A QUARTERLY ANALYSIS OF THE UNITED STATES' IMPORT DEMAND FOR VARIETIES OF GREEN COFFEE

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This is to certify that the

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ABSTRACT

A QUARTERLY ANALYSIS OF THE UNITED STATES' IMPORT DEMAND FOR VARIETIES OF GREEN COFFEE

by John Nduka Abaelu

The primary task of this study was to elucidate the economic relationships among the three principal varieties of green coffee traded internationally and the factors influencing their market prices. The three coffee varieties are milds, brazils, and robustas.

Because of the unavailability of data relating to other major coffee-importing countries the study was limited to the U.S. market; the United States takes up around 50 percent of all coffees going into international trade. The sample period covered the marketing years 1953 through 1961, each year being divided into four quarterly observation periods. Adequate data were not available for the period prior to 1953 and the period subsequent to 1961 was excluded because of extensive market stabilization efforts under the international coffee agreement. All data came from secondary sources.

Two simultaneous equation systems were constructed. In the first system of equations (Submodel I) brazils and milds were combined into one commodity called arabicas

and then the economic relation between arabicas and robustas was analyzed. In the second equation system (Submodel II) the three coffee varieties were separated. Three structural equations were constructed for each coffee variety; namely an import demand function, an export supply function and, finally, a stock demand function. Thus, there was a total of six structural equations in Submodel I while Submodel II consisted of nine equations. Two alternative assumptions were made about the functional form of the relationships - neither the arithmetic nor the logarithmic form was indisputably superior.

Five different estimation methods were used - Ordinary Least Squares (OLS), Two-Stage Least Squares (TSLS), Three-Stage Least Squares (I3SLS), Limited Information Single Equation (LISE), and Iterative Three-Stage Least Squares (I3SLS). The 3SLS and I3SLS used the 2SLS estimates as their starting estimates. Because of desirable asympototic properties the 3SLS estimates were given full economic interpretation and were considered the standard empirical result.

Overall the estimates obtained were satisfactory. Import demand functions gave good statistical fits, with R^2 values exceeding 0.90 in every case. Within a substantial price

range, substitution was the dominant economic relationship among the three coffee varieties. Estimated price flexibilities in the logarithmic function were 0.13, -0.35, and -0.27 for milds, brazils and robustas, respectively. These figures suggest high price elasticities of demand. Estimated income flexibility with respect to the U.S. economy was negative, except in the case of milds. In the logarithmic function the income flexibilities were for milds, brazils and robustas, respectively, 0.19, -0.64 and -1.26. The exclusion of the trend variable, which was highly correlated with the income variable, might have caused some bias in calculated income flexibilities.

This study has helped to illuminate the structural characteristics of the U.S. green coffee market. The parameters estimated were economically plausible and should be useful for the making and/or evaluation of coffee policy-national or international. The estimates were applied to one aspect of policy: the international coffee agreement. Excess productive capacity was considered the major long-run problem of the coffee industry but serious difficulties exist - economic and social - which could hinder desirable curtailment of production. Suggested short-run and long-run approaches to the problems of the industry were considered.

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By

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CHAPTER I

INTRODUCTION AND THE PROBLEM

Analyses of import demand functions go beyond estimation of structural coefficients and elasticities. The estimated parameters are usually applied in the making and evaluation of various public policies, for example trade, production, fiscal and exchange policies. Estimates of price, income, and cross elasticities of demand for green coffees are of great value to coffee producers, their governments and the numerous commercial interests involved in the marketing process. In a non-static world subject to structural changes, periodic revision of these estimates is desirable to reflect the current situation of the commodity market. By so doing, significant shifts of economic parameters can be discovered, and new strategies for meeting the changed situation devised. Such strategies could involve, inter alia, efforts to break into new and growing markets, to ward off competitors' thrusts into traditional market strongholds, or a reconsideration of domestic production policies.

Since the early 1950's, there has been a substantial increase in the production and consumption of instant coffee in the United States (see Tables 1 and 2 below). Corresponding with this is the growth of the share of the U.S. coffee market

going to robusta coffees relative to other types of green coffee (Table 4 in Chapter II). In Table 1, it is seen that between 1953-63 there occured an appreciable gain in the production of instants; the rate of increase rapidly reached its peak in 1956 and since then has been declining, though in an irregular fashion. Total physical production of instants apparently began levelling off around 1961 and declined, for the first time, in 1963. The data in Table 2 comes from a national panel of households which provides information on their purchases of soluble and regular coffees. The increase in household consumption of coffee in the form of instants is quite striking and provides some explanation of the gain in the manufacture of the product. Presumably, the greater convenience and the possibility of waste reduction associated with instants are the basic factors in its favor.

The above developments probably meant a change in the structure of the coffee market and related economic parameters. To say this, however, is in no way to suggest the existence of an unanimity in the literature on the economics of coffee with regard to the nature of the economic relationship between robustas and arabicas, the other major types of green coffee. It is indeed an old and unresolved question. Some authorities cite the maintenance of rigid blend formulas by manufacturers

Table 1. The United States: Production of Regular and Instant Coffees, 1954-63
(1000's of 60 kilo-bags of 132.276 lbs each)

Year	(1) Total bags of green coffee roated	(2) Number going into Regular coffee	(3) Number going into Instant coffee	(4) Percentage (3) is of (1)	(5) Percent change in roastings of Instant coffee over preceding year
1954	17,601	15,549	2,052	11.7	--
1955	18,813	16,490	2,323	12.3	+13.2
1956	20,263	17,123	3,140	15.5	+35.2
1957	20,321	16,985	3,336	16.4	+ 6.2
1958	20,937	17,445	3,492	16.7	+ 4.7
1959	21,698	17,954	3,744	17.3	+ 7.2
1960	21,895	16,896	3,999	18.3	+ 6.8
1961	22,294	18,284	4,010	18.0	+ 0.3
1962	22,677	18,595	4,082	18.0	+ 1.8
1963	22,815	18,881	3,934	17.2	- 3.6

Source: Annual Coffee Statistics (Pan American Coffee Bureau, New York, 1963) p. 27.

(Note: Before 1957, roastings by, or sales to, the military services were excluded. They are included from 1957 and represent about 2 per cent).

Table 2. Proportion of Instant Coffee in Total Coffee Purchases by Households (converted to lbs. Green Coffee equivalent) - The United States, 1951-63

Year	Percent Instant Coffee
1951	5.5
1952	6.5
1953	8.2
1954	12.7
1955	13.6
1956	16.0
1957	18.4
1958	19.3
1959	19.9
1960	20.6
1961	20.7
1962	21.3
1963	21.2

Source: Market Research Corporation of American (quoted) in Annual Coffee Statistics, Pan American Coffee Bureau, New York, 1963, p. 28

as evidence of the limited substitutability between robustas and arabicas. The demand for robustas, it is argued, is a residual demand arising primarily from the manufacturers' desire to hold down product costs of blending in cheaper, inferior raw materials. Beyond a critical level, the argument goes on, the use of robustas may affect the taste of the product and thus result in some loss of market. Illustrative of this standpoint is the following statement.

> Most of the large coffee-importing countries of the world use a minor proportion of robustas in blends, both of regular and of soluble coffee. To use more in any given blend would change the taste of the brand product, which, according to informed people in the trade, could have an unfavorable effect on sales value.[1]

On the other hand, other experts argue that in practice there is an appreciable substitution between robustas and arabicas, most importantly in the manufacture of instant coffee -- a product which has experienced a fast rate of expansion since the last war and which is said to utilize a high proportion of robustas. Writing on this point, Rowe observes that the expansion of soluble manufacture has not affected the total

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[1]James E. Wood, "The Robusta Situation and Suggested Means of Improving It", (Unpublished paper by Director of Research, Pan American Coffee Bureau, New York, August, 1960), p. 3.

consumption of coffee but has altered the kinds of coffee demanded because robusta has some positive technical and price advantages for soluble manufacture and is largely used for this purpose. He states further than soluble coffee made entirely from brazils, and still more from milds, is of high quality and if the prices of these coffee subtypes fall sufficiently relative to that of robustas, a higher proportion of them might be substituted for robustas.[2] Further illustration of this controversy is provided by the opinions expressed by two writers in a well-known coffee-trade journal. With respect to soluble coffees, Sivetz observed,

> The tendency in the U.S. among some firms that sold largely on price, was to use Robustas and/or imperfect coffees. Since the public accepted these solubles, it encouraged the application of low-priced coffees to the extent that the growth of imports of Robustas to the United States has increased many fold since the end of World War II.[3]

In the same journal, Haarer dismissed the notion that robustas are "hard" coffees, adding:

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[2]J.W.F. Rowe, The World's Coffee - A Study of the Economics and Politics of the Coffee Industries of Certain Countries and of the International Problem (Her Majesty's Stationary Office, London, 1963) p. 25

[3]M. Sivetz, "Soluble Coffee -- In Transition", Coffee and Tea Industries and the Flavour Field (Spice Mill Publishing Co., New York, May 1962) p. 7

> Good robusta coffee is a mild form of coffee akin to Santos in flavor and it is particularly useful in the 'Instant Coffee' trade because of its cheapness and its rich flavor.[4]

The resolution of this controversy is apparently impossible in the absence of knowledge relating to secret trade formulas. None the less, the fundamental issue can be approached with statistical procedures. If manufacturers alter their blend formulas significantly in response to changes in the relative prices of raw materials, it would seem logical to expect that this would be reflected in the pattern of import demand. Moreover, the claim that the demand for robustas is residual, put in economic terms, is really tantamount to an argument for complementarity and, if this be the true state of affairs, it would also be mirrored in the import demand pattern. Consequently, it should be possible to analyze the postwar competition, if any, between robustas and arabicas without the necessity of probing trade secrets.

To avoid possible confusion later on, it is necessary at this juncture to note that one of the two classes of coffee mentioned above consists of two distinct subtypes that differ substantially in quality. Specifically, the arabicas consist

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[4]A.E. Haarer, "Robusta Coffees", Coffee and Tea Industries and the Flavour Field (Spice Mill Publishing Co., New York, September 1962) p. 15

of two important subtypes identified in the trade by the name of brazils and milds. The latter grown outside Brazil, but mostly in Western hemisphere countries, are the premium green coffees of commerce responsible for much of the aroma and flavor of blend products. For this reason, the milds have consistently enjoyed a price premium over the brazils. Since the milds and brazils are de facto different economic goods, it would appear most useful, to attempt to separate them in the analysis subsequently presented. A single import demand function for arabicas is likely to create the impression that the two commodities are demanded in some permanently fixed proportion determined by the weighing procedure used. Even less plausible, it would seem, is the implication that robustas do compete with the milds as well as brazils. Although there is a division of expert opinion on the substitution between arabicas and robustas, most authorities are agreed that such substitution as has occurred affected only certain grades of brazils, and milds not at all. In view of this, the analysis undertaken will be presented in two parts: the first part will investigate the economic relationship between robustas and arabicas while the second is a breakdown of the first part into a three-commodity model involving robustas, brazils and milds.

To summarize the problems to which this study is addressed, we first recall that there exist in world trade three major subclasses of green coffees, namely, milds, brazils, and robusta coffees. This study is primarily an attempt to clarify the nature of their economic relationships as well as the factors underlying the determination of their prices in the market.

Objectives of the Study

(i) To construct a quarterly econometric model that explains the post World War II behavior of the U.S. green coffee market.

(ii) To test the seasonality of the U.S. import demand for green coffees.

(iii) To estimate the structural parameters (and the price, income and cross flexibilities) of the import demand for various types of green coffee in the United States.

(iv) To test the connection between robusta imports and the production of instant coffee in the United States.

(v) To draw policy inferences from the results of the study and attempt an economic appraisal of the performance of various price stabilization programs, especially those adopted in the 1962 International Coffee Agreement.

Procedure

As the first objective states, this study is aimed at the United States Coffee market. The United States is by far the largest world coffee consumer, taking up around 56 percent of all coffees moving in international trade channels. This proportion is even higher for coffees originating in the Western hemisphere. Because of its predominant size, therefore, developments in the United States coffee market probably have a profound impact on other markets and, a fortiori, on the economies of the producing countries. Hence, despite its limited scope, an analysis of the U.S. market should yield results that convey the major part of the total picture. By the same token, only U.S. imports from the major producing countries of the different types are considered. This is the only way to keep track of the different coffee types since import statistics are not classified by type. For instance, robusta imports from Uganda, important as they are, are excluded because, until very recently, coffee imports from East Africa are grouped together and this presumably includes a sizeable proportion of arabicas from Kenya and Tanganyika. For our present purposes, imports from the former French West Africa and Angola represent the imports of robustas; the milds and brazils are represented by imports from Colombia and Brazil

respectively. In this way, the mixing of types is kept to a minimum and the value of the results is not seriously impaired since the selected countries account for 70 to 100 percent of the U.S. imports of the relevant types of coffee.

This study pertains to the period 1953-61, data for ealrier postwar years being either unavailable or inadequate. The period subsequent to 1961 is not included because the International Coffee Agreement was in effect and this is believed to have caused extensive changes in the conditions underlying coffee marketing. The observation period is defined in terms of quarters. The green coffee marketing year begins early in July and ends the following June. The decision to carry out a quarterly analysis is prompted by an additional interest in the factors associated with intra-seasonal movement of coffee prices. Seasonal shifts in the level of the import demand function probably occur in practice and the model is modified at the appropriate point to test this hypothesis.

There are two parts to the analysis. The first part is the more aggregative and is designed to explore the competitive relationship between robustas and arabicas as a group. Natural and logarithmic functional forms are employed alternatively in the estimation. The former assumes an additive functional

form in contrast to the geometric form implicit in the latter. In part two, the arabica demand function is disaggregated into brazils and milds. The principal structural relationships of the two parts express the spot market price as a function of three endogenous and three predetermined variables.[5] Preliminary analysis revealed a high degree of correlation between one of the predetermined variables, per capita disposable income, and the trend variable, hence the decision was made to drop the latter. The other predetermined variable, production of processed coffee lagged four quarters, was retained. Another structural equation fitted involves the use of a simple stock adjustment model to estimate the end-of-quarter inventory levels. As will be made clear in Chapter III, a number of assumptions were made in order to obtain data used in the equation, consequently the resulting estimates should be judged with these assumptions in mind. The last structural relation in the model relates to the export supply to the U.S. market (measured by port arrivals at U.S. docks) of each class of coffee, the explanatory variables

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[5]For a definition of these terms, see Richard J. Foote, Analytical Tools for Studying Demand and Price Structures (Agriculture Handbook No. 146, U.S. Department of Agriculture, Washington, D.C., 1958) p. 7

being the expected New York spot price and available coffee exports in the producing countries.

Five methods of estimation are employed: Ordinary Least Squares (OLS), Two-Stage Least Squares (TSLS), Limited Information Single Equation (LISE), Three-Stage Least Squares (3LSL), and the Iterative Three-Stage Least Squares (I3SLS). It is a common econometric practice to use two or more estimation methods to fit the same structural equation. Except for the OLS method, the desirable properties that have been proved for these estimation methods are asymptotic properties. Since we are confronted with a small sample, the properties of the coefficient estimates are not definitely known. This is an important reason for estimating each equation by different methods. If the results do not differ significantly from each other, the analyst can have greater confidence in using them, though, as Christ points out, comparisons of this type cannot be conclusive because the true values of the parameters are not know.[6] Be that as it may, this "conventional wisdom" is adhered to in this study.

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[6]Carl F. Christ, "Simultaneous Equation Estimation: Any Verdict Yet?" Econometrica, Vol. 28 (October, 1960), p. 835

Since we are primarily concerned with the structural relationships between different classes of green coffees and the simultaneous determination of their prices, we know that the use of OLS technique to estimate some of the equations in the system will yield results that are statistically biased. To obtain consistent estimates of the structural coefficients, the structural equations must be fitted by methods that allow for simultaneity and this implies the last four methods given above. The OLS method if strictly appropriate for fitting two of the equations pertaining to each class of the commodity, namely the export supply and stock demand relations since an undirectional causal mechanism is assumed. Like the OLS method, the 2SLS and LISE are single equation methods but they differ in that they take partial account of the equation being embedded in a system. This is the sense in which these estimators are regarded as simultaneous equation estimation methods. The 3SLS and I3SLS estimators are complete system methods since the coefficients of all the identified equations in the system are estimated simultaneously. In other words, these estimators utilize all of the restrictions specified in the system.

The 3SLS method utilized the 2SLS estimates and disturbance covariance matrix to obtain the third-stage coefficient estimates. The 3SLS estimates are known to be asymptotically more efficient than the equivalent estimates obtained by the 2SLS method. For the purpose of this study, the 3SLS estimates are regarded as the standard results for comparison and interpretation.

Using the 3SLS estimates and disturbance covariance matrix, the nth-stage coefficient estimates (I3SLS) can be obtained by an interative procedure. So far as the I3SLS estimates are concerned, it has been shown that the procedure does not result in further gains in asymptotic efficiency. Nevertheless, it would still be of interest to see how the estimates compare with those obtained by other estimators.

As a brief preview of the study procedure, the next chapter contains a review of the world coffee situation since the end of the last World War, highlighting on the position of coffee in the economy of the major producing countries. An economic and statistical model of the U.S. coffee market is formulated and the estimation techniques used in the analysis are discussed in Chapter III. The empirical results are presented and discussed in Chapter IV. The policy implications of the study are considered in Chapter V, particularly

in relation to the U.N. International Coffee Agreement. Finally, a summary of the study and the overall conclusions derived are presented in the last chapter.

Sources of Data

Data for the analysis come from various sources, the major ones being the U.S. Department of Commerce publications: the U.S. Import Statistics; "Total Inventories of Green Coffee held by Roasters, Importers and Dealers in the United States"; the publications of the Bureau of Labor Statistics; U.S.D.A. Foreign Agricultural Circulars; Annual Coffee Statistics by the Pan American Coffee Bureau; information obtained from the Sugar and Tropical Products Division of the U.S.D.A. and from the firm of George Gordon Paton, New York. Appendix B contains the basic data used in the analysis. The absence of data precluded consideration of the postwar years prior to 1963. Though this reduces the total number of observations, no serious harm is done since the breakthrough of robustas in the U.S. market did not actually occur until the early 1950's.

Review of Literature

Since World War II, there has been a sustained interest in the analysis of import demand functions. Most of the initial

efforts indicated that price elasticities in international trade are less than unity and because of this it was argued that free price and exchange-rate adjustments would be unable to bring about an equilibrium of exchange in international trade.[7] Critics of the low elasticity view refute the statistical validity of the estimates, pointing to such shortcomings as the failure to allow for structural changes, the inappropriateness of the OLS method, errors of observation, etc. These shortcomings, they argue, tend to bias the estimates downwards and as such restrictive policies, conceived on the notion of low price elasticities, would do more harm than good.[8]

The resolution of such a controversy is surely an empirical task. But it is quite clear, to begin with, that whether or not the price elasticity of import demand is low depends largely on the commodity in question. In the case of coffee, Wickizer has asserted that the elasticity of trade demand is

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[7]J. H. Adler, "United States Import Demand During the Interwar Period," American Economic Review, Vol. 25 (June 1945) p. 418; T. C. Chang, "International Comparison of Demand for Imports", Review of Economic Studies, Vol. 13 (1945-46) p.53

[8]A. C. Harberger, "A Structural Approach to the Problem of Import Demand", American Economic Review, Vol. 43 (May, 1953) p. 148; G. Orcutt, "Measurement of Price Elasticities in International Trade", Review of Economics and Statistics, Vol. 32 (May, 1950) p. 117

fairly high. In his own words,

> Because coffee drinking is generally a habit, it is common to observe that moderate changes in price produce slight responses in consumption. The demand for coffee is thus considered to be quite inelastic. This is largely true of consumer demand, especially over short periods, because habits are not quickly changed. It is less true of the responsiveness of trade demand over short periods, and of consumer demand over long periods. The demand of the trade for raw coffee over longer periods must, of course, reflect consumer demand for the beverage.[9]

The above statement by Wickizer was published about twenty-three years ago, therefore, it would be worth our while to ascertain the current situation with regard to the elasticity of trade demand. One of the more recent statistical studies on green coffee import demand was made by Hopp and Foote in 1955 using data relating to the period 1882-1949.[10] These analysts constructed an unidirectional equation connecting import value per pound to three predetermined variables, namely the ratio of available world stocks at the start of the marketing year to the current level of world consumption, the ratio of available Brazil exportable production to current

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[9]V. D. Wickizer, The World Coffee Economy With Special Reference to Control Schemes (Food Research Institute, Stanford University, 1943) p. 32

[10]H. Hopp and Richard J. Foote, "A Statistical Analysis of Factors that Affect Prices of Coffee", Journal of Farm Economics, Vol. 37 (August, 1955) p. 429

levels of Brazil imports, and a trend factor. Using the OLS method an R^2 value of .70 was obtained. However, no estimates of price and income elasticities were made. A subsequent study by Daly fitted a single equation model expressing the New York wholesale price of Santos 4 as a function of per capita disposable income, total U.S. domestic supply facing consumers (defined as inventory plus current imports) and the ratio of world supply to world exports.[11] Separate equations were fitted for the prewar and postwar periods. Estimates of income flexibility for the prewar and postwar periods were 0.713 and 1.513, respectively, and the associated price flexibilities with respect to quantity were -2.070 and -2.257.

