due to two main factors: first, the high tariffs on cocoa by-products in the European Economic Community countries, and, second, the commercial quality restraints imposed by

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[75] In 1961 the following taxes were levied directly upon cocoa beans on the value at first sale: 1 percent work welfare tax, 11.05 percent state sales tax (levied at each transaction), 3.3 percent or 6.7 percent municipal tax depending upon the "municipio" (county); on the final export value the following were levied: 7 percent state export tax, 15 percent as "retenção cambial" (federal), 1 percent extension tax (to support the Bahian Cocoa Institute), and 1.224 percent export tax by the municipio (county) of Ilhéus.

manufacturers in the foreign consuming areas. The first factor has been counterbalanced by the establishment of an exchange discount for cocoa butter and cake smaller than that imposed on beans.

V. THE INTERNATIONAL COCOA MARKET OPERATION

The main international cocoa markets in the world are located in New York and London. Other markets of less international significance are situated in Amsterdam, Hamburg, Paris, and Antwerp.

The New York and London markets interact rather closely although some difference in the quotations in these two markets exists.[76] The United States is the main market for Brazilian cocoa although European countries had increased their cocoa purchases from Brazil.

As it was stated, production of cocoa does not change significantly in the short run due to variations in the market price. The amount of new cocoa available in any particular period has therefore to be taken as predetermined. The economic function of the cocoa markets throughout the world has been therefore to establish a price at which demand is brought to the level of supply.

The New York market may be divided into two sections so-called the actuals market and terminal market. It is the terminal market that comprises the bulk of operations of the New York cocoa exchange.[77]

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[76] Some of them are due to differences of quality of cocoa which the quotations referred. Organization for European Economic Cooperation, Cocoa: The Main Product of Overseas Territories, Paris, O.E.E.C., June, 1956, p. 100.

[77] In London, however, manufacturers buy most of their cocoa on the actuals market.

Little cocoa changes hands in the terminal market, which is fundamentally concerned with paper transactions, the most important of them being the "cocoa future contract." This legal instrument is tied up to a unity purchase of 30,000 pounds of cocoa at a stated price for delivery in some stated month.[78] The contract may be sold or bought before the maturity date is reached.[79]

The main feature of terminal cocoa market as in any other future commodity market is the possibility of minimizing commodity marketing and processing losses which are due to price fluctuations. This procedure is usually called "hedging" which calls for some specialized knowledge and skill.

Actually, the hedging operation in the cocoa market may be of to sorts. First, "the sale of one or more cocoa future contract to eliminate or lessen the possible decline in value of a purchase of an approximately equal amount of actual cocoa"[80] is called a short hedge operation; and, second, "the purchase of one or more future contracts to eliminate or lessen loss from the possible advance in the value of the actual cocoa needed to fill a forward sale of either cocoa or any of its products"[81] is in turn called a long hedge operation.

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[78]Under Exchange regulations, the delivery month may be the current month or any one of the ensuing 14 months; however, most trading is confined to March, May, July, September, and December positions.

[79]Normally, the selling and buying operations of cocoa future contract may be carried out under two types of transactions: a "market order" (a purchasing whatever the level of price may be), and "limited order" (a transaction at a determined price level in the market).

[80]Understanding the Cocoa Market, New York Cocoa Exchange, Inc., New York, 1968.

[81]Ibid.

It may be noted that in the cocoa market both the grower, the importer, and the manufacturer may hedge to protect themselves against a wide variation on the cocoa price level.

The New York Cocoa Exchange is also a useful medium for price fixing or hedging in "cocoa products." By the nature of its delivery contract the cocoa product futures market is directly tied to that of cocoa bean market. The parallelism in price behavior between certain cocoa products and cocoa beans makes it possible to employ futures effectively in hedging or pricing these products. For example, cocoa liquor prices tend to move together with cocoa bean prices; however, the prices of powder and butter--products directly obtained by pressing cocoa liquor--follow different patterns; cocoa butter prices tend to move in unison with bean prices, "but cocoa powder do not, or at least not with the same regularity."[82]

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[82] Cocoa, p. 53.

CHAPTER IV

GENERAL PROCEDURE

This chapter shall present a set of functional relationships connecting certain economic variables assumed to directly affect the Brazilian cocoa prices in the world market. These relationships were postulated on the basis of economic theory, evidence from existing empirical studies, and the judgment about the factors most relevant to the commodity market.

Before presenting the set of variables related to the subject of this chapter, some of the problems involved in constructing a model like that proposed by this study must be pointed out. Brazilian cocoa exports fluctuated to some extent throughout the entire period from 1946 to 1966. Since exports are closely correlated to production, factors affecting the late such as weather, pests and diseases, and so on, contributed to a large degree to fluctuations in the level of cocoa shipments to overseas. Apart from these factors which may have contributed considerably, these fluctuations reflected also the actions of several other factors like changes in monetary, fiscal and exports policy, and so on. In general, cocoa, as any other agricultural commodity traded in the international market, is sensitive to these factors. Because of lack of information the model presented in the next chapter did not take their influence into account. The time period of the study raised other problems in limiting the statistical model to some economic factors more

relevant to the study.[83] Such limitations come primarily from lack of statistical data on the basis, for example, of quarterly period for all variables to be dealt with. Facing these problems and limitations the hope was that errors due to incomplete knowledge were not as serious as to jeopardize the results achieved by this study. The size of the explained residual provided a statistical measure of the effects of omitted variables.

