SPATIAL ANALYSIS OF THE WORLD COFFEE MARKET: THE BRAZILIAN COMPETITIVE POSITION

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

by

Sergio Alberto Brandt, B.S., M.S.

* * * * * * *

The Ohio State University
1967

Approved by

Marvin L. Smith
Adviser
Department of Agricultural Economics and Rural Sociology

FINAL APPROVAL OF DISSERTATION

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Professor Ralph W. Sherman — R. W. Sherman
Professor Glen C. Himes — Glen C. Himes

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SPATIAL ANALYSIS OF THE WORLD COFFEE MARKET:

THE BRAZILIAN COMPETITIVE POSITION

by

Sergio Alberto Brandt, Ph.D.

The Ohio State University, 1967

Professor Mervin G. Smith, Adviser

In the process of production and export adjustment to the conditions of the International Coffee Agreement, it has been suggested that Brazil has still a comparative advantage in coffee, over most of its competitors. The country has a favorable location with respect to the large world markets, production costs are among the lowest in the world and a climate suited to the best types (varieties) of product.

The general objective of this study is to evaluate the marketing advantage of Brazilian coffee in the world markets. The theory of interregional competition is applied to the world coffee industry to contribute to an understanding of the economic forces at work and to measure some relevant economic relationships.

The specific objectives of this research are to (1) describe the present distribution pattern for coffee; (2) develop estimates of transportation cost functions for coffee; (3) determine the best markets for Brazilian coffee and to analyze the effects of import tariffs and export quotas on the selection of these markets;

(4) estimate inter-market price relationships and their effects on location of coffee production; and (5) indicate the locational advantage of Brazil with respect to marketing coffee.

Thirty-nine regions of the world were taken as a closed market; imports and exports of other countries were excluded from the sample. Only the coffee arriving in the consumer countries in green unroasted form was considered.

The transportation model was used to determine various interrelationships existing between the 21 exporting countries and the 18 consumer countries included in the sample. Information used consisted of (1) imports of each of the consumer countries; (2) shipments of each exporting country; (3) exportable production of each exporting country; (4) transportation costs from each shipping country to each importing country; and (5) import tariffs imposed by each importing country on each exporting country. These data were obtained for the harvest year of 1964-1965. The transportation model was applied to four selected situations, ranging from "free market" (no export restrictions and no import tariffs) to "completely controlled market" (with export quotas and with import tariffs). The results of these four experiments were examined in order to determine the probable effects of the mentioned restrictions on the selection of best markets for Brazilian coffee and on the competitive position (comparative advantage) of Brazilian coffee.

Evidence obtained suggests that, under current conditions, the best markets for Brazilian coffee would be the United States,

Canada, Argentina, France, Netherlands, Sweden, Denmark, Spain, Eastern Europe, and Algeria.

Elimination of tariffs and of export (ICO) quotas apparently have a substantial effect on this selection of best markets. Assuming that Brazil will have to live with the International Coffee Agreement, an alternative is still open, through the implementation of the Article 47 of that Agreement. Gradual reduction of import tariffs are expected to affect both the total volume of exports and the distribution pattern of Brazilian coffee.

The launching of aggressive promotion programs, and the development of the so called "new markets" are also evident policy implications in the demand side of the market.

Brazil has a small (less than US $1.00 per bag) pure locational disadvantage relative to the bulk of the world output and exports. When tariffs are considered, the relative disadvantages reach levels as high as US $13.00 per bag. Policies directed toward improved coffee harvest and processing and to more efficient, lower cost, techniques of production are in order for the Brazilian coffee industry. To attain higher levels of effective competition, the Brazilian "Arabicas" should be "washed" and harvest should be mechanized. The current policies, conducted by the Brazilian Coffee Institute, toward diversification, cost reduction, quality improvement, and coffee industrialization, are consistent with the evidence obtained in this study.

ACKNOWLEDGMENTS

The Author expresses special and the most sincere appreciation to:

Dr. Mervin G. Smith and Dr. Glenn C. Himes, advisers, for their leadership, guidance and constructive criticism during the development of this research throughout his program of studies.

Dr. Francis E. Walker, for reading the first draft of this dissertation, making many valuable comments and suggestions for improvement, and for giving the benefit of his expert knowledge during these last two years.

Dr. Alvin E. Coons, Dr. Ralph W. Sherman, and Dr. M. Eugene Cravens, for their scholarly guidance and understanding while his program was developed.

Mrs. Elizabeth E. Howard and Miss Nancy E. March, for their efficient statistical services, both for this research and for the whole of his program of studies.

Dr. Rubens A. Dias and Dr. John H. Sitterley, for their high, and hopefully fulfilled, expectations.

Agency for International Development, State of Sao Paulo (Brazil), Pan-American Union, and the Brazilian Embassy in the United States, for their financial support.

VITA

November 15, 1933 . . .	Born - Petropolis, Rio de Janeiro, Brazil
1960.	B.S., ESA, Viçosa, Minas Gerais, Brazil
1961-1962	Research Technician, Institute of Rural Economics, Viçosa, Minas Gerais, Brazil
1962-1963	M.S., Purdue University, Lafayette, Indiana
1963-1964	Instructor, Agricultural Marketing, Graduate School, Viçosa, Minas Gerais, Brazil
1964-1966	Research Assistant, Division of Agricultural Economics, Department of Agriculture, State of Sao Paulo, Brazil

FIELDS OF STUDY

Major Field: Agricultural Economics
Specialized in Agricultural Development, Economic Theory, and Marketing

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CHAPTER I

INTRODUCTION

In the process of production and export adjustments to the conditions of the International Coffee Agreement, it has been suggested that Brazil may still have a comparative advantage in coffee, over some of its competitors. That country seems to have a relatively favorable location with respect to the larger world markets, its production costs seem to be among the lowest in the world and its climate seems to be suited to the best varieties of product.[1/]

Starting in the late 1950's, the world coffee market was characterized by large surpluses. Exportable production exceeded exports year after year and unsold stocks continued to grow. By far the greatest part of these stocks was accumulated in Brazil, where the excess supply of exportable coffee was over 50 million bags.[2/]

The severe decline in coffee prices which started in 1957 and gained momentum in 1958 and 1959 abated thereafter. From 1959 to 1963 the annual average rate of decline in the price of "Brazils" was of about 2 percent. It was of about 15 percent per year in the

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1/ Viton, A. The World Coffee Economy. Rome: FAO. Commodity Bulletin Series No. 3, 1961, p. 12-13.

2/ Lovasy, G., et al. The International Coffee Market, in IMF Staff Papers, Vol. XI, No. 3, p. 367. For data on the amount of supluses, see Section on "Description of the Coffee Market," in Chapter I.

previous three years. Meanwhile, the price of "Africans" and "Manis" (other Latin American type) showed a somewhat different pattern.3/

Coffee is a major source of foreign exchange earnings of Brazil.4/ This heavy dependence on coffee trade makes the country peculiarly vulnerable to world market development over which it has little control. The instability has widespread repercussions throughout its economy. High prices aggravate serious internal inflationary pressures and economic distortions. When coffee prices drop so too do government revenues, private investments, imports, and the level of general economic activity.

The International Coffee Agreement between consumer and producer countries is a means of dealing with severe price fluctuations. However, even within the frame of the ICA, the problems of distribution, competition and of barriers to competition between "Brazils," "Africans," and "Manis" remains a serious one. Specifically, the coffee agreement does not restrict the pattern of trade. It restricts only the total exports of coffee from each exporting country. Exporting countries are free to attempt to increase their sales in the best markets of the world. It is known that major exporting countries have been engaging in strong promotional efforts in the major consumer markets.5/ Even without non-price competition policies, it might be that the present distribution patterns are

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3/Lovasy, G., et al., op. cit., p. 367-369.

4/About 44% of total value of exports in 1965. See PACB. Annual Coffee Statistics, No. 29, 1965, p. 120.

5/PACB, op. cit., p. 8-9.

not the most economical ones (lowest total cost). Discriminating custom duties, imposed by some consuming countries might also result in less than optimal (lowest total cost) distribution patterns in the world markets.

Objectives

The general objective of this study is to evaluate the locational advantage (relative transportation cost advantage) of Brazilian coffee in the world markets. The theory of interregional competition is applied to the world coffee economy to contribute to a better understanding of the economic forces at work and to measure some relevant economic relationships.

The specific objectives of this research are to (1) develop estimates of transportation rates of coffee; (2) determine the best markets for Brazilian coffee; (3) analyze the effects of elimination of import tariffs on these markets; (4) analyze the effects of elimination of ICA quotas on the pattern of distribution of coffee; (5) indicate the location advantage of Brazil with respect to marketing coffee.

Description of the Coffee Market

A brief description of the characteristics, trends and organization of the world coffee market shall place the following analyses in a more appropriate perspective.

Coffee production response to price seems to be very inelastic in the "short-run" (one year period) but relatively elastic in the

"long-run" (six to seven years period). New coffee plantings begin to bear in 2 to 5 years, but substantial crops cannot be expected until 6 to 8 years.[6/] Coffee production seems to be more responsive to prices in Latin America than in Africa. Differences in availability of alternatives to labor employed in coffee cultivation seem to be one of the reasons for this difference.[7/] Vagaries in weather are factors which play a recurring role in determining output. Southern Brazil, in particular, where most of the Brazilian output is produced, has from time to time been beset by severe weather conditions--frost, fire, and prolonged drought.

Two types of government interference in the coffee market are of special relevance in determining output. One refers to the diversification program[8/] and the export taxation policy.[9/] In the longer run these policies should lead to reduced production and capacity. World coffee production has risen from about 35 million bags in 1948 to almost 80 million bags in 1960. Since then it has decreased to about 52 million bags in 1965. In the post-war period the output of "Robustas" (grown mainly in Africa) has risen relatively faster than the output of "Arabicas" (grown mainly in Brazil and other Latin America countries).

6/ Hopp, H. Supply and Demand in Relation to the Price of Coffee. Washington, D. C.: USDA - FAC - 30 - 54, p. 15.

7/ Viton, A. op. cit., p. 30.

8/ Brazil has planned the destruction of two billion coffee trees. By 1967 about 36% of this target were achieved.

9/ A substantial share of the export price is taxed away from producers in Brazil and Colombia. This share goes close to 50% of the export price in both countries.

Recent history of coffee trade was characterized by alternating periods of acceleration and retardation. Evidence collected by Beckford suggests that these fluctuations ("Kuznets cycles") reflect rhythms in demand in the industrially advanced countries. World and Brazilian coffee exports seem to conform in phase with secular swings in American demand, although the expected export lags are not evident. The absence of these lags may reflect either the influence of other importing countries or the stockpilling of coffee in Brazil. World coffee exports passed through phases identical with those of Brazil. During the last hundred years, four long swings can be observed. The average duration of the four swings is 20 years.[10/]

Net world exports have shown a steady pattern of growth since 1948. However, world surpluses started pilling up since 1953. Net surpluses were grossly estimated at about 50 million bags in 1965: about 80% in Brazil, 10% in Colombia, and the remaining 10% in several other countries. The total would have been much larger had not Brazil destroyed a substantial amount of low quality coffee (approximately 10 million bags) and almost 730 million coffee trees since 1962 (representing about 4 million bags per year).[11/]

The demand for coffee seems to be relatively inelastic with respect to price and income. Price elasticity ranges between -0.2 and -0.7, for higher and lower income countries, respectively. The

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10/ Beckford, G. L. F. Secular Fluctuations in the Growth of Tropical Agricultural Trade, in Economic Development and Cultural Change, Vol. XIII, Part I, October 1964, p. 80-94.

11/ Wickizer, V. D. International Collaboration in the World Coffee Market, in FRI Studies, Vol. IV, No. 3, 1964, p. 273-304.

income elasticity appears to fall off sharply as per capita income rises. It ranges between about 0.3 in Sweden and 0.7 in Italy.[12/] One of the most remarkable developments in the coffee trade, during the last two decades has been the considerable increase in the share of "Robusta." This is closely linked to the expansion of instant coffee manufacture. Superior quality of soluble coffee is obtained by using only "Brazils" or "Milds." For regular coffee, which absorbs over 80% of total green coffee roasted in the U. S., the use of "Robusta" is limited because of its "distinct" flavor. In the U. S. market, in the period 1953-1963, the elasticity of substitution between "Brazils" and "Robustas" was equal to -0.98, between "Brazils" and "Milds" varying between -1.6 and -2.8.[13/]

Price and substitution elasticities of demand have an important relationship with another characteristic of the world coffee trade--the widespread use of import tariffs and quotas. Tariffs remain an important obstacle to the expansion of coffee consumption in many consumer countries. The common tariff for the

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12/ Viton, A., op. cit., p. 31-33; Daly, R. F. Coffee Consumption and Prices in the United States, in Agricultural Economics Research, Vol. X, No. 3, July 1958, p. 62-64; and Szarf, A., et al. Factors Affecting United States Coffee Consumption, in Monthly Bulletin of Agricultural Economics and Statistics, October 1954.

13/ Lovasy, G., et al., op. cit., p. 379; and Abaelu, J. N. A Quarterly Analysis of the United States Import Demand for Varieties of Green Coffee. East Lansing: MSU, Unpublished Ph.D. dissertation, 1966. In 1964-65 the average price of "Brazil," was $0.41 per pound, the average price of "Manis" was $0.45 per pound and the average price of "Robustas" was $0.35 per pound. It is assumed here that these price differentials are indicators of quality differentials.

six members of the European Common Market--free entry of coffee from affiliated African countries and a 9.6% ad valorem duty for coffee from all other origins--is expected to induce a further shift in favor of "Robustas."[14] Elsewhere in Europe, coffee levies vary widely. Green coffee enters duty-free in Austria and Norway. In Spain, Denmark, Finland, Sweden, and England the duties are specific, when and if applied. It is evident that the specific type of duty is not discriminatory against either "Brazils" or "Milds." Eastern European countries usually resort to quota restrictions.[15]

Of particular interest is the expansion of the instant coffee industry. Consumption of soluble coffee in the United States has risen from 0.26 cups per capita per day in 1953 to 0.58 cups p.c. p.d. in 1965, or from 10 to 21 percent of total cups, in the last thirteen years. In Europe, the percentage of total coffee consumption represented by soluble currently ranges between 75% in England and 1% in Sweden, Norway, Italy, and Finland.[16]

The use of coffee in soluble form represents a significant saving in green coffee to produce a given number of cups of coffee. Estimates of the average saving vary between 15 and 40% of the weight of green coffee used. This might be a partial explanation for the

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[14] Lovasy, G., et al., op. cit., p. 381.