As is evident from the foregoing summary, previous demand studies on green coffees have been limited in scope. To date green coffee demand has been analyzed as if there were no substantial differences between the varieties. Because we doubt the soundness of this practice, we attempt to separate the three principal varieties in this study. It is, perhaps, in this respect that this study can make some valuable contribution to the existing knowledge about the commodity. However, more research is needed as more and better data become available and one useful task for future research could be the analysis

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[11]Rex F. Daly, "Coffee Consumption and Prices in the United States", Agricultural Economics Research, Vol. 10, No. 3. (July, 1958) p. 61

of multiple-market interrelationships, which, as has been noted, is not possible in the present circumstances.

CHAPTER II

THE POST-WORLD WAR II SITUATION IN THE COFFEE WORLD

The World Coffee Situation

Since World War II, the value of world coffee exports has increased tremendously reaching record highs in the fifties. A recent FAO document states that during this period coffee was the most valuable single agricultural commodity in world trade, slightly in front of raw cotton, raw wool and wheat.[1] This was a total reversal of the state of affairs of the late twenties when world exports of coffee occupied fifth place among the principal agricultural products, its value being exceeded by raw cotton, wheat, sugar and wool.[2] This was mainly the result of a more rapid increase of coffee prices relative to export volume. By contrast, most other commodities gained in total value through increased export volume relative to unit prices.

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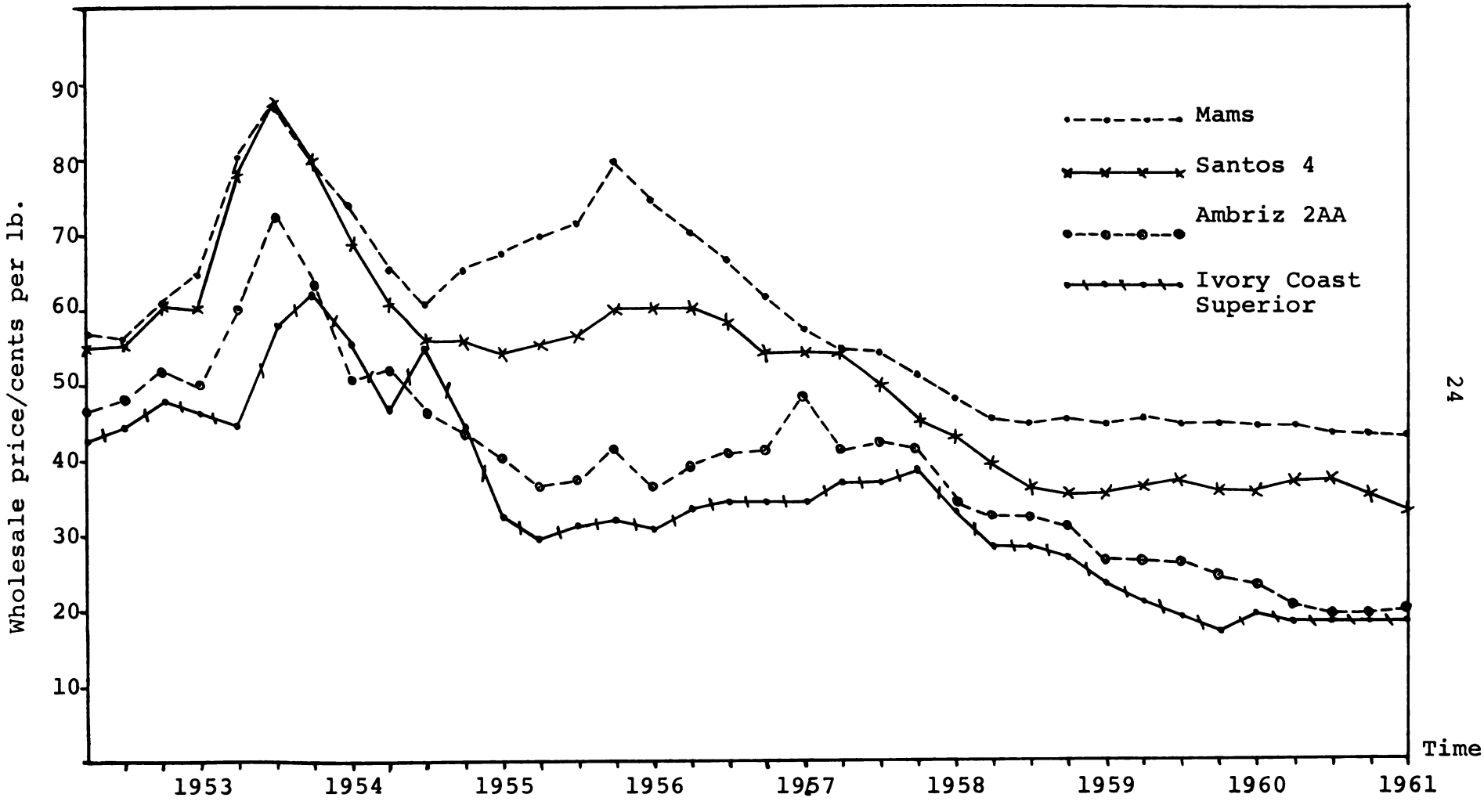
[1]FAO, The World Coffee Economy, Commodity Bulletin Series, Vol. 33, (Rome, 1961) p. 1

[2]FAO, The World's Coffee, (International Institute of Agriculture, Bureau of FAO, Rome, 1947) p. 40

The increased value of coffee trade was to some countries a source of blessing and to others the beginning of grave problems. To all alike the instability of prices remained a common problem contributing notoriously to sharp fluctuations of import capacity and the uncertainty of development financing. Of course, the experience of individual countries differed, depending on the particular circumstances affecting the supply and demand of their particular type of coffee. Generalization is dangerous and Figure 1 demonstrates the propensity of robusta prices to more frequent fluctuations. Presumably, the relative stability of Santos 4 and Mams, from 1958 onwards reflects the effect of the withholding policy pursued by Brazil and Colombia under the auspices of the 1957 Inter-American Coffee Agreement in Mexico.

This period also witnessed the emergence of the African Continent as an important source of raw coffee. A combination of several factors was responsible for this development. Among these were the high prices that prevailed at a time when the western world was recovering from the ravages of World War II. Shipping difficulties during the war years had prevented Latin American supplies from reaching European markets. This had led to vigorous encouragement of coffee planting in several colonial territories in Africa and elsewhere. Response by

Figure 1. Quarterly New York Wholesale Prices of Green Coffee by Commercial Types, 1953-61



farmers was rapid since prices and attendant returns were high. More and more, a large part of the peasant economy, which until then had remained outside the influence of the modern sector, was drawn into the orbit of the money economy. Most of the trees then planted came into full bearing in the years after the war and the fact that prices remained high and, indeed, improved further, enabled the new coffee industry to take root. Further planting was begun and a number of new producing countries were well in the road to becoming coffee-dependent economies. Add to this the acute postwar dollar shortage which interferred with international commerce generally and we have an additional reason for encouraging production in colonial countries. Britain, Belgium, Portugal, France and others went a step further and granted special preferential terms on coffee imports from their overseas colonies in discrimination against other sources. Under this market umbrella, the survival of colonial coffee industries was practically assured. It is perhaps to this arrangement that the Swynnerton Plan for Kenya African agriculture, heavily geared to coffee as it is, owes much of its success.[3]

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[3]The Swynnerton Plan was devised by a former colonial Director of Agriculture in Kenya. It aimed at raising Kenya African incomes through the incorporation of profitable export cash crops into the farming system. Coffee arabica was one of the major cash crops chosen with pyrethrum and others according to the agricultural conditions of the locality. The farm plan itself was a kind of "blueprint" drawn up by officials and operated under continual supervision by them.

More arabica planting went ahead in Tanganyika and the Congo. In Uganda, West Africa, Madagascar and Angola robusta was the sole variety planted and it is this type that today accounts for roughly 70 percent of coffee exports from the African Continent.

From Table 3 can be obtained some impression of the growth of coffee production in Africa as compared with other regions of the world. The progress made during and after the war years is quite striking. Additional fillip to robusta production came from the increasing consumer acceptance of soluble coffee in the manufacture of which robustas are said to have certain technical and cost advantages. Whether or not these advantages are real and substantial is a moot question but there is no doubt that the postwar rise of robusta trading has been achieved at a time when exports of arabicas have trended downwards.

The soluble coffee market has developed fastest in the United States and it is interesting that this coincided with rising robusta imports from Africa. Prior to the war the U.S. market was served almost exclusively from Latin American sources. In 1951, coffee imports into the U.S. from African sources amounted to about 4.8 percent of the total imports of the commodity and in 1963 the figure had risen to 21.4 percent

Table 3. World Coffee Production by Areas 1921-39 and 1947-59
(Annual averages in thousand metric tons)

Period	Brazil	Colombia	Other Latin American Countries	Africa	Rest of the World	Total
1921-25	887	124	296	32	98	1437
1926-30	1288	175	344	53	135	1995
1931-35	1366	223	355	92	142	2178
1936-39	1388	265	397	149	156	2355
1947-50	1031	339	405	248	68	2091
1951-53	1105	397	467	332	94	2395
1954-56	1129	359	536	467	116	2607
1957-59	1917	470	617	597	144	3745

Source: FAO, The World Coffee Economy, Commodity Bulletin Series, Vol. 23 (Rome, 1961), p. 11

- a growth rate indicative of the deep inroad robustas had made into blend formulations. The resulting change in market shares, increasingly in favor of robustas during the decade, is demonstrated by Table 4.

From the foregoing, we can identify two significant features of the world's coffee situation since the 1950's. One is the spread of production to a large number of new countries as well as increases in older producing countries. Second is the substantial change in the market shares held by the major producing countries. These changes in market shares have been attributed to several factors that operated more or less simultaneously. These are the rise in the consumption of soluble coffee, the postwar dollar shortage, the preferential treatment accorded to colonial producers by metropolitan governments, and, finally, the relative movement of costs and prices in the producing countries.

An Overview of Coffee in Selected National Economies

The extent to which individual countries were affected by the aforesaid developments in the coffee market of necessity depends on the size of the coffee sector relative to the rest of the economy and on the share of coffee in total exports. Those Latin American countries excessively dependent

Table 4. The Trend of African Producers' Share of the U.S. Green Coffee Market, 1951-63

Year	Percent	Year	Percent
1951	4.8	1957	14.9
1952	6.1	1958	14.7
1953	7.0	1959	13.0
1954	9.0	1960	17.2
1955	11.4	1961	20.4
1956	11.8	1962	20.8
		1963	214.

Source: Annual Coffee Statistics, (Pan American Coffee Bureau, New York, 1963) p. 31

on coffee inevitably suffered more from shrinking markets occasioned by African competition. Lest we exaggerate the importance of this African competition it should be borne in mind that part of the market shrinkage might have been due to other economic factors, for instance a negative income elasticity of demand. No evidence was found in the literature concerning the income elasticity of demand for the sub-classes of green coffee in the importing countries. A negative income elasticity would of course contribute to such shrinkage, and this will be investigated as part of our present task. While an exact correspondence may not exist, it is nevertheless instructive to note that a recent study of the import demand for cocoa beans yielded a negative income elasticity of demand in the United States.[4] A priori, we would not expect a high correlation between rising incomes and coffee imports since coffee consumption is mostly a matter of habit and therefore may not increase substantially when income does. On the other hand, growth of the adult population

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[4]J. R. Behrman, "Cocoa: A Study of Demand Elasticities of the Five Leading Consuming Countries, 1950-1961", Journal of Farm Economics, Vol. 47, No. 2, May 1965, p. 410

(say, 15 yrs. old and above) is likely to be a more important shifter of the coffee import demand function.

Table 5 demonstrates the export importance of coffee in various producing countries. From this table it is evident that the major coffee-dependent countries in the western hemisphere are Colombia, Brazil, Costa Rica, El Salvador, Haiti and Guatemala. Because of the premium quality of the coffee produced in the other countries, Brazil is probably the only country that would be directly affected by robusta competition. However, in view of the joint utilization of brazils and milds at the manufacturing level a decline in the use of brazils would inevitably affect the demand for milds.

Brazil

Although her share of world production has declined from 65 percent to about 48 percent, Brazil still maintains production leadership among the coffee producing nations. Because of the magnitude of her production and the fact that brazils are the price-setters in the world market; changes in Brazilian output and official coffee policy cause profound reactions in the markets of other coffee varieties.

Some of the most serious problems associated with the Brazilian coffee industry stem partly from natural elements,

Table 5. Coffee: Export Value as a Percentage of Total Exports, 1960-64

Continent and Country	Year 1960	1961	1962	1963	1964
North America:					
Costa Rica	50.5	49.0	55.5	49.7	42.2
Dominican Rupublic	12.0	10.0	11.5	10.6	16.8
El Salvador	65.7	58.9	55.5	48.5	50.9
Guatemala	69.8	62.8	62.4	49.5	36.5
Haiti	51.3	41.0	69.8	36.8	47.8
Honduras	18.9	13.0	14.7	17.3	17.9
Mexico	9.7	9.0	7.9	4.6	9.2
Nicaragua	30.5	25.4	17.1	16.4	19.6
South America:					
Brazil	56.2	50.6	52.9	63.1	53.1
Colombia	71.7	70.9	72.9	69.4	73.5
Ecuador	21.4	15.1	17.8	13.8	16.7
Peru	4.3	4.6	4.5	4.7	5.6
Venezuela	.8	1.0	.7	.9	.7
Africa:					
Angola	35.0	36.1	43.7	40.1	48.7
Congo, Leopoldville	13.0	N.A.	3.8	6.8	N.A.
Cameroon	19.0	21.2	20.4	20.2	27.6
Ethiopia	54.4	49.6	53.7	49.6	60.5
Ivory Coast	50.0	46.2	39.7	43.1	42.6
Kenya	29.2	30.0	27.9	25.1	32.7
Malagasy Rep.	31.5	29.0	31.9	28.9	27.0
Tanzania	14.0	12.7	12.8	10.8	15.8
Uganda	35.2	30.4	53.6	52.8	54.9
Asia and Oceania:					
India	1.0	1.1	1.2	1.1	1.0
Indonesia	2.3	1.0	1.8	N.A.	N.A.

Source: Foreign Agriculture Circular, (USDA, Washington, D.C. February, 1966), p. 10

such as production cycles and frost disasters, and partly from the overexpanded condition of the industry. Coffee production shows fairly appreciable fluctuations from year to year, not only because of the variation in seasonal condition and the damage due to diseases and pests, but also because of other factors peculiar to the plant. The most outstanding is the alternation of an abundant crop which exhausts the tree and a poor crop. Superimposed on this two-year cycle is a longer cyclical pattern of output. Excess capacity became a very serious problem as a result of the planting rush in the Parana province after 1945. The high yields obtained on the new estates considerably reduced costs per unit of output and at the same time created a downward pressure on world coffee prices. Lower coffee prices in turn affected the ability of the old and relatively high cost estates in Sao Paulo to compete effectively in the world market.

Brazil had for some time been engaged in various plans designed to limit overproduction. This was considered necessary to bring world supply and demand into rapport at higher prices. Though experience had shown that world prices were about the only effective control on production, the aforesaid difficulty

arising from the development of Parana led to a renewal of official effort at production control and the Sao Paulo coffee belt became the focus of a new subsidized eradication scheme.

As of December 1, 1961, the Brazilian Coffee Institute (BCI) estimated that production would reach 43 million bags in 1964/65 and thereafter become stabilized at 37-38 million bags if their current trends continued.[5] The new eradication plan aimed to cut back production by 12 million bags to around 25 million bags. The plan also provided for a subsidy to plant one new tree for every five eradicated; altogether 2 million non-economic trees would be eradicated. By 1970/71 the new trees would yield some 5 million bags which would bring the total national output to 30 million bags -- enough for exports, domestic consumption, and reserves against emergencies.

As indicated above, previous efforts to reduce excess capacity had met with little success and, more often than not, with outright antagonism. Politically powerful planters,

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[5]J.W.F. Rowe, "The World's Coffee-A Study of the Economics and Politics of Certain Countries and of the International Problem. (Her Majesty's Stationery Office, London, 1963) p. 60

who had backed the nation's valorization schemes, were understandably hostile; for an official surrender to the lure of free market competition would mean bankruptcy and starvation for them and large segments of the population. If more rapid voluntary eradication is to come about, generous financial compensation is undoubtedly required. However, the cost to the government is likely to prove prohibitive. The proposed subsidies under the new eradication and diversification scheme were estimated to amount to a total of 70 billion cruzeiros for the first two years. Towards meeting the expenditure involved, the BCI was to contribute 7 billion cruzeiros from the surplus of export tax fund ($22 per bag); another 7-15 billion cruzeiros were to come from government sources, and the remaining 50 billion to be borrowed abroad. Interests and repayment of the foreign loan would be completed in 10 years out of funds saved from the cost of financing and warehousing of surplus stocks, assuming a severe drop in surplus production after 1963/64 and the continuation of the export tax.

However, even if such a large amount of foreign loan could be found it might prove difficult to pay it off. In the first place, farmers might press hard for a tax cut when surpluses are reduced and, secondly, those who remain in coffee

farming may resent paying $22 per bag in export tax to subsidize those withdrawing from coffee. The third problem is economic rather than political. To accept compensation a planter would want at least the discounted present value of the income streams expected over the remaining productive life of his trees less their salvage value (if any). Because export prices have remained pegged above equilibrium levels as a matter of policy, it is conjectured that the total fund required for compensation would greatly strain the resources of the authorities. And if adequate compensation is not forthcoming many owners of old and relatively high-cost trees might still find production profitable. A large number of these people are unskilled and therefore the opportunity cost of staying in coffee farming is close to zero. Under such circumstances, exit from an industry is usually minimal even if prices decline precipitously. Moreover, old coffee trees represent a "fixed asset" with salvage value near zero while the official prescription on further planting may be thought of as placing the acquisition cost of new trees at infinity if enforced. Consequently, so long as the marginal return from coffee is bounded by the salvage and acquisition prices, the planter will be unwilling to discontinue production on his farm. Furthermore, discontinuation of production could lead

to extensive social difficulties in the rural areas which producers may wish to avoid.

In summary of the Brazilian situation, the following may be noted: her dwindling share of world coffee exports and the problem of excess capacity. Under conditions of free marketing her old and high-cost coffee estates cannot compete effectively with the large new low cost capacity which has developed elsewhere, in and outside Brazil. Her many efforts to deal with these problems continue to have a profound effect on external markets.

Colombia

Colombia is the second biggest coffee producer in the world and derives about 70 percent of her total export earnings and 10 percent of her G.N.P. from the commodity. She is also the principal producer of the mild type for which her climate and topography are especially favorable.

The coffee industry was largely developed in the 1930's when the repeated destruction attractive level, but also enabled U.S. consumers to develop a taste for the flavor of Colombians. In consequence, Colombia's coffee trade policy was largely independent of, and frequently opposed to, Brazil's. By 1940, however, both countries were forced to cooperate more

with each other because of the common problem posed by the inaccessibility of European markets.

Structurally, the Colombian coffee industry also differs from Brazil's. The majority of coffee farms in Colombia are small-scale family enterprises generally intercropped with food crops. Acçording to Rowe, about 94 percent of coffee farms are below 100 hectares and these account for 63 percent of the total production.[6] An advantage of this form of organization is that it permits a substantial degree of economic resilience which is largely unknown in Brazil.

Because of the continued popularity of Colombians, consumption has not been appreciably out of line with production. However, Colombia since 1950 has been operating a coffee withholding program aimed at maintaining and/or increasing coffee dollar earnings. In 1957 and 1958, these coffee withholdings were financed by loans to growers through new emissions from the Central Bank and by 1961 the total accumulated debt was of the order of 500 million pesos.[7]

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[6]J.W.F. Rowe, The World's Coffee, op. cit., p. 64

[7]T.J. Goering, "Colombian Agricultural Price and Trade Policies", (Universidad Nacional de Colombia, Facultad de Agronomia, Palmira, Colombia, 1961), p. 29

Colombian coffee exports are among the most heavily taxed exports of the country. In 1960-61, the National Association of Exporters estimated that taxation amounted to no less than 40 percent of the average export price of around 65 U.S. dollars per bag. Revenue accruing to the government from coffee taxes totaled 799 million pesos, and to the National Federation of Coffee Growers 262 million pesos.

Coffee sold by producers includes two qualities -- excelso, which is the only type that can be exported, and a lower grade known as pasilla. As reported by Goering, a pasilla tax of six percent was established in 1942 and must be paid prior to obtaining a coffee export license. In addition to the pasilla tax and the 15 percent export tax levied on all major exports, coffee exporters must pay a tax in kind equal to 17 percent of the excelso coffee which is to be exported. This tax goes to the National Coffee Fund and, if the quantity so taken is not enough to remove all surplus production out of the market, the Coffee Fund management is empowered to purchase and hold additional quantities.

Domestic opposition has not been lacking against Colombia's policies of retention of stocks and excessive taxation. Some groups of coffee farmers have argued that

Colombia should be free to compete with other mild producers on an economic basis. Colombia could tolerate lower prices but had no means of reducing her production because there were no alternative crops to coffee in the districts where erosion poses a severe problem. Instead of the present policy, the group wanted a drastic reduction of the tax burden and stock retention. They argued that export prices might fall as a result but with lower taxes current producer prices could be protected. It was also the group's contention that the only form of diversification practicable under Colombian conditions was the addition of supplementary enterprises (rabbit raising, chicken or egg production, etc.) to provide fuller employment for the family.