I. DEFINITIONS OF VARIABLES

Four exogenous or predetermined variables which were assumed to affect the Brazilian cocoa price level were selected (Table 20). From this set of variables four equations were set up on the basis of statistical and economic theory. Endogenous variables are indicated by letter Y, and letter X has been used for predetermined variables appropriately subscripted. This nomenclature was adopted in the present study. The following were the variables selected.

Y_1 - The annual average wholesale New York spot price of Brazilian cocoa exports in cents per pound deflated by the BLS wholesale price index (1957-59 = 100).

Y_1' - The simple annual average wholesale New York spot price of Brazilian cocoa exports in cents per pound.

X_1 - The level of cocoa production in Brazil in thousand long tons per year.

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[83] Recall that the period of analysis adopted in the present study is that from 1946 to 1966.

Table 20. Average Wholesale Brazilian Cocoa Price, Cocoa Production in Brazil and Other Areas, Cocoa in Stock in Consuming Areas, and the Wholesale Price Index, Period 1946 to 1966

Year	Average Wholesale New York Spot Price (1) Brazilian Cocoa	Cocoa Production Lagged One Year (2) Brazil	Cocoa Production Lagged One Year (2) Other Areas	Cocoa Beans in Stock in the Consuming Areas (3)	The Wholesale Price Index (4)
	------- Cents/Pound ------	---------- 1,000 long tons ----------			
1946	12.1	138	514	162	66.1
1947	34.4	103	511	143	81.2
1948	39.0	83	510	204	87.9
1949	21.2	143	630	171	83.5
1950	29.2	148	612	216	86.8
1951	35.1	153	650	134	96.7
1952	35.8	55	587	125	94.0
1953	34.9	140	618	161	92.7
1954	55.7	163	613	232	92.9
1955	36.2	140	662	244	93.2
1956	25.5	168	675	226	96.2
1957	30.5	160	738	143	99.0
1958	43.3	161	612	174	100.4
1959	35.4	172	736	274	100.6
1960	26.8	198	841	421	100.7
1961	22.4	122	1,053	424	100.3
1962	21.3	116	1,007	425	100.6
1963	26.5	111	1,049	449	100.3
1964	23.2	123	1,097	594	100.5
1965	16.9	116	1,369	416	102.5
1966	23.0	171	1,038	353	105.9

Source: From column (1) to column (3)--Cocoa Statistics, Gill and Duffus, London, England, October, 1968; column (4)--Agricultural Statistics, U.S.D.A., United States Government Printing Office, Washington, D.C., 1967, p. 562.

X_2 - The production of cocoa beans in other producing areas in thousand long tons per year.

X_3 - The volume of cocoa beans in stock in consuming areas in thousand long tons at the end of preceding year.

X_4 - The wholesale price index calculated by the Bureau of Labor Statistics (1957-59 = 100).

II. THE MODELS AND ECONOMIC RATIONALE

As it may be seen, there was just one part in the model presented which may be summarized by the following relations:

$$Y_1 : X_{1_{(t-1)}}, X_{2_{(t-1)}}, X_3. \qquad 4.1$$

$$Y_1 : X_{1_{(t-1)}}, X_{2_{(t-1)}}, X_3, X_4. \qquad 4.2$$

Commas in the above relations are to be read as "and" while the colon is read "depends on."[84] In both relations the normalized variable was assumed to be related to the exogenous variables in additive rather than in multiplicative fashion; consequently, a linear relationship was assumed to exist. In this connection "ordinary least squares" technique provided valid estimates of the coefficients in the equations.

The main objective of this study, as it was stated in the introductory chapter of this thesis, was to determine the most relevant factors associated with variations in the level of Brazilian cocoa price,

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[84] R. J. Foote, Analytical Tools for Studying Demand and Price Structure, United States Department of Agriculture, Agriculture Handbook, No. 146, Washington, D. C., p. 8.

and consequently to establish a predictive equation for it. This in turn means that the price variable related to the Brazilian cocoa production was chosen as the dependent variable. Data for expressing the international price of Brazilian cocoa were those concerned with the U. S. market.[85] This was done on the grounds that, beside being the major consuming area of Brazilian cocoa, the U. S. market has been the most important area in the world as far as cocoa consumption. So, changes in this particular market quite reflected fluctuations in the other markets, as, for example, that in London.[86]

In accordance with economic theory, an inverse relationship between price and quantity of cocoa produced during the period of analysis was assumed to exist. The current levels of cocoa production in Brazil (X_1) and in other producing areas (X_2) were taken as being predetermined because total output is known prior to marketing.

Importers' current activity with regard to stocks (X_3) has normally an impact on current spot prices, and the latter also influences the stock demand. As a result, the stock variable was defined as exogenous.

The use of the wholesale price index in deflating prices follows the traditional economic theory dealing with forecasting, and with demand and supply studies. When used as an extra variable the price index is generally assumed to aggregate unmeasurable factors affecting a particular economy, and consequently the marketing of one commodity.

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[85]More specifically those quoted at New York Cocoa Exchange Market.

[86]Organization for European Economic Cooperation, Cocoa: The Main Products of Overseas Territories, Paris, O.E.E.C., June, 1956.

According to some of the aspects of the economic theory summarized in Chapter III cocoa production variables (X_1 and X_2) were lagged one year. The rationality behind this is explained by the fact that past year production has at least in the short run influence in the next year price following as result the Cobweb line of reasoning of variations in commodity prices.