[15] See Appendix Table 13 for custom duties imposed by the different countries.

[16] PACB. Annual Coffee Statistics, No. 29, 1965, p. 51-57.

recent decline in per capita imports of green coffee into the United States market.[17]

The consummation of an international coffee agreement in 1962 was essentially an understanding between the world's greatest coffee-consuming country, the United States, and the world's largest coffee-producing country, Brazil. The first International Coffee Conference, called in 1902, failed to take appropriate steps to relieve hardships resulting from overplanting in a few years earlier. It was not until the Inter-American Coffee Agreement of 1941 that the manipulation of the coffee market became more than a strictly national (Brazilian) affair. It terminated in 1948, when it was understood that there was no longer a surplus, or a threat of one.[18]

The new ICA has features which might make it succeed where other pacts have failed. To begin with, the ICA is not a hasty contrivance, weak in coverage, lacking in broad political support. It is a long term arrangement, negotiated in 1962, and now covers about 96% of the world total exports and about 80% of the world total imports. Support has come not only from governments but also from the trade associations in the consuming countries. It has come into being with tremendous and unprecedented political backing. Consuming countries are committed to help police the agreement. The ICA may be classified as an export restriction type of agreement, but

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[17] U. S. per capita imports of green coffee decreased from 20.4 pounds per year in 1961 to 18.8 pounds per year in 1965.

[18] Wickizer, V. D., op. cit., p. 273-304. Shisko, I. The Coffee Outlook Under a "Model" International Agreement, in Jiller, H. (Ed.) Guide to Commodity Price Forecasting. New York: CRB, 1965, p. 108-18.

it also includes provisions to encourage removal of import taxes and tariffs, to expand promotional activities, to reduce world stocks and to put limitations on the growth of production.

The International Coffee Organization was established to administer the provisions of the agreement. Its highest authority is the International Coffee Council, consisting of all members of the ICO. The executive Board (seven exporting and seven importing members) acts when the Council is not in session. Its key task is to assign export quotas to exportation members, and adjust these quotas under the "waiver clause" which essencially provides relief in hardship cases. While basic quotas are written into the Agreement, the actual operative quotas are set for each coffee year, according to the Countil's estimate of world demand. The Council also distributes quarterly quotas. Currently, both operative quotas and waivers (quota increases) are related to price changes. A ICO Indicator Price (arithmetic average of selected types) is computed daily. The Council set the 1964-65 indicator price range with a floor of 38.00 and a ceiling of 44.00 United States cents per pound. If the indicator price is outside this range, for more than fifteen days, the Council may adjust quotas in order to bring prices back into line.

Adjustments of production are to be made in two stages. The difference between current production and the production target (about 77 million bags) is to be reduced by 50 percent by 1969. The remaining is to be eliminated by 1972. The tools of production adjustments are erradication of coffee trees and diversification.

At the light of these trends and characteristics of the world coffee market, it becomes easier to understand the pressures that the producer countries and traders are suffering, in order to adjust their production and trade patterns to the new conditions. Analyses presented further should be considered under these circumstances.

CHAPTER II

THE THEORY OF INTERNATIONAL TRADE

During the past few centuries economists have evolved a body of theory that seeks to describe the ways in which national economies trade and interact with each other. In the current century, it appears that the works of Yntema,[19] Ohlin,[20] Harbeler,[21] and Viner,[22] deserve special reference for their masterly treatment of the pure theory of international trade.

The purpose of this chapter is to provide a systematic but deliberately brief account of what is conceived to be the modern theory of international trade.

Lets assume first that two countries, A and B, grow product x. However, lets suppose that, in absence of trade, the price of product x in B is lower (because of differentials in supply costs and/or demand prices).[23] The relevant fact here is that there would be a movement of product x from B to A.

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[19] Yntema, T. O. A Mathematical Reformulation of the General Theory of International Trade. Chicago, The University of Chicago Press, 1932.

[20] Ohlin, B. Interregional and International Trade. Theory and Economic Policy. Homewood: Richard D. Irwin, Inc., 1962.

[21] Harbeler, G. A Survey of International Trade Theory. Princeton: Princeton University Press, 1961.

[22] Viner, J. Studies in the Theory of International Trade. London: George Allen & Unwin Ltd., n.d.

[23] Supply costs are low, for example, if output/input ratios are low or if wages are low. Demand prices can be relatively low due to small population or low income levels.

Price differential will stimulate exports of product x from B to A untilit is eliminated. In equilibrium, the sum of quantities demanded is equal to the sum of quantities supplied.

If it costs one dollar per unit to move product x from B to A, the final price in A will have to be just $1.00 above the final price in B. At the final B price, the excess of supply over demand in B market must equal the excess demand over supply in the A market at the final A price. That is to say, the amount of product x people in B want to export must equal the amount people in A want to import if the prices in the respective markets are truly equilibrium ones.[24/]

This trade in product x, by altering prices in the two markets, changes the quantities demanded and supplied in the two countries. The consequences of trade is to raise the market price of product x in B (larger production and surplus, and smaller consumption) and reduce the price in A (smaller production, greater import demand and consumption).

Trade must be in two directions. B will import some other product from A in exchange for x. Lets assume that this other product is y, and suppose that country A has lower relative cost in producing both products, than country B. It is said that country A has an absolute advantage in both lines of production. However, if the two countries are trading, it is the comparative advantage of each nation that matters. Country A will produce and export the

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[24/] Kemp, M. C. The Pure Theory of International Trade. Englewood Cliffs, N. J.: Prentice-Hall, Inc., p. 324.

product in which its absolute advantage is greater, the same occurring in country B. That is to say, both countries would not undertake those enterprises in which they have comparative disadvantages.

National specialization in production is really one of the outstanding facts of economic life. Clearly, different nations must prossess overwhelming advantages in certain lines of production. Also, differences in climate, factor endowments and the desire to minimize the freight bill incurred for moving raw materials and final products. A nation specializes in those products that its producers can sell cheaply; ability to quote low prices is largely based on low unit costs of production.

A nation will have low unit cost of production of a good if its output-input ratio is high, if the inputs are low priced, and if the total transportation bill (for factors and products) is low. The importance of climate, specially in agriculture, lies in the fact that it largely determines the ratio of output to input. Variation in factors prices seems to be largely due to differences in their supply.[25]

As a rule, it can be said that there would be very little international trade if all countries had the various factors of production in approximately the same proportions. If transportation costs were nil, national specialization would be complete, given disproportionate factor endowments.

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[25] Enke, S., et al., International Economics. Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1957, p. 48-63.

Costs of transportation of commodities is the only source of price differences between countries to be specifically analysed in this study. Differences due to costs of production and quality will be ignored in the main body of the research and will be discussed again only in the final chapters of this project, where conclusions and implications are to be presented.

Costs of transporting commodities between countries have never been satisfactorily integrated into the competitive general equilibrium theory of international trade.[26] We shall present the algebraic analogue of the geometric model originally due to Cunynghame:[27]

$$(1) \quad DD_1: \quad Q_1' = a + bP_0$$

$$(2) \quad DD_2: \quad Q_2' = a + b(P_0 + C)$$

$$(3) \quad \text{Equilibrium:} \quad Q_1' + Q_2' = Q_1 + Q_2$$

where DD_1 and DD_2 are the known linear demand schedules for the product at the countries A and B; Q_1' and Q_2' are the unknown consumption levels after trade; a and b are the known parameters of the demand function (assuming that both countries have the same function); P_0 is the unknown equilibrium price for country A, determined by the intersection of the excess supply curves (ES_1 and ES_2), after

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[26] Kemp, M. C., op. cit., p. 143.

[27] Cunynghame, Sir H. A Geometrical Political Economy. Oxford: Oxford University Press, 1904. For a simple presentation of the geometric model, see Judge, G. G., et al. Estimation of Spatial Equilibrium Models, in JFE, Vol. XL, No. 4, November 1958, p. 801-808, from where most of the balance of this chapter was taken.

trade; C is the known unit transport cost between A and B; Q_1 and Q_2 are the known consumption levels before trade.

Equations (1) and (2) may be solved uniquely for the three unknowns:

$$(4) \quad Q_1' + Q_2' = 2a + 2bP_0 + bC$$

$$(5) \quad Q_1 + Q_2 = 2a + 2bP_0 + bC$$

The solution for P_0, the equilibrium price in the surplus region, yields:

$$P_0 = \frac{1}{2b} (Q_1 + Q_2 - bC - 2a)$$

Given the unique P_0, equilibrium price in the deficit region is, then, $P_0 + C$, and these values may be substituted into (1) and (2) for unique solution for Q_1' and Q_2'.

Import tariffs can be added to C, the unit transportation cost, and its effects analysed accordingly. An export quota smaller than exportable production means a shift to the left (a decrease) in the supply curve of the exporting country. Effects of export quotas can be appraised by means of changes in the supplies attributed to each participating country. Product will move from A to B if production costs in A plus transfer changes (transportation costs and tariffs and duties) are less than production costs in B.

In the following chapter we shall present a discussion of the linear programming transportation model used for the study of optimal resource use patterns within the world coffee economy, considering

the impact of transfer costs, tariff rates and export quotas on the solution. Other impediments to international trade are not included in the analysis.

CHAPTER III

METHODOLOGY

Background

"The price at any particular producing point tends, aside from collusion or special agreement between rival producers of transportation and processing services, to vary directly with distance from the central market or consuming center. Under competitive conditions, the price to the producer would be the central market price less the cost of transportation services between the producing location and the consuming center.[28/]

Accepting this hypothesis, and assuming that the United States is the market center, then the price of coffee is set in that center. The problem, however, is not that simple. The United States is a part of the international coffee market; and as such has some influence on, but does not set prices (disregarding government policies and the international agreement).

The effective price in the producing countries' ports, Paranagua for instance, tends to be the central market (New York) price minus the cost of transportation from those markets to the exporting country. Nearby countries like Colombia and Mexico theoretically would

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[28/] Heady, E. O., Economics of Agricultural Production and Resource Use. New York: Prentice-Hall, Inc., 1952, p. 642.

gain the difference between their transportation costs to New York and the costs of transportation from Brazilian ports to these ports of consuming countries.

The transportation model of linear programming is applicable for the study of optimal resource use patterns within the world coffee economy. Variations of the model may be used to illustrate the effects of restrictions (e.g., tariffs or import taxes) and other imperfections (e.g., export quotas) on movement patterns and prices.

This analysis assumes, of course, representation of an entire region by a point in that region, no trans-shipping occurs, profit maximization, homogeneous product, perfect knowledge of the market, production and consumption in each region is fixed, a storable product, freedom from external control, available storage, and unit transfer costs independent of volume shipped, among other things. With a nonperishable product like coffee and the existing market facilities these assumptions may not be much unrealistic. The fourth assumption will be discussed further.

Transportation Model

The transportation model is used to study green coffee flows and intermarket prices. In this model it is necessary to take as given total quantities available in each shipping area and total amounts consumed in each importing market. The transportation model then provides a minimum transportation cost solution for moving the specified quantities to the several markets. This is known as the

Koopmans-Hitchock problem in linear programming.[29]

In short, a homogeneous product is to be shipped in the amounts $a_1, a_2, \ldots, a_m$, respectively, from each of m shipping origins and received in amounts $b_1, b_2, \ldots, b_n$, respectively, by each of n shipping destinations. The cost of shipping a unit amount from the i^{th} origin to the j^{th} destination is C_{ij} and is known for all combinations (i, j). The problem is to determine the amounts X_{ij} to be shipped over all routes (i, j) so as to minimize the total cost of transportation.

To develop the constraints of the problem, the so called transportation tableau, could be set. The amount shipped from origin i to destination j is X_{ij}; the total shipped from origin i is $a_i \geq 0$, and the total received by destination j is $b_j \geq 0$. Here we temporarily impose the restriction that the total amount shipped is equal to the total amount received; that is

$$\sum_i a_i = \sum_j b_j = A$$

The total cost of shipping X_{ij} units is $C_{ij}X_{ij}$. Since a negative shipment has no valid interpretation for the problem as

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[29] Koopmans, T. C. Optimum Utilization of the Transportation System, in Econometrica, Vol. XVII, p. 136-146; and Hitchock, F. L. Distribution of a Product from Several Sources to Numerous Localities, in Journal of Mathematical Physics, Vol. 20, 1941, p. 224-30. Most of the methodological developments presented here were first learned from Himes, G. C. International Competition in the Feed Grain Economy. Columbus: The Ohio State University, Unpublished Ph.D. dissertation, 1964, 93 p.

stated, we restrict each $X_{ij} \geq 0$. The mathematical statement of the transportation problem is to find values for the flows (variables) X_{ij} which minimize the total cost

$$(1) \qquad \sum_{i=1}^{m} \sum_{j=1}^{n} C_{ij} X_{ij}$$

Subject to the constraints

$$(2) \qquad \sum_{j=1}^{n} X_{ij} = a_i \qquad i=1, 2, \ldots, m$$

$$(3) \qquad \sum_{i=1}^{m} X_{ij} = b_j \qquad j=1, 2, \ldots, n$$

$$(4) \qquad X_{ij} \geq 0$$

In order for equations (2) and (3) to be consistent, the sum of equations (2) equal to the sum of equations (3); id est.

$$(5) \qquad \sum_{i=1}^{m} \sum_{j=1}^{n} X_{ij} = \sum_{j=1}^{m} X_{ij} = \sum_{i} a_i = \sum_{j} b_j = A$$

The system of equations (1) to (5) is a linear-programming problem with m + n equations in mn variables.[30/]

[30/] The maximum number of basic solution is m + n - 1. Gass, S. I. Linear Programming. Methods and Applications. New York: McGraw-Hill Book Company, 2nd Ed., 1964, Chapter 10; King, R. A. (Ed.) Interregional Competition Research Methods. Raleigh: Agricultural Policy Institute, 1963, 204 p.; and Takayama, T., et al. International Trade Models, in Illinois Agricultural Economics, Vol. 4, No. 3, December 1964.

In addition to providing the minimal cost flows of coffee, the solution to the transportation cost problem yields the price differentials between markets and between shipping points. If the equilibrium price in any one market was given, the price in all other markets and shipping points could be computed.