Despite these arguments, the direction of official coffee policy remains largely unchanged. Stock retention and heavy taxation have continued much as before. The accumulated stocks have been used more and more under bilateral barter trade agreements with a number of European countries. Under these barter agreements with Great Britain, France and Spain, Colombia in 1960 exchanged cotton and coffee for dairy cows, beef cattle, and Merino sheep. Colombia also has bilateral trade agreements with Western Germany, Denmark, Finland, Italy, Ecuador, Japan. Automobile and utility

vehicles have been imported from Germany, France, Italy and Japan in exchange for cotton. From Finland medium duty construction equipment has been imported in exchange for coffee.[8]

Ivory Coast

Ivory Coast is now the leading producer of robusta coffees and is the third largest world producer of coffee. It derives about 40 percent of total export earnings therefrom. In 1960/61 production reached the 3 million bag level and exports went up to 22,563,000 bags. But throughout the period of study no serious surplus problem occurred in the Ivory Coast nor in any other robusta-producing country.

Structurally, the Ivory Coast coffee industry is dominated by small, scattered, peasant holdings mostly in the size range 5-10 hectares. Government policy is oriented toward improving efficiency and quality without encouraging the extension of planted area. The stringent quality control begins with hand sorting at the farm. Subsequently, the beans are machine-graded according to size and low-grade beans are barred from exports.

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[8]T.J. Goering, op. cit., pp. 31-32

The support price to the farmer (producer's guaranteed price) in 1963 averaged 14.8¢ per lb.[9] Coffee exporters however have to pay a number of taxes - namely, export, inspection, statistical, and port-use taxes. In total these taxes amount to just about 3 1/3¢ per lb.

Angola

Angola is another coffee-dependent economy in Africa with about 50 percent of her exports coming from the commodity. It is the fourth biggest producer in the world and ranks second to the Ivory Coast in the production of robustas. Total production in 1962/63 amounted to 3.1 million bags, three times the 1950/65 average.[10]

The bulk of Angolan coffee exports are sold in Europe, particularly in Portugal. Exports to the dollar area have risen considerably in the last decade and coffee is responsible for 90 percent of the total trade with the U.S.A.

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[9]Coffee Situation: Programs and Policies in Producing Countries (USDA, Foreign Agriculture Service, July, 1963) p. 14

[10]Coffee Situation: Programs and Policies in Producing Countries, op. cit., p. 10

So far, Angola has been fortunate in having no serious surplus problem and no major restrictions on production and marketing, except perhaps for rigid export quality standards. Angola, however, subscribed to the Second Mexico Agreement of the 1950-60 year which adopted a policy of supply restriction to combat persistent price declines. This she did in conjunction with the coffee-producing members of the French Community in Africa, notably the Ivory Coast. Despite this development Angolan coffee stocks have not approached a substantial magnitude.

About the most important policy action was the introduction in 1959 of a schedule of export price minima that were revised regularly every two weeks to reflect the current external market condition. There are no internal taxes or restrictions on coffee and export taxes amount to 12-18 percent of the official value (with lesser amounts on the higher quality). Contrary to the usual purpose of export price minima in Latin American coffee countries, the aim in Angola was not supply limitation. Indeed, minimum prices were set almost at all times below world market levels and as a result no harm was done to export demand. The basic purpose of the policy was to give domestic producers some protection

from wildly fluctuating prices which could damage additional investments in the industry. But in having a minimum export price policy, Angola is unique among other producers on the Continent. Most others guarantee a producer price at the start of each production season which is paid to producers by marketing board agents. In the event of foreign prices turning out to be below the guaranteed price, stabilization reserves, accumulated in good years, are drawn upon to make up for the losses incurred by the board. Thus, the essential difference between export price minima and a guaranteed price policy centers on the fact that the former places only a floor on (not a ceiling) producer prices, while the latter does both at the same time.

The preceding account, albeit brief, of the situation in selected producing countries has provided some insight into the supply forces that have shaped the postwar coffee market. The United States generally has maintained an open-door policy to coffee imports and such restraints as have existed on its market have had their origins on the supply side, especially Latin America. African suppliers, until very recently, have experienced no surplus problem which meant

that production and exports have usually been equated.[11] Without supply regulation programs to buttress prices, it is not surprise that robustas have persistently fetched much lower prices than other coffees. Thus, the low price of robustas cannot be explained, as most people are wont to do, entirely on the basis of inferior quality. Price differentials would shrink considerably if other coffees had been as freely exposed to the play of market forces.

Coffee Price Valorization Programs

The purpose of this section is to sketch and appraise some of the postwar efforts to stabilize coffee prices. Valorization policies as they are called, have commonly been predicated on this ground. In actuality, however, these programs are motivated by a multitude of objectives such as higher prices, larger foreign exchange receipts, and others. The mixture of objectives makes the task of evaluation very difficult.

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[11]The Republic of the Ivory Coast is the only African producer known to have fairly substantial stocks. The figure was estimated at 1.2 million in the 1960-61 coffee marketing year. Before this time, surpluses were inconsequential.

The history of the Brazilian valorization policy is well documented and, perhaps, well-known.[12] Our interest at present centers on the postwar period, although it is recognized that the events discussed probably were influenced by experiences gained from operating the program in the past. The major development of interest relates to the new stringent regulations governing the exportation of coffee to overseas markets -- regulations adminstered and policed by newly-created quasi-government agencies both in Brazil and Colombia. The Brazilian Coffee Institute (BCI) supervised the registration and movement of produce from inland warehouses to the ports and ultimate exports from the ports to oversea markets. It also enforced export licensing laws and monthly quota restrictions on the ports. The Colombian National Federation of Coffee Growers (CNFCG) combined technical assistance to farmers with the enforcement of prescribed minimum export prices. The early 1950's stand out indeed as a period of strict supply regulation. Three principal outcomes of this policy were:

1. the prescribed export price minima were generally higher than the market could bear

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[12]Excellent accounts are given in: V.D. Wickizer, The World Coffee Economy With Special Reference to Control Schemes (Food Research Institute Studies, Stanford University, 1943) and J.W.F. Rowe, Markets and Men, (McMillan Company, New York, 1936)

2. hugh quantities of unsold produce were accumulated

3. easy central bank credits enabled the agencies to finance purchases from farmers at the prescribed prices and to meet storage costs.

One basic aim of policy was apparently to raise prices to buyers just enough without hurting quantities purchased so the increased foreign earnings could be used to stem the widening trade gap. Not only was this hope unfulfilled, but also inflation, already a problem, became aggravated. Neither devaluation nor the introduction of a multiple exchange system, with a punitive incidence on coffee exporters, could solve the problem. Instead dealers found a number of evasive ways enabling them to circumvent the regulations.[13] In the meantime, coffee exports progressively declined. Import prices in the U.S. rose sharply enough to prompt two commissions of inquiry (1951 and 1954) both of which blamed the price increase on supply manipulation and the panic behavior of importers. To what extent surpluses were accumulated in this period is at best a "guesswork".

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[13]The Federal Trade Commission (1954) reported that the major devices took the form of underinvoicing and overinvoicing. Exporters underinvoice so the importer abroad pays the difference between the invoice price and the market price to the exporter's account in a New York bank, while importers under-invoice so they can buy part of their dollars at the lower free market price.

If we keep in mind the overwhelming size of the combined production of Brazil and Colombia, useful deductions may follow from certain estimates by the Pan American Coffee Bureau. For the crop years 1954/55 through 1957/58, the Western hemisphere had a total exportable production of 120,906,000 bags, each of 132.3 lbs. Of this, a total of 105,767,000 bags was exported, leaving a cumulative surplus for those four crop years of 15,139,000 bags. In the crop year 1958/59 exportable production was 40,153,000 bags against exports of 31,325,000 bags -- an increase of 8,828,000 bags or 58 percent more than the cumulative surplus of the previous four years. Most of these surpluses, as one would expect, occurred in Brazil. Meanwhile severe pressure had been mounting on prices since about the end of the 1955-56 year and negotiations for an intergovernmental effort to arrest the decline resulted in the 1957 Mexico Agreement between seven Latin American producing countries, namely Brazil, Colombia, Costa Rica, El Salvador, Guatemala, Mexico, and Nicaragua. Signatories to the Agreement gave formal support to the idea of withholding a portion of exportable production. A second Agreement was made in 1958 at the end of the first which, in any case, did not operate effectively. This time membership rose to fifteen. The principle of regulated marketing was again approved, each signatory pleding to withhold 5 percent of exportable production

up to 300,000 bags and 10 percnet thereafter. The two biggest producers, which also had the bulk of the accumulated surplus, made the greatest sacrifice: Brazil was to withhold 40 percent and Colombia 15 percent of their individual exportable production. A third renewal of the Agreement in 1959 brought in some African countries for the first time. The French Community, Cameroon and the Portuguese territories joined while British East Africa and Belgian Congo remained outside the group. Membership of the African countries was, however, shortlived for they soon withdrew to form a regional organization with other producing countries on the African Continent.

The above account is to be seen as no more than a bird's eye-view of valorization activities in the period. It is possible to take issues with the appropriate authorities on several grounds, first for fixing export price minima as high as they did. Probably working on the assumption of a low price elasticity of import demand it was reckoned that raising prices would not reduce exports proportionately. But this turned out to be an erroneous calculus because demand for brazils or milds, individually, is more elastic than the demand for coffee as a group. High prices might well have caused foreign consumers to seek cheaper substitutes which

they apparently found in robustas. It is no accident that instant coffee, and hence robusta coffees, entered the market in the early 1950's when prices of other raw coffees were too high. The situation is somewhat reminiscent of the way mild coffees captured part of the market in the interwar period when Brazil was purchasing and burning coffee in an effort to raise prices.

Valorization and such "price defense" policies can hardly be justified on economic grounds when the heart of the coffee problem lies in the persistent excess of production over current levels of consumption. As has been mentioned, excessive production has been a perennial problem of the Brazilian industry. Effort to pare down productive capacity should perhaps have received more attention than it did despite the social difficulties that might have occurred. This appears the only long-run solution while valorization is a costly and short-run approach. Unfortunately, enthusiastic advocates of the policy often do not ponder sufficiently upon the costs involved. One of the real costs of the policy, especially between 1950-55, was the inflationary condition which it fostered.

Inflation was fostered largely by the huge credits extended both by the Brazilian and Colombia central banks to the BCI and CNFGG, respectively, for the purchase of stocks to be held off

the market. Purchases from producers at the prescribed minimum prices, which were higher than market prices, served to raise the quantity of money in private circulation and without a corresponding increase in the national product, the general price level rose substantially. A number of times the instrument of devaluation was applied in an attempt to halt the widening trade gap. However, there is no automacity as regards the improvement of the trade balance following a devaluation -- the trade balance may or may not improve, depending on the elasticities of foreign demand and domestic supply of exports, the elasticities of domestic demand and foreign supply of imports and, finally, on the income effects of devaluation.

Devaluation has the effect of lowering the price of exports to foreign buyers and so stimulates an increase in the volume demanded by them. Given sufficient elasticity of supply, the physical volume of exports will rise without affecting domestic prices. Consequently, the total value of exports will rise in terms of domestic currency, the extent of the increase depending on the elasticity of foreign demand and the home elasticity of supply. The increase in the value of exports will be smaller the smaller is the foreign elasticity of demand, given the domestic supply elasticity. In the limit, when the foreign demand is perfectly inelastic there will be no

increase in the volume of exports and hence no increase in their value. With the foreign demand elasticity at unity, implying constant expenditure in terms of foreign currency, the value of exports is independent of supply elasticity and increases in proportion to the fall in the exchange rate. Robinson has stated that a high elasticity of home supply tends to reduce or to enhance the increase in the value of exports induced by a fall in the exchange rate according as the foreign elasticity of demand is less or greater than unity.[14]

On the side of imports, devaluation has the effect of raising the relative price of imports and, although the volume of imports out of a given income may be less, the total expenditure on imports may rise. The value of imports in terms of domestic currency will rise or fall according as the elasticity of demand is less or greater than unity. In general, when the home demand has less than unit elasticity, the value of imports will increase by more, and when it has greater than unit elasticity will fall by more, the greater is the foreign elasticity of supply.[15]

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[14]J. Robinson, "The Foreign Exchanges", Readings in the Theory of International Trade, (American Economic Association, 1950) p. 90

[15]J. Robinson, ibid., p. 92

Thus devaluation does not automatically improve the trade balance. As is apparent from the preceding paragraphs, it is quite possible for the value of imports to rise by more than the value of exports has risen in which event devaluation only worsens the trade situation.

Moreover, there is the income effect of devaluation to be reckoned with. The initial increase in exports following a devaluation has an impact on the domestic economy which is analogous to that associated with increased investment. In other words, it gives rise to higher expenditures, employment, and incomes. Arising from this is a change in the average (and/or marginal) propensity to consume and to import. A high average propensity to import works against the desired goal of devaluation, making the trade gap difficult to close. In Brazil, of the early 1950's, this factor in combination with a substantial flight of capital in the wake of inflation frustrated many official efforts to correct the trade gap by means of devaluation. The resort to a multiple exchange arrangement also proved to be of limited effectiveness in the absence of strong measures designed to limit consumption and promote savings.

Summary

In this chapter we have presented a sketch of the situation in the post-World War-II coffee market, emphasizing the entrance

of robusta coffees. The emergence of robustas apparently caused a structural change, implying new economic parameters. Problems facing the coffee industry in the principal producing countries selected on the basis of the class of the commodity which they produce were discussed briefly in the second section. The third section contained a critical discussion of the valorization efforts of the Latin American countries -- an effort forced upon them not only by incessant price fluctuations but also by shrinking markets, scarcity of development finance, trade imbalance, etc. Devaluation has been used in the Latin American coffee countries almost as a pet weapon for combating adverse trade balances. The brief theoretical discussion of this policy instrument points out its limitations as well as the circumstances under which it will be effective. The elasticity of foreign demand is a key consideration in the application of devaluation. In the succeeding chapters, elasticity of demand will be calculated for the United States, which takes up around 56 percent of all coffees moving into international trade.

CHAPTER III

THE ECONOMIC AND STATISTICAL MODEL OF THE U.S. GREEN COFFEE MARKET

In this chapter the purpose is to postulate and rationalize the key behavioral relationships believed to exist in the raw coffee market of this country. In other words, we shall present a set of functional relationships connecting certain economic variables. These relationships are postulated on the basis of economic theory, evidence from existing empirical studies, and our judgement about the factors most relevant to the commodity market. Thus, as in all econometric model building, arbitrary judgements have influenced the choice of the final form of the model. Each of the relationships is, in a formal sense, referred to as a structure and the whole set of relationships as an economic model.

A model may sometimes consist of two parts: one part may assume the existence of exact structural relations while the other part includes a stochastic term in each equation. When an exact relation is assumed by the analyst, the particular equation becomes an identity; in the model to be presented no identities occur.

For purposes of statistical estimation, further assumptions are required for which economic and technical knowledge provide little guidance. Specifically, assumptions about the algebraic form of the relationship and the probability distribution of the disturbance terms must be made by the analyst. These specifications often are made to simplify statistical analysis and are thus arbitrary. The set of structural relationships consistent with both the economic and statistical specifications made is formally known as a statistical model.

Before presenting the variables of the model, note should be taken of the special problems involved in constructing a model of the green coffee market. The United State's imports of coffee fluctuated considerably throughout the entire period covered by the analysis. Apart from seasonal factors which might have contributed substantially, these fluctuations reflect the action of a multitude of factors. Chief of these are changes in monetary, fiscal, coffee export policy, dock strikes, and many others. Coffee import demand by consuming countries is strongly sensitive to these factors. Yet, because of lack of information, the model has taken no explicit account of their influence. In this kind of situation, the hope of the analyst is that errors due to incomplete specification are not so serious as to greatly jeopardize the

results. The size of the unexplained residual provides a measure of the influence of omitted variables.

There are two parts to the model, each depending on the degree of aggregation involved. Submodel I is more aggregated in the sense that arabicas, consisting of brazils and milds, are treated as a single commodity. In effect this model is concerned with the economic relationship between robustas and arabicas. In Submodel II the arabica demand function is disaggregated into two separate demand functions, one for brazils and the other for milds. Justification for disaggregation comes from the widespread belief that the rise in robusta trading noted earlier has had little impact, if any, on the milds, but has had a substantial effect on the trade in certain grades of brazils.

There are six endogenous and eleven predetermined variables in Submodel I. Submodel II, on the other hand, contains nine endogenous and fourteen predetermined variables. Endogenous variables are generally represented by the letter Y and appropriately subscripted. Similarly, the letter X stands for a predetermined variable. In conformity with conventional practice lagged endogenous and exogenous variables are collectively referred to as predetermined variables.

Submodel I

Definition of variables:

Y_1: per capita valume of U.S. coffee imports from Brazil and Colombia. Population is the total U.S. population (excluding Armed Forces abroad) fifteen years old and above.

Y_2: weighted average wholesale spot price (new York) of Santos 4 and MAMS deflated by the BLS index of spot prices of 22 basic commodities (1957-59=100).[1]

Y_3: per capita stock of arabica coffees in the United States at the end of the current quarter.

Y_4: weighted average wholesale spot price (New York of the Ambriz 2AA and Ivory Coast Superior deflated by the BLS index of spot prices of 22 basic commodities (1957-59=100).

Y_5: per capita volume of U.S. robusta imports from Angola and the Republic of the Ivory Coast.

Y_6: per capita stock of robusta coffees in the U.S. at the end of the current quarter.

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[1]Of the 22 commodities, 9 are foodstuffs (butter, cocoa beans, corn, cotton seed oil, hogs, lard, steers, sugar, and wheat), and 13 are raw industrials (burlap, copper scrap, cotton, hides, etc.). The prices of these 22 commodities are presumed to be among the first to be influenced by actual or anticipated changes in economic conditions.

X_1: per capita production of regular ground coffee in the U.S. lagged four quarters i.e., production in the same quarter of the previous year.

X_2: per capita disposable personal income in the U.S. deflated by the BLS consumer price index (1957-59=100).

X_3: expected wholesale spot price of arabicas (N.Y.). This is measured simply by the arithmetic average of the spot price in the two previous quarters.

X_4: total available exports from Brazil and Colombia per capita of U.S. population (excluding Armed Forces abroad) fifteen years old and above.

X_5: per capita production of regular ground coffee in the U.S. in the current quarter.

X_6: per capita stock of arabicas in the U.S. lagged four quarters i.e. in the same quarter of the previous year.

X_7: per capita production of instant coffee in the U.S. lagged four quarters.

X_8: expected wholesale spot price (N.Y.) of robustas, also measured as a simple mean of the spot prices in the two preceding quarters.

X_9: total available exports of robustas from Angola and the Republic of the Ivory Coast per capita of U.S. population (excluding Armed Forces abroad) fifteen years old and above.

X_{10}: per capita production of instant coffee in the U.S. in the current quarter.

X_{11}: per capita stock of robusta coffees lagged four quarters.

Economic Rationale

A discussion of the economic rationale of each of the structural relations in Submodel I now follows:

EQUATION 1: U.S. Import Demand for Arabica Coffees

$\underline{Y_2}, Y_1, Y_3, Y_4; X_1, X_2$

Following Foote, commas in the above relation are to be read as "and" while the semicolon should read "appear in relation with".[2] Endogenous variables are given to the left of the semicolon and predetermined variables to the right. In the above expression, as well as in others in this chapter, the normalized variable appears first and is underlined for ease of recognition.

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[2]Richard J. Foote, Analytical Tools for Studying Demand and Price Structures (USDA, Agriculture Handbook No. 146, Washington, Government Printing Office, 1958) p. 8

Since Y_2, Y_1, Y_3 and Y_4 are assumed to be jointly determined within the model, only simultaneous equation estimating techniques will yield consistent estimates of the coefficients. The economic rationale of the above structural relation is as follows:

The focus of analysis is on determining the factors associated with variations in the import price of the subclasses of coffee. This means the price variable is chosen as the normalizing variable, or, in a less strict sense, the dependent variable. We do so because, since consumption per capita has apparently been relatively stable during the sample period, changes in the quantity of supply are directly reflected in the level of market prices. As will be seen later on, this will mean that instead of the usual elasticities we shall be calculating price and income flexibilities. The relation between the two concepts is explained in the next chapter (page).

It was assumed a priori that price (Y_2) and quantity (Y_1) are mutually determined. An inverse relationship is assumed to exist between the two variables, in accordance with traditional demand theory. One possible circumstance under which an inverse price-quantity relationship would not hold relates

to a condition of strong anticipatory demand, or speculation. For instance, if importers and roasters view an initial rise in price as a signal for further increases, they will, in general, increase their purchases to beat the anticipated increase. In this case a positively sloped demand function -- a perverse demand function -- is obtained. Perverse demand curves also arise in relation to prestige goods where a price rise, by enhancing the prestige value of the good, may result in increased purchases. These are the commonest explanations of perverse demand functions.