III. STATISTICAL ASSUMPTIONS

In statistical terminology the model connecting economic factors which may affect the Brazilian cocoa price in the international market is a linear model. This means that the parameters of the structural equations appear in linear relations with the endogenous variable.

As an illustration of a linear model, consider the equation number (4.1) of the model to be proposed.

$$Y_{1_t} = B_o + B_1X_{1_t} + B_2X_{2_t}\ B_3X_{3_t} + B_4X_{4_t} + B_5X_{5_t} + B_6X_{6_t} + E_t$$

where Y and X are, respectively, endogenous and predetermined variables at time (year) t. The disturbance term "E_t" reflects the effects of unspecified variables as well as effects of random phenomena. The "B_i's" coefficients and the parameters of "E_i - distribution" are unknown and it is desired to derive estimates for these unknowns.

For convenience, the above equation may be written in matrix notation as $\underline{\overline{Y}} = \underline{\overline{X}}\,\underline{\overline{B}} + \underline{\overline{E}}$ where:

$\underline{\overline{Y}}$ is the vector of observation Y_i; in this study a column vector with 21 elements.

$\underline{\bar{X}}$ is the matrix of independent variables X_i's, in this case 21 x 4 matrix.

$\underline{\bar{B}}$ is the vector of parameters "B_i's" to be estimated; in this study a column vector with five elements.

$\underline{\bar{E}}$ is the vector of errors, in this case a column vector with 21 elements.

For estimation and testing purposes, several statistical assumptions have to be made. It is assumed, for example, that elements of $\underline{\bar{E}}$ are normally distributed with the expected mean value equals to zero and the variance equals to σ^{2}[87], and finally, that they are uncorrelated. Consequently, the regression equation in matrix form can be written as $E(\underline{\bar{Y}}) = \underline{\bar{X}}\underline{\bar{B}}$ '4.3 .

The error sum of squares is then defined by the following equations:

$$\underline{\bar{E}}'\underline{\bar{E}} = (\underline{\bar{Y}} - \underline{\bar{X}}\underline{\bar{B}})'(\underline{\bar{Y}} - \underline{\bar{X}}\underline{\bar{B}}) \qquad 4.4$$

or

$$\underline{\bar{E}}'\underline{\bar{E}} = \underline{\bar{Y}}'\underline{\bar{Y}} - 2\underline{\bar{B}}'\underline{\bar{X}}'\underline{\bar{Y}} + \underline{\bar{B}}'\underline{\bar{X}}'\underline{\bar{X}}\underline{\bar{B}} \qquad 4.5$$

where $\underline{\bar{Y}}'$, $\underline{\bar{X}}'$, $\underline{\bar{B}}'$, and $\underline{\bar{E}}'$ are the transpose matrices of $\underline{\bar{Y}}$, $\underline{\bar{X}}$, $\underline{\bar{B}}$, and $\underline{\bar{E}}$, respectively.

The least squares estimate of $\underline{\bar{B}}$ is the value of $\underline{\bar{B}}$'s elements (parameters B_i) which minimizes $\underline{\bar{E}}'\underline{\bar{E}}$. In other words, by differentiating equation 4.5 with respect to $\underline{\bar{B}}$ and equating it to zero the following relation is obtained.

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[87] σ^{2} is an indication of the variance in a total population.

$$(\underline{\bar{X}}'\underline{\bar{X}})\underline{\bar{B}} = \underline{\bar{X}}'\underline{\bar{Y}} \qquad 4.6$$

and

$$\underline{\bar{B}} = (\underline{\bar{X}}'\underline{\bar{X}})^{-1}\ \underline{\bar{X}}'\underline{\bar{Y}} \qquad 4.7$$

The main assumptions for obtaining the "B_i" values are that first, the "P" normal equations are independent, and, second, $\underline{\bar{X}}'\underline{\bar{X}}$ is nonsingular so that the $(\underline{\bar{X}}'\underline{\bar{X}})^{-1}$ does exist.

The solution of equation 4.7 gives estimation of $\underline{\bar{B}}$, which minimizes the error sum of squares $\underline{\bar{E}}'\underline{\bar{E}}$. Note that the assumption of normal distribution of $\underline{\bar{E}}$ is required for testing hypothesis.

For the model to be unbiased the variance of expected values of Y_i from the regression equations, and variance of E_i must be equal to variance about regression denoted by σ^2_{xy}, which in turn is estimated by the expected value of mean square of the residual or expected value of S^2 from the sample data. In summary, the following condition must be met: $V(Y_i) = V(E_i) = \sigma^2_{xy} = E(S^2) = \sigma^2$, 4.8

where

$V(Y_i)$ is the variance of expected value of Y_i from the established regression equation.

$V(E_i)$ is the variance of errors E.

σ^2 is the variance of the total population.

IV. ESTIMATION METHOD

A priori, it was assumed that the set of variables which were assumed to affect the Brazilian cocoa prices comprised the most important economic factors concerned with the problem. From that set a structural

equation was to be chosen including as many variables as possible, representing the "best regression equation" for attaining the objective of the study. In this connection the "stepwise regression procedure" was used. In general, this method starts with the correlation matrix; the first independent variable "X" to enter into regression is the one most highly correlated with the response. Using the partial correlation coefficient of the variables not in the equation, the next independent variable is chosen as the one most highly correlated with the response given the regression equation with two independent variables; next the method examines the contribution of the first variable "X" if the second one had been entered at the beginning of the procedure. By analyzing the F-ratio obtained from the analyses of variance for the equation the second variable may be retained. The method starts again by using the same criteria for entering or rejecting some additional variables.