A comparison of the minimal cost shipping pattern with the actual pattern of coffee flows and a comparison of the theoretical and actual price differentials could also be made, providing a rough test of the efficiency of the world market in allocating supplies and in determining prices. Still another use, which is to be made of the price data developed, is to indicate the best markets for green coffee shipped from Brazil, assuming that the least cost transportation flows were followed in practice. Tariffs and duties on coffee imports and their effects on the export flows of coffee are also to be analyzed.[31/]

Price differentials due to quality differences raise additional computational problems. Most consumer countries usually import coffee of all three types and some producing countries produce coffee of different types. It was first thought that using a linear programming model and adding restrictions for those market shares in each individual country would make more realistic the analytical procedure. However, data unavailability eliminates that alternative.

31/ For a pioneer study in this area, see Bates, T. H. Political and Economic Constraints on Efficient Pricing and Allocation in International Sugar Trade, in Proceedings of the 1966 WFEA Meeting, Los Angeles, 1966, p. 163-70.

Estimates are not available for those shares for producing countries.[32/]

Given the direct solution to the transportation problem (i.e., the optimal set of geographical flows), we may now consider world price differentials, which are thought of as one of the prime allocators of regional distribution. As in any linear programming problem, the solution implicitly places values on the various inputs and/or outputs. With the aid of the duality theorem of linear programming, a unique set of world price differentials may be derived which correspond to the optimal set of flows. Thus, in a minimal-cost transportation solution, the dual problem is concerned with deriving that set of regional price differentials relative to a particular base (V_j's and U_i's) which is consistent with the optimum set of flows. In developing the dual formulation, let V_j be the price differential associated with the destinations and U_i be the price differential associated with the origins or supply points. The problem may be then stated algebraically as one of the maximizing:

$$(6) \qquad \Sigma\, b_j V_j - \Sigma\, a_i U_i = S = \text{Maximum}$$

subject to

$$(7) \qquad V_j - U_i \leq c_{ij}$$

[32/] Although the assumption of product homogeneity is necessary for the transportation model, given present data availabilities, this does point to an important area for future research work.

In the equation (6) the maximum S is equal to the total cost of transportation derived in the minimum formulation; i.e., equation (1) is equal to equation (6). Therefore, the maximum problem may be thought of as finding the values of U_i and V_j that will maximize the total gain in value of amounts shipped subject to nonpositive profits on each shipment. Thus, it is possible to interpret U_i as the value of the product at the supply origin i, and V_j as the value of the product delivered at destination j.

Equation (7), then, may be written as:

$$(8) \quad V_j \leq U_i + C_{ij}$$

This relationship now states that for any supply-destination pair, the value at the destination or demand point must be no greater than the value at the supply point plus transportation cost. If some surplus region is chosen as the base, then a set of price differentials is generated subject to this choice. The values of U_i also measure the comparative price advantage of the surplus regions, and the V_j are delivered price differentials that correspond to the most economical allocation of supply from the viewpoint of minimum aggregate transportation cost. These outcomes are the competitive equilibrium solutions that would result from the efforts of exporters at the supply countries to dispose of their supplies at minimum possible costs of transportation.

The balance of this dissertation consists of work connected with: (1) derivation of a semi-log transportation function for green coffee; (2) determination of the "best" markets for Brazilian coffee,

in terms of selected ranges of relative costs of using non-optimal routes; (3) indication of the locational advantage of Brazil with respect to marketing coffee, by means of comparisons among price differentials (U_i's) associated with origins or supply points. The effects of ICO quotas and import quotas, on selection of "best" markets and on comparative advantage, are to be analyzed by means of comparisons among solutions of four different models. Model I will exclude both quotas and tariffs; Model II includes export quotas but excludes tariffs; Model III excludes export quotas but includes tariffs; and Model IV includes both restrictions.

The data to be used in this analysis are: (1) annual imports of green coffee in each of the known important consumer countries; (2) annual exports from each important producer country shipping to those consumer countries; (3) estimated transportation changes for sea routes connecting each producer country with each consumer country; and (4) tariffs imposed by importing countries on coffee shipped from one or more sources.

Regional Demarcation and Basing Points

Fourty-eight countries throughout the world were selected for analysis. These countries were aggregated in thirty-nine regions, including 16 regions in the Americas, 15 in Europe, 13 in Africa and 4 in Asia and Oceania. The eight major producers in the OAMCAF (see Table 1, footnote b) were considered as one region. Kenya and Uganda were also grouped in one region. Burundi and Tanzania, West Germany-Austria, Italy-Switzerland, and Belgium-Luxemburg were also

Table 1. Exporting Regions and Basing Points for 21 Selected Exporting Regions.

Number	Region	Basing Point
1	Brazil	Paranagua
2	Colombia	Buenaventura
3	Guatemala	Puerto Barrios
4	México	Vera Cruz
5	El Salvador	Acajutla
6	Costa Rica	Limon
7	Ecuador	Guayaquil
8	Venezuela	Maracaibo
9	Nicaragua	Corinto
10	Dominican Replublic	Santo Domingo
11	Honduras	Puerto Cortez
12	Peru	Callao
13	Haiti	Port-au-Prince
14	Ethiopia	Djibouti
15	Kenya-Uganda	Mombasa
16	Burundi-Tanzania	Dar-Es-Salaam
17	India	Bombay
18	Angola[a/]	Luanda
19	OAMCAF[b/]	Bingerville
20	Congo (D.R.)	Matadi
21	Indonesia	Surabaya

a/ Major producer among Portugal's African States.

b/ Cameroon, Central African Republic, Congo (Brazzaville), Dahomey, Gabon, Ivory Coast, Madagascar, and Togo.

considered as composed regions. Angola, the major African state linked to Portugal, was considered as one region.

The markets chosen and their respective basing points are listed in Tables 1 and 2. Each importing or exporting "country" (region) was considered as a market area for green coffee.

In the harvest year of 1964-65, the countries included in the study exported about 96% of the world total exports of green coffee and imported about 80% of the same total. All the analyzed exporting countries had assigned ICO export quotas. They fulfilled almost 99% of the global ICO quota. All importing countries included in this analysis are also members of the Agreement. Those figures are empirical evidence of the coverage of the ICO and of the present analysis.[33/]

The criteria for selection of the basing points were the relative importance of the sea ports of each country. In the case of a region being the result of aggregation of two or more countries, a major port of the most important country of that region was selected.

All countries included in the analysis exported or imported more than 200 thousand bags (bags of 132.276 pounds) of green coffee in the harvest year of 1964-65.

33/ Cf. Shisko, I. The Coffee Outlook Under a "Model" International Agreement, in Jiller, H. (Ed.). Guide to Commodity Price Forecasting. New York: Commodity Research Bureau, Inc., 1965, p. 117; and PACB. Annual Coffee Statistics, No. 29, 1965, p. 9-10.

Table 2. Importing Regions and Basing Points for 17 Selected Importing Regions.

Number	Region	Basing Point
22	United States	New York City
23	Canada	Montreal
24	Argentina	Buenos Aires
25	West Germany-Austria	Hamburg
26	France	Le Havre
27	Italy-Switzerland	Naples
28	Netherlands	Rotterdam
29	Belgium-Luxemburg	Antwerp
30	Sweden	Stockholm
31	United Kingdom	Liverpool
32	Denmark	Copenhagen
33	Finland	Helsinski
34	Portugal	Lisbon
35	Spain	Coruna
36	Eastern-Europe[a/]	Leningrad
37	Japan	Yokohama
38	Australia	Melbourne
39	Algeria	Algiers

a/ Albania, Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Rumania, and USSR.

Transfer Costs

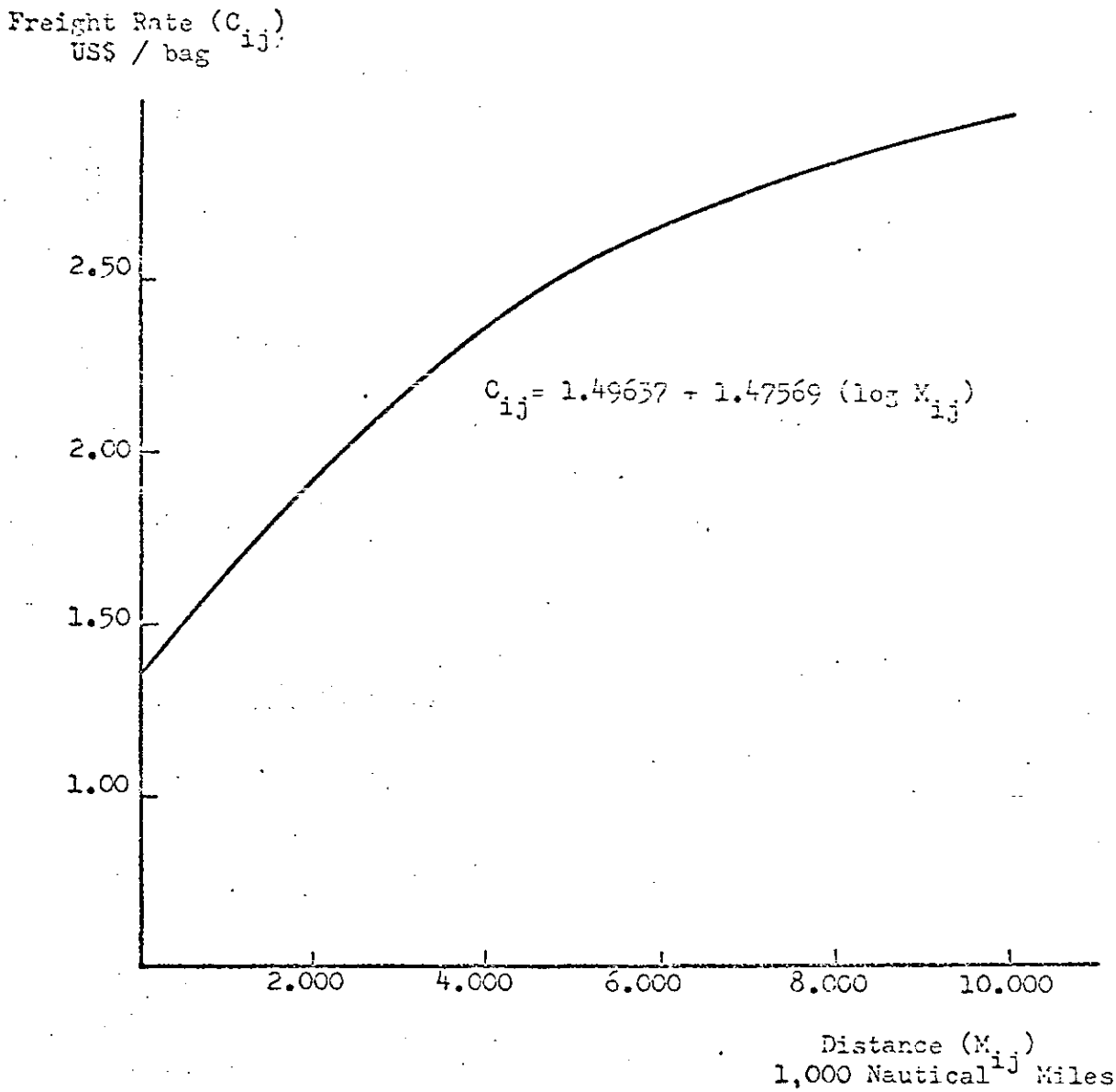
Transportation costs associated with the international shipments of a commodity like green coffee are only one of the variables affecting international competition. Differences in costs of production and transfer costs associated with institutional barriers like tariffs or custom duties may exert an effect on the flow of the commodity. Per unit transfer costs, C_{ij}, can be formulated to include one of these costs in addition to the cost of transportation. Any cost which can be expressed as a constant rate per unit of commodity transferred can be incorporated in the C_{ij} values.[34/]

Ocean freight rates, custom duties and internal taxes on imports are explicitly considered in this analysis.[35/] In order to obtain these informations, the following procedure was used: ocean freight rates for moving green coffee from exporting to importing countries were not a matter of public record until recently but were obtained, in 1965-66, from the trade, by the Department of Research of the Pan American Coffee Bureau (Table 3). Mileage estimates between the selected origins and destinations were obtained from the Mercantile Marine Atlas and this information was combined with the freight rates and a cost function was estimated (Chart 1):

34/ Walker, F. E. Transportation and Spatial Equilibrium Models for the Inter-regional Analysis. New Orleans: Southern Farm Management Research Committee Workshop, 1964, Mimeo., p. 3-6.

35/ For a recent example of work in this area, see Dean, G. W., et al. Trade and Welfare Effects of EEC Tariff Policy: A Case Study of Oranges, in JFE, Vol. 48, No. 4, Part I, November 1966, p. 826-46.

Chart 1. Ocean Freight Rates For Green Coffee, 1964-65



Source of Derivation: Data in Table 3.

Table 3. Ocean Freight Rates and Distances for Shipping Green Coffee Between Selected Ports and New York City, Hamburg, and Amsterdam Ports, 1965-66.

Port	Ocean Freight Rate ($/1,000 bags) a/		Distance (1,000 nautical miles) b/	
	New York	Hamburg (H) or Amsterdam (A)	New York	Hamburg (H) or Amsterdam (A)
Buenaventura	1,852	2,840 (H)	2.370	5.447 (H)
Limon	1,892	2,728 (H)	2.017	4.897 (H)
Guayaquil	2,183	...	2.847	...
Acajutla	2,116	3,003 (H)	2.907	5.884 (H)
Puerto Barrios	1,633	2,646 (H)	2.197	5.285 (H)
Port-au-Prince	2,183	2,356 (H)	1.192	4.380 (H)
Puerto Cortez	1,693	2,646 (H)	2.177	5.265 (H)
Vera Cruz	1,713	2,852 (A)	1.783	5.106 (A)
Corinto	2,116	3,003 (A)	2.692	5.517 (A)
Callao	2,303	2,356 (A)	3.352	6.174 (A)
Maracaibo	1,587	...	1.845	...
Paranagua	2,708	2,731 (A)	5.089	5.602 (A)
Matadi	2,495	...	5.033	...
Djibouti	2,008	...	6.150	...
Bombay	2,835	2,852 (A)	9.144	7.303 (A)
Surabaya	2,820	2,827 (A)	10.404	8.563 (A)
Bingerville	2,495	...	3.863	...
Dar-es-Salaam	2,569	...	8.228	...

a/ PACB. Op. Cit., p. 168-69.

b/ The Mercantile Marine Atlas, London: G. Philip and Son, Limited, 14th Ed., 1962

$$(10)\quad C_{ij} = 1.49637 + 1.47569\ (\log M_{ij})$$

$$r^2 = 0.67$$

where C_{ij} = transport cost in dollars per bag from region i to region j;

M_{ij} = distance in nautical miles from region i to region j.

Given this transport function, transportation rates between the basing points representing each pair of regions were estimated. (See Table 4.)