The quarterly price data used in the analysis was obtained from information furnished by the Sugar and Tropical Products Division of the U.S. Department of Agriculture. The deflator, index of spot prices of 22 basic commodities (1957-59=100), comes from publications of the Bureau of Labor Statistics (see footnote 1 of this chapter). This index is considered a better indicator of the relationship between green coffee spot prices and the general price level than the more aggregate wholesale price index also calculated by the Bureau of Labor Statistics.

Importers' current activity with regard to stocks has an impact on current import price, and the latter also influences

stock demand. As a result, the stock variable is defined as endogenous in the above relation. What is actually required is a series that will reflect the tendency of stocks during the quarter, that is whether an accumulation or reduction is taking place. Of the alternatives considered, the most suitable seemed to be the end-of-quarter inventory level. This series is assumed to change with stock accumulation or reduction during the relevant quarter.

A positive relationship was assumed between price (Y_2) and the end-of-quarter quantity of arabica stock. To obtain the quantity of arabicas in total stocks the latter was multiplied by a factor representing the proportion of arabicas in total coffee imports during the current quarter. Recall that total coffee imports refer to imports from Colombia, Brazil, Ivory Coast Republic and Angola. The first two countries are the major exporters of arabicas. This method of calculating the share of the different varieties in total stocks is undoubtedly open to error. It is only one of several methods that could be used and there is no way of knowing beforehand which method yields the best result. Quarterly total inventory data on all coffees have been published by the U.S. Department of Commerce Bureau of the Census since 1953.

A priori, the weighted average price of robustas (the Ambriz 2AA and Ivory Coast Superior) is expected to be positively related with the price of arabicas since the two commodities are, by hypothesis, substitutes. There is, however, a limit to the degree of substitution; for the necessity of maintaining brand-product quality places a constraint on the substitution process.

Per capita production of roasted ground coffee is highly correlated with the sales of the processed commodity in the United States. Sales figures could not be obtained; so production is used as a proxy variable for sales. It is assumed that sales (and hence production) are determined principally by economic conditions in the economy and not by conditions existing in the green coffee market. With this reasoning, production is regarded as an exogenous variable in the economic model. Lagging this variable four quarters implies that current import purchases are related to the level of production which, from past experience, processors consider normal for the particular quarter. For instance, winter is a high sales and production period and our assumption is that current purchases this winter are related to the level of production normal for the winter period. In general, a

positive relationship is expected between lagged production and spot prices. Production data are obtainable from quarterly publications of the Bureau of Census cited earlier.

Per capita disposable personal income is a traditional variable in market demand functions. This variable is considered exogenous to the coffee market as it depends on economic conditions in the United States, and the coffee sector is not considered large enough to influence the general level of personal incomes. In this connection, we may note that Girschick and Haavelmo have disagreed with the prevalent practice of treating income as an exogenous variable in statistical demand studies. Their argument runs thus:

> ----it has been argued that, if the commodity in question represents only a small part of the budget, the repercussions upon income of variations in the demand for the commodity could be neglected. This hypothesis is obviously false. We could always split up total consumption into small subgroups by a sufficiently detailed specification of the various types of consumer goods. Obviously, such a regrouping could not alter the fact that changes in the total consumer expenditures have a direct effect on income, income being the sume of consumers' expenditures and investment expenditures. We must, therefore, assume that income depends to some extent on the random shifts -- in the demand for food.[3]

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[3]M.A. Girschick and T. Haavelmo, "Statistical Analysis of the Demand for Food: Examples of Simultaneous Estimation of Structural Equation", Studies in Econometric Methods (Cowles Commission, Monograph 14, and John Wiley, 1961) p. 93

Despite the weight of their authority in the field of econometrics, we believe that it is reasonable to view income as an exogenous variable in most micro-analytic studies. This is the usual practice and it is followed in this study. In the specific case of coffee, we further assume that it is a normal economic good so that a positive income coefficient is expected. In practice, this would mean that as per capita income increases the import price of coffee rises because of an increase in demand, assuming other relevant factors constant.

Lastly, a trend variable which was specified in the preliminary analysis was later dropped because of high inter-correlation with the income variable. Dropping the trend variable, however, does not ease the problem if interpreting the per capita income coefficient; for if it is dropped, the income coefficient then represents the trend effect and the joint effects of changes in income and population fifteen years old and above (excluding Armed Forces abroad).

EQUATION 2: Export Supply of Arabica Coffees

$\underline{Y_1}$; X_3, X_4

This expression states that port arrivals at U.S. docks of arabica imports "appear in relation" with two predetermined variables -- expected spot price and the available exportable

production at the supply sources. At equilibrium, port arrivals equal total domestic disappearance in any given quarter. Since there is only one endogenous variable in this expression, the equation can be fitted by an ordinary least squares method provided the single endogenous variable is the normalizing variable. The theoretical properties of the estimates so obtained are equivalent to those obtained by simultaneous equation estimators.

The expected N.Y. wholesale spot price is assumed to have a positive influence on the export decisions of coffee exporters in the arabica countries as well as the decisions of the marketing control institutions responsible for determining quantities to be released for exportation during any period of time. The simple measure of expected spot price used is the arithmetic mean of the spot price in the two previous quarters.

Available exports are actually the total arabica exports from Brazil and Colombia in the current quarter. This variable is taken to be predetermined because total output is known prior to marketing and, secondly, the total quantity to be exported is prescribed well in advance of marketing.[4]

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[4]K.A. Fox, Econometric Analysis for Public Policy (Iowa State College Press, 1958) p. 36

This covers both the quantity to be released from existing stocks and the part of current production that will go directly to export markets.

EQUATION 3: Stock Demand for Arabica Coffees

Y_3; X_3, X_5, X_6

In the above relation, stocks "appear in relation" with expected wholesale spot price, production of regular coffee (the proxy variable for sales), and stocks of arabica in the same quarter of the previous year.

The stock demand relationship was obtained from a postulated simple "Stock Adjustment" model. It may be noted that a recent econometric work at Harvard by Houtthaker and Taylor has sought to generalize the use of "Stock Adjustment" models in demand analysis by applying it to non-durable goods and services. In a lucid exposition of their work, Taylor distinguished between "pure" inventory adjustment models and other models in which the phenomenon of habit formation was paramount.[5] Habit formation is said to be present in the

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[5]L.D. Taylor, "Forecasting from Generalized Stock Adjustment Models". (Paper read to the 7th Annual Forecasting Conference, New York Area Chapter of the American Statistical Association, April, 1965)

consumption of a good or service when its recent use has a positive effect on its present consumption. Taylor considered the pure inventory model to be more applicable to durable goods, while for non-durables and services habit formation was more important. The partial slope coefficient between consumption purchases and stocks was described as being in general negative for durables but positive for non-durables. In addition, in inventory adjustment the short-run elasticity with respect to a change in income is greater than the long-run elasticity. The reverse is true for commodities subject to habit formation since inertia and lethargy characterize habit formation in the short run and purhcases of the commodity respond only slowly to changes in income.

With respect to the commodity with which we are presently concerned, coffee is undboutedly a habit-forming commodity with a small positive income elasticity of demand in the short run. However, whether or not these facts do apply at the wholesale import market for green coffees is an open question. We hypothesized a small positive income elasticity of demand as well as a positive relationship between current purchases (or current price) and stocks. The stock adjustment model used is now presented.

Introducing new variables for convenience of presentation, our stock adjustment model for coffee is:

$$S_{1i} - S_{1i-1} = \alpha_o + \alpha_1 (S^*_{1i} - S_{1i-1}) + \varepsilon_i \quad (1)'$$

where S_{1i} = quantity of arabica stocks at the end of the current quarter (obtained by multiplying inventory by the fraction of total imports originating from Brazil and Colombia).

S^*_{1i} - the desired stock level in the current quarter

S_{1i-1} = actual level of stock at the end of the last quarter.

In words, equation (1)' states that the difference between the actual quantity of stocks at the end of the current quarter and last quarter is proportional to the difference between the currently desired quantity of stocks and the actual quantity at the end of last quarter.

The desired stock level itself is a function of current sales of ground coffee (production is used as a proxy) and the expected wholesale spot price. Thus:

$$S^*_{1i} = \lambda_1 R_{1i} + \lambda_2 P^*_{1i} \quad (2)'$$

where: R_{1i} = current quarter's production of roasted ground coffe

P^*_{1i} = expected spot price

Substituting (2)' in (1)', we obtain

$$S_{1i} - S_{1i-1} = \alpha_o + \alpha_1\lambda_1 R_{1i} + \alpha_1\lambda_2 P^*_{1i} - \alpha_1 S_{1i-1} + \varepsilon_1 \quad (3)'$$

and simplifying,

$$S_{1i} = \sigma_o + \sigma_1\lambda_1 R_{1i} + \alpha_1\chi_2 P^*_{1i} + (1-\alpha_1) S_{1i-1} + \varepsilon_i \quad (4)'$$

Now P^*_{1i} is not observable, so an observable series has to be used in its place. It was considered a good approximation to use the simple mean of the spot prices in the two previous quarters.

Reverting to our standard notations, the equation actually fitted was:

$$Y_3 = \beta_o + \beta_1 X_3 + \beta_2 X_5 + \beta_3 X_6 + u_i \quad (5)'$$

This is an undirectional equation, therefore Ordinary Least Squares is an appropriate estimator.

The expected spot price (X_3) is a measure of speculation on the part of coffee buyers. If spot prices in the two preceding quarters were high, they are expected to continue in the present quarter. Thus, no accumulation of stocks is undertaken and some reduction may actually occur in practice. Conversely, low spot prices tend to generate expectations that they will continue low, thus favoring some build-up of stocks.

The specification of X_5 signifies the assumption that current stock demand is related to current roasting activity. As the latter increases, existing stocks are drawn down sometimes below the normal working level. Consequently, part of current stock demand goes to replenish the stock on hand as it is drawn upon for roasting. X_6 is, again, a specification which implies processors relate their current stock demand with the level of stocks which they regard as adequate for that time of the year.

The rest of the equations in Submodel I are, respectively, the import demand, export supply, and stock demand functions for robustas. All the variables have the same explanation as for arabicas. For completeness, the remaining robustas structural relationships are stated below:

Import demand: $\underline{Y_4}, Y_1, Y_5, Y_6; X_2, X_7$ (4)

Export supply: $\underline{Y_5}, X_8, X_9$ (5)

Stock demand: $\underline{Y_6}; X_8, X_{10}, X_{11}$ (6)

Submodel II

Earlier, it was stated that Submodel II is an attempt to disaggregate the arabica demand function for the purpose of investigating the underlying interrelationships between the

three principal classes of coffee. In chapter one we also noted that an aggregate arabica demand function might suggest that brazils and milds are demanded in some fixed proportion arbitrarily determined by the weights used by the analyst. Moreover, Submodel I, as formulated, implies some direct relation between robustas and milds, besides brazils. This does not accord with opinions in the trade. Therefore, Submodel II aims to rectify both shortcomings. The only real justification for aggregating two or more commodities is that the individual commodity parameters are about the same in magnitude and sign. This condition should be tested in the case of coffees since structural coefficients may differ among the varieties of the commodity.

Disaggregation of the commodity is given emphasis in Submodel II. If differences exist, administrators in the producing countries can frame better commodity policies, given information relating to the particular class of coffee which they produce rather than information pertaining to coffee as a whole. Because of these considerations the statistical analyses of this study are concentrated on Submodel II.

Table 6 summarizes Submodel II and shows the linear restrictions on the individual equations. The explanation of

Table 6. Schematic Diagram of Submodel II

Equation Number	Description of Equation	Endogenous Variables									Predetermined Variables													
		Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	Y_7	Y_8	Y_9	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}
1	Import Demand for Milds	X	X	X	X						X	X												
2	Export Supply of Milds	X											X	X										
3	Stock Demand for Milds				X								X		X	X								
4	Import Demand for Brazils		X	X		X	X	X			X	X												
5	Export Supply of Brazils							X									X	X						
6	Stock Demand for Brazils						X								X		X	X						
7	Import Demand for Robustas		X					X	X	X	X								X					
8	Export Supply of Robustas								X												X	X		
9	Stock Demand for Robustas									X											X		X	X

NB: The underscored "X" indicates the normalized variables of the equations.

the varables correspond to that already given under Submodel I, except that care should be taken not to confuse the class of coffee subclasses. Particular points worthy of note in regard to the new structural equations are as follows: milds and brazils are assumed competitive and so the price of the latter is specified as a variable in the demand function of milds. Prices of milds and robustas are specified in the demand function of brazils, and prices of brazils in the robusta demand relation. In the robusta relation production of instant, rather than regular, coffee is specified with the aim of testing the alleged connection between robusta trading and instant coffee production.

Definition of Variables

Y_1 = Per capita volume of U.S. coffee imports from Colombia. Population is the total U.S. population (excluding armed forces abroad) fifteen years old and above.

Y_2 = Average wholesale spot price of MAMS (New York) deflated by the BLS index of spot prices of 22 basic commodities (1957-59=100).

Y_3 = Wholesale spot price of Santos 4 (New York) deflated by the BLS index of spot prices of 22 basic commodities (1957-59=100).

Y_4 = Per capita stock of milds in the U.S. at the end of the current quarter.

Y_5 = Per capita volume of U.S. coffee imports from Brazil.

Y_6 = Weighted average wholesale spot price of robustas (the Ambriz 2AA and Ivory Coast Superior/Courant) deflated by the BLS index of spot market prices at 22 basic commodities (1957-59=100).

Y_7 = Per capita stock of brazils in the U.S. at the end of the current quarter.

Y_8 = Per capita volume of robusta imports from Angola and Ivory Coast.

Y_9 = Per capita stock of robustas in the U.S. at the end of the current quarter.

X_1 = Per capita production of regular ground coffee in the U.S. lagged four quarters.

X_2 = Per capita disposable personal income in the U.S. deflated by the BLS Consumer Price Index (1957-59=100).

X_3 = Expected wholesale spot price of MAMS (New York) measured simply by the arithmetic average of the spot price in the two previous quarters.

X_4 = Available exports of milds per capita of U.S. population (exluding Armed Forces abroad) fifteen years old and above.

X_5 = Per capita production of ground coffee in the U.S. in the current quarter.

X_6 = Per capita stock of milds lagged four quarters.

X_7 = Expected spot price of Santos 4 (New York) measured simply by the arithmetic average of the spot price in the two previous quarters.

X_8 = Per capita stock of brazils lagged four quarters.

X_9 = Available exports of brazils per capita of U.S. population (excluding Armed Forces abroad) fifteen years old and above.

X_{10} = Per capita U.S. production of instant coffee lagged four quarters.

X_{11} = Expected spot price of robustas (New York) measured simply by the arithmetic average of the spot prices in the two previous quarters.

X_{12} = Total available exports of robustas from Angola and the Ivory Coast Republic per capita of U.S. population (excluding Armed Forces abroad) fifteen years old and above.

X_{13} = Per capita U.S. production of instant coffee in the current quarter.

X_{14} = Per capita stock of robusta lagged four quarters.

Statistical Assumptions

In statistical terminology, the model of the coffee market postulated is a linear model. This means that the parameters of the structural equations appear in linear relations with the explanatory variables. The explanatory variables are first assumed to enter the relations in an additive fashion and then, as an alternative, they are assumed to enter in a multiplicative manner. The latter relationship is easily changed to an additive one by logarithmic transformation.

As an illustration of a linear model, consider equation (1) of Submodel II and suppose there are T observations on this equation. This may be written as follows:

$$\alpha_1 Y_{1t} + \alpha_2 Y_{2t} + \alpha_3 Y_{3t} + \alpha_4 Y_{4t} + \beta_1 X_{1t} + \beta_2 X_{2t} + u_{1t} = 0;$$
$$t = 1, 2, \ldots T$$

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

The appropriate estimating procedure depends on the a priori theory about the process by which the variables are generated and on the statistical assumptions with respect to the disturbance term. As the Y's are jointly determined variables, it is clear that the OLS technique is inappropriate. Estimates derived by this method will be biased and inconsistent. The conditions which have to be met before OLS estimates are accepted as best, unbiased, efficient, and consistent are too well-known to be repeated, and discussion is confined to simultaneous equation methods only.[6] First, it should be noted that in the other equations some of the α and β coefficients are specified equal to zero. This is necessary to achieve structural identification, otherwise statistical estimation is impossible.

A single joint observation on the equations of Submodel II in quarter t may be written, for convenience, in matrix from:

$$AY_t + BX_t + U_t = 0 \quad (6)$$

where A = a GxG (in this study, 9 X 9) matrix of coefficients (α's) of current endogenous variables.

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[6]See any econometric text book, for example J. Johnston, Econometric Methods, (McGraw-Hill Book Co., New York, 1960) pp. 106-108

B = a GxK (here, 9 X 14) matrix of coefficients (β's) of predetermined variables.

Y_t, X_t, and U_t = column vectors of G, K and G elements, respectively.

For estimation purposes, several assumptions have to be made:

(a) The matrix A is assumed to be nonsingular. This permits the vector Y_t to be expressed in terms of the X_t. Thus, if we premultiply all the terms in (6)' by A^{-1} the following reduced-form equation results:

$$A^{-1}AY_t + A^{-1}BX_t + A^{-1}U_t = 0 \qquad (7)'$$

or, $$Y_t + A^{-1}BX_t + A^{-1}U_t = 0 \qquad (8)'$$

Alternatively, $$Y_t + \pi X_t + V_t = 0 \qquad (9)'$$

where π = a GxK matrix of reduced-form coefficients each each of which is a non-linear function of elements in the A and B matrices.

V_t = a column vector of G-reduced-form disturbances, each a linear combination of the structural disturbances.

(b) $E(U_t) = 0$ for all t, meaning that the expected value of the disturbance terms is zero in time period t.

(c) $E(U_{it}U_{js}) = \Sigma$ if t = s for any two equations i and j. This implies homoskedasticity and Σ is a symmetric matrix of the variances and covariances of the U'_{ts}. Σ is assumed to be non-diagonal.

(d) $E(U_{it}U_{js}) = 0$. This means there is no correlation between the predetermined variables and the disturbance term of each equation. The processes generating them are independent of each other.

(f) Correct specification is assumed as well as the absence of errors-in-variables, in other words, the model is a "pure shock" one.

(g) The covariance matrix of predetermined variables (Σ_{xx}) at time t is nonsingular, that is to say, there should be no correlation between paris of predetermined variables and any dependence is sufficiently weak so that plim $T^{-1}X'X = \Sigma_{xx}$.[7]

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[7]See A.S. Goldberger, Econometric Theory (John Wiley and Sons, Inc., New York, 1964) p. 299, for details of the stochastic specifications

Additionally, one of the endogenous variables in each relation is chosen as the normalizing variable, i.e., dependent variable with a coefficient of -1. Since different estimates are derived depending on the normalizing variable used, it is essential to pick the one around which the structure is constructed. For instance, if the analyst's purpose is to explain variation's in a commodity's price, then this variable should be selected as the normalizing variable.

Identification

Prior to estimation of the parameters in a system of simultaneous relationships, the identification status of each of the structural equations must be ascertained. As has been noted elsewhere, identification is achieved by placing certain a priori restrictions on the coefficient matrices of the endogenous and predetermined variables and, in some cases also, on the variance-covariance matrix of the structural disturbances. But this is only a neccesary, not sufficient, condition.

The necessary or order condition of identifiability requires that the number of variables excluded from the equation (more generally the number of linear restrictions on the parameters of the equation) be at least equal to the number (G say) of structural equations in the complete system, less one.

The sufficient or rank condition requires in addition that one can obtain at least one nonvanishing determinant of order G-1 out of those coefficients, properly arranged, with which the variables excluded from the structural equation appear in the G-1 other equations.[8]

Symbolically, the necessary condition is met if $G^{\Delta\Delta} + K^{**} \geq G-1$, where $G^{\Delta\Delta}$ = a number of endogenous variables in the system but excluded from a particular equation of concern.

K^{**} = number of predetermined variables in the system but excluded from that equation.

G = total number of endogenous variables in the system.

Subtracting $G^{\Delta\Delta}$ from both sides, the above condition is alternatively expressed as:

$$K^{**} \geq G^{\Delta} - 1$$

where G^{Δ} = number of endogenous variables in the equation. The sufficient condition requires that the rank of a special submatrix of the reduced-form coefficients ($\pi^{**\Delta}$) be equal to G -1, that is the submatrix of reduced-form coefficients whose rows consist of the endogenous variables in the equation and columns are the excluded predetermined variables occuring in the other equations.

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[8]H.C. Hood and T.C. Koopmans, Studies in Econometric Method, (Cowles Commission and J. Wiley and Sons, Inc., Monograph No. 14, 1953) p. 38

In summary, $K^{**} < G^{\Delta}-1$ implies under or no identification (i)

$K^{**} \geq G^{\Delta}-1$ and $r(\pi^{**\Delta}) = G^{\Delta}1$ implies under-identification (ii)

$K^{**} = G^{\Delta}-1$ and $r(\pi^{**\Delta}) = G^{\Delta}-1$ implies exact identification (iii)

$K^{**} > G^{\Delta}-1$ and $r(\pi^{**\Delta}) = G^{\Delta}-1$ implies over identification (iv)

So far as our model is concerned, the order condition for identification is met. However, no test for the rank condition was carried out explicitly.