In summary this seems to be the best of the variable selection procedures recommended by statistical theory.[88] One must, however, keep in mind throughout the entire process the original correlation matrix to avoid including independent variables highly correlated to each other, decreasing as a result the reliability of the net regression coefficient.[89]

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[88] N. R. Draper, and H. Smith, Applied Regression Analysis, Wiley and Sons, Inc., New York, 1966, p. 172.

[89] This can be seen from the formula for the standard error of the regression coefficients in the case of two independent variables: $S_{b_1} = s_{y.12}/\sqrt{\Sigma x^2_1 \ (1 - r_{12})}$ where r_{12} is the correlation coefficient between variables X_1 and X_2. The S_{b_1}, is smallest when r_{12} is zero, but as r_{12} approaches to one (perfect correlation), the denominator of the equation approaches to zero and S_{b_1}, becomes very large and the regression coefficient itself becomes unreliable. In case, however, when the purpose is that of production "then intercorrelation of explanatory variables may not be too serious, provided it may reasonably be expected to continue in the future." J. Johnston, Econometric Methods, McGraw-Hill, Inc., New York, 1963, p. 207.

As stated at the beginning of this chapter four equations were selected for estimating the dependent variable Y_1 and Y_1'. To select the best estimating equation, it was necessary to test and compare each of the equations from a statistical and economic standpoint. Primarily the test applied to the present study was the one explained by Fox[90] which provides a means to test the significance of the coefficient of determination with relation to the other coefficients of determination. The test was performed in a systematic manner by testing the equations against each other to determine if one was statistically superior to the other in its ability to estimate the Brazilian cocoa price level in the international market. Finally, economic consideration gave support to the equation established by the stepwise procedure.

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[90] K. A. Fox, Intermediate Economic Statistics, Wiley and Sons, Inc., New York, 1968, pp. 233-237.

CHAPTER V

ECONOMIC AND STATISTICAL ANALYSIS

In this chapter those economic factors affecting the international price level of Brazilian cocoa were analyzed by a stepwise method[91] in order to establish equations which would adequately estimate the price level referred before.

I. REGRESSION EQUATION ANALYSIS

As stated earlier, four exogenous variables were selected as most important in the determination of the Brazilian cocoa price level. Two sets of equations were previously established. In the first one, the endogenous variable Y was deflated by the appropriated wholesale price index and then related to the exogenous variables; in this case the response variable was appropriately indicated as Y_1. In the second set, the endogenous variable did not appear in real terms and the index was considered as extra exogenous variable; the response variable was indicated by Y_1'. In summary it can be rewritten that:

$$Y_1 : X_{1_{(t-1)}}, X_{2_{(t-1)}}, X_3. \qquad 5.1$$

$$Y_1' : X_{1_{(t-1)}}, X_{2_{(t-1)}}, X_3, X_4. \qquad 5.2$$

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[91] A stepwise regression analysis was performed by an electronic computer. The University of Tennessee Computing Center, "BMDO2R Stepwise Regression" version of December 17, 1965.

To begin with, the calculated correlation matrix of the original variables (Table 21) gives the statistical basis for selecting some of the exogenous variables which appeared first, highly correlated with the response, and second, for delecting those exogenous variables highly correlated with each other. However, economic consideration gave support for using some of them that were intercorrelated with each other to some extent.

In this connection two sets with two relations each were established for further statistical computation. In the first equation of the first set the deflated cocoa Brazilian New York spot price appeared in relation with the Brazilian cocoa production (X_1), the rest of the world cocoa production (X_2), and the cocoa stock level in consuming areas (X_3); in the second equation the response appeared in relation with the Brazilian cocoa production (X_1), and the cocoa stock level in the market (X_3). The economic rationale behind this is connected with the fact that, although variables X_3 and X_2 appeared with high coefficient of correlation, those factors have been important in the establishment of cocoa market price. In fact, one of the characteristics of cocoa economy is the predominance of large sellers and large buyers in the international market;[92] as a result, the two main economic forces affecting the international cocoa price have been the production level and the amount of cocoa beans held

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[92]It has been written that the cocoa market was dominated by large buyers and large sellers. For example, the Hershey Chocolate Company is by far the largest buyer and manufacturer of cocoa beans in the U. S. A. In the United Kingdom, the Cadbury's, Fry's, and Rorontries dominate the market taking together some 70 percent of the raw cocoa imported by the country. Organization for European Economic Cooperation, Cocoa: The Main Product from Overseas Territories, OCCE, Paris, 1956, p. 113.

Table 21. The Correlation Matrix of the Original Data

Variables	Annual Average N.Y. Spot Price of Brazilian Cocoa Exports, Not Deflated	Cocoa Beans Production		Cocoa Beans in Stock in Consuming Countries	The Wholesale Price Index	Annual Average N.Y. Spot Price of Brazilian Cocoa Exports, Deflated
		Brazil	Other Areas			
	Y_1'	X_1	X_2	X_3	X_4	Y_1
Y_1'	1.0000	0.0457	-0.5084	-0.4148	0.1035	0.9708
X_1		1.0000	-0.00378	0.0298	0.2183	-0.0303
X_2			1.0000	0.8523	0.6616	-0.6271
X_3				1.0000	0.5383	-0.5081
X_4					1.0000	-0.1080
Y_1						1.0000

Source: The University of Tennessee Computer Center, "BMDO2R Stepwise Regression," December 17, 1965.

by traders and manufacturers as inventories. In the second set of equations the same sort of criteria was adopted but the wholesale price index was used as an extra endogenous variable.