It seems relevant to discuss here the transportation policies adopted by the shipping lines. The various ports of the world are divided among the various shipping lines. A group of lines divided up an area of the world and establish a freight rate of shipping certain commodities.

Among the obstacles to trade in coffee with which coffee producting countries have long been concerned are fiscal levies and quantitative import restrictions. Under the provisions of the Article 47 of the ICA, the members are committed to investigate ways and means by which the obstacles to increased trade of coffee could be progressively reduced and eventually, whenever possible, eliminated. Tariffs are still an important obstacle to the expansion of coffee trade in the absolute majority of importing countries, despite persistent efforts to have them reduced or eliminated. In 1965 there were changes in rates of duties on coffee, with some increases and some decreases being made. In general, however, the basic situation

Table 4. Transportation Costs Between Selected Regions (U.S. $/bag)

From \ To	United States	Canada	Argentina	W. Germany -Austria	France	Italy Switzerland	Netherlands	Belgium--Luxemburg	Sweden
Brazil	2.54	2.61	1.63	2.63	2.58	2.59	2.60	2.60	2.69
Colombia	2.05	2.31	2.60	2.58	2.53	2.61	2.55	2.55	2.65
Guatemala	2.00	2.28	2.63	2.56	2.51	2.60	2.53	2.51	2.65
Mexico	1.87	2.26	2.68	2.57	2.52	2.62	2.54	2.54	2.64
El Salvador	2.18	2.38	2.65	2.63	2.58	2.66	2.59	2.60	2.74
Costa Rica	1.95	2.20	2.54	2.51	2.45	2.55	2.48	2.48	2.59
Ecuador	2.17	1.99	2.66	2.64	2.59	2.66	2.61	2.61	2.70
Venezuela	1.89	2.27	2.64	2.56	2.51	2.60	2.51	2.53	2.65
Nicaragua	2.12	2.36	2.64	2.62	2.57	2.65	2.59	2.59	2.68
Dominican Republic	1.64	2.00	3.49	2.43	2.32	2.45	2.36	2.36	2.36
Honduras	2.00	2.27	2.63	2.56	2.50	2.60	2.53	2.40	2.65
Peru	2.27	2.46	2.71	2.69	2.64	2.71	2.66	2.66	2.74
Haiti	1.61	2.05	2.51	2.42	2.36	2.47	2.39	2.39	2.53
Ethiopia	2.66	2.66	2.76	2.47	2.40	1.99	2.43	2.43	2.54
Kenya-Uganda	2.86	2.85	2.67	2.72	2.68	2.44	2.70	2.70	2.77
Burundi-Tanzania	2.85	2.85	2.66	2.71	2.66	2.42	2.68	2.68	2.76
India	2.91	2.92	2.87	2.79	2.75	2.55	2.77	2.77	2.84
Angola	2.56	2.59	2.38	2.50	2.44	2.46	2.47	2.47	2.57
OAMCAF	2.36	2.43	2.37	2.32	2.23	2.25	2.27	2.27	2.40
Congo (D.R.)	2.53	2.57	2.43	2.48	2.42	2.44	2.45	2.45	2.55
Indonesia	3.00	3.00	2.90	2.89	2.86	2.69	2.87	2.88	2.93

Table 4. (continued)

From \ To	United Kingdom	Denmark	Finland	Portugal	Spain	Eastern Europe	Japan	Australia	Algeria
Brazil	2.59	2.63	2.58	2.44	2.51	2.71	3.09	2.87	2.52
Colombia	2.52	2.60	2.66	2.41	2.50	2.68	2.77	2.80	2.54
Guatemala	2.50	2.58	2.64	2.44	2.53	2.71	2.79	2.81	2.59
Mexico	2.51	2.59	2.63	2.41	2.49	2.66	2.90	2.95	2.61
El Salvador	2.57	2.69	2.74	2.49	2.55	2.72	2.87	2.89	2.60
Costa Rica	2.44	2.54	2.60	2.32	2.42	2.62	2.82	2.84	2.46
Ecuador	2.58	2.65	2.71	2.49	2.56	2.71	2.73	2.73	2.59
Venezuela	2.50	2.58	2.64	2.45	2.52	2.71	2.91	2.92	2.45
Nicaragua	2.56	2.64	2.69	2.47	2.54	2.71	2.86	2.48	2.58
Dominican Republic	2.31	2.42	2.51	2.26	2.35	2.59	2.89	2.90	2.42
Honduras	2.49	2.58	2.64	2.46	2.52	2.71	2.79	2.83	2.47
Peru	2.64	2.71	2.74	2.56	2.62	2.77	2.71	2.69	2.65
Haiti	2.35	2.45	2.52	2.29	2.38	2.61	2.87	2.89	2.44
Ethiopia	2.42	2.49	2.56	2.28	2.35	2.57	2.73	2.72	2.36
Kenya-Uganda	2.68	2.73	2.77	2.56	2.62	2.79	2.75	2.66	2.59
Burundi-Tanzania	2.63	2.72	2.77	2.54	2.59	2.77	2.74	2.63	2.62
India	2.76	2.81	2.85	2.65	2.70	2.86	2.46	2.52	2.70
Angola	2.46	2.53	2.59	2.26	2.35	2.60	2.97	2.97	2.37
OAMCAF	2.25	2.34	2.42	1.96	2.10	3.44	3.04	2.83	2.03
Congo (D.R.)	2.43	2.50	2.57	2.23	2.33	2.58	2.98	2.79	2.26
Indonesia	2.87	2.90	2.94	2.77	2.81	2.95	2.25	2.28	2.72

Sources of Derivation: Data in Table 13 of Appendix and Equation (1).

remained about as it was in the previous years.[36] Taxes on Brazilian coffee ranged from as high as U. S. $60.85 per bag (in Australia) to as low as U. S. $1.32 per bag (in Spain). No customs duties were imposed by the United States, Algeria and Eastern Europe (Table 13 of Appendix).[37] Total transfer costs, i.e., transportation costs plus tariffs are presented in Table 5.

Surplus and Deficit Regions

The major countries making up the world coffee market are either exporting (surplus) or importing (deficit) countries. That is to say, the twenty-one exporting regions considered in this study do not import any amounts of coffee (See Table 6 and 7).

Brazil competes mainly with other twenty coffee-producing surplus regions. They are located in Latin America and Africa. Substantial quantities are also exported from India and Indonesia. Brazil has been the dominant supplier of the world coffee market. However, during the last decade, the aggregate African share of the world market has been greatly increased. Increased competition also comes from other producers of high-quality coffee located in Latin America.[38] Evaluation of the competitive position of Brazilian coffee in the international market is in order.

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[36] See Appendix Table 14.

[37] For detailed analyses of the impact of taxes on coffee imports see Viton, A., The World Coffee Economy. Rome: FAO. Commodity Bulletin Series No. 33, 1961, p. 33-35; and FAO. Coffee Taxes and Consumption in Importing Countries, in Monthly Bulletin of Agricultural Economics and Statistics, September, 1960, p. 8-13.

[38] Lovasy, G., et al., op. cit., p. 267-388.

Table 5. Transfer Costs (Including 1965 Duties) Between Selected Regions (U.S. $/bag)

From \ To	United States	Canada	Argentina	W.Germany -Austria	France	Italy Switzerland	Netherland	Belgium-Luxemburg	Sweden
Brazil	2.54	9.22	15.09	18.50	15.25	15.26	9.21	5.25	7.93
Colombia	2.05	8.92	43.52	18.45	15.20	15.28	9.16	5.20	7.94
Guatemala	2.00	8.89	43.55	18.43	15.18	15.27	9.14	5.17	7.94
Mexico	1.87	8.87	43.60	18.44	15.19	15.29	9.15	5.19	7.93
El Salvador	2.18	8.99	43.57	18.50	15.25	15.33	9.20	5.25	8.03
Costa Rica	1.95	8.81	43.46	18.38	15.12	15.22	9.09	5.13	7.83
Ecuador	2.17	8.60	43.58	18.51	15.26	15.33	9.22	5.26	7.99
Venezuela	1.89	8.88	43.55	18.43	15.18	15.27	9.12	5.18	7.94
Nicaragua	2.12	8.97	43.56	18.49	15.24	15.32	9.20	5.24	7.97
Dominican Republic	1.64	8.61	44.41	18.30	14.99	15.12	8.97	5.01	7.65
Honduras	2.00	8.88	43.55	18.43	15.17	15.27	9.14	5.05	7.94
Peru	2.67	9.07	43.63	18.53	15.31	15.38	9.27	5.31	8.03
Haiti	1.61	8.66	43.43	18.29	15.03	15.14	9.00	5.04	7.82
Ethiopia	2.66	9.27	43.68	18.34	15.07	14.66	9.04	5.08	7.83
Kenya-Uganda	2.86	9.46	43.59	18.87	15.35	12.67	9.31	5.35	8.06
Burundi-Tanzania	2.85	9.45	43.58	18.57	15.33	15.09	9.29	4.92	8.05
India	2.91	2.91	43.79	18.66	15.42	15.22	9.38	5.42	8.13
Angola	2.56	9.20	43.30	18.37	15.11	15.13	9.08	5.12	7.86
OAMCAF	2.36	9.04	43.29	2.43	2.43	2.25	2.27	2.27	7.69
Congo (D.R.)	2.53	9.18	43.35	2.48	22.42	2.44	2.45	2.45	7.84
Indonesia	2.99	2.99	43.82	18.76	15.36	15.36	9.48	2.52	8.22

Table 5. (continued)

From \ To	United Kingdom	Denmark	Finland	Portugal	Spain	Eastern Europe	Japan	Australia	Algeria
Brazil	4.17	18.50	26.39	60.52	3.83	2.71	49.39	63.72	2.52
Colombia	4.10	18.47	26.47	60.49	3.82	2.68	49.07	63.65	2.54
Guatemala	4.03	18.45	26.45	60.52	3.85	2.71	49.09	63.66	2.59
Mexico	4.09	18.46	26.44	60.49	3.81	2.66	49.20	63.78	2.61
El Salvador	4.15	18.56	26.55	60.57	3.87	2.72	49.17	63.47	2.60
Costa Rica	4.02	18.41	26.41	60.40	3.74	2.62	49.12	63.69	2.46
Ecuador	4.16	18.52	26.52	60.57	3.88	2.71	49.03	63.60	2.59
Venezuela	4.03	18.45	26.45	60.53	3.84	2.71	49.21	63.77	2.45
Nicaragua	4.14	18.51	26.50	60.55	3.86	2.71	49.16	63.33	2.58
Dominican Republic	3.89	18.29	26.32	60.34	3.67	2.59	49.19	63.75	2.42
Honduras	4.07	18.45	26.45	60.54	3.84	2.71	49.01	63.66	2.47
Peru	4.22	18.56	26.55	60.64	3.94	2.77	49.01	63.54	2.63
Haiti	3.93	18.32	26.33	60.37	3.70	2.61	49.17	63.74	2.44
Ethiopia	2.42	18.36	26.37	60.36	3.67	2.57	49.03	63.57	2.36
Kenya-Uganda	2.68	18.87	23.81	60.74	3.94	2.79	2.75	63.51	2.59
Burundi-Tanzania	2.68	18.59	26.58	60.62	3.91	2.77	2.74	63.48	2.62
India	2.76	18.68	26.66	60.75	4.02	2.86	2.46	63.37	2.70
Angola	2.64	18.40	26.40	22.26	3.67	2.60	49.27	63.61	2.37
OAMCAF	4.83	18.30	26.23	60.00	3.42	3.44	49.34	63.73	2.03
Congo (D.R.)	4.01	18.37	26.38	60.31	3.65	2.58	49.28	63.64	2.26
Indonesia	4.45	18.77	26.75	60.85	4.13	2.95	48.55	63.13	2.72

Sources of Derivation: Data in Table 4 and Table 13 of Appendix.

Table 6. Green Coffee: Exportable Production and Operative ICO Export Quotas of Selected Regions, 1964-65 (Thousand bags). a/

Number	Region	Exportable Production	Operative ICO Quota
1	Brazil	24,500 b/	16,827
2	Colombia	6,500	5,620
3	Guatemala	1,420	1,257
4	Mexico	1,580	1,411
5	El Salvador	1,935	1,561
6	Costa Rica	685	888
7	Ecuador	750	516
8	Venezuela	275	444
9	Nicaragua	525	455
10	Dominican Republic	525	525
11	Honduras	365	266
12	Peru	680	496
13	Haiti	385	393
14	Ethiopia	1,300	1,098
15	Kenya-Uganda	3,080	2,248
16	Burundi-Tanzania	790	676
17	India	460	313
18	Angola	3,045	2,045
19	OAMCAF	5,571	4,021
20	Congo (D.R.)	900	1,066
21	Indonesia	1,850	1,099
	Total	57,121	43,225

a/ Source: PACB. Annual Coffee Statistics, No. 29, 1965, p. 87 and 172.

b/ Arithmetic average of 1963-64 and 1965-66 figures.

Table 7. Green Coffee: Net Imports of Selected Types by Selected Regions, 1964-65 (Thousand Bags).a/

Number	Region	Imports		
		Arabica	Robusta	Total
22	United States	16,075	5,272	21,347
23	Canada	1,083	175	1,258
24	Argentina	505	0	505
25	West Germany-Austria	4,354	525	4,879
26	France	891	2,726	3,617
27	Italy-Switzerland	1,734	1,008	2,742
28	Netherlands	796	582	1,378
29	Belgium-Luxemburg	863	266	1,129
30	Sweden	1,459	73	1,532
31	United Kingdom	261	712	973
32	Denmark	692	132	824
33	Finland	628	45	673
34	Portugal	0	215	215
35	Spain	573	237	810
36	Eastern-Europe	1,210	553	1,763
37	Japan	131	234	365
38	Australia	88	157	245
39	Algeria	82	418	500
	Total	31,425	13,330	44,755

a/ Source: PACB. Op. Cit., p. 76 and 126-27.

The harvest year 1964-65 was selected. Yet with the 1965-66 crop much below normal the 1964-65 time period seemed very reasonable and appropriate.

In 1964 the ICA, fixed total quotas of its members at about 103% of the basic quotas for the crop year 1964-65. Following a price fall, the Council reduced the quotas to about 99%.[39/] Table 6 shows the actual quotas in effect after the final Council action.