Estimation Methods

For purposes of comparision, Ordinary Least Squares (OLS) is used in conjunction with four others; namely, Two-Stage Least Squares (TSLS), Limited Information Single Equation (LISE), Three-Stage Least Squares (3SLS) and the Iterative Three-Stage Least Squares (I3SLS). The first three are limited information methods while the last two are full information methods in the sense that, unlike the first group, they utilize all the a priori restrictions specified for every relationship in the system.

Three considerations may justify the use of the limited information method. One is the fact that the difficulty,

time, and cost of computations increase with the number of equations for which overidentifying information is employed. Another is that the researcher may be only interested in the estimates of parameters in some equations because the marginal cost of acquiring information about the remaining equations exceeds the marginal benefit. Finally, and not the least important, the researcher may lack adequate knowledge on which to base a priori restrictions on the coefficients of certain equations outside the subset in which he is basically interested. This is a particularly cogent argument in the present case.

With the exception of the OLS, a brief description of the estimating techniques and the theoretical properties of the respective estimates are now given, beginning with the limited information methods.

Two-Stage Least Squares (2SLS)

The Theil-Basmann 2SLS consists of two steps, the first of which serves to estimate the moment matrix of the reduced-form disturbances associated with the non-normalized endogenous variables in a particular equation. This moment matrix is subtracted from the matrix of the associated endogenous variables which are thus "purged" of the stochastic component associated with the disturbance term u. The "purified" explanatory

variables, so to say, are inserted in the original structural equation and the OLS method used to derive the parameter estimates. These structural parameter estimates are consistent, asymptotically unbiased, and asymptotically efficient.

Limited Information Single Equation (LISE)

This technique, originally developed by Anderson and Rubin, is also one of those that utilize only part of the a priori information; that is, it is used for estimating a subset of a fully identified system of equations.[9] Koopmans states that the estimates of the parameters are maximum likelihood estimates provided the model itself is valid.[10] For the model to be valid it is necessary, inter alia, that the rest of the equations be linear and that the correct classification of endogenous and exogenous variables be used. If the model is valid, then the estimates made are consistent and are also asymptotically efficient in comparison with all other asymptotically normal estimates using the same or less information.

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[9]T.W. Anderson and H. Rubin, "Estimation of the Parameters of a Single Equation in a Complete System of Stochastic Equations," Annals of Mathematical Statistics, Vol. 20, March, 1949, p. 46

[10]W.C. Hood and T.C. Koopmans, op. cit., p. 162

Three-Stage Least Squares (3SLS)

Zellner and Theil first published this estimation method in 1962.[11] The key concept is the use of the 2SLS estimated moment matrix of the structural disturbances to estimate all the coefficients of the entire system simultaneously in the third stage. The method has full information characteristics to the extent that, if the moment matrix of the structural disturbances is not diagonal (that is, if the structural disturbances have nonzero contemporaneous' covariances), the estimation of the coefficients of any identifiable equation gains in efficiency as soon as there are other equations that are overidentified. Further, the method can take account of restrictions on parameters in different structural equations. Zellner and Theil point out that the 3SLS estimates are more efficient than 2SLS estimates but in the event of a diagonal moment matrix of the structural disturbances both methods yield theoretically equivalent estimates. The estimates of the structural coefficients are asymptotically unbiased, consistent and asymptotically efficient if the variance-covariance matrix of the structural disturbances have no a priori restrictions.

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[11] A. Zellner and H. Theil, "Three Stage Least Squares: Simultaneous Estimation of Simultaneous Equations", Econometrica, Vol. 30, No. 1, (January, 1962), p. 54

Iterative Three-Stage Least Squares (I3SLS)

Zellner and Theil also suggested in the article cited above that it would be possible to set up an iterative procedure which utilizes the estimates of the moment matrix of structural disturbances obtained in the third stage for computing parameter estimates in the fourth stage (4SLS), and so on to the nth stage. The iteration is terminated when there is no substantial change between successive estimates (that is, convergence is obtained), or if successive changes tend to become larger, in which case the operation is deemed a failure. No formal proof has yet been given as to the statistical properties of the I3SLS estimates, but it was the increase in efficiency implied by Zellner and Theil that first prompted the inclusion of the I3SLS among our estimating methods. But against this potential benefit must be set the greater susceptibility of full information estimators to misspecification errors as Monte Carlo studies have shown. Furthermore, in a recent article Madansky has formally shown that no further gain in the asymptotic variance of the estimator can be obtained through iteration.[12] On the

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[12]A. Madansky, "On the Efficiency of Three-Stage Least Squares Estimation," Econometrica, Vol. 32, No. 1-2 (January-April, 1964) p. 51

other hand, with a small sample, as we have, no proof of improvement, no change, or detriment has been published.

Evaluation of the Economic Model Constructed

In his previously cited journal article, Daly commented as follows:[13]

> Coffee prices depend to a considerable extent on general economic conditions and consumer incomes in the United States as well as on world supply conditions and many other forces that cannot be measured. Most producing countries exercise controls over the production and marketing of coffee. Consumption and price are influenced in many European countries by import restrictions, colonial preference, tariffs, and taxes. Cyclical variations in production and inadequate statistical reporting on production and stocks contribute to considerable variation in price and complicate the job of analyzing price movements as well. Many of these institutional factors are major influences in price-making in the current coffee situation, particularly as they modify available market supplies. Another analytical complication arises from the need to treat the interdependence of world supply and demand conditions -----.

The same note echoed in the 1955 study by Hopp and Foote who went further to suggest that "these difficulties apparently have been sufficiently serious to discourage research analysts ----".[14]

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[13]Rex F. Daly, op. cit., p. 66

[14]H. Hopp and Richard J. Foote, op. cit., p. 429

However, because of the enormous importance of coffee to several developing countries, it is desirable to attempt further analysis of the coffee market despite the problems involved. As was noted in the introductory chapter, Daly's model regressed the New York spot price of Santos 4 on three predetermined variables and derived OLS estimates of the structural parameters. To recapitulate, the structure was:

P; Y, S, W (10)'

where P = wholesale spot price (New York) of Santos 4 deflated by the consumer price index (CPI).

Y = domestic U.S. consumer income deflated by the CPI.

S = current coffee imports plus carryover stocks in the U.S. (i.e. current total supply) per head of population (15 years old and above)

W = the ratio, world stocks plus world production ÷ world exports, indicating relative supply.

An obvious implication of Daly's model is that the price of Brazilian Santos 4 can be taken as adequately representing the behavior of the prices of other major coffees. It is questionable that this assumption was based on a complete assessment of the empirical situation. Certainly, robusta prices have not always moved in the same direction as brazils

nor have prices of milds. At the same time, recognition of their different behavior patterns in a model may aggravate an already complex analytical problem. Secondly, the treatment of current imports plus carryover stocks as predetermined denies the mutual dependence between the current level of stocks and current import price. We believe there is a mutual relationship between the two; that is prices determine stock demand, and conversely. In another sense it appears incorrect to grup stocks with imports and define their sum as the total current market supply facing consumers. Statistics compiled by the Bureau of Census shows that the bulk of domestic U.S. stocks (about 60 percent) is in the hands of roasters and that none of this is resold subsequently. Roasters' stocks, of course, influence prices through their effect on current demand. Our model accorded a major explanatory role to stocks despite the very difficult accounting problem involved. The results of the experiment in constructing stock demand functions for each coffee class are reported in the next chapter.

The model by Hopp and Foote also underrates the major differences within the commodity group. As such it would provide less useful policy signals to individual coffee countries. The model is:

$$Y; X_1, X_2, X_3 \qquad (11)'$$

where Y = average import value (cents/lb.) deflated by personal disposable income per capita in the U.S.

X_1 = average world stocks at the start of the current year ÷ average world imports or deliveries for the five preceding years.

X_2 = average Brazilian exportable production in current year ÷ average Brazilian exports for the five preceding years.

X_3 = trend factor.

In conclusion, our model of the green coffee market attempts to focus on the principal component sectors to improve understanding of inter-sectoral relationship. Inevitably, this task faces numerous problems of an analytical and accounting nature. Nonetheless, the effort is necessary in the interest of good commodity policy, especially if the weak points in the analysis are recognized and made explicit. This we hope to do further in the succeeding chapters.

CHAPTER IV

EMPIRCAL RESULTS

In the last chapter, we discussed the economic model of the green coffee market of the United States. This chapter presents the results obtained from estimating those economic relationships. Recall that Submodel I involves a simplification in that it assumes only two types of the commodity exist, namely arabicas and robustas, whereas in Submodel II all three principal varieties are included. Because of this simplification, simultaneous estimation methods are not applied to Submodel I and the discussion pertaining to it is based on OLS results. Submodel II is fitted using four different simultaneous equations estimating techniques; the 3SLS results are interpreted most fully and their policy implications are considered further in the next chapter.

The overall results obtained from the analysis are considered satisfactory. Most of the structural relationships estimated gave good statistical fits, as indicated by the calculated coefficients of determination. On this criterion the logarithmic functional relations appear not

to have a significant advantage over the corresponding arithmetic forms.

The overall results consistently bear out the hypothesis regarding the dominance of a competitive relationship among the major coffee varieties. The algebraic signs of the relevant coefficient estimates are consistent with competition hypothesis and the estimates themselves are generally significant at the accepted critical probability level. The calculated price flexibilities appear plausible; however, the negative income flexibilities for brazils and robustas seem to contradict the initial hypothesis that green coffees are normal goods.

Despite the observations made in the preceding paragraphs, certain specific issues arose in the analysis -- statistical and empirical -- which deserve to be brought out explicitly. These issues are discussed in the section immediately following in the hope that they will help to place the empirical results later presented in a clearer light. To this task we now turn.

Statistical and Empirical Issues

As already stated, the purpose of this section is to clarify the statistics calculated so that the reader may be aware of their limitations in the context of this study.

The unadjusted coefficient of multiple determination ("R^2") is calculated for all of the estimators employed, except the I3SLS.[1] Under the classical least squares the R^2 statistic is a measure of the goodness of fit in the sense that it indicates what proportion of the variance in the dependent variable is explained by, or is associated with, variations in the independent or explanatory variables. This is not the case in simultaneous economic systems which assume mutual dependence among some included variables, hence none of the mutually dependent variables can be regarded as truly dependent in the classical sense. Since the R^2 values presented are based on the unmodified standard formula, it should be stressed that their main purpose is for comparison.

As a preliminary comment on the R^2 values obtained, the LISE procedure yielded most low, and sometimes, negative values.[2] Presumably, negative R^2 values result from the

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[1]The adjusted coefficient of multiple determination (R^{-2}) is free on the bias of R^2 because its formula utilizes the correct degrees of freedom instead of the total number of observations. The biased version is used here only for convenience.

[2]When a negative R^2 is obtained the value of the estimated relationship for prediction is virtually destroyed, for, in this event, more accurate forecasts of the normalized variable could be obtained from the mean than from the estimated relationship, at least during the sample period.

fact that this estimator one is in effect minimizing the sum of the squared deviations from all of the endogenous variables in the structural relation being fitted whereas in the OLS and other estimators employed the deviations are centered on a single dependent or normalized variable, as the case may be.

The Durbin-Watson ("D.W.") statistic was also obtained but, as in the case of R^2, caution is urged in interpreting this statistic since it was also developed primarily for use in single equation models in which the explanatory variables are assumed fixed. This is why no explicit test is made for the presence or otherwise of autocorrelation among the disturbance terms.

Another matter to be borne in mind concerns the coefficient standard errors which are presented and the significance tests made. We note, first of all, that the formulas by which these are calculated apply only asymptotically in the present case. Secondly, note that multicollinearity was a serious problem in this study, as is frequently the case in analyses of historical data. For example, in the import demand equations, two of the major explanatory variables, price and disposable personal income, turned out to be highly inter-correlated and each is in turn correlated with the variable

constant term to the order of 0.9. A well-know way of evading multicollinearity is to insert in the equation being fitted an estimate of the income coefficient (say) obtained from an independent source and then proceed to estimate the other coefficient. Apart from certain conceptual difficulties, such an attempt was not made in the present case because the only known estimate of income coefficient (Daly's) was obtained under different analytic assumptions and objectives.[3] Multicollinearity may cause imprecise estimates of the coefficients of affected variables: the standard errors are large, the coefficient signs may be altered, and the isolation of the individual effects of the variables is impossible. Another way of circumventing multicollinearity is to drop one of the affected variables and regard the coefficient of the variable remaining as expressing both the effect of the excluded one and the

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[3]One of the most serious strictures levied on the practice of combining cross-section and time-series data center around the implicity conflict between economic behavior in the long and short run. By the same token, an unthinking "borrowing" of coefficients from different statistical models could lead to violation of important behavioral assumptions. For more on these issues, see E. Kuh: "The Validity of Cross-Sectionally Estimated Behavior Equations in Time Series," Econometrica, Vol. 27, No. 1 (January, 1959) pp. 197-214

the remaining variable itself. However, this device does not remove interpretation difficulties and it was for this reason particularly that we decided to retain both variables. It should be noted also that because of large standard errors the usual tests of significance may fail even in respect of important variables specified in the structural relation.

In simultaneous economic systems, the threat from multicollinearity is particularly severe. This is so in part because the nature of the system itself implies that some explanatory variables in the structural equations are correlated. Secondly, the estimating method employed can sometimes aggravate multicollinearity. Specifically, if the 2SLS method is used the subtraction of the reduced-form matrix of disturbance terms from the vector of structural endogenous variables may increase the collinearity between certain explanatory variables. As Theil points out, the degree of the increase depends on the magnitude of the reduced-form disturbance matrix relative to the vector of endogenous variables. If the former is small, then aggravation of multicollinearity is relatively minor, but in this event, the difference between the OLS and 2SLS will also be quite small.[4]

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[4]H. Theil, "Implications of Multicollinearity", Economic Forecasts and Policy, (North-Holland Publishing Co., Amsterdam, 1961) pp. 355-357

Clearly, these problems are germane in comparing the performances of the different estimators employed in the analysis. For if the reduced-form disturbance matrix is of significant magnitude, we may expect somewhat larger coefficient standard errors for the 2SLS estimator, and possibly for the 3SLS as well. This is more or less the pattern that emerges from visual inspection of Tables 8, 9, and 10 except that the 3SLS standard errors are in general rather less than the corresponding 2SLS errors. However, this comment should be treated as a mere observation on the present data and not as evidence of the performance of the estimators under circumstances of multicollinearity.

The last analytical problem encountered is technical rather than statistical and applies exclusively to the I3SLS estimation procedure. The estimated coefficients converged reasonably well only in the case of the arithmetic relation but not in logarithms. For this reason the I3SLS estimates are not reported in Appendix A in which the results of the logarithmic fit are presented.

In the arithmetic relation the I3SLS procedure was applied 66 times, averaging 3.79 seconds per iteration. The maximum absolute change ratio from the estimates obtained at the penultimate iteration was approximately 1.53×10^{-1}. The largest changes occurred in coefficients of very small order of magnitude.

In the logarithmic relation the system seemed to move in an oscillatory or unstable manner, the size of the absolute change in the coefficients rising and falling in successive iterations. For example, at the 68th iteration the maximum absolute change ratio from the preceding coefficients was roughly 1.44×10^{-1}; at the 69th stage it was 9.88, and at the final iteration it was 4.63×10^{-5}. Thus, a total of 70 iterations was applied, averaging 3.79 seconds each. The instability that developed in the estimation process was again largely due to coefficients of very small order of magnitude which were changing continually. An example is a coefficient which changed from 1.46×10^{-7} at the 65th iteration to 6.02×10^{-8} at the 70th iteration.[5]

The Estimated Relationships

The plan for presenting the results is as follows: first, the estimates obtained from Submodel I are given in Table 8, followed by related discussion on an equation-by-equation basis. Next, the results of Submodel II are discussed and the supporting Tables of estimated coefficients and statistics presented. Note that Tables 8 through 11 are obtained from the arithmetic functional forms. For the results of the

[5]Estimates of coefficients were printed out at intervals of 5 iterations.

logarithmic forms the reader is referred to Appendix A. A standard format is used for Tables 8 through 11 -- the estimated coefficients are given beside the appropriate estimator used and directly below are the associated coefficient standard errors.

After discussions of the structural form estimates, we attempt further evaluation of the economic model by means of Figures 3 through 5, which illustrate the patterns of the actual and estimated prices obtained by the 3SLS method. As will be remembered, because of asymptotic efficiency the 3SLS estimates were nominated in the previous chapter as the standard against which the other results would be compared. Because of this, Figures 3 through 5 may be seen as the "standard" relative pattern of actual and estimated prices. This pattern can be of considerable assistance in appraising the economic model constructed because it not only shows the closeness between the observed and estimated price series but also indicates whether or not the model captures the turning points in the original series.

Finally, the reduced-form 3SLS equations are evaluated with respect to their forecasting potential. This is done by graphing and comparing the reduced-form estimates of prices

and the observed prices. A trial conditional price forecast is then made for the first quarter of 1962, which is outside the sample period used in the analysis.

Table 7

Results of Submodel I OLS
Estimates and Associated Statistics

Equation (1): Import Price of Arabicas

(a) $\hat{Y}_2 = 118.2326 - 0.8104Y_1 + 5.9505Y_3 + 0.2293Y_4 -$
$(48.0341)\ (0.7316)\quad (1.2270)\quad (0.1503)$
$0.7369X_1 - 30.8796X_2$
$(1.6542)\quad (25.3980)$
$R^2 = 0.94$; D.W. = 0.99

(b) $\text{Log}\hat{Y}_2 = 2.1250 - 0.1246 \text{ Log } Y_1 + 0.3397 \text{ Log } Y_3 +$
$(0.2710)\ (0.0618)\qquad (0.0755)$
$0.2184 \text{ Log } Y_4 - 0.546 \text{ Log } X_1 - 2.9163 \text{ Log } X_2$
$(0.0897)\qquad (0.1379)\qquad (0.6690)$
$R^2 = 0.94$; D.W. = 1.14

Equation (2): Export Supply of Arabicas

(a) $\hat{Y}_1 = -0.1702 + 0.311X_3 + 0.3980X_4$
$(1.7132)\ (0.0146)\quad (0.2065)$
$R^2 = 0.16$; D.W. = 2.24

(b) $\widehat{\text{Log } Y_1} = -0.4012 + 0.305 \text{ Log } X_3 + 0.5916 \text{ Log } X_4$

(0.4040) (0.1690) (0.2347)

$R^2 = 0.19$; D.W. = 2.09

Equation (3): Stock Demand for Arabicas

(a) $\hat{Y}_3 = 0.2387 - 0.0051X_3 + 0.1557X_5 + 0.7431X_6$

(1.2464) (0.0067) (0.2146) (0.1305)

$R^2 = 0.54$; D.W. = 2.09

(b) $\widehat{\text{Log } Y_3} = 0.1441 - 0.894 \text{ Log } X_3 + 0.1972 \text{ Log } X_5 +$

(0.3731) (0.1293) (0.3536)

$0.7114 \text{ Log } X_6$

(0.1320)

$R^2 = 0.51$; D.W. = 1.95

Equation (4): Import Price of Robustas

(a) $\hat{Y}_4 = 60.3170 + 0.4157Y_2 - 30.7492Y_5 - 7.1053Y_6 -$

(51.6208) (0.1858) (16.3999) (19.4737)

$20.6350X_2 + 26.2933X_7$

(26.6867) (9.2972)

$R^2 = 0.93$; D.W. = 1.54

(b) $\text{Log } Y_4 = 1.3068 + 0.5621 \text{ Log } Y_2 - 0.1150 \text{ Log } Y_5 -$

(0.7612) (0.2686) (0.1380)

$0.1192 \text{ Log } Y_6 - 2.1382 \text{ Log } X_2 + 0.5827 \text{ Log } X_7$

(0.1100) (1.320) (0.2175)

$R^2 = 0.92$; D.W. = 1.16

Equation (5): Export Supply of Robustas

(a) $Y_5 = 0.1046 - 0.0023X_8 + 0.3246X_9$

(0.0731) (0.0010) (0.0496)

$R^2 = 0.77$; D.W. = 2.76

(b) $\text{Log } Y_5 = 0.0115 - 0.3182 \text{ Log } X_8 + 0.9887 \text{ Log } X_9$

(0.2346) (0.1539) (0.1809)

$R^2 = 0.70$; D.W. = 2.63

Equation (6): Stock Demand for Robustas

(a) $Y_6 = 0.0095 - 0.0011X_8 + 0.2063X_{10} + 0.3716X_{11}$

(0.2357) (0.0023) (0.5130) (0.1673)

$R^2 = 0.45$; D.W. = 1.90

(b) $\text{Log } Y_6 = 0.0344 - 0.3782 \text{ Log } X_8 + 1.0873 \text{ Log } X_{10} +$

(0.5901) (0.4232) (0.6233)

$0.0901 \text{ Log } X_{11}$

(0.1750)

$R^2 = 0.41$; D.W. = 2.00

Import Price of Arabicas (milds and brazils)

The two functional forms gave about the same statistical fit: R^2 was 0.94. Thus, the model as formulated does a good job of explaining variations in the price of arabicas. With the exception of the two predetermined variables all other variables have signs consistent with expectation. The negative income coefficient would seem to indicate that arabicas are an inferior good, at least in the U.S. economy. In this connection, it is relevant to note that, unlike income, per capita consumption of all green coffees in the U.S. has been declining since World War II.[6] In part, this decline of per capita green coffee consumption could be caused by improved technical efficiency and probably also by a change of consumer taste towards lighter brewed coffees. Both factors could have the effect of reducing the quantity of raw coffee required per cup of coffee, and this at a time when per capita income in the U.S. has been rising.