In summary the four equations related above may be written as follows:

$$Y_1 : X_{1_{(t-1)}}, X_{2_{(t-1)}}, X_3. \qquad 5.3$$

$$Y_1 : X_{1_{(t-1)}}, X_3. \qquad 5.4$$

$$Y_1' : X_{1_{(t-1)}}, X_{2_{(t-1)}}, X_3, X_4. \qquad 5.5$$

$$Y_1' : X_{1_{(t-1)}}, X_3, X_4. \qquad 5.6$$

The following results were obtained for each relation stated above:[93]

Relation (5.3)

$$Y_1 = 56.646 - \underset{(0.01663)}{0.032891}\, X_{2_{(t-1)}} + \underset{(0.02961)}{0.0082769}\, X_3 - \underset{(0.06271)}{0.011968}\, X_{1_{(t-1)}}$$

$$R^2 = 0.3733 \qquad Se^* = 9.2924$$

$$Fc = 3.733$$

Summary Table 22 provides additional information about the steps performed by the analysis.

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[93] The variables are shown in the order which they entered into the regression equation.

* Se is the standard error of estimate in cents.

Table 22. Steps Performed by the "BMDO2 Stepwise Regression Program," Relation (5.3)

Step Number	Variable Entered	Multiple R	Multiple R^2	F Value to Enter or Remove
1	X_2	0.6271	0.3933	12.3156
2	X_3	0.6291	0.3958	0.0759
3	X_1	0.6302	0.3733	0.0364

Relation (5.4)

$$Y_1 = 43.296 - 0.041702\ X_3$$

(0.01622)

$R^2 = 0.2581$ Se = 9.7503

Fc = 6.612 (Table 23)

Table 23. Steps Performed by the "BMDO2 Stepwise Regression Program," Relation (5.4)

Step Number	Variable Entered	Multiple R	Multiple R^2	F Value to Enter or Remove
1	X_3	0.5081	0.2581	6.612

The possibility of including other variables to increase the precision of estimate was dropped due to the fact that the "F-level to enter" of the variables not in equation was lower than that required by the analysis.

Relation (5.5)

$$Y_1'^{*} = -14.553 - \underset{(0.01374)}{0.0049714\ X_{2(t-1)}} + \underset{(0.22781)}{0.90478\ X_4} - \underset{(0.04739)}{0.044090\ X_{1(t-1)}} + \underset{(0.02143)}{0.012049\ X_3}$$

$R^2 = 0.6281$ $\quad$ Se = 6.6990

Fc = 6.755 (Table 24)

Relation (5.6)

$$Y_1' = -2.7673 - \underset{(0.01740)}{0.048754\ X_3} - \underset{(0.26007)}{0.50215\ X_4} - \underset{(0.06083)}{0.011009\ X_{1(t-1)}}$$

$R^2 = 0.3237$ $\quad$ Se = 8.7639

Fc = 2.712 (Table 25)

Summarizing the following equations were obtained by the stepwise analysis of the data presented in Table 20, page 79.

$$Y_1 = 56.646 - \underset{(0.01663)}{0.032891\ X_{2(t-1)}} + \underset{(0.02961)}{0.0082769\ X_3} - \underset{(0.06271)}{0.011968\ X_{1(t-1)}} \qquad 5.3$$

$R^2 = 0.3733$ $\quad$ Se = 9.2924

Fc = 3.733

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*Recall that Y_1' is the average wholesale Brazilian cocoa spot price (N. Y.) not deflated by the BLS wholesale index number.

Table 24. Steps Performed by the "BMD02' Stepwise Regression Program," Relation (5.5)

Step Number	Variable Entered	Multiple R	Multiple R^2	F Value to Enter or Remove
1	X_2	0.5084	0.2585	6.6225
2	X_4	0.7762	0.6025	15.5813
3	X_1	0.7879	0.6207	0.8164
4	X_3	0.7925	0.6281	0.3162

Table 25. Steps Performed by the "BMD02 Stepwise Regression Program," Relation (5.6)

Step Number	Variable Entered	Multiple R	Multiple R^2	F Value to Enter or Remove
1	X_3	0.4148	0.1720	3.9476
2	X_4	0.5678	0.3224	3.9948
3	X_1	0.5690	0.3237	0.0328

$$Y_1 = 43.296 - \underset{(0.01622)}{0.041702}\ X_3 \qquad 5.4$$

$R^2 = 0.2581$ Se = 9.7503

Fc = 6.612

$$Y_1' = -14.553 - \underset{(0.01374)}{0.04971}\ X_{2_{(t-1)}} + \underset{(0.22781)}{0.90478}\ X_4 - \underset{(0.04739)}{0.044090}\ X_{1_{(t-1)}} + \underset{(0.02143)}{0.012049}\ X_3 \qquad 5.5$$

$R^2 = 0.6281$ Se = 6.6990

Fc = 6.755

$$Y_1' = -2.7673 - \underset{(0.01740)}{0.048754}\ X_3 - \underset{(0.26007)}{0.50215}\ X_4 - \underset{(0.06083)}{0.011009}\ X_{1_{(t-1)}} \qquad 5.6$$

$R^2 = 0.3237$ Se = 8.7639

Fc = 2.712

Only equation 5.5 was significant at the $\alpha = 0.01$ confidence level.