Exports above or below ICO assigned quotas may be explained by authorized exports to "new markets," "shortfalls" (failures to fulfill quotas) and or minor statistical deviations. The difference between total exports and total ICO quota may be explained, at least to a certain extent, by Brazilian "shortfalls."[40/]

Starting in the late 1950's, the international coffee market was characterized by large surpluses; exportable production exceeded exports year after year and unsold stocks continued to grow. By far the greatest part of these stocks was accumulated in the Brazilian warehouse.[41/] Surveys indicated that the 51 million bags of coffee stored in Brazil could yield 41 million bags of marketable coffee. However, some trade sources contended that usable stocks were much lower than 41 million . . . quite possible even lower than 20 million. Reviewing past incidents of severe frost

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[39/] PACB. op. cit., p. 2.

[40/] Export figures greater than exportable production figures may be explained by reduction of stocks through exports of previous carry-overs.

[41/] Lovasy, G., et al., op. cit., p. 367.

and drought in Brazil, Shisko found that "declines in annual production ranged from 30% to over 50%. In these severe instances, production remained depressed for two to three seasons, then recovered to the prefrost level."[42] Complete elimination of Brazilian coffee surpluses is assumed to the next four years, provided that the Brazilian Coffee Institute takes some important measures, abandoning indiscriminate production of low quality coffee and giving financial incentives to more careful processing.

The transportation model, as used here, requires that special assumption be made. The commodity studied is considered to be a homogeneous product. Green coffee of all sources, regardless of type, variety or mode of processing, is assumed to be a single product. However, some supply areas have export coffee of different types and most consuming areas also demand different varieties and types.[43] In addition, different varieties do have a high degree of substitutability.[44] If it were possible and feasible to consider quality variation, some deviations in the findings probably would result. However, information on supply of different types and varieties of coffee, per producing countries, was not available at

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[42] Shisko, I., op. cit., p. 115.

[43] See for instance, Hurt, L. C., Coffee Situation, Programs, and Policies in Producing Countries. Washington, D. C.: USDA-FAS, Bulletin M-148, 1963, 19 p.; and Viton, A., op. cit., p. 8-27. See also Table 5 of this study.

[44] Gertrude Lovasy, and Lorette Boissonneault, the distinguished economists of the International Monetary Fund, have shown that elasticities of substitution for Robustas and Brazils and for Manis and Brazils, in the U. S. Market, are respectively -0.98 and -2.8. Cf. Lovasy, G., et al., op. cit., p. 278-382.

the time this study was conducted. This fact precluded the use of a spatial linear programming model through which the impact of quality differentials could be evaluated. That is, information on imports by types is available (Table 8) but one cannot determine how much, of each type came from each exporting country. The following analyses consider only total import figures.

CHAPTER IV

RESULTS

The Dennis transportation model computer program[45] was used to determine the optimal shipment patterns of the world coffee market under four different assumed conditions. The first condition (Model I) assumes a "free market" situation where neither export quotas nor import tariffs are imposed. Model II assumes that export quotas are imposed but no import tariffs exist. Model III is one where export quotas are absent but import tariffs are present. In the Model IV both export quotas and import tariffs are imposed.[46]

Since in each of the four models total surpluses are different from total deficits, a "dummy" region (a "source" in Models II and IV and a "destination" in Models I and III) was used, from where lacking or unused coffee would come from or flow in. The matrices required for solution of these models are a 21 by 19 (Models I and IV) and a 22 by 18 (Models I and III), allowing shipments from 13 Latin American countries, 6 African regions, 2 Asian countries and the artifical origin vector (21a) to 12 European regions, 3 American countries, Japan, Algeria, Australia, and the artifical destination vector (39a). There are 21 real origins and 18 real destinations.

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[45] Dennis, J. B. A High-Speed Computer Technique for the Transportation Problem, in JACM, Vol. 5, No. 2, April 1958, p. 132-53.

[46] Quotas and tariffs are imposed (assumed) only for the real origins and destinations. Dummy origins and destinations are used to make total exports equal to total imports, and they carry no import tariffs.

The numbers used to identify regions, in Tables 8, 9, 10, and 11, are the same as those used in Tables 6 and 7 of the previous chapter.

The transportation model requirements are: (1) a homogeneous product; (2) the quantities that would be required at each destination and the supplies of each origin are known (Tables 6 and 7); and (3) the cost of moving (transportation or transfer costs) the commodity from all origins to all destinations is known (Tables 4 and 5). The object is to program the coffee movements in order to minimize total transportation costs. From the computer output, the optimal flows of green coffee, the marginal value differences of the product (V_j's and U_i's), and the total transportation cost are obtained. Those are the elements that indicate: (1) the "best" markets for Brazilian coffee; (2) the effects of elimination of tariffs on the selection of these best markets; (3) the effects of elimination of ICA export quotas on the optimal pattern of distribution of coffee; and (4) the locational advantage of Brazil with respect to marketing coffee. These are the specific objectives of the study as indicated in Chapter I.

Selection of Best Markets

Best markets for Brazilian coffee are selected in terms of relative costs of using non-optimal routes. Selected ranges of these relative costs are indicated furtherly. All references to "best markets" mean best markets for coffee coming from Brazil.

Table 8. Optimal Allocation of Green Coffee Between Selected Regions. Model I: "Free Market" Situation, 1964-65, Expressed in Thousand Bags (Quantity Figures) and U.S. Dollars per Bag (Marginal Values and Relative Costs).[a/]

Origin	Destination								
	22	23	24	25	26	27	28	29	30
1	6,472	508	505	3,985	-0.02	-0.15	0.00	0.00	1,532
2	6,500	-0.19	-1.46	-0.44	-0.46	-0.60	-0.44	-0.44	-0.45
3	1,420	-0.21	-1.54	-0.47	-0.49	-0.70	-0.47	-0.45	-0.50
4	1,580	-0.32	-1.72	-0.61	-0.63	-0.85	-0.61	-0.61	-0.62
5	1,935	-0.13	-1.32	-0.36	-0.38	-0.58	-0.30	-0.36	-0.41
6	665	-0.18	-1.50	-0.47	-0.48	-0.70	-0.47	-0.47	-0.49
7	-0.25	750	-1.65	-0.63	-0.65	-0.84	-0.63	-0.63	-0.63
8	225	-0.31	-1.66	-0.58	-0.60	-0.81	-0.56	-0.58	-0.61
9	525	-0.17	-1.53	-0.41	-0.43	-0.63	-0.41	-0.41	-0.41
10	525	-0.28	-2.75	-0.69	-0.65	-0.90	-0.65	-0.65	-0.56
11	765	-0.20	-1.54	-0.47	-0.48	-0.74	-0.47	-0.34	-0.50
12	680	-0.12	-1.35	-0.33	-0.35	-0.54	-0.33	-0.33	-0.32
13	385	-0.37	-1.81	-0.72	-0.73	-0.96	-0.92	-0.72	-0.77
14	-0.57	-0.50	-1.58	-0.29	-0.29	1,300	-0.28	-0.28	-0.30
15	-0.32	-0.24	-1.04	-0.09	-0.12	652	-0.10	-0.10	-0.08
16	-0.33	-0.26	-1.05	-0.10	-0.12	740	-0.10	-0.10	-0.09
17	-0.37	-0.31	-1.26	0.00	-0.19	-0.11	-0.17	-0.17	-0.15
18	-0.15	-0.11	-0.88	804	-0.01	-0.15	1,378	729	-0.01
19	-0.15	-0.15	-1.07	-0.02	3,617	-0.14	0.00	0.00	-0.04
20	-0.14	-0.11	-0.95	0.00	-0.01	-0.15	0.00	-400	-0.01
21	-0.46	-0.39	-1.27	-0.26	-0.30	-0.25	0.00	-0.28	-0.24
Total	21,347	1,258	505	4,879	3,617	2,742	1,378	1,129	1,532
V_j	2.54	2.61	1.63	2.63	2.56	2.44	2.60	2.60	2.69

Table 8. (continued)

Origin	Destination										Total	U_i
	31	32	33	34	35	36	37	38	39	39(a)		
1	-0.01	824	673	-0.14	-0.07	1,763	-0.84	-0.59	-0.11	8,238	24,500	0.00
2	-0.43	-0.46	-0.57	-0.60	-0.55	-0.46	-1.01	-1.01	-0.62	0.49	6,500	0.49
3	-0.46	-0.49	-0.60	-0.68	-0.63	-0.54	-1.08	-1.07	-0.72	0.54	1,420	0.54
4	-0.60	-0.63	-0.72	-0.78	-0.72	-0.62	-1.32	-1.32	-0.87	0.67	1,580	0.67
5	-0.35	-0.42	-0.52	-0.55	-0.47	-0.37	-0.98	-0.97	-0.55	0.36	1,935	0.36
6	-0.45	-0.50	-0.61	-0.61	-0.57	-0.50	-1.66	-1.15	-0.64	0.59	685	0.59
7	-0.62	-0.64	-0.75	-0.81	-0.74	-0.62	-1.10	-1.09	-0.80	0.62	750	0.62
8	-0.57	-0.60	-0.71	-0.80	-0.77	-0.65	-1.31	-1.29	-0.69	0.65	225	0.65
9	-0.50	-0.43	-0.53	-0.59	-0.52	-0.42	-1.03	-0.62	-0.59	0.42	525	0.42
10	-0.38	-0.68	-0.82	-0.85	-0.80	-0.77	-1.53	-1.51	-0.99	0.89	525	0.89
11	-0.45	-0.49	-0.60	-0.70	-0.63	-0.54	-1.08	-1.07	-0.60	0.54	365	0.54
12	-0.33	-0.35	-0.43	-0.53	-0.45	-0.33	-0.73	-0.68	-0.51	0.27	680	0.27
13	-0.70	-0.75	-0.87	-0.92	-0.87	-0.83	-1.55	-1.54	-0.96	0.93	395	0.93
14	-0.29	-0.31	-0.43	-0.43	-0.36	-0.31	-0.93	-0.89	-0.40	0.45	1,700	0.45
15	-0.10	-0.10	-0.19	-0.26	-0.18	-0.08	-0.50	-0.38	-0.18	2,428	3,070	0.00
16	-0.12	-0.11	-0.21	-0.26	-0.17	-0.08	-0.51	-0.37	-0.23	0.02	790	0.02
17	-0.18	-0.18	-0.27	-0.35	-0.26	-0.15	-0.21	-0.24	-0.29	460	460	0.00
18	44	-0.03	-0.14	-0.09	-0.04	-0.02	-0.85	-0.62	-0.09	0.13	3,045	0.13
19	929	-0.04	-0.17	215	810	-0.06	-1.12	-0.93	0.00	0.33	5,321	0.33
20	0.00	-0.02	-0.14	-0.08	-0.04	-0.02	-0.88	-0.66	500	0.15	900	0.15
21	-0.29	-0.27	-0.36	-0.47	-0.32	-0.24	365	245	-0.31	1,240	1,850	0.00
Total	973	824	673	215	810	1,763	365	245	500	12,366	57,121	----
V_j	2.58	2.63	2.58	2.30	2.44	2.71	2.25	2.28	2.41	0.00	----	----

a/ Total transportation cost= U.S. $102,807,185. Quantity figures are underscored, while marginal values and relative costs of using non-optimal routes are not underscored.

Table 9. Optimal Allocation of Green Coffee Between Selected Regions. Model II: With ICO Export Quota Restrictions and Without Import Tariffs, 1964-65, Expressed in Thousand Bags (Quantity Figures) and U.S. Dollars (Marginal Values and Relative Costs).[a/]

Origin	Destination								
	22	23	24	25	26	27	28	29	30
1	8,031	742	505	4,674	-0.01	-0.25	1,378	0.00	-0.01
2	5,620	-0.19	-1.46	-0.49	-0.50	-0.76	-0.44	-0.44	-0.46
3	1,257	-0.21	-1.54	-0.49	-0.48	-0.80	-0.47	-0.45	-0.51
4	1,411	-0.32	-1.72	-0.60	-0.62	-0.95	-0.61	-0.61	-0.63
5	1,561	-0.13	-1.38	-0.30	-0.37	-0.68	-0.35	-0.36	-0.46
6	888	-0.18	-1.50	-0.59	-0.47	-0.80	-0.47	-0.47	-0.50
7	-0.25	516	-1.65	-0.50	-0.64	-0.94	-0.63	-0.63	-0.64
8	444	-0.31	-1.66	-0.66	-0.59	-0.91	-0.56	-0.58	-0.62
9	455	-0.17	-1.43	-0.35	-0.42	-0.73	-0.41	-0.41	-0.42
10	525	-0.19	-2.76	-0.89	-0.65	-0.01	-0.66	-0.66	-0.58
11	266	-0.20	-1.54	-0.34	-0.47	-0.80	-0.47	-0.34	-0.51
12	496	-0.12	-1.35	-0.20	-0.34	-0.64	-0.33	-0.33	-0.33
13	393	-0.37	-1.81	-0.99	-0.72	-1.06	-0.72	-0.72	-0.78
14	-0.47	-0.40	-1.48	-0.14	-0.18	1,088	-0.18	-0.18	-0.21
15	-0.33	-0.15	-0.95	-0.02	-0.02	1,518	-0.01	-0.01	730
16	-0.23	-0.16	-0.95	-0.01	-0.01	126	0.00	317	0.00
17	-0.21	-0.15	-1.08	-0.23	-0.02	-0.05	-0.01	-0.01	313
18	-0.15	-0.11	-0.88	205	621	-0.25	0.00	812	-0.02
19	-0.16	-0.16	-1.08	-0.21	2,996	-0.25	-0.01	-0.01	-0.06
20	-0.15	-0.12	-0.96	-0.15	-0.01	-0.26	-0.01	-0.01	-0.03
21	-0.71	-0.64	-1.52	-0.10	-0.54	-0.60	-0.52	-0.53	489
21(a)	-0.15	-0.08	-1.06	-2.95	-0.12	-0.35	-0.09	-0.09	-0.01
Total	21,347	1,258	505	4,879	3,617	2,742	1,378	1,129	1,532
V_j	2.54	2.61	1.63	2.63	2.57	2.34	2.60	2.60	2.68

Table 9. (continued)