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[6]Journal of Commerce, "The Commodity Ring", (February 11, 1966)

One surprising result from this import function is the fact that only two variables, robusta price and arabica stocks, were significant in the arithmetic relation.[7] With the logarithmic relation all variables, except lagged production of regular ground coffee, turned out to be highly significant. It would seem, therefore, on the basis of the number of significant variables, that a logarithmic functional relationship is the more appropriate. Because of the non-signficance of lagged production of regular coffee, the inference is made that this variable is not an important determinant of arabica import prices.

The income flexibility of demand derived from the arithmetic relation is -1.46 at the mean level which is roughly half of the constant income flexibility of -2.90 yielded by the logarithmic relation. This implies that a one percent increase in income leads to a 2.9 percent decrease in import price, with the price of robusta and other

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[7]Because of the distortion caused by multicollinearity, it is perhaps unsafe to speak in terms of significance and nonsignificance in respect of the affected variables, specifically price and income. We use them in this case only in a loose sense; subsequently, they are applied to variables no substantially collinear with others.

Though most empirical studies tend to use 0.01 and 0.05 critical probability limits, the complexity of the price-making forces in the international coffee market does not justify this degree of confidence in the estimates. A more liberal and arbitrary critical limit of 0.10 is used in this study.

factors remaining unchanged. Also, the calculated arithmetic and constant price flexibility coefficients were, respectively, -0.05 and -0.13.

The stock variable is highly significant and bears the expected positive sign. The positive robusta price coefficient bears out our a priori assumption about the dominance of a substitution, rather than complementary, relationship between the two coffee classes.

Export Supply of Arabicas

This relationship did not give a good statistical fit. The R^2 for the arithmetic and logarithmic functions were 0.16 and 0.19, respectively. To some extent the poor fit was anticipated. Certain variables, believed to be important determinants of export supply from the Latin American producing nations, were not specified because of measurement and interpretation problems. Two such variables are monetary and exchange policies both of which affected the flow of the commodity into world commerce throughout the study period. Speculation by traders as to the future of the exchange rate, frequently manipulated by the authorities, could have affected the quantity of exports.

Though an unsatisfactory fit was obtained, the estimated coefficients came out with the expected signs and both were

significant in natural and logarithmic functions. A one percent increase in available exports in the arabica countries gives rise to about 0.6 percent increase in supplies to the U.S. market.

Lastly, the relationship between supply and expected price is consistent with expectation, indicating that exports to the U.S. increase with expected spot price.

Stock Demand for Arabicas

All the variables specified in the equation had the expected coefficient signs but the equation itself did not explain a high proportion of the variance in the dependent variables. The R^2 value for the arithmetic form was 0.54, only 0.03 better than for the alternative functional form.

Of the variables included, only the lagged stock variable (X_6) was significant, and highly so in both of the functional forms. On this evidence it would seem that the most important determinant of stock demand is the volume of stock which processors and dealers judge to be adequate for meeting the roasting demand normal in that time of the year. This does not appear implausible, especially if we remember that actual experience, based on the situation in the not too distant past, tends to be weighted heavily in practical business decisions.

The non-significance of the expected price variable is surprising, but it might be due to the aggregation of arabicas or the poor specification of the expected price variable. Thus, until the disaggregated function is considered it might be wrong to conclude that speculation is an unimportant factor in stock demand.

Import Price of Robustas

Again, there was not a substantial difference in the performance of the two functional forms when compared on the basis of the goodness of fit. The arithmetic relation yielded an R^2 of 0.93, only 0.01 better than the other form.

The coefficient signs, except those of income and stock came out as expected. The negative income coefficient indicates that coffee robusta is an inferior commodity in the U.S. economy, same as arabicas. This result is again contrary to the initial hypothesis.

In this equation, the stock variable coefficient is not significant. The negative sign is also contrary to expectation but probably indicates that stock build-up is undertaken largely during the period of low robusta prices. This, in practice, could mean that processors merely take advantage of low prices and is in contrast to the case of arabicas where

the initial stimulus on prices seems to come from active stock accumulation.

Lagged production of instant coffee is highly significant and bears the right coefficient sign. Consequently, the prevalent opinion in the trade with reagrd to the correlation between robusta trading and instant coffee manufacturing appears to be confirmed. A one percent increase in instant production would be associated with 0.6 percent increase in robusta prices.

The coefficient of arabica price bears the right (positive) sign showing as before that a substitution relationship was dominant between the two coffee varieties. A one percent increase in robusta prices is accompanied by about 0.6 percent increase in arabica price, with other factors remaining constant.

The calculated income flexibility of demand at the point of means was -1.42 in the arithmetic relation and in the other a constant income flexibility of -2.14. Also, the price flexibility was, respectively, -0.25 and -0.12. Again, as was found in the case of arabicas, a negative income flexibility coefficient suggests a fall in the price of robustas as the U.S. per capita income grows, assuming the price of arabicas is constant.

Export Supply of Robustas

A fairly good statistical fit was obtained from the estimated equation. The arithmetic form did somewhat better than the logarithmic, the respective R^2 values being 0.77 and 0.70.

The negative sign of the expected spot price (X_8) is inconsistent with a priori hypothesis. This inverse relationship deserves further comment. A special feature of robusta trading has been the relative concentration of export supply in the first half of the marketing season. The practice is presumably necessitated by lack of storage facilities and/or supply management programs in general, contrary to the situation in the Latin American arabica countries. The consequence is a depressing effect of heavy export supplies on robusta prices in the early part of the season. Subsequently, as supplies run out the pressure relaxes and prices rise again in the latter half. Thus, there is in actuality an inverse correlation between export quantity and price. Hence the negative coefficient of spot price.

Finally, the variable, X_9, bears the "correct" sign--an increase of available robusta exports is associated with a rise in supply to the U.S. market. The estimated coefficient was highly significant.

Stock Demand for Robustas

The performance in terms of statistical fit of the postulated relationship was not satisfactory. The arithmetic R^2 value was 0.45, only better than the corresponding value for the logarithmic relation by 0.04.

In the arithmetic form, the lagged stock variable (X_{11}) was significant; it was not in the logarithmic form. The opposite is true of current production of regular coffee (X_{10}). The variable for expected spot price (X_8) failed to be significant in either functional form and, in addition, had a negative sign contrary to hypothesis. In this relation the estimated coefficient and algebraic signs are considered generally unsatisfactory. As such they do not afford a good basis for drawing useful conclusions. Evidently more information is required regarding the important factors influencing the robusta stock demand function.

Seasonality of Coffee Import Demand

One of the aims of this study was to investigate the influence of seasonal factors on import demand. Seasonal factors can cause either a shift of the demand function, a change in its slope, or both together. Changes of this sort will in general result in different elasticity coefficients from one season to the next with different implications for policy.

The test carried out related to seasonal shifts of the level of the demand function. To do this the structural equations were modified to include dummy variables for seasons and the OLS fit was applied in the usual manner.[7]

No significant improvement of the statistical fit was obtained as a result of the inclusion of dummy variables. For a specific example, the robusta demand function gave an R^2 value of 0.93 without dummy variables and gained approximately 0.01 from their inclusion. Because of this it was considered that the role of seasonal factors on coffee import demand was probably a minor one. Therefore, Submodel II, on which statistical analysis is concentrated, did not include dummy variables.

Since many people regard processed coffee as a cold-season beverage it might be thought that import demand for the raw materials is seasonal. This is evidently a non sequitor. The coffee business especially import-processing, is apparently specialized on a year-round basis. Processors,

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[7]For an example, see W. G. Tomek, "Using Zero-One Variables with Time Series Data in Regression Equations", Journal of Farm Economics, Vol. 45, No. 4 (November, 1963) p. 814

for instance, do not manufacture ground coffee one season and shift to cocoa or tea manufacturing another season. And, despite stocks in hand, import demand will not shift if processors maintain a fairly smooth flow of output throughout the year. It is not unrealistic to suppose the maintenance of a smooth flow of output because it is not necessary that output and sales should balance season by season -- sometimes relatively more of the output will go into finished inventory while at other times more will be sold directly to wholesalers. Thus, it is quite possible that seasonal factors do not affect import demand in a substantial way. Another reason for this view derives from the fact that the 4-period lagged variable included in the structural demand relation was non-significant though it probably caught some of the seasonality effects.

Submodel II

Import Price of Milds

Three of the 3SLS estimated coefficients had signs that contradicted a priori hyptheses. Lagged production of regular coffee (a proxy variable for sales in the same period of the past year) came out with a negative coefficient, implying the opposite of expectation. However, the coefficient was non-significant, as it was in the aggregated arabica demand function of Submodel 1.

The next variable with an unexpected negative coefficient was the stock variable. Because the coefficient is significant, it is desirable to seek possible reasons for the negative sign obtained. One explanation that suggests itself lies in our method of allocating total stocks to the different classes of the commodity. As will be recalled, this was done simply by dividing the end-of-quarter stock in proportion to the current imports of the different classes. If we overlook speculation for the moment, it is apparent that stock accumulation is avoided when the average level of prices during the quarter is high, and conversely. Now, our method of allocating stocks could bias the share of milds downwards when their price is high relative to brazils'. For if the relative price of milds is high its relative share of total arabica purhcases, and hence of stocks, will be small. The converse is also applicable.

The price-quantity relation turned out opposite to expectation; the coefficient was positive as well as significant. As will be seen in subsequent sections, the price-quantity relations for brazils and robustas were negative as postulated. No ready explanation of the positive relation found in this case is available. Trade in mild coffees was no more subject to speculative demand than were the other

Table 8. Submodel II - Arithmetic Form
EQUATION 1. Import Price of Mild Coffees Estimated Coefficients and Associated Statistics

	Estimator	Y_2	Y_3	Y_1	Y_4	Constant	X_1	X_2	"R^2"	"D.W."
1.	3SLS (2SLS)	-1	1.1612	8.6160	-10.4184	-21.3515	-0.6757	8.9486	0.91	0.85
			0.1689	4.3968	4.5775	31.2110	1.4734	8.1894		
2.	2SLS	-1	0.9877	6.9716	-6.9682	4.6455	-0.2638	1.1030	0.02	0.63
			0.2828	6.5522	6.5179	51.4222	1.9404	13.5226		
3.	OLS	-1	0.8256	2.7820	-1.8388	34.4322	-0.6396	6.3755	0.92	0.37
			0.1846	4.3316	3.8723	34.0637	1.8242	9.0360		
4.	LISE	-1	4.3502	100.8940	-110.6638	-629.5930	7.0466	159.0892	-1.68	2.40
			1.5955	36.9622	36.7692	290.0847	10.9463	76.2840		
5.	I3SLS	-1	1.1587	0.5322	-4.6862	-9.4435	-0.1540	5.1944	n.c.	n.c.
			0.0066	0.1712	0.2041	7.4487	0.8365	2.4749		

n.c. = not calculated

varieties, especially brazils. Nor is it very likely that its premium quality confers upon it the attributes of a "prestige good" whose snob appeal, and hence purchases, rises when its prices increases. This would be irrational conduct on the part of coffee processors. Still we submit a hypothesis which is somewhat analogous to this situation. With demand stable, a substantial increase in the price of milds could be due to a short supply in the producing countries. Processors might, as a result, reduce some of their expenditures on other varieties and purchase relatively more of premium coffee. A higher proportion of the latter would be used in blend products to improve their quality; ultimately, the final consumer not only pays a higher price (because of the increase in the price of raw coffee) for canned coffee, but also gets better quality for money spent. In his previously cited paper, Wood based his contention against substitution between arabicas and robustas on an essentially similar premise.[8] But we rather doubt his main conclusion since the results presented later indicate significant competition between robustas and brazils contrary to his position.

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[8]James E. Wood, op. cit., p. 3.

The coefficient of the price of brazils (Santos 4) was positive, indicating that brazils and milds are primarily substitutes but a one percent increase in the price of brazils causes a less than proportionate increase in the price of milds. The value of the coefficient of the price of brazils was 0.9 in the logarithmic function.

The income coefficient for milds was positive, the only positive income coefficient among the three coffee varieties. The indication is that milds are normal economic goods; that is to say, other relevant factors being equal, an increase in per capita income results in the increase in demand for mild coffees.

The calculated income flexibility was 0.39 at the point of means and 0.19 in the logarithmic form. Thus, other factors remaining unchanged, a one percent change in per capita income would raise price 0.19 percent. The price flexibility coefficient was, again at the point means, 0.18. The corresponding logarithmic estimates of the flexibility coefficient with respect to price was 0.13. It should be noted that the reciprocal of the flexibility coefficient is not equal to the corresponding elasticity coefficient. When substitutes and complements are involved, as in the present case, the divergence between the two may become quite large.

As Houck ably put it:

> ---under rather general conditions, the reciprocal of the direct price flexibility --- is the lower absolute limit of the corresponding direct price elasticity. The difference between the two depends upon the strength of cross effects of commodity substitution and, if relevant, complementarity.[9]

So far as the "R^2" values are concerned, the 3SLS, 2SLS and OLS yielded about the same result (0.92) but LISE was extremely poor (-1.68). Excluding the constant term and X_1, which was consistently non-significant, the different estimators agreed regarding the sign of the coefficients. Though there was variation in the magnitude of the estimated coefficients, the 2SLS, 3 SLS and I3SLS were fairly close to each other. LISE estimates were consistently larger, coefficient by coefficient, than other estimators. We do not know the performance of these estimators when multicollinearity exists between some specified variables and it is possible that a large part of the difference between the estimates was due to multicollinearity.

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[9]J.P. Houck, "The Relationship of Direct Price Flexibilities to Direct Price Elasticities," Journal of Farm Economics, Vol. 47, No. 3, (August, 1965) p. 789. Houck, quoting Foote, states further that these relations may be obscured in real situations if changes in stocks or net exports are important.

Import Price of Brazils

With the 3SLS estimation procedure some of the estimated coefficients came out with signs the opposite of expectation. The income coefficient, for example, was negative, the figure being -17.91. An increase in per capita disposable income would thus be accompanied by a decline in the demand for brazils, and hence a fall in price. Brazils, therefore, appear to be an inferior good. The associated income flexibility of demand at the point of means is -0.89 and the logarithmic form is -0.64. It should be recalled, however, that the trend variable was highly intercorrelated with income. Interpretation difficulties are made even more difficult when it is remembered that the trend term is usually a measure of systematic changes in unknown factors which may be social, technical or economic in nature.

An inverse price-quantity relationship was obtained which is consistent with traditional demand theory and the quantity coefficient itself is significant. The price flexibility of import demand from the arithmetic relation was -0.11 and -0.35 from the logarithmic function.

The coefficient of lagged production of regular coffee was non-significant, confirming the finding in Submodel 1. The stock variable had a positive coefficient and was also significant.

Table 9. Submodel II - Arithmetic Form
EQUATION 4. Import Price of Brazils Estimated Coefficients and Associated Statistics

Estimator	Y_3	Y_2	Y_5	Y_7	Constant	X_1	X_2	"R^2"	"D.W."
1. 3SLS	-1	0.6368	-2.1095	4.3014	56.3122	0.2180	-17.9129	0.93	0.70
		0.1117	1.1875	2.2273	21.4416	1.3465	5.6516		
2. 2SLS	-1	0.3451	-2.3677	6.7829	105.7176	0.0501	-31.6207	0.93	0.95
		0.2017	1.8465	4.0169	35.7121	1.9114	9.4225		
3. OLS	-1	0.6299	-1.1393	2.9006	-38.2443	1.1139	-7.9667	0.98	1.22
		0.0774	0.5002	1.24681	18.8901	0.8379	5.1096		
4. LISE	-1	2.0478	-39.4118	-23.4567	-12.0643	7.4386	20.3477	-8.01	2.19
		2.3685	21.6783	47.1595	419.2633	22.4401	100.6216		
5. I3SLS	-1	0.8671	-0.4901	-0.2242	12.6780	0.1502	-4.4438	n.c.	n.c.
		0.0025	0.0440	0.0615	6.4277	0.7305	2.1490		

n.c. = not calculated

Price of milds was highly significant and positive, again confirming the substitution relationship between milds and brazils. The value of the estimated coefficient was 0.64, but note that this is not a cross flexibility coefficient.[10]

The "R^2" of 0.93 indicates a good statistical fit and "D.W." was 0.70. Both 2SLS and OLS performed well on this criterion, their respective "R^2" being 0.93 and 0.98. They also yielded the same coefficient signs as the 3SLS. However, the magnitude of the coefficients differs between the estimators.

LISE was the poorest in terms of statistical fit ("R^2" was -8.01) and the coefficient standard errors were large.

Import Price of Robustas

All the coefficients estimated have the expected signs and were "significant", except for the coefficient of the stock variable. The quotes around the word significant should serve as a reminder of the previously expressed scepticism about applying this term to the estimated income

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[10]A cross flexibility coefficient is mathematically as $\frac{dP_A}{dQ_B} \cdot \frac{\bar{Q}_B}{\bar{P}_A}$ The coefficient (0.64) = $\frac{dP_A}{dP_B}$

Table 10. Submodel II - Arithmetic Form
EQUATION 7. Import Price of Robustas Estimated Coefficients and Associated Statistics

Estimator	Y_6	Y_8	Y_8	Y_8	Constant	X_{10}	X_2	"R^2"	"D.W."
1. 3SLS	-1	0.2328	-44.0571	0.9372	94.2833	14.4980	-26.4801	0.92	1.57
		0.0964	18.3448	22.5288	29.4304	6.8522	9.2519		
2. 2SLS	-1	0.2906	-44.6317	-3.9164	91.4804	30.1532	-31.2224	0.92	1.98
		0.2632	28.3641	33.7684	46.4554	10.0389	14.2141		
3. OLS	-1	0.5690	-17.0904	-21.8210	43.5048	20.3159	-16.5336	0.94	1.52
		0.1513	15.3757	17.4267	27.3345	8.1463	8.9008		
4. LISE	-1	0.0945	-63.7478	14.4235	125.3114	34.1471	-41.1804	0.90	2.00
		0.2981	32.1250	38.2461	52.6152	11.3700	16.0988		
5. I3SLS	-1	0.2842	-46.4358	-9.7400	69.5835	-9.4210	-8.7095	n.c.	n.c.
		0.0990	11.4803	14.3573	18.7506	5.0569	6.2541		

n.c. = not calculated

and price coefficients. As was stated, these two variables are highly correlated and standard errors tend to be very large under such a condition. However, in this equation, as well as in the demand functions for milds and brazils, we note that the ratio of the coefficients to their standard errors exceeded 2, which implies asymptotic significance at the 5 percent critical probability level.

The non-significance of the stock variable indicates its relative unimportance in robusta import decisions, as was found in Submodel 1. In contrast, lagged production of instants was again highly significant. This being the case, we regard it as well substantiated that the growth of instant coffee production was a major factor that influenced the rise in robusta trading since the 1950's.

The positive relationship between robusta prices and brazils confirmed that the two varieties are substitutes. However, they are imperfect substitutes since a one percent rise in the price of brazils is accompanied by only a 0.6 percent increase in the price of robusta, as obtained from the logarithmic relation. Again, this coefficient estimate is not equivalent to a cross flexibility of demand as was pointed out previously.

The negative income coefficient (-16.53) implies an inferior good, and an income flexibility at the point of means of -1.82. In logarithms, the value obtained was -1.26. These compare with -1.42 and -2.14 obtained in Submodel 1.

With regard to the quantity variable the negative sign of the coefficient was as expected. The coefficient itself (-44.06) is significant and implies a price flexibility of -0.36 in the arithmetic function and -0.27 in logarithms. The suggested lower bound on the direct price elasticity of import demand is about -2.78.

So far as the statistical fit is concerned, 3SLS performed quite well with an "R^2" value of 0.92; "D.W." was 1.57. Other estimators, except the I3SLS for which "R^2" was not obtained, also did well on this account. The 2SLS gave 0.92, OLS 0.94, and LISE, which did poorly on other equations, gave 0.90.

In general, the 2SLS estimates are closest to those of 3SLS, especially if the stock variable and lagged production of regular coffee, which were in every case non-significant, are ignored. The discrepancies between the estimates obtained by the various estimation methods are probably explained by specification errors and some errors in variables. With international trade statistics particularly the chances of errors in variables are fairly high.

Table 11

Submodel II. Arithmetic Form Estimates and Associated Statistics Export Supply and Stock Demand Functions (Milds and Brazils)

Equation (2): Export Supply of Milds

$$Y_3 = 0.9138 + 0.0027X_3 + 0.0404X_4 \qquad R^2 = 0.03$$

(0.3658) (0.0035) (0.0552)

Equation (3): Stock Demand for Milds

$$Y_4 = 0.2906 + 0.0002X_3 + 0.0896X_5 + 0.2131X_6 \qquad R^2 = 0.06$$

(0.7977) (0.0047) (0.1421) (0.1744)

Equation (5): Export Supply of Brazils

$$Y_5 = 0.7814 + 0.0175X_7 + 0.5538X_9 \qquad R^2 = 0.07$$

(1.3422) (0.0125) (0.6657)

Equation (6): Stock Demand for Brazils

$$Y_7 = 2.7320 - 0.1382X_5 + 0.0058X_7 + 0.2492X_8 \qquad R^2 = 0.08$$

(1.2278) (0.2208) (0.0071) (0.1811)

Export Supply of Milds and Brazils

Because of the similarity of the estimated supply functions for milds and brazils it is convenient to discuss them together. From the standpoint of statistical fit, both relationships performed very poorly: the R^2 for the supply function of mild coffees was only 0.03 while for brazils it was 0.07.