To assess the significance of the equations indicated above and further selecting one for attaining the objectives of this thesis, a statistical test was carried out by looking at the significance of the increase in variation accounted for by adding variables in equations. In this sense, equation 5.3 was tested against equation 5.4, and the same criteria was applied to testing equation 5.5 against 5.6. In the first case Table 26 gave the necessary elements for performing the test of significance of the increase in variation accounted for by adding variables to equation 5.4.

Table 26. Analysis of Variance for Equations 5.3 and 5.4

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square
Linear Regression (5.3)	22,457.46		
Linear Regression (5.4)	22,119.06		
Additional Variation Accounted for by terms X_2 and X_1	338.40	2	169.20
Residual from Linear Equation (5.3)	1,468.00	18	86.35

The significance of the increase in variation can be tested by calculating: Fc = 169.20/86.35 = 1.931. By referring to an F-table ratio of mean squares based on two degree of freedom in the numerator and eighteen in the denominator (F_{α} = 0.01 = 6.01), it can be said that the increase in explained variation was not significant. In view of this result, another criteria was used; equation 5.3 was selected on the grounds that it showed a higher coefficient of determination coupled with a lower standard error of estimate when compared with equation 5.4

In the second case the following results were obtained for testing the significance of the increase in variation between equations 5.5 and 5.6 (Table 27).

From Table 27 Fc equals to 13.10 compared to the F-table ratios (F_{α} = 0.01, 1, 16 = 8.53) led to the conclusion that the increase in explained variation accounted for by adding variable X_2 (cocoa bean production from other areas) was significant. As a result, equation 5.5 was retained for further analysis.

Table 27. Analysis of Variance for Equations 5.5 and 5.6

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares
Linear Regression (5.5)	20,012.12		
Linear Regression (5.6)	19,424.12		
Additional Variation Accounted for by Term X_2	588.00	1	588.00
Residual from Linear Equation (5.5)	718.00	16	44.88

Finally, equations 5.3 and 5.5 were selected, and then analyzed from statistical and economic standpoint.

II. STATISTICAL AND ECONOMIC EVALUATION OF THE MODELS

To evaluate the reliability and statistical ability of the selected equations for forecasting the Brazilian cocoa price level in the international market, tests of significance of parameters were first carried out, and finally, data related to the specific variables were inserted into the selected equation.

Again, the following equations were primarily selected:

$$Y_1 = \underset{(0.01663)}{56.646-0.032891\ X_{2(t-1)}} \quad \underset{(0.02961)}{+0.0082769\ X_3} \quad \underset{(0.06271)}{-0.011968\ X_{1(t-1)}}$$

$tc = 1.17^*$ $tc = 0.28^*$ $tc = 0.19$

$R^2 = 0.3733$ $Se = 9.2924$ $Fc = 3.733$

$$Y_1' = \underset{(0.01374)}{-14.553-0.04971\ X_{2(t-1)}} \quad \underset{(0.22780)}{+0.90478\ X_4} \quad \underset{(0.04739)}{-0.04409\ X_{1(t-1)}} \quad \underset{(0.02143)}{+0.012049\ X_3}$$

$tc = 3.63^*$ $tc = 3.97^*$ $tc = 0.93$ $tc = 0.56$

$R^2 = 0.6281$ $Se = 6.6990$ $Fc = 6.755^*$

*Significant at 99 percent confidence level.

From statistical standpoint the following considerations were taken into account to select equation 5.5 as the more adequate one to attain the objectives of this study. First, the significance of the regression equation, 5.3, was low at 99 percent confidence level to assure reliability for any prediction for years ahead. Second, the coefficient of determination of equation 5.5 showed a decreased amount of variability in Y explained by independent variables X. Third, the standard error of estimate of equation 5.3 was bigger than that of equation 5.5. Those facts led, finally, to the selection of this equation as the one for predicting the Brazilian cocoa price level in the international market.

From economic standpoint the model as being represented by equation 5.5 considered two important factors in the cocoa economy: first, the level of cocoa production in the world excluding Brazil (X_2), and second, the level of inventories held by consuming countries (X_3). Since Brazilian cocoa production has been just a small percent of the total world production, and since producers and manufacturers of cocoa beans do in fact exercise an oligopolistic position in the market, the equation seemed to be economically and statistically supported.

It must also be pointed out that, although there was a negative relationship between price (Y) and production (X_1 and X_2) in equation 5.3 and 5.5 following the traditional economic theory, the stock variable (X_3) appeared in a positive relationship with price (Y) when used with cocoa production from other areas (X_2). This may be attributed to interactions between stock variable (X_3) and cocoa production from other areas beside Brazil (X_2). From Table 21, page 89, the calculated simple

correlation between those two variables was equal to 0.8523; the likelihood of multicolinearity arose at this point. When stock variable (X_3) alone appeared in relation with the Brazilian cocoa prices (equation 5.4), and when it was used with Brazilian cocoa production (X_1) and price index variable (X_4) the sign turned out to be negative and the "b" coefficient statistically significant. However, when both variables (X_2 and X_3) appeared in the same equation the significance of their "b's" values decreased and even the sign of the stock variable (X_3) became positive.