Origin	Destination									Total	U_i
	31	32	33	34	35	36	37	38	39		
1	0.00	824	623	-0.14	-0.07	-0.02	-1.09	-0.84	-0.10	16,822	0.00
2	-0.42	-0.46	-0.57	-0.60	-0.55	-0.48	-1.26	-1.26	-0.61	5,620	0.49
3	-0.35	-0.49	-0.60	-0.68	-0.63	-0.56	-1.33	-1.32	-0.71	1,357	0.54
4	-0.59	-0.63	-0.72	-0.78	-0.72	-0.64	-1.57	-1.57	-0.86	1,711	0.67
5	-0.34	-0.42	-0.52	-0.55	-0.47	-0.39	-1.23	-1.22	-0.54	1,561	0.36
6	-0.44	-0.50	-0.61	-0.61	-0.57	-0.50	-1.41	-1.40	-0.63	888	0.59
7	-0.61	-0.64	-0.75	-0.81	-0.74	-0.64	-1.35	-1.34	-0.79	536	0.62
8	-0.56	-0.60	-0.71	-0.80	-0.73	-0.67	-1.56	-1.54	-0.68	444	0.65
9	-0.39	-0.43	-0.53	-0.59	-0.52	-0.44	-1.28	-0.87	-0.58	455	0.42
10	-0.62	-0.69	-0.83	-0.86	-0.81	-0.80	-1.79	-1.77	-0.90	525	0.90
11	-0.44	-0.49	-0.60	-0.70	-0.62	-0.56	-1.33	-1.32	-0.59	266	0.54
12	-0.32	-0.35	-0.43	-0.53	-0.45	-0.35	-0.98	-0.93	-0.50	496	0.27
13	-0.69	-0.75	-0.87	-0.92	-0.87	-0.85	-1.80	-1.79	-0.95	393	0.93
14	-0.18	-0.21	-0.33	-0.33	-0.26	-0.23	-1.08	-1.04	-0.29	1,088	0.35
15	0.00	-0.01	-0.10	-0.17	-0.09	-0.01	-0.66	-0.54	-0.08	2,248	-0.09
16	-0.01	-0.01	-0.11	-0.16	-0.07	233	-0.66	-0.52	-0.12	676	-0.08
17	-0.01	-0.02	-0.11	-0.19	-0.10	-0.01	-0.30	-0.33	-0.12	313	-0.16
18	407	-0.03	-0.14	-0.09	-0.04	-0.04	-0.10	-0.87	-0.08	2,045	0.13
19	0.00	-0.05	-0.14	215	810	-1.09	-0.38	-1.19	0.00	4,021	0.34
20	566	-0.03	-0.15	-0.09	-0.05	-0.05	-0.14	-0.92	500	1,066	0.16
21	-0.03	-0.02	-0.11	-0.22	-0.12	-0.01	365	246	-0.05	1,099	-0.25
21(a)	-0.10	-0.06	-0.01	-0.39	-0.15	1,530	-0.69	-0.66	-0.27	1,530	2.69
Total	973	824	623	215	810	1,263	365	245	500	44,755	----
V_j	2.59	2.63	2.58	2.30	2.44	2.69	2.00	2.03	2.42	------	----

a/ Total Transportation Cost = U.S. $100,468,540. Quantity figures are underscored, while marginal values and relative costs of using non-optimal routes are not underscored.

Table 10. Optimal Allocation of Green Coffee Between Selected Regions. Model III: Without ICO Export Quotas and with Import Tariffs, 1964-65, Expressed in Thousand Bags (Quantity Figures) and U.S. Dollars (Marginal Values and Relative Costs).[a/]

Origin	Destination								
	22	23	24	25	26	27	28	29	30
1	6,402	-3.83	505	-3.16	505	-0.34	1,378	-0.33	1,532
2	6,500	-4.02	-28.92	-3.60	-0.44	-0.85	-0.44	-0.77	-0.45
3	1,420	-4.04	-29.00	-3.63	-0.47	-0.89	-0.47	-0.79	-0.50
4	1,580	-4.15	-29.18	-3.77	-0.61	-1.04	-0.61	-0.94	-0.62
5	1,935	-3.96	-28.84	-3.52	-0.36	-0.77	-0.35	-0.69	-0.41
6	685	-3.99	-28.88	-3.61	-0.44	-0.87	-0.45	-0.78	-0.47
7	750	-3.58	-28.86	-3.54	-0.38	-0.78	-0.38	-0.71	-0.38
8	275	-4.14	-29.11	-3.74	-0.58	-1.00	-0.56	-0.91	-0.63
9	525	-4.00	-28.89	-3.57	-0.41	-0.82	-0.41	-0.74	-0.41
10	525	-4.12	-30.22	-3.81	-0.64	-1.10	-0.66	-0.99	-0.57
11	365	-4.03	-29.00	-3.63	0.00	-0.89	-0.47	-0.67	-0.50
12	-0.13	-3.68	-28.54	-3.24	-0.06	-0.44	-0.06	-0.39	-0.05
13	385	-3.81	-28.88	-3.49	-0.32	-0.76	-0.33	-0.66	-0.38
14	-0.38	-4.14	-28.85	-3.26	-0.08	335	-0.09	-0.42	-0.11
15	-2.57	-4.32	-30.75	-5.78	-2.35	2,407	-2.35	-2.68	-2.33
16	-0.31	-4.06	-28.49	-3.23	-0.08	-0.17	-0.08	77	-0.07
17	-2.85	460	-31.18	-5.80	-2.65	-2.78	-2.65	-2.98	-2.63
18	-0.16	-8.16	-28.35	-3.17	1,520	-0.35	-0.01	-0.34	-0.02
19	-12.84	-16.83	-41.22	3,979	1,592	-0.35	-6.08	-10.37	-12.73
20	-12.85	-16.51	-41.12	900	-0.03	-0.38	-6.10	-10.39	-12.72
21	-0.85	798	-31.13	-5.82	-2.68	-2.84	-2.67	1,052	-2.64
Total	21,347	1,258	505	4,879	3,617	2,742	1,378	1,129	1,532
V_j	2.54	5.39	15.09	15.34	15.25	14.92	9.21	4.92	7.98

Table 10. (continued)

Origin	Destination										Total	U_i
	31	32	33	34	35	36	37	38	39	39(a)		
1	-1.49	824	-0.33	-58.12	-0.02	1,263	-46.65	-0.24	-0.01	11,591	24,500	0.00
2	-1.91	-0.46	-0.90	-58.58	-0.50	-0.46	-46.82	-0.66	-0.52	-0.49	6,500	0.49
3	-1.94	-0.49	-0.93	-58.66	-0.58	-0.54	-46.89	-0.72	-0.62	-0.54	1,420	0.54
4	-2.08	-0.63	-1.05	-58.76	-0.67	-0.62	-47.13	-0.97	-0.77	-0.67	1,500	0.67
5	-1.83	-0.42	-0.85	-58.53	-0.42	-0.37	-46.79	-0.62	-0.45	-0.36	1,935	0.36
6	-1.91	-0.48	-0.92	-58.51	-0.50	-0.48	-46.95	-0.78	-0.52	-0.59	685	0.59
7	-1.85	-0.39	-0.83	-58.54	-0.44	-0.37	-46.66	-0.49	-0.45	-0.37	250	0.37
8	-2.05	-0.60	-1.04	-58.78	-0.68	-0.66	-47.12	-0.94	-0.59	-0.65	225	0.65
9	-1.88	-0.43	-0.86	-58.57	-0.47	-0.42	-46.84	-0.27	-0.49	-0.42	525	0.42
10	-2.11	-0.69	-1.16	-57.84	-0.76	-0.78	-47.35	-0.17	-0.81	-0.90	525	0.90
11	-1.93	-0.49	-0.93	-58.68	-0.57	-0.54	-56.89	-0.72	-0.50	-0.54	365	0.54
12	-1.54	-0.08	-0.55	-58.24	-0.13	-0.06	-46.27	-0.06	-0.14	680	680	0.00
13	-1.79	-0.36	-0.81	-58.51	-0.43	-0.44	-46.97	-0.80	-0.47	-0.54	385	0.54
14	965	-0.12	-0.57	-58.22	-0.12	-0.12	-46.55	-0.35	-0.11	-0.26	1,300	0.26
15	-2.25	-2.62	673	-60.59	-2.38	-2.33	-2.26	-2.28	-0.33	-2.25	3,080	2.25
16	8	-0.09	-0.52	-58.32	-0.10	-0.06	365	245	-0.11	95	720	0.00
17	-2.56	-2.66	-3.08	-60.81	-2.69	-2.63	-2.20	-2.37	-2.67	-2.50	440	2.48
18	-0.10	-0.04	-0.48	215	810	-0.03	-46.67	-0.27	500	-0.14	3,015	0.14
19	-15.17	-12.82	-13.19	-70.62	-12.63	-13.25	-59.62	-13.27	-12.59	-13.02	5,527	13.02
20	-14.19	-12.73	-13.18	-70.77	-12.70	-12.23	-59.40	-13.02	-12.61	-12.86	900	12.86
21	-4.17	-2.67	-3.09	-60.85	-2.72	-2.64	-48.21	-2.05	-2.61	-2.40	1,850	2.40
Total	973	824	623	215	810	1,263	365	245	500	12,366	57,121	----
V_j	2.68	18.50	26.06	2.40	3.81	2.71	2.74	63.48	2.51	0.00	------	----

a/ Total Transportation Cost = U.S. $226,386,100. Quantity figures are underscored, while marginal values and relative costs of using non-optimal routes are not underscored.

Table 11. Optimal Allocation of Green Coffee Between Selected Regions. Model IV: With ICO Export Quota Restrictions and With Import Tariffs, 1964-65, Expressed in Thousand Bags (Quantity Figures) and U.S. Dollars (Marginal Values and Relative Costs). a/

Origin	Destination										
	22	23	24	25	26	27	28	29	30	31	32
1	8,011	1,033	505	-3.16	2,889	-0.31	1,378	-0.30	1,036	-1.46	824
2	5,620	-6.19	-28.92	-3.60	-0.44	-0.82	-0.44	-0.74	-0.45	-1.88	-0.46
3	1,257	-6.21	-29.00	-3.63	-0.47	-0.86	-0.47	-0.76	-0.50	-1.91	-0.49
4	1,411	-6.32	-29.18	-3.77	-0.61	-1.01	-0.61	-0.31	-0.62	-2.05	-0.63
5	1,561	-6.13	-28.94	-3.52	-0.36	-0.74	-0.35	-0.66	-0.41	-1.80	-1.42
6	888	-6.18	-28.96	-3.63	-0.46	-0.86	-0.47	-0.77	-0.49	-1.90	-0.50
7	516	-5.75	-28.96	-3.54	-0.38	-0.75	-0.38	-0.68	-0.38	-1.82	-1.39
8	444	-6.31	-29.11	-3.74	-0.58	-0.97	-0.56	-0.88	-0.61	-2.03	-0.60
9	455	-6.17	-28.89	-3.57	-0.41	-0.79	-0.41	-0.71	-0.41	-1.85	-0.43
10	525	-6.29	-30.22	-3.86	-0.64	-1.07	-0.66	-0.96	-0.57	-2.08	-0.69
11	266	-6.20	-29.00	-3.63	-0.46	-0.86	-0.47	-0.64	-0.50	-1.90	-0.49
12	-0.22	-5.80	-28.49	-3.19	-0.01	-0.38	-0.01	-0.31	426	-1.46	-0.03
13	393	-5.27	-29.27	-3.88	-0.71	-1.12	-0.72	-1.02	-0.77	-2.15	-0.75
14	-0.17	-6.34	-28.88	-5.29	-0.11	494	-0.12	-0.42	-0.14	604	-0.15
15	-2.60	-8.52	-30.78	-3.81	-2.38	2,296	-0.38	-0.68	-0.36	-2.29	-0.65
16	-0.34	-6.26	-28.52	-3.26	-0.11	-0.17	-0.11	30	-0.10	369	-0.12
17	-0.68	225	-29.01	-3.63	-0.53	-0.58	-0.48	-0.78	-0.46	-0.36	-0.19
18	-0.16	-6.12	-28.35	-3.17	520	-0.32	-0.01	-0.31	-0.02	-0.07	-0.03
19	-12.84	-18.84	-41.22	3,813	203	-0.32	-6.03	-10.34	-12.73	-15.14	-11.93
20	-12.85	-18.85	-41.12	1,066	-12.72	-0.35	-6.10	-10.36	-12.72	-14.16	-11.78
21	-2.88	-2.78	-31.16	-5.85	-2.71	-2.84	-2.70	1,029	-3.27	-4.31	-3.70
21(a)	-15.46	-14.78	-2.51	-2.66	-2.75	-3.05	-8.74	-13.05	-10.02	-15.09	-11.1
Total	21,347	1,258	505	4,879	3,617	2,742	1,378	1,129	1,232	273	571
V_j	2.54	3.22	15.09	15.34	15.25	14.95	9.21	4.95	7.98	2.71	18.50

Table 11. (continued)

Origin	Destination							Total	U_i
	33	34	35	36	37	38	39		
1	673	-58.12	-0.02	233	-46.62	245	-0.01	16,827	0.00
2	-8.46	-58.58	-0.50	-0.46	-46.79	-45.64	-0.52	5,620	0.49
3	-8.49	-58.66	-0.58	-0.54	-46.86	-45.70	-0.62	1,257	0.54
4	-8.61	-58.76	-0.67	-0.62	-47.10	-45.95	-0.77	1,411	0.67
5	-8.41	-58.53	-0.42	-0.37	-46.76	-45.60	-0.45	1,561	0.36
6	-8.50	-58.54	-0.52	-0.50	-46.94	-45.78	-0.54	888	0.59
7	-8.39	-58.54	-0.44	-0.37	-46.63	-45.47	-0.45	516	0.37
8	-8.60	-58.78	-0.08	-0.65	-47.09	-45.92	-0.54	444	0.65
9	-8.42	-58.57	-0.47	-0.42	-46.81	-45.25	.0.45	455	0.42
10	-8.72	-58.84	-0.76	-0.78	-46.32	-45.15	-0.59	525	0.90
11	-8.49	-58.68	-0.57	-0.54	-58.86	-45.70	-0.49	266	0.54
12	-8.00	-58.19	-0.08	-0.01	-46.19	-45.09	-0.81	495	-0.05
13	-8.76	-58.90	-0.82	-0.83	-47.33	-46.17	-0.50	393	0.93
14	-8.16	-58.25	-0.15	-0.15	-46.55	-45.36	-0.09	1,098	0.29
15	-7.59	-60.62	-2.41	-2.36	- 2.26	-47.29	-0.86	2,248	2.28
16	-8.11	-58.25	-0.13	-0.09	277	-45.01	-0.14	676	0.03
17	-8.47	-58.64	-0.52	-0.46	88	-45.18	-0.50	313	0.31
18	-8.04	215	810	-0.03	-46.64	-45.25	500	2,015	0.14
19	-20.75	-49.38	-12.63	-13.75	-59.59	-58.25	-12.59	4,021	13.02
20	-20.74	-49.85	-12.70	-12.73	-59.37	-58.00	-12.61	1,065	12.83
21	-10.68	-60.88	-2.75	-2.67	-48.89	-47.06	-2.64	1,095	2.43
21(a)	-15.72	-15.60	-14.19	1,530	-15.23	-15.15	-5.49	1,530	18.00
Total	673	215	810	1,763	365	245	500	44,755	----
V_j	18.50	2.40	3.81	2.71	2.77	18.50	2.51	----	----

[a] Total Transportation Cost = U. S. $203, 692, 100. Quantity figures are not underscored while marginal values and relative costs of using non-optimal routes are not underscored.