These poor results underscore the limitation of our knowledge regarding the major determinants of supply. In the last chapter it was suggested that monetary and exchange factors were a substantial influence on the supply side during the study period. Their omission from the equation stemmed in part from data difficulties but even more important, were the associated measurement and interpretation problems. For instance, it is difficult to determine the extent to which exporters' expectations and behavior were affected by frequent changes in the exchange rate, particularly the rate applying to coffee receipts. Speculation was probably rampant especially in the early part of the study period.

The signs of the estimated coefficients were consistent with expectation but, because of large standard errors, neither coefficient was significant. It is apparent that a drastic reformulation of these equations is required to obtain relationships that can reasonably explain actual behavior.

Stock Demand for Milds and Brazils

With the exception of X_5 in the stock demand for brazils, the estimated coefficients had signs as initially hypothesized.

But, again, the statistical fits were extremely poor -- R^2 values were 0.06 for milds and 0.08 for brazils. When compared with an R^2 of 0.54 obtained from arabica stock demand in Submodel 1, the indication is that our method of estimating the shares of the varieties in total stocks is inappropriate. More accurate information is required about the relative importance of the different varieties in total stocks. Since such information might prove difficult to obtain, it remains an open question whether or not one should attempt to disaggregate the stock function.

Actual and Estimated Prices

Figures 2, 3, 4 show actual or observed prices along with the estimates derived from the 3SLS estimation. We present as one further way of investigating the merits of the structural model formulated. The "R^2" measures of the goodness of fit have already indicated this to some extent but they do not show whether the estimates have consistently moved in the same direction as the observed series; in other words, it is also important to ascertain how well the model captures the direction of change and the turning points in the actual series.

The unexplained residuals of each of the estimated structural demand relations are plotted directly below each figure as deviations from observed values. Three classes of factors are known to cause unexplained residuals; these are errors in the data, omission of some explanatory variable(s), and use of wrong types of functional form, incorrect lags, etc.[11] We are most concerned about the second class, for we do know there are some key variables that we have not specified owing to the absence of data and there may be others that we have not thought about. A non-random pattern in the plot of unexplained residuals is often regarded as indicating that some relevant variables have not been included. Subsequent improvement of the model consists in the identification and introduction of such omitted variables.

Import Price of Milds (Figure 2)

With price as the normalized variable, the 3SLS "R^2" value was 0.91. The estimated prices moved in the same

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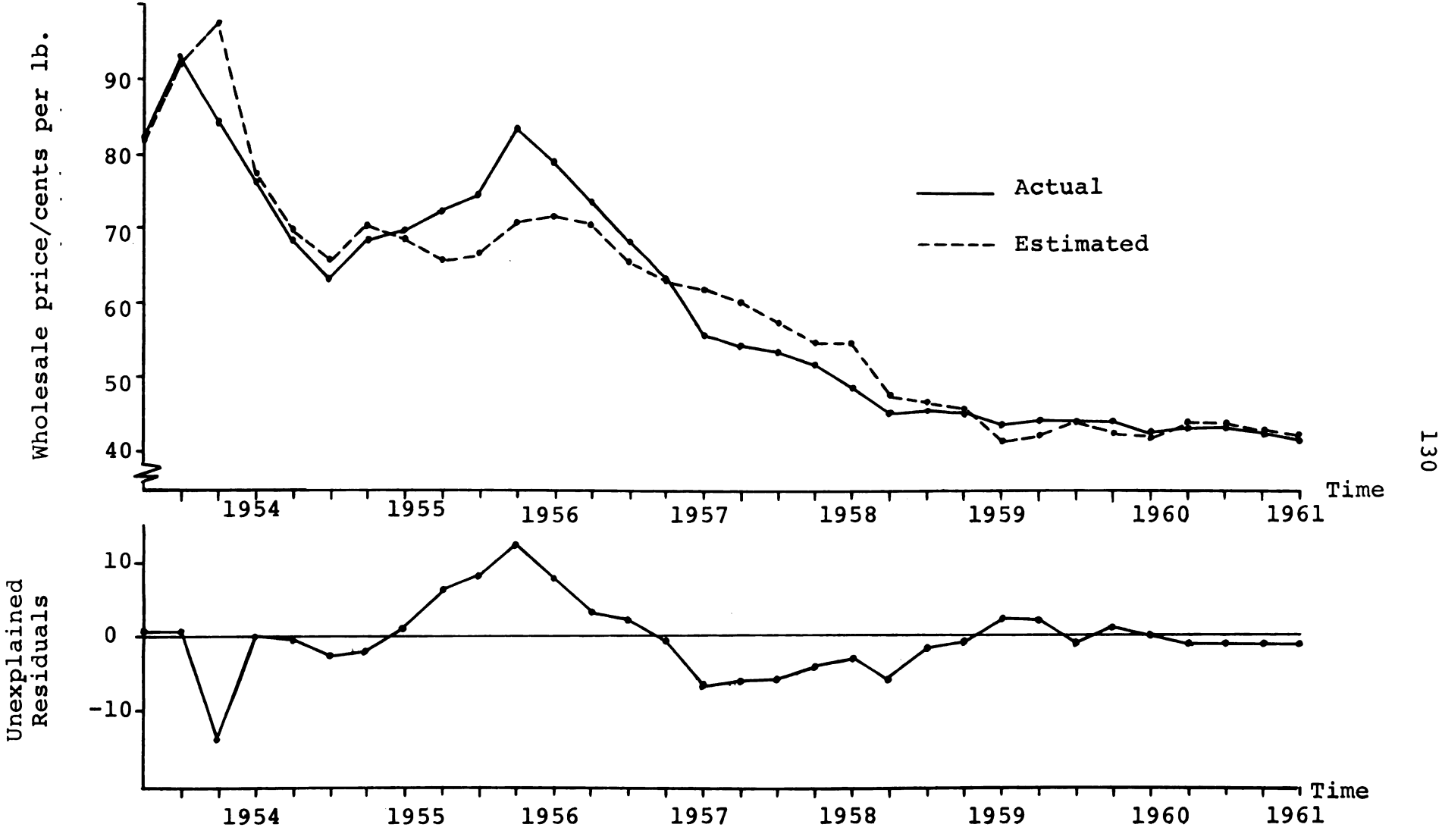
[11]Richard J. Foote, op. cit., pp. 172-173.

Figure 2. Structural Equation (1): Import Price of Milds (Mams) Actual and Estimated



direction and also fitted the actual observations relatively well throughout the sample period. The largest residuals occurred in the third quarters of 1954 and 1956 when the actual price was, respectively, overestimated and underestimated by about 13 percent in each case. The model also missed the actual direction of change in the third quarter of 1954 and again in the fourth quarter of 1956. Overall, however, the direction of both series is the same and the fit is reasonably close. The pattern of the residuals was somewhat cyclical in the early part of the period but the fit appeared to improve over time. This presumably suggests a shift over time in the importance of certain explanatory variables.

The study by Hopp and Foote, already cited, provides a clue to the way in which the cyclical pattern of the residuals may be examined.[12] They pointed out that in general the unexplained residuals were positive when prices were rising or remained relatively high, and negative when

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[12]See Chapter 1, page 16. The economic explanation suggested by the authors is quoted in Richard J. Foote, op. cit., pp. 117-78: "When supplies are declining, efforts are made to maintain coffee inventories and prices tend to be higher than would be expected from the level of supply in relation to current consumption. When supplies are increasing, inventories can be reduced; hence, prices tend to be lower than would be expected based on relative supplies."

prices were declining or remained relatively low. Defining these as inflationary and deflationary periods, they found that prices were on the average 21 percent higher during inflation than would have been expected from the regression equation and 11 percent lower during deflationary periods. Appropriate adjustment of the computed prices raised the percentage of the variation explained from 70 to 84 and also led to improved forecasts outside the sample period they studied.

By and large, the unexplained residuals obtained from the present equation behaved somewhat as described by these analysts. Except for a short interval between 1959-60, the residuals are negative in the period subsequent to 1957 -- a period during which prices have been persistently declining. The upward price trend between 1955 and 1957 is reflected in positive residuals over most of that period, and the pattern of the earlier period roughly supports the description made by Hopp and Foote.

Import Price of Brazils (Figure 3)

For this equation, "R^2" was 0.93. Figure 3 demonstrates the time path of the relation between the estimated prices and the observed price series. The general movement and

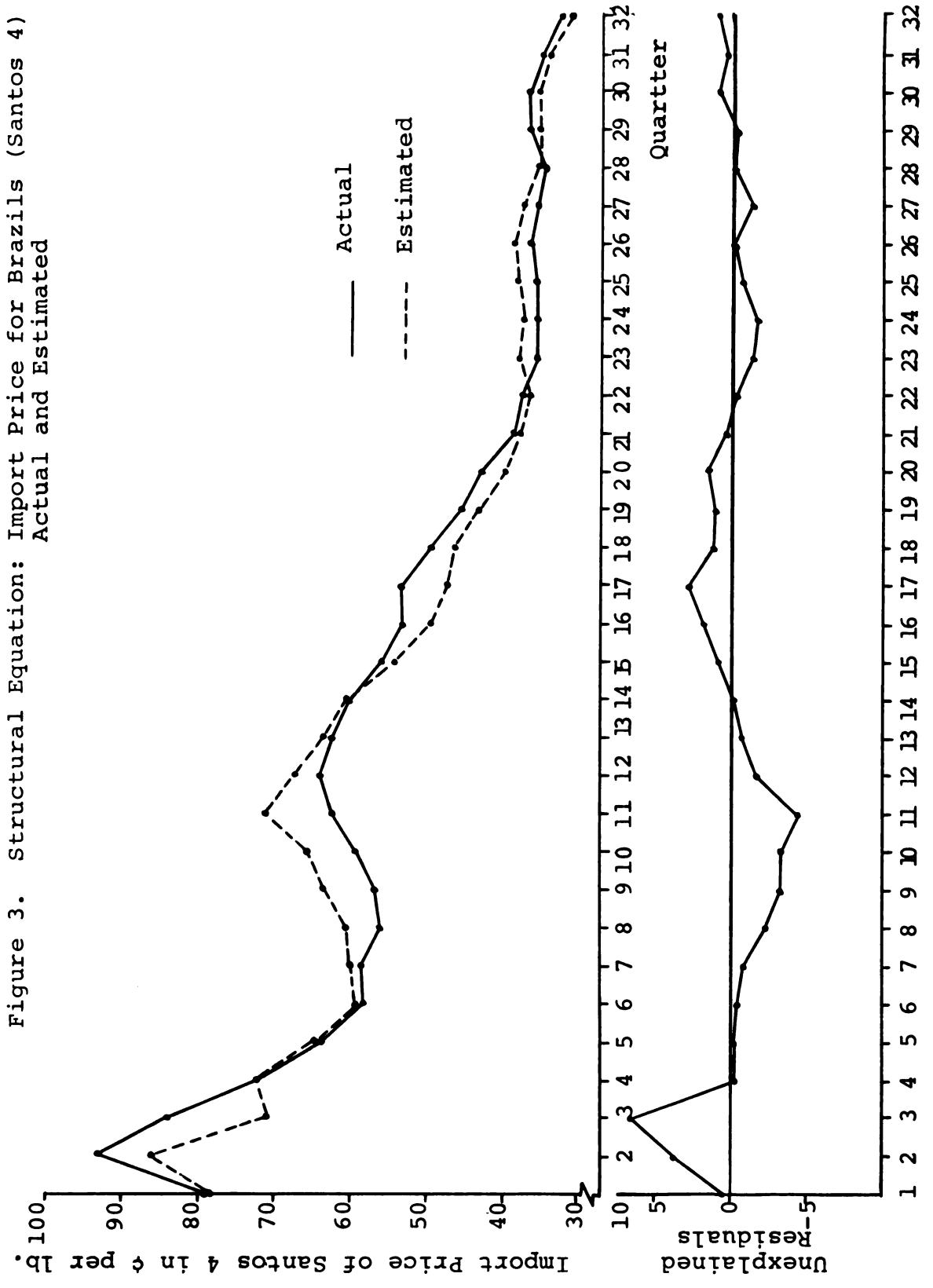


Figure 3. Structural Equation: Import Price for Brazils (Santos 4)
Actual and Estimated

direction of both series is close, particularly after the fourth quarter of 1956. The largest discrepancy between estimates and actual prices occurred in the third quarters of 1954 and 1956, as was the case for milds. The earlier period was a time when prices rose sharply because of an intensive supply-restriction operation in the major Latin American producing countries. Actual market prices were then underestimated by 6.5 percent and the over-estimate in the second period was almost 13 percent. However, the turning points occurring in the original series were generally picked up by the model.

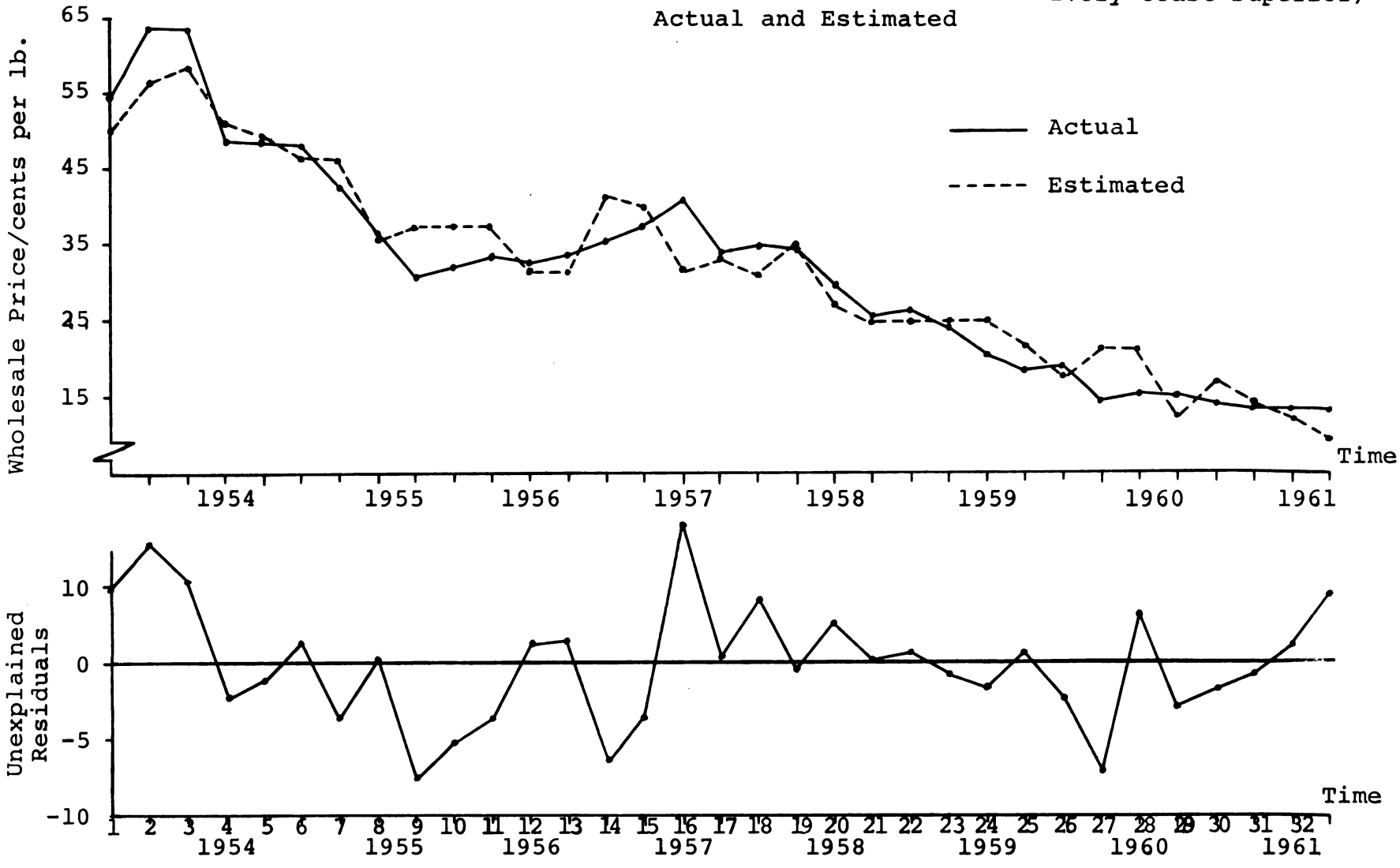
Like the previous case, the unexplained residuals trace a cyclical pattern. Of significant interest perhaps is the fact that the cycle is opposite to that relating to mild coffees. Presumably, there is an inverse relationship between the factors omitted from the two equations. Further exploration of this aspect is desirable for a more complete understanding of the interrelationship between the two commodities. Specifically worthwhile are considerations along the lines suggested by Hopp and Foote concerning inflationary and deflationary periods, more so because the expected price variable in the stock equation did not work well.

Import Price of Robustas (Figure 4)

A good statistical fit (with "R^2" of 0.93) was obtained for the robusta demand function. Despite the closeness of estimates and observed prices, the direction of movement differed at various points, as can be seen from Figure 4. The purpose and value of the graphical method of appraising the demand equations constructed is, perhaps, well illustrated in this diagram. For good predictions, estimates and observed values not only have to be close but should also change in the same direction. Presumably, the relatively greater fluctuation of robusta prices made it more difficult to pick up all the turning points accurately. The model as fitted missed the direction of change in actual prices first quarter of 1956, fourth quarter of 1957, and again in the third quarter of 1960. The order of magnitude of the divergencies at these points were, respectively, +20, -20 and + 30 percent.

The unexplained residuals exhibit a somewhat escillatory pattern, except for the interval beginning first quarter of 1958 through second quarter of 1959. Large residuals also occurred in some quarters of 1954, 1956, 1958 and 1960.

Figure 4. Structural Equation (7): Import Price of Robustas (Ambriza 2AA and Ivory Coast Superior) Actual and Estimated



Reduced-Form Estimates

Once a complete and identified simultaneous system of equations has been constructed, it is easy to obtain therefrom a set of reduced-form equations, each of which expresses an endogenous variable as a function of the predetermined variables in the system and a distubrance term. Reduced-form equations are particularly useful for prediction purposes, for a knowledge of the parameters of the equation implies knowledge of the conditional distribution of the dependent variables, given values for the predetermined variables. Thus, for prediction we only need to know the values of the predetermined variables at any specified period of time and the coefficients of the reduced form. With this information, conditional point forecasts of the dependent variables may be made.

The theoretical properties of the reduced-form coefficients are directly related to those of the structural counterparts. Consistency and asymptotic efficiency have been shown to carry over from the structural to the reduced-form parameters. Much, however, remains to be known about the relationship between the finite-sample properties of the coefficients of the two forms. Goldberger points out that

small sampling errors in individual structural coefficients may build up into large sampling errors in the derived reduced-form coefficients. All this is to say that the reduced-form equations may yield rather imprecise conditional forecasts of the dependent variables.

The procedure followed in the present exercise is to use the derived 3SLS reduced-form equations to forecast prices of coffee during the sample period. In contrast to the estimated prices discussed earlier, the reduced-form model utilizes the actual values of the exogenous variables in the forecast period and the values of lagged variables realized in the relevant past period to obtain estimates of prices in the forecast period and does not use actual values of endogenous variables. Graphical comparison of the forecast and actual prices is then made as well as a conditional point forecast for the first quarter of 1962 (outside the studied period). The actual or observed values of the exogenous variables are used and values of lagged endogenous variables are those actually observed in the relevant past period. As an ex-post forecast, the main aim is to see how accurately the reduced-form would have forecast the actual prices, if it were in fact used during the sample period.

The reduced-form coefficients obtained and the related "R^2" values are summarized in Table 12. Before discussing the results of this part of the study, a final comment about the point forecast for the first quarter of 1962. As will be recalled, the International Coffee Agreement was made during the 1962 marketing year. It is not know what immediate impact the Agreement had on coffee demand but it appears plausible that certain reactions must have been induced, if only for the wide publicity given to export quotas as a means by which an international council would seek to reduce excessive price fluctuations. When this consideration is viewed in conjunction with the statistical question relating to the small sample precision of the reduced-form coefficients, serious doubt is cast on the use of the derived reduced-form relations as a tool for forecasting beyond the sample period. Both of these factors could have contributed to the failure of our forecasts of prices in the first quarter of 1962 and because the latter went astray by a wide margin they are not shown in Figures 5 through 7.