Inserting 1967 and 1968 data into the equation 5.5 and solving for Y_1', the Brazilian cocoa price level was estimated at 22.46 cents while the actual price was 26.35 cents per pound in 1967, an underestimate of 3.89 cents; and at 23.39 cents while the actual price in 1968 was 32.85 cents per pound, again an underestimate of 9.46 cents per pound. Table 28 summarizes the results obtained above.

Table 28. Comparison Between the Actual and Estimated Brazilian Cocoa Prices in the International Market, Years 1967 and 1968.

Year	Actual Average Wholesale New York Spot Brazilian Cocoa Price (1)	Estimated Average Wholesale New York Spot Brazilian Cocoa Price (2)	Difference Between Columns (1) and (2)
		-----Cents/Pound-----	
1967	26.35	22.46	-3.89
1968	32.85	23.39	-9.46

SOURCES: Column (1) - Gill and Duffus, Cocoa Market Report, No. 227, London, England, June 13, 1969, p. 21; Column (2) - From the selected equation $Y_1' = -14.553 - 0.04971\ X_{2(t-1)} + 0.90478\ X_4 - 0.04409\ X_{1(t-1)} + 0.012049\ X_3$.

Since some statistical assumptions were made for estimation and test purposes they should at this point be checked. Among them those concerned with the distribution of the residuals and the correlation among them deserve special attention. Insofar as the first one it was assumed that E_i were normally distributed with expected mean zero and standard deviation σ^2. Symbolically, it may be written that $E_i \sim N(0,\sigma^2)$ so that $E_i/\sigma^2 \sim N(0,1)$. If the model is correct the residual mean square S^2 may estimate σ^2. From Table 29 it appears that these assumptions were met since 95 percent of E_i/S^2 lies between -1.96 and +1.96.

The second assumption may be checked by using the Durbin-Watson test. The "d" coefficient for this test was calculated as being equal to 1.8919, and by applying the Theil-Nagar[93] approach to calculating the degree of correlation among residuals it turned out to be equal to 0.11 which may be considered a low level of correlation. The importance of this assumption comes from the fact that correlation among residuals reduce the efficiency of the Ordinary Least Square technique since it leads to biased estimates not of the structural parameters but of their variances.

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[93]The following formula was used:

$$\hat{\rho}_o = \frac{T^2 (2-d) + 2\Lambda^2 - 2}{2T^2 - 2\Lambda - 1},$$

where $\hat{\rho}_o$ is the correlation coefficient; T is the number of observations; d is the Durbin-Watson statistics; and Λ is the number of parameters in the equation. From Agricultural Economics 5120, Classnotes, Winter 1970.

Table 29. Actual and Estimated Cocoa Price, Residuals, and Normalized Residuals, Period 1946 to 1966

Year	Actual Cocoa Spot (N.Y.) Price (1)	Estimated Cocoa Spot Price (2)	Residuals	Normalized Residuals
	Cents/Pound			
1946	12.1	15.6	-3.5	-0.52
1947	34.4	30.7	3.7	0.55
1948	39.0	38.4	0.6	0.89
1949	21.2	25.4	-4.2	-0.63
1950	29.2	29.6	-0.4	-0.59
1951	35.1	35.5	-0.4	-0.59
1952	35.8	40.4	-4.6	-0.69
1953	34.9	34.4	-0.5	-0.74
1954	55.7	34.6	21.1	3.15
1955	36.2	33.6	2.6	0.39
1956	25.5	34.2	-8.7	-1.29
1957	30.5	33.8	-3.3	-0.49
1958	43.3	40.9	2.4	0.36
1959	35.4	35.6	-0.2	-0.29
1960	26.8	31.1	-4.3	-0.64
1961	22.4	23.6	-1.2	-0.18
1962	21.3	26.4	-5.1	-0.76
1963	26.5	24.6	1.9	0.28
1964	23.2	23.6	-0.4	-0.59
1965	16.9	10.0	6.9	1.03
1966	23.0	26.4	-3.4	-0.51

Source: (1) Cocoa Statistics, Gill and Duffus, London, England, October, 1968, p. 35; (2) from the equation

$$Y_1 = -14.553 - 0.04971X_{2(t-1)} + 0.90478X_4 - 0.04409X_{1(t-1)} + 0.012049X_3;$$

(3) from the relation residuals/Se where Se equals to 6.699.

CHAPTER VI

SUMMARY AND CONCLUSIONS

I. SUMMARY

This research was an attempt to identify some economic factors affecting the level of Brazilian cocoa prices in the international market, and further, to establish a simple econometric model to predict the future behavior of Brazilian cocoa prices.

The analysis was based on the period 1946 to 1966, using annual average data collected from secondary sources. However, in dealing with the description of the world cocoa economy, years prior to 1946 were used.

The main cocoa producing and exporting areas comprise developing nations. The main producing countries in order of importance are Ghana, Nigeria, Brazil, Ivory Coast, and the Cameroom Republic. These countries are currently responsible for about 80 percent of the world's cocoa production. An estimation of the annual cocoa production increases from 1900 to 1966 was about 15,600 long tons. The main causes of the increase in the world cocoa production were: first, the availability of abundant land suitable for cocoa beans in some Western African countries; second, the use of some improved varieties of cocoa and the control of pests and diseases in some producing areas; and finally, the long period of high prices which encouraged replanting and new plantings. Despite increases in production and export, their levels fluctuated to some extent throughout the entire period covered by this analysis.