Tables 8, 9, 10, and 11 show the results of the analyses. Solutions presented at Tables 8 and 9 yield information regarding best markets for Brazilian coffee directly by giving schedules of optimal shipments. They also yield information concerning alternative routings, referred to as the cost of using non-optimal routes. The cost of using non-optimal routes is actually the dual solution of the transportation problem. The advantage of this second solution lies in the fact that it indicates all possible optimal and near optimal markets, whereas the first solution shows only one set of optimal markets. This solution also shows the magnitude by which any given non-optimal route differs in cost from the optimal route. The cost of using non-optimal routes is a schedule of relative costs involved in using any other route at the expense of optimal routes. This cost is a combination of added transportation cost for using the non-optimal route, and opportunity cost incurred by selling in the less lucrative markets. Obviously, this value will always be zero for an optimal route and a negative number for a non-optimal route, its size depending upon how far it deviates from the optimal.

The cost of using non-optimal routes was used to determine which of the consumer countries were the "best" markets, and which were "good" markets, for Brazilian coffee, under the four models programmed. Routes with costs below $0.10 (Models I and II) and below $0.20 (Models III and IV) were defined as "best" markets. Those with costs between $0.11 and $0.20 (Models I and II) and between $0.21 and $0.50 per bag (Models III and IV) were considered as "good" markets for Brazilian coffee.

The dummy origin in Models II and IV indicates "other producing countries." Zero transportation or transfer costs are attached to their shipments. This explains the differences between total transportation costs in the optimal solutions of Models I and II, and III, and IV, respectively, where same amounts were shipped each time.

Under both Models I and II, the United States, Canada, West-Germany-Austria, France, Netherlands, Belgium-Luxemburg, Sweden, United Kingdom, Denmark, Finland, Spain, and Eastern Europe are "best" markets for Brazilian coffee. Portugal and Algeria are "good" markets in both of those Models, but Italy-Switzerland is a "good" market only in Model II. The only difference between Models I and II is the introduction of export quotas (Model II). This small shift in Brazilian "good" markets seems to be a response to competition from other areas of the world, i.e., the equivalent to a liberation of export quotas.

With the volume presently permitted by the ICO for Brazilian exports, the desirability of making contacts and promotion in the so called "new markets" of the world was already felt. Disruption of the Agreement would put additional pressure on the ability to export additional amounts of Brazilian coffee. The amounts of coffee shipped from Brazil to the different consumer countries change due to the imposition of ICO export quotas. When these restrictions are considered, Brazil increases shipments to the United States, Canada, West-Germany-Austria, and the Netherlands, but decreases its shipments

to Sweden and Eastern Europe. (See Tables 8 and 9). This, of course, is indicated only by one optimal solution for Models I and II (without tariffs).

Under Models III and IV, the United States, Argentina, France, Netherlands, Sweden, Denmark, Spain, Eastern Europe, and Algeria are "best" markets for Brazilian coffee. Italy-Switzerland and Belgium-Luxemburg are "good" markets in both of those models. Canada is "best" market only in Model IV, and Finland and Australia are "good" markets only in Model III. The impact of import tariffs is overwhelming. The effect of increased shipments is not strongly felt. Countries with lowest import tariffs are the "best" markets and countries with moderate restrictions are "good" markets for Brazilian coffee. Brazilian and Latin America governments, in general, should put additional pressure over some EEC governments in order to obtain progressive reductions in favors presently granted to "Overseas Associated States" (Former African Colonies) exports of coffee. Article 47 of the ICA provides for investigation of ways and means by which obstacles to trade could be progressively reduced and eventually eliminated. However, in the near past years, what has been observed is an almost random variability in tariffs, with some increases and some decreases being made. Special targets could be West-Germany, France and Italy, the most significant coffee consumer European countries. The case of Eastern European countries, here indicated as best markets for Brazilian coffee, deserves separate discussion. The Soviet Union and its satelites usually do not engage in monetary restrictions to coffee trade. However, each of those

countries do restrict the total amount of imports. Policies to expand these markets are tied to general trade policies.

The imposition of export quotas also affects the pattern of trade when tariffs are considered. Going from Model II to Model IV, i.e., from a market without tariffs to one with tariffs, it is seen that Brazil increases exports to Canada, France, Sweden and Eastern Europe, but decreases its exports to the United States, West-Germany-Austria, Denmark, and Finland. (Tables 10 and 11.) Again, this is the expected result indicated by only one optimal solution. The analysis of non-optimal cost coefficients might throw additional light on the stability of these solutions.

Comparative Advantage

Since the transportation model simultaneously consider available supplies, requirements, and transportation or transfer cost, shipping point price differentials (U_i's) as well as terminal market price differences (V_j's) are indicated. By observing the premium or discount from a particular base, it is possible to estimate the locational advantage of any country relative to competing countries. This information has been obtained for each of the four models programmed (Tables 8, 9, 10, and 11.) In each of these models, the Brazilian shipping point is used as the base. The positive values of U_i's indicate comparative advantage and negative values would indicate comparative disadvantage relative to Brazil. Zero values for other countries indicate no advantage or disadvantage relative to Brazil.

Countries having more locational advantage than Brazil greatly exceed the number of countries having no advantage. Brazil has an advantage or almost null disadvantage over Kenya-Uganda, India, Indonesia, and Burundi-Tanzania in both Models I and II. The mentioned null advantages occur because Brazil is at about the same distance from North American and European countries, which are the major deficit areas. However, those regions which have no locational advantage relative to Brazil account for only a small share of the world exportable output and aggregate ICO export quota. Thus, Brazil has a locational disadvantage relative to the bulk of exportable output and aggregate ICO export quota.

When import tariffs are considered, this picture is slightly changed. Under conditions of Models III and IV, Brazil is in a comparative disadvantage relative to all countries, except Peru and Burundi-Tanzania (about null disadvantage). In this case, disadvantage is due to the fact that except for Argentina, all other import tariffs represent an additional burden on Brazilian exports. Countries in the EEC favor their Overseas Associated States, England, Australia, and Canada favor the British Commonwealth countries, and Portugal gives special protection to its "Estados Ultramarinos," i.e., the African colonies.

The comparative disadvantages of Brazil are quantitatively small under Models I and II, reaching a maximum of about $1.00 per bag. Under Models III and IV, those disadvantages reach levels as high as $13.00 per bag. However, such high levels are observed for only two regions, namely the OAMCAF and Congo.

With the coffee market not free from monetary restrictions (tariffs), the imposition of export quotas would increase the comparative disadvantage of Brazil over Haiti, Ethiopia, Kenya-Uganda, Burundi-Tanzania, and Indonesia, but would reduce the comparative disadvantage (or increase the comparative advantage) of Brazil over Peru and India.

The second set of marginal values (V_j) are marginals for deficit or consumer regions and may be used in the following manner. One thousand bags unit of imports of Brazilian Coffee transferred from Canada with a marginal value of $2.57 per bag (Table 9) to Argentina with a marginal value of $1.29 per bag would result in saving of $1,280 in the aggregate transportation cost for coffee. These marginal values for import countries also have some noteworthy implications. For example, if a new, large instant coffee industry were considering location in a consumer country, under the current market conditions (i.e., Model III, Table 10), the United States, Algeria, and Portugal would be likely areas for establishment, ceteris paribus.

If costs of production were equal in all of the producing countries, the solution of Model I would indicate that certain changes were going to occur over time in the location of the world coffee production.[47] Coffee production would tend to increase in export regions with high marginal values. Obviously, the relative cost of

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[47] Based on the assumption that present export regions are the primary coffee producing areas and would be considered as more likely to increase production than currently negligible producers.

production in each region plays a major role in allocating coffee production between regions of the world. Nonetheless, the empirical evidence obtained in this research project constitutes an explanation for the post-war expansion of coffee production and exports from the new African nations, and the relative decline of the Brazilian share of the world market.[48] The comparative position of Brazil may not become worse under increased market restrictions (tariffs). Apparently, the prospects of future Brazilian participation in the world market may be somewhat bright. Table 12 presents a summary of results concerning to Brazil.

It should be emphasized here, the competitive position or locational advantage, is determined by volume supplied and transportation or transfer charges, and does not include several important variables such as cost of production and product quality. These factors no doubt have as much to do with determining the area of production as does location. This is illustrated by the fact that Brazil manages to overcome substantial location and tariff disadvantages and ships to Japan and Australia.[49] Brazil is not expected to discontinue coffee production and exports simply because it is faced by locational disadvantages. A substantial part of the African coffee regions is not suited to production of "Arabicas" (i.e., Brazil's

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[48] Previous explanation for these structural changes in the coffee market is found, inter-alia, in Viton, A., op. cit., p. 13-14. In short, that author says that the post-war "dollar shortage" stimulated the English and French to expand coffee production in their African colonies (i.e., "Associated States").

[49] During the year 1964-65 Brazil exported about 53,000 bags to Japan and about 3,000 bags of coffee to Australia (Table 12).

Table 12. Exports and Non-Optimal Route Relative Costs of Brazilian Coffee. Actual Situation and Four Models, 1964-65, Expressed in Thousand Bags (Quantity Figures) and U.S. Dollars (Relative Cost Figures).

Destination	Exports and Non-Optimal Route Relative Costs [a]				
	Actual	Model I	Model II	Model III	Model IV
United States	5,744	6,472	8,031	6,402	8,011
Canada	385	508	742	-3.83	1,035
Argentina	466	505	505	505	505
West-Germany-Austria	721	3,985	4,674	-3.16	-3.16
France	486	-0.02	-0.01	505	2,389
Italy-Switzerland	602	-0.15	-0.25	-0.34	-0.31
Netherlands	479	0.00	1,378	1,378	1,378
Belgium-Luxemburg	344	0.00	0.00	-0.33	-0.30
Sweden	960	1,532	-0.01	1,532	1,036
United Kingdom	50	-0.01	0.00	-1.49	-1.46
Denmark	605	824	824	824	212
Finland	317	673	673	-0.33	-7.39
Portugal	0	-0.14	-0.14	-58.12	-58.12
Spain	131	-0.07	-0.07	-0.02	-0.02
Eastern-Europe	912	1,763	-0.02	1,763	1,763
Japan	53	-0.84	-1.09	-46.65	-46.62
Australia	3	-0.59	-0.84	-0.24	-45.22
Algeria	0	-0.11	-0.10	-0.01	-0.01
Dummy Destination	2,240 [b]	8,238 [c]	0	11,591 [c]	0
Total	13,408	24,500	16,827	24,500	16,827

a/ Export figures are underscored and non-optimal route relative costs are not underscored.

b/ "Other destinations".

c/ "Storage".

and Manis) which are at a premium in the world markets. Previous evidence, though not conclusive, points out that relative costs of production may be lower in Brazil than in other areas of the world. Because of the small locational disadvantage Brazilian producers might be needed to reduce production costs, produce an even superior product, or be willing to accept a lower rate of profit than do producers in other regions of the world. Since large segments of the Brazilian coffee industry are under influence of direct control of the government, these implicit policy suggestions may be expanded to government policies. The current policies, conducted by the Brazilian Coffee Institute, toward diversification, cost reduction and quality improvement, are consistent with the evidence obtained in this and in previous studies.

CHAPTER V

SUMMARY AND IMPLICATIONS

Summary

The primary objective of this study was to determine Brazil's best markets for green coffee and the competitive position of Brazilian coffee producers. Best markets were considered to be those in which the shipper's net price was highest. Using the theory of interregional competition as a framework, estimates were obtained of best markets, good markets, locational advantages of different producing regions of the world, and of price differences between consumer regions.

Thirty-nine regions of the world were taken as a closed market; imports and exports of other countries were excluded from the sample. Only the coffee arriving in the consumer countries in green unroasted form was considered.

The transportation model was used to determine various interrelationships existing between the 21 exporting countries and the 18 consumer countries included in the sample. Information used consisted of (1) imports of each of the consumer countries; (2) shipments of each exporting country; (3) exportable production of each exporting country; (4) transportation costs from each shipping country to each importing country; and (5) import tariffs imposed by each importing country on product of each exporting country. These data were obtained for the harvest year of 1964-65. The transportation

model was applied to four selected situations, ranging from "free market" (no export restrictions and no import tariffs) to "completely controlled market" (with export restrictions and import tariffs). These situations or models were examined in order to determine the probable effects of the mentioned restrictions on the selection of best markets and on the competitive position of Brazilian coffee.

Policy Implications

Under a "free market" situation, the "best" markets for Brazilian coffee are the United States, Canada, Argentina, West-Germany-Austria, France, Netherlands, Belgium-Luxemburg, Sweden, United Kingdom, Denmark, Finland, Spain, and Eastern Europe. This pattern is not affected by the introduction of export quota restrictions. However, when only import tariffs are imposed, the "best" markets for Brazilian coffee become the United States, Argentina, France, Netherlands, Sweden, Denmark, Spain, Eastern Europe, and Algeria. Under fully restricted trade, i.e., quotas plus tariffs, the "best" markets for Brazilian coffee are the United States, Canada, Argentina, France, Netherlands, Sweden, Denmark, Spain, Eastern Europe, and Algeria.

The selection of "best" markets for Brazilian coffee is apparently affected by the operation of the International Coffee Agreement. Reduced shipments of all countries, by enforcement of the ICO quotas means diminished competition faced by Brazilian producers. The impact of import tariffs on the selection of "best" markets for Brazilian coffee is noticeable. Countries like Canada, West-Germany-Austria, Beligium-Luxemburg, United Kingdom, and Finland, all of

which imposing tariffs on imports, are no longer "best" markets for Brazilian coffee when tariffs are considered in the transportation model.

The launching or expansion of aggressive promotion programs, the maintenance of the International Coffee Agreement, and attempts to implement and Article 47 of the Agreement towards progressive elimination of import tariffs, are the evident policy implications. This study also points out a need to explore and develop the so called "new markets."[50] Educational programs and use of easier forms of the drinking powder, such as "instant coffee" and "freeze-dried coffee," could help in the implementation of greater sales to these "new market" countries.

Brazil has a pure locational disadvantage (free market conditions) relative to the bulk of the world output and exports. The country has practically no pure locational advantage or disadvantage relative to Burundi-Tanzania, Kenya-Uganda, India and Indonesia. Quantitatively and on the whole, those differences do not exceed U. S. $1.00. When import tariffs are considered, this picture is greatly changed: Brazil is in no locational advantage or disadvantage relative to Burundi-Tanzania and Peru only. The relative disadvantages

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50/ Ex-quota markets, generally referred to as "new markets" are listed in Annex B of the ICA. In the thirty-one countries listed therein (i.e., Japan, the USSR and satelites, the two Chinas, the Republic of South Africa, the Philippines and Kuwait) the consumption of coffee is extremely low or negligible, specially in terms of per capita offtake. With few exceptions, the economies of the "new markets" are characterized by general conditions of underdevelopment and very low levels of per capita income. Cf. PACB, op. cit., p. 4.

reach levels as high as U. S. $13.00 per bag, relative to two African regions. Other Latin American coffees (Manis) do not appear to have any substantial locational advantages, under either type or market, over "Brazils." A sizeable portion of coffee of African origin is considered as of inferior quality relative to that from Brazil. Both "Manis" and "Robustas" are estimated to cost more to produce than "Brazils." Thus, if production costs were taken into account and since quality differentials do play a role in coffee consumer behavior, the competitive position of Brazilian coffee should not be classified as a disadvantageous one. From that global point of view, Brazil could supply the coffee needed by the most important consumer countries. This perhaps could be done cheaper than the other Latin American countries do and, certainly, with a better quality than that provided by most African countries. To attain this level of effective competition, however, the Brazilian "Arabicas" should be "washed" and production costs could not be greater than $1.00 per bag below other countries costs of production. Policies directed toward improved coffee harvest and processing and to more efficient, lower cost, techniques of production are in order for the Brazilian coffee industry. Of particular interest to Brazilian producers might be the recent development of new coffee harvesting machinery.[51/] Labor is a particularly important item in total cost of coffee production in Brazil. About 70 percent of total labor required for coffee production is consumed in picking. Basic economic and topographic

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51/ Cf. PACB, op. cit., p. 41-43, for description of that equipment.

conditions in Hawaii (where the machinery was developed) is quite similar to that where most coffee is grown in Brazil. This new technology would permit and favor both quality improvement and cost reduction. It harvests almost only ripe berries and is highly labor saving.

This favorable perspective for Brazilian coffee, however, is greatly reduced by discriminatory tariffs currently imposed by some European and one North-American countries. The EEC countries, United Kingdom, Portugal, and Canada give special favors to their associated coffee producing countries. Argentina is the only country to favor Brazilian coffee imports. Evidence obtained in this study, however, indicates that Brazil would be the Argentina's only significant supplier under any of the analyzed degrees of market freedom. In other words, Argentina's favorable tariff policy seems to be of no concrete competitive advantage to Brazil. Again, the policy implications point toward the necessity of implementing the Article 47 of the International Coffee Agreement. In general, progressive reduction of import tariffs will tend to favor the Brazilian competitive position in the world coffee market.

Implications for Further Research

This study of international competition gave insight into some of the problems facing the green coffee market. Perhaps when more information, such as estimates of production of types of coffee per producer countries, becomes available, a spatial linear programming model could introduce further refinements into the analysis and the competitive advantage of each country could be estimated with more precision.

Demand and or supply relations could also be estimated, permitting the development of the more refined spatial equilibrium models. Dropping the assumptions of fixed consumption and or production would make the analysis more realistic. The IBRD, FAO, and ICO have recently agreed to conduct jointly a study of the world coffee economy. Central in that project are the analyses of demand and supply structural relationships.

Brazil's major problem in the past was to prevent oversupplying the world market. Today that possibility has been taken care of by the operation of the International Coffee Agreement. The selection of optimal schedules of exports is a problem analyzed in the present study. Future research, as indicated, should provide more complete answers to it.

But much more remains to be done. The Brazilian Coffee Institute is currently implementing an extensive diversification program. Coffee is being substituted by other enterprises. Research could help the decision-making process in the Institute and among the coffee planters. Of special importance, at the moment, are analyses of the existing diversification program, indication of alternative investment opportunities, estimates of returns to resources used in coffee production and in alternative enterprises, and the analysis of factors affecting the costs of producing coffee and the means of reducing them.

The above seems to be the major and more urgent contributions that agricultural economics research could and should make, if Brazil

is to retain the leadership of the world coffee market, and promote balanced growth of its economy.

APPENDIX

Table 13. Distances Between Selected Ports of the World Used to Determine Ocean Freight Rates (1,000 Nautical Miles). [a/]

From \ To	N.Y. City	Montreal	Bs. As.	Hamburg	Havre	Naples	Rotterdam	Antwerp	Stocklm
Paranagua	5.098	5.681	0.785	5.869	5.411	5.512	5.602	5.594	6.438
Buenaventura	2.370	3.541	5.638	5.447	5.001	5.704	5.192	5.180	6.016
Puerto Barrios	2.197	3.379	5.906	5.285	4.839	5.601	5.030	5.018	6.036
Vera Cruz	1.783	3.270	6.321	5.361	4.915	5.812	5.106	5.094	5.930
Acajutla	2.907	3.978	6.075	5.884	5.438	6.141	5.629	5.617	6.953
Limon	2.017	2.991	5.088	4.897	4.451	5.154	4.642	4.639	5.466
Guayaquil	2.847	4.018	6.115	5.924	5.478	6.181	5.669	5.657	6.493
Maracaibo	1.845	3.365	5.892	5.271	4.825	5.587	5.016	5.003	6.022
Corinto	2.692	3.863	5.960	5.769	5.323	6.026	5.514	5.502	6.338
Santo Domingo	0.998	2.180	4.707	4.056	3.640	4.402	3.831	3.819	3.837
Puerto Cortez	2.177	3.359	5.886	5.265	4.819	5.581	5.010	4.098	6.016
Callao	3.352	4.523	6.620	6.429	5.983	6.686	6.174	6.162	6.998
Port-au-Prince	1.192	2.374	4.900	4.280	3.834	4.596	4.025	4.013	5.031
Djibouti	6.150	6.138	7.197	4.564	4.114	2.157	4.309	4.297	5.133
Mombasa	8.335	8.326	6.244	6.752	6.294	4.345	6.497	6.486	7.259
Dar-Es-Salaam	8.228	8.211	6.129	6.637	6.179	4.230	6.382	6.370	7.144
Bombay	9.144	9.132	8.574	7.558	7.100	5.151	7.303	7.291	8.065
Luanda	5.375	5.508	3.978	4.824	4.360	4.494	5.569	4.557	5.330
Bingerville	3.863	4.274	3.988	3.592	3.143	3.262	3.337	3.325	4.098
Matadi	5.033	5.348	4.261	4.662	4.204	4.332	4.407	4.395	5.168
Surabaya	10.404	10.392	8.923	8.838	8.366	4.411	8.563	8.551	9.387

Table 13. (continued)

From \ To	Liverpool	Copenhagen	Helsinki	Lisbon	Coruna	Leningrad	Yokohama	Melbourne	Algiers
Paranagua	5.508	6.029	5.536	4.342	4.851	6.649	11.930	8.538	4.957
Buenaventura	4.928	5.607	6.112	4.269	4.779	6.290	7.344	7.591	5.064
Puerto Barrios	4.766	5.445	5.950	4.468	4.977	6.668	7.552	7.799	5.521
Vera Cruz	7.868	5.521	6.026	4.183	4.683	6.141	9.122	9.409	5.680
Acajutla	5.365	6.444	6.951	4.705	5.216	6.727	8.497	8.744	5.611
Limon	4.378	5.057	5.562	3.719	4.229	5.740	7.894	8.141	4.524
Guayaquil	5.405	6.084	6.589	4.747	5.256	6.767	6.867	7.114	5.551
Maracaibo	4.752	5.431	5.938	4.453	4.963	6.654	9.018	9.265	4.442
Corinto	5.290	5.929	6.446	4.592	5.101	6.612	8.382	8.629	5.390
Santo Domingo	3.567	4.246	4.841	3.268	3.778	5.469	8.751	8.998	4.257
Puerto Cortez	4.746	5.425	5.932	4.446	4.957	6.648	7.572	7.819	4.541
Callao	5.910	6.589	7.096	5.250	5.761	7.278	6.662	6.609	6.056
Port-au-Prince	3.761	4.440	4.947	3.461	3.972	5.653	8.557	8.804	4.351
Djibouti	4.220	4.727	5.231	3.383	3.892	5.344	6.893	6.798	3.832
Mombasa	6.308	6.812	7.417	5.221	5.742	7.532	7.072	6.134	5.483
Dar-Es-Salaam	6.293	6.797	7.302	5.116	5.627	7.417	6.957	6.029	5.812
Bombay	7.214	7.718	8.225	6.556	6.548	8.338	4.493	4.961	6.533
Luanda	4.476	4.984	5.489	3.302	3.814	5.604	9.960	7.414	3.939
Bingerville	3.244	3.752	4.259	2.071	2.582	4.372	11.192	8.646	2.499
Matadi	4.314	4.822	5.327	3.140	3.652	5.442	10.122	7.576	3.301
Surabaya	8.474	8.978	9.493	7.302	7.814	9.618	3.242	3.270	6.798

a/ Mercantile Marine Atlas. London: G. Philip and Son. Limited, 14th Ed., 1952.

Table 14. Custom Duties on Green Coffee, 1965 (Equivalents in U.S. $/bag)

By / Against	United States	Canada	Argentina	W. Germany -Austria	France	Italy-Switzerland	Netherlands	Belgium-Luxemburg	Sweden
Brazil	0.00	6.61	13.46	15.87	12.67	12.67	6.61	2.65	5.29
Colombia	0.00	6.61	40.92	15.87	12.67	12.67	6.61	2.65	5.29
Guatemala	0.00	6.61	40.92	15.87	12.67	12.67	6.61	2.65	5.29
Mexico	0.00	6.61	40.92	15.87	12.67	12.67	6.61	2.65	5.29
El Salvador	0.00	6.61	40.92	15.87	12.67	12.67	6.61	2.65	5.29
Costa Rica	0.00	6.61	40.92	15.87	12.67	12.67	6.61	2.65	5.29
Ecuador	0.00	6.61	40.92	15.87	12.67	12.67	6.61	2.65	5.29
Venezuela	0.00	6.61	40.92	15.87	12.67	12.67	6.61	2.65	5.29
Nicaragua	0.00	6.61	40.92	15.87	12.67	12.67	6.61	2.65	5.29
Dominican Republic	0.00	6.61	40.92	15.87	12.67	12.67	6.61	2.65	5.29
Honduras	0.00	6.61	40.92	15.87	12.67	12.67	6.61	2.65	5.29
Peru	0.00	6.61	40.92	15.87	12.67	12.67	6.61	2.65	5.29
Haiti	0.00	6.61	40.92	15.87	12.67	12.67	6.61	2.65	5.29
Ethiopia	0.00	6.61	40.92	15.87	12.67	12.67	6.61	2.65	5.29
Kenya-Uganda	0.00	6.61	40.92	15.87	12.67	12.67	6.61	2.65	5.29
Burundi-Tanzania	0.00	6.61	40.92	15.87	12.67	12.67	6.61	2.65	5.29
India	0.00	0.00	40.92	15.87	12.67	12.67	6.61	2.65	5.29
Angola	0.00	6.61	40.92	15.87	12.67	12.67	6.61	2.65	5.29
OAMCAF	0.00	6.61	40.92	0.00	0.00	0.00	0.00	0.00	5.29
Congo (D.R.)	0.00	6.61	40.92	0.00	0.00	0.00	0.00	0.00	5.29
Indonesia	0.00	0.00	40.92	15.87	12.67	12.67	6.61	2.65	5.29

Table 14. (continued)

By / Against	United Kingdom	Denmark	Finland	Portugal	Spain	Eastern Europe	Japan	Australia	Algeria
Brazil	1.58	15.87	58.08	23.81	1.32	0.00	46.30	60.85	0.00
Colombia	1.58	15.87	58.08	23.81	1.32	0.00	46.30	60.85	0.00
Guatemala	1.58	15.87	58.08	23.81	1.32	0.00	46.30	60.85	0.00
Mexico	1.58	15.87	58.08	23.81	1.32	0.00	46.30	60.85	0.00
El Salvador	1.58	15.87	58.08	23.81	1.32	0.00	46.30	60.85	0.00
Costa Rica	1.58	15.87	58.08	23.81	1.32	0.00	46.30	60.85	0.00
Ecuador	1.58	15.87	58.08	23.81	1.32	0.00	46.30	60.85	0.00
Venezuela	1.58	15.87	58.08	23.81	1.32	0.00	46.30	60.85	0.00
Nicaragua	1.58	15.87	58.08	23.81	1.32	0.00	46.30	60.85	0.00
Dominican Republic	1.58	15.87	58.08	23.81	1.32	0.00	46.30	60.85	0.00
Honduras	1.58	15.87	58.08	23.81	1.32	0.00	46.30	60.85	0.00
Peru	1.58	15.87	58.08	23.81	1.32	0.00	46.30	60.85	0.00
Haiti	1.58	15.87	58.08	23.81	1.32	0.00	46.30	60.85	0.00
Ethiopia	0.00	15.87	58.08	23.81	1.32	0.00	46.30	60.85	0.00
Kenya-Uganda	0.00	15.87	58.08	23.81	1.32	0.00	0.00	60.85	0.00
Burundi-Tanzania	0.00	15.87	58.08	23.81	1.32	0.00	0.00	60.85	0.00
India	0.00	15.87	58.08	23.81	1.32	0.00	0.00	60.85	0.00
Angola	1.58	15.87	0.00	23.81	1.32	0.00	46.30	60.85	0.00
OAMCAF	1.58	15.87	58.08	23.81	1.32	0.00	46.30	60.85	0.00
Congo (D.R.)	1.58	15.87	58.08	23.81	1.32	0.00	46.30	60.85	0.00
Indonesia	1.58	15.87	58.08	23.81	1.32	0.00	46.30	60.85	0.00

Sources: PACB. Annual Coffee Statistics, No. 29, 1965, p. 170; and Henderson, H. Terms Used in International Agricultural Trade, Washington, D.C.: USDA-FAS, Bulletin M-152, 1963, p. 10. and 146.

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