The major cocoa consuming areas are the United States, the Federal Republic of Germany, the Netherlands, the United Kingdom, and France. These countries accounted for about 70 percent of the world cocoa imports. From 1900 to 1966 the total cocoa import level showed an increase of about 12,700 long tons per year stemming from changes in the per capita income and population growth. Comparing the observed increases in cocoa production and cocoa import level in the period above, it can be seen that they were closely related. It may be concluded that the level of cocoa consumption in producing areas has been markedly low, except in Brazil where it has been increased in absolute terms with the level of cocoa grindings.

In Brazil cocoa beans is now the third most important product as far as the export sector is concerned, following coffee and sugar. In this connection its contribution to increasing the Brazilian exchange revenue amounted on the average to 4.9 percent in the period 1946 and 1966. Its participation in the Brazil's Internal Income was about 0.4 percent in the same period. Concerning cocoa's position within the agriculture sector, it may be said that since 1946 its share of the total land area devoted to agriculture has remained constant, approximately 1.7 percent. Insofar as the participation of Brazilian cocoa beans in the international market is concerned, it may be pointed out that Brazil's share in the total world export increased from 17.5 in 1946-50 to 18.1 percent in 1955-59. From 1960-61 to 1965-66 their participation decreased from 12.0 to 8.5 percent, respectively.

One of the main features of the cocoa economy has been the widespread price fluctuation in the international market. These

fluctuations may be classified under three categories: (1) the short-term fluctuations reflecting variations occurring from hour to hour, day to day, and even week to week; (2) the intermediate-term fluctuations representing the responses of cocoa industry system to annual variations in the world production of cocoa beans; and (3) the long-term fluctuations reflecting variations which have occurred within long periods of time due to interactions of price and production of cocoa beans.

Because several cocoa producing areas depend upon the cocoa trade to obtain and to increase foreign exchange revenue, some kind of government intervention has been observed in the cocoa economy since 1946. Particularly in Brazil, the official control was introduced in 1938 and since then many modifications in the marketing process have been introduced.

Another interesting point in the cocoa economy of the producing areas was that cocoa beans have been cultivated markedly in small holdings areas. For example, a recent survey indicated that 71 percent of the holdings were smaller than 0.5 hectares. The only exception seems to be in Brazil.

The main international markets in the world were found to be New York and London, and they interact rather closely with each other. The U. S. A. is the main market for Brazilian cocoa production; however, increases in cocoa purchases from Brazil by European countries have been observed.

The New York cocoa market can be divided into two sections: (1) the actual market, and (2) the terminal market. This study is somewhat related to the actual market, although the bulk of the operations of the New York Cocoa Exchange is carried out in the terminal market.

A least squares linear regression model was chosen to deal with the problem of attaining the objectives of this study. Since it was selected, many variables supposed to affect the Brazilian cocoa prices in the international market within the period 1946 to 1966 the "stepwise regression procedure" was used in the analysis. Four linear structures were established for further computation. This was done on the basis of the correlation matrix of the original data and on the basis of the knowledge of some aspects of the cocoa economy. In the first two structures the Brazilian cocoa price was deflated by the wholesale price index, and in the remaining two structures the price appeared in real terms and the index was considered as extra exogenous variable.

To select a model which could explain the economic forces affecting the behavior of Brazilian cocoa prices, the criteria was the one which could provide a means of testing the significance of the coefficient of determination with relation to the other coefficient of determination of the structures. The test was performed in a systematic manner by testing the equations against each other. Finally, two structures were selected in which the Brazilian cocoa price was first deflated by an index, and second, it did not appear in real terms. To choose one between them, a statistical test of significance of the coefficients was carried out.

II. CONCLUSIONS

The economic and statistical structure described below was selected by the present study:

$$Y_1' = \underset{}{-14.553} \underset{(0.01374)}{-0.04971\ X_{2(t-1)}} \underset{(0.22781)}{+0.90478\ X_4} \underset{(0.04739)}{-0.04409\ X_{1(t-1)}} \underset{(0.02143)}{+0.012049\ X_3}$$

$$R^2 = 0.6281 \qquad Se = 6.6990$$

where: X_1 is the Brazilian cocoa production; X_2 is the cocoa production in other areas; X_3 is the cocoa stock in consuming areas; and X_4 is the wholesale price index.

This model considered two important factors in the cocoa economy; first, the level of cocoa production in the world excluding Brazil, and second, the level of inventories held by consuming countries. Since Brazilian cocoa production has been just a small percent of the total world production, and since producers and manufacturers of cocoa beans do, in fact, exercise an oligopolistic position in the market, the model seemed to be economically and statistically supported. The ability of the model in predicting the Brazilian cocoa prices for 1967 and 1968 was considered reasonable, but caution must be taken in dealing with future forecasts. From the coefficient of determination of 0.6281 it may be inferred that more price variation could be explained by the effects of other variables not included in the analysis. The role of expectations in determining the cocoa price level is a very important factor provided that lack of reliable information about the size of production in each season and that of inventories held by manufacturers and traders is somewhat limited. This expectation gives rise to price fluctuations which occurs within one year. Further studying about the behavior of Brazilian cocoa price on a monthly basis could result in a refinement of the model achieved in the present study.

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