Import Price of Milds (Figure 5)

The general direction of the observed price series was picked up quite well by the reduced-form equation, and the "R^2"

Table 12. Submodel II (3SLS)
Reduced-Form Coefficient Estimates and "R^2"

Predetermined Variables	Equation 1: Price of Milds	Equation 4: Price of Brazils	Equation 7: Price of Robustas
	Coefficients	Coefficients	Coefficients
	Y_2 dependent:	Y_3 dependent:	Y_6 dependent:
	Constant: 184.1139	Constant: 181.5302	Constant: 127.8271
X_1	-1.6217	-0.8146	-0.1897
X_2	-34.4850	-46.8788	-37.3959
X_3	0.1386	0.0883	0.0205
X_4	2.4417	1.5549	0.3620
X_5	-0.7178	-1.0234	-0.2383
X_6	-3.3237	-2.1166	-0.4929
X_7	-0.0584	-0.0503	-0.0117
X_8	-1.9753	-1.7012	-0.3961
X_9	-2.8626	-2.4653	-0.5740
X_{10}	0.0000	0.0000	14.4980
X_{11}	0.0000	0.0000	0.1339
X_{12}	0.0000	0.0000	-11.0343
X_{13}	0.0000	0.0000	0.0899
X_{14}	0.0000	0.0000	0.2030
	"R^2" = 0.84	"R^2" - 0.80	"R^2" = 0.89

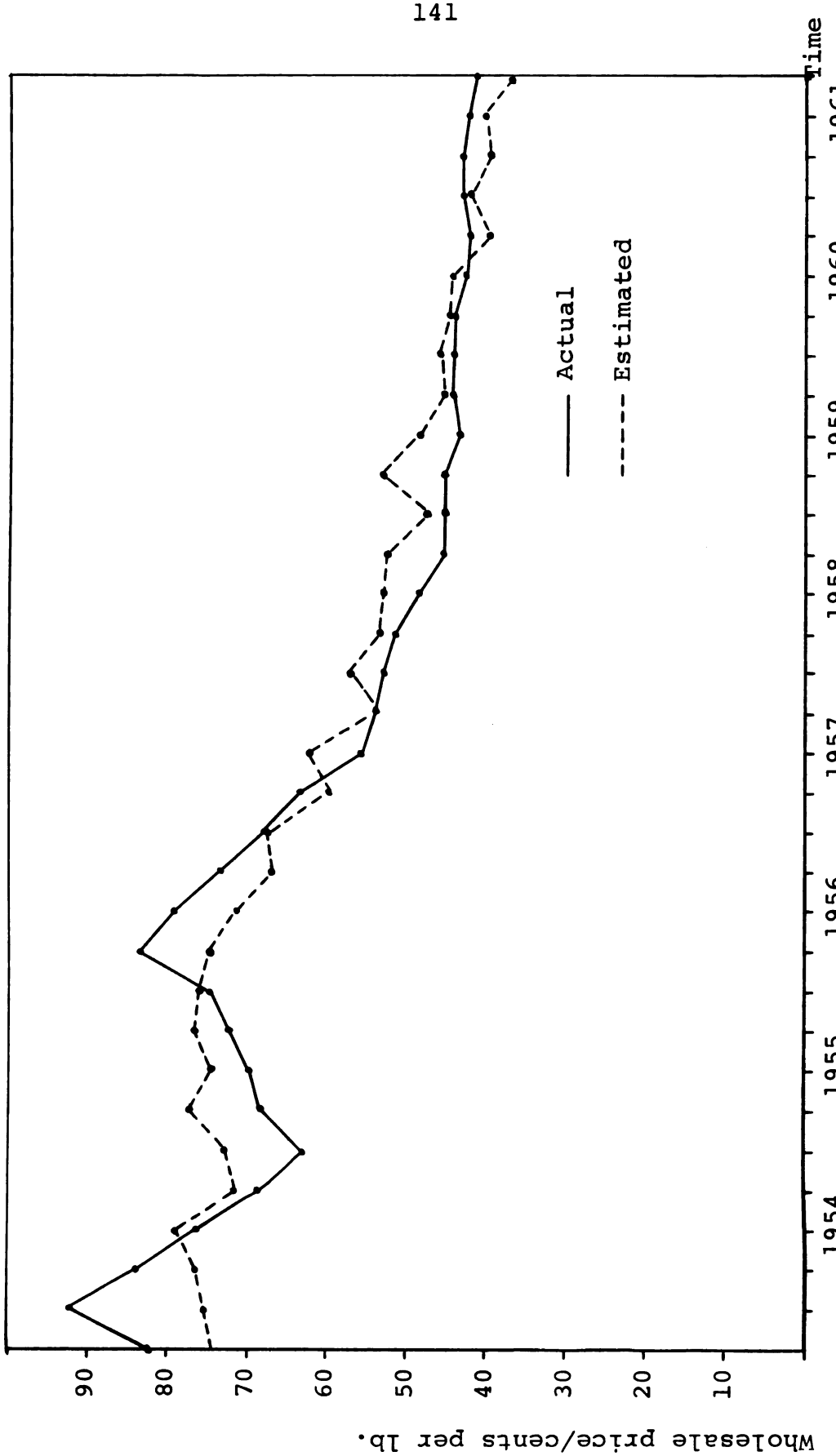


Figure 5. Reduced-Form Equation (1): Import Price of Milds (Mams) Actual and Estimated

was 0.84. Fairly large divergencies occurred in certain quarters of 1954 through 1956, the largest being in the second quarter of 1954 when there was an underestimate of about 19 percent. The sharp price peaks in 1954 and again in 1956 were not captured by the forecasting mechanism. The predicted price for the first quarter of 1962 went astray by a wide margin and, consequently, is not shown in Figure 5. Since the model did not do a good job of predicting prices outside the sample period studied, the reduced-form equation should not be used for this purpose without revision of the structural model itself. In revising the model, it may be worthwhile to consider among other things, Hopp and Foote's stratification on the basis of inflationary and deflationary periods.[13] In that study they claimed that this adjustment substantially improved the forecasting performance of their model.

Import Price of Brazils (Figure 6)

The "R^2" was fairly good (0.80) and the series of the estimated and observed prices agreed reasonably well, especially

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[13]This point was made previously. However, we doubt that it will lead to a major change in flexibility coefficients which are our prime concern.

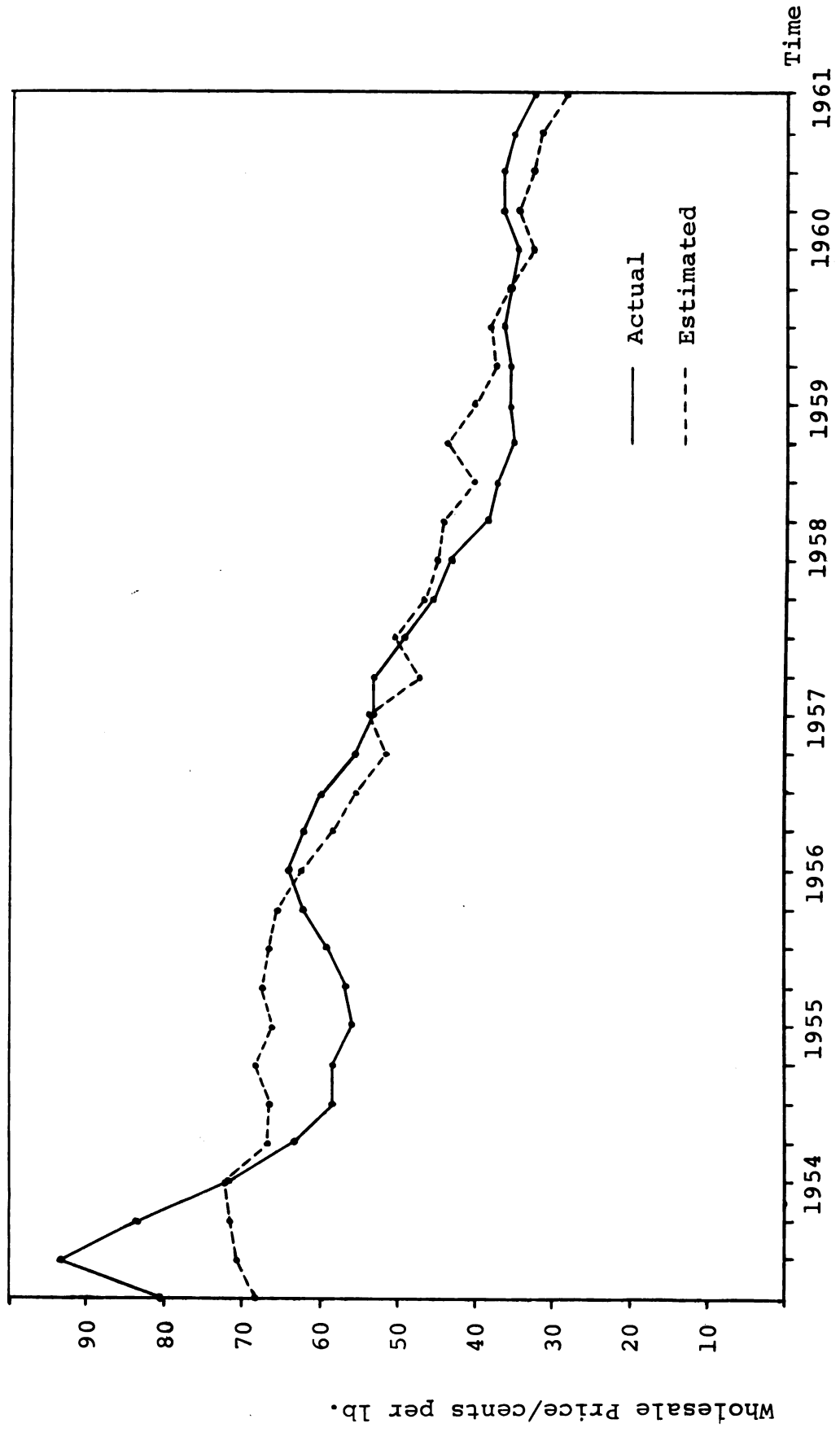

Figure 6. Reduced-Form Equation (4): Import Price of Brazils (Santos 4) Actual and Estimated

from the third quarter of 1956 onwards. Prior to this time, there was substantial divergence between the two series, for instance the peak of 1954 was underestimated by almost 30 percent. We recall, however, that this was a period when severe export and exchange restrictions were operated by both Brazil and Colombia and this evidently created extensive disturbances in the coffee market. With speculation apparently on the increase, the poor forecasts obtained may be more readily understood. Subsequent to 1956, however, estimates and original prices are generally quite close and no serious errors occur in terms of the direction of change. The relatively more stable conditions in this period is probably the reason for the improved forecasting efficiency.

Import Price of Robustas (Figure 7)

The derived "R^2" (0.89) was the highest obtained for any coffee class. The forecast prices closely followed the time path of the observed prices, especially after the later part of 1956. In the earlier period, substantial deviations were recorded in the third quarter of 1954 (an underestimate of 15 percent) and in the first quarter of 1956 (overestimate of 20 percent). The only substantial error in the direction

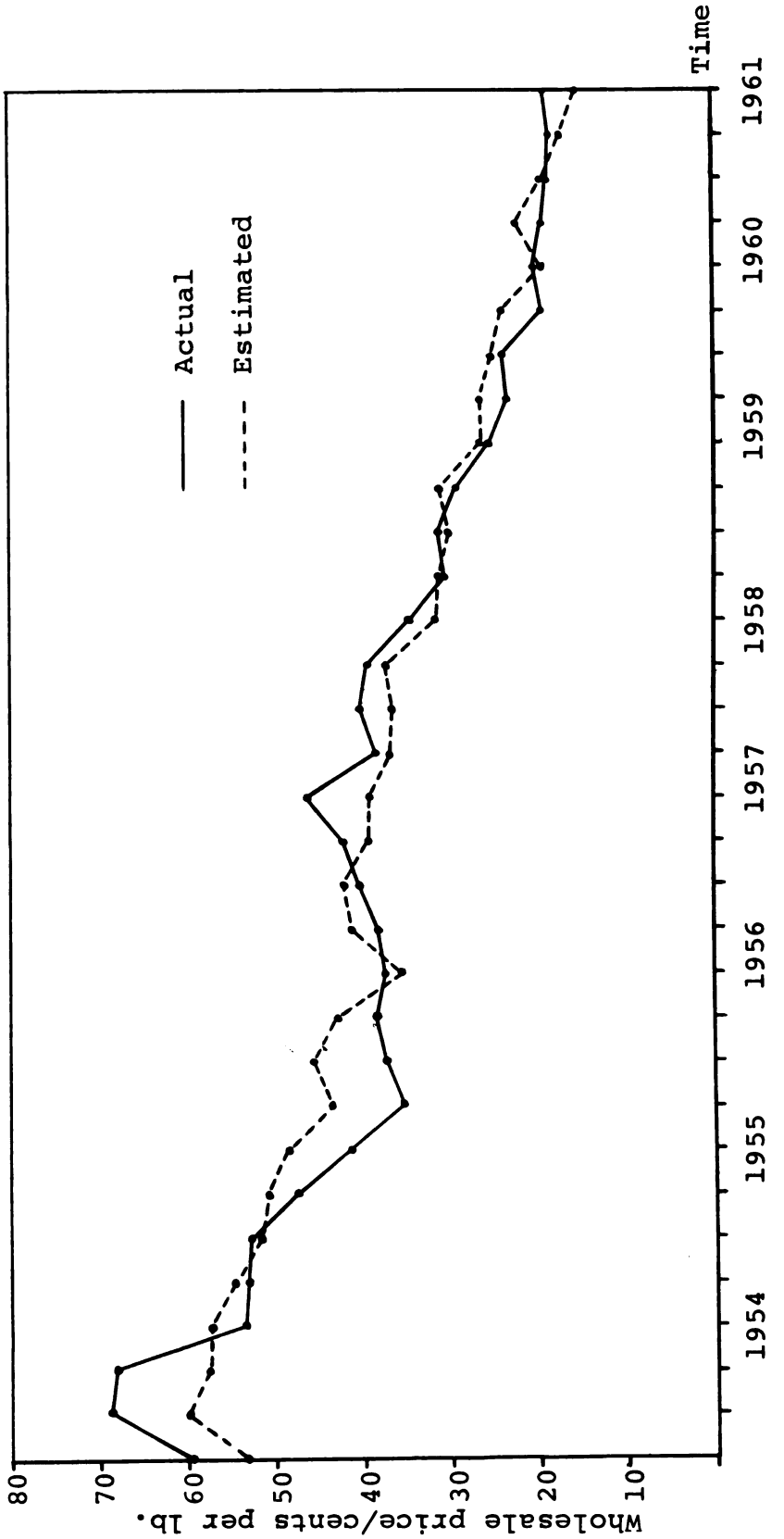

Figure 7. Reduced-Form Equation (7): Import Price of Robustas (Ambriz 2AA

of change occured in the fourth quarter of 1956 when the estimated series turned downwards contrary to the observed series. All in all, the robusta reduced-form function did a remarkably good job of prediction during the sample period. But beyond this period, the conditional point forecast made diverged considerably from the actual price.

Conclusions

Broadly speaking, the estimated import demand function for each of the three subclasses of coffee was reasonably satisfactory; in each case the derived coefficient of determination exceeded 0.90. However, there was less satisfaction with the performances of both the export supply and stock demand functions. To improve their explanatory power, these functions need substantial revision. The export supply relation might be improved appreciably if, among other factors, the effects of changes in monetary, exchange and fiscal policies in the producing countries could be introduced explicitly. On the other hand, the stock function is likely to remain an elusive problem given the difficulty of obtaining accurate information on the relative magnitudes of coffee varieties in total U.S. stocks. Desirable improvement of the

overall model can also be sought along the lines suggested by Hopp and Foote; namely, by partitioning data on the basis of inflationary and deflationary periods.

However, the model does indicate the predominance of a substitution relationship between the principal coffee varieties. As specified in the equations, milds and brazils are rival goods, the same for robustas and brazils. The relevant coefficients estimated bear the positive sign necessary for this condition and are significant. Submodel I also indicates robustas and arabicas (milds and brazils together) are largely competitive and that seasonality factors have no appreciable influence on import demand.

As regards the flexibility coefficients calculated, the direct price flexibility of demand for each of the subclasses of coffee is well below unity. Note again that the inverse of the direct price flexibility is a good measure of the lower bound on the direct price elasticity, so long as all cross flexibilities are zero. This condition is not met in our model since the subclasses appear to be substitutes. Nonetheless, we conjecture that the low price flexibilities imply reasonably elastic demand for the subclasses of the commodity. To give a specific example of the interpretation of the direct price flexibilities, a one percent increase in the quantity

of brazils will cause a 0.35 percent decrease in its price, assuming the constancy of prices of related goods and disposable income.[13]

Interestingly, the income flexibility of demand was positive in the case of milds but negative for brazils and robustas. In the logarithmic function, the estimates obtained for milds, brazils and robustas, respectively, were 0.19, -0.64, and -1.26. Thus, with respect to the milds, a one percent increase in per capita disposable income results in 0.19 percent increase in its price, if the prices of the other coffee varieties remain unchanged. Note, however, that these estimates of income flexibility are probably biased. We dropped the trend factor from the structural equations estimated because of its high intercorrelation with the income variable; consequently, it is possible full allowance was not made for changes in taste and technology, the latter in particular affected the number of cups per pound of green coffee. A question worth special examination is why the milds

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[13]Going back to the relationship between direct price flexibility and direct price elasticity, the calculated coefficient suggests the following lower bound of price elasticity for brazils:

Lower bound of price elasticity = $\frac{1}{.35}$ = 2.85, assuming all cross price flexibilities = 0.

are apparently normal economic goods while the other varieties appear to be inferior goods. The answer to this question seems to lie in the fact that we disaggregated the commodity and, in trade circles, the resulting subclasses are differentiated on the basis of quality. The milds are the premium coffees while robustas are supposedly the most inferior in quality. As a general interpretation affecting all subclasses, an increase in U.S. per capita income would probably result in increasing demand for high quality coffee, unless the prices of the others change in an offsetting direction. This could mean an increasing use of the milds both for the manufacture of regular and instant coffees.

At present it appears that instant manufacture utilizes a considerable proportion of robustas and our results indicate a significant relation between price of robustas and instant production. Continuation of this relation in the years ahead depends on the preservation of present relative price patterns and on the position of consumer incomes. Given no substantial change in these conditions and the further growth of instants, robustas could capture still a larger share of per capita consumption of green coffees. This is more likely to happen if present research efforts succeed in discovering good

chemical additives to improve the flavor of instants; in the event of this, the use of brazils and/or milds to improve the flavor of instants will probably decrease. The cost of raw coffees will then become the most important consideration in blend formulation and the low price of robustas will be important.

CHAPTER V

POLICY IMPLICATIONS OF THE RESULTS

In this chapter further study is made of the economic and policy implications of the key results of the analysis; namely, the income and price flexibilities of demand of the subclasses of green coffee. As the policy aspect is approached mainly from an international standpoint, we shall devote the the latter part of this chapter to examining the policies prescribed in the International Coffee Agreement.

We recall from the last chapter that the estimated income flexibility of demand was positive for milds and negative in the case of brazils and robustas. From this it was inferred that milds are probably the only normal economic goods among the three subclasses of coffee. However, it should be borne in mind that these estimates of income flexibility are probably biased to the extent that the model fitted failed to allow for changes in taste and technology, which resulted in more cups of coffee per pound of green coffee. Having noted this possibility of bias, we now proceed with an illustration of the economic interpretation of the income flexibilities.

In the short-run, an increase in per capita disposable income causes a parallel upward shift of the budget line on the consumer's indifference scale. The new position of equilibrium is such that the consumption of milds is increased while the consumption of the other varieties is decreased. Given the availability of stocks, the supply of milds can be increased to meet the higher level of consumption. Thus, in the short-run with per capita consumption of total green coffees unchanged, an increase in disposable income would probably mean greater use of premium coffee over the nonpremium coffee varieties. The obverse of this inference is, perhaps, already obvious: in a period of re-ession or declining incomes, probably more of nonpremium coffees will be used over the milds.

In the long-run the conditions underlying the preceding short-run analysis may change. But let us, for convenience, assume they do not and also that the upward trend of income continues, then the demand prospect for milds is improved. Consequently, judicious expansion of their production is indicated. On the other hand, the production of brazils and robustas should be contracted; these are the varieties whose production has risen to most since 1947, as Table 3 in Chapter II demonstrates. However, increased population may

substantially raise future demand for coffee, lessening the need to contract production.

Three other considerations are relevant in a policy of contracting coffee production. One is the impact on foreign exchange receipts and import capacity; the second is concerned with the fixed asset nature of coffee trees; and the third involves the existence of an alternative for exportable production. Under our assumptions, reducing production could mean a decrease in total foreign exchange earnings which hurts import capacity and development financing. The seriousness of this depends on the contribution of coffee to total export proceeds and, as Table 5 shows, Brazil and the robusta countries could be severely hurt in the absence of an alternative for exportable production. Thus, if no other way exists for augmenting its foreign exchange receipts, the government concerned might be reluctant to reduce production. Even if it should want to do so the fixed asset nature of coffee trees means that individual producers themselves might be unwilling to cooperate unless adequately compensated. Coffee trees are a fixed asset in the sense that their salvage price is usually less than their marginal return to the producer. As long as this is the case continued

exploitation of existing trees is economical but no further extension of production will be made because the marginal return is reckoned less than the acquisition cost of new trees. Contraction of production can be achieved in this situation only in the circumstance that adequate compensation is forthcoming and covers the discounted value of the future stream of net returns derivable over the remaining productive life of the trees minus salvage value for trees and land (if any). As observed in Chapter II, the total funds that would be involved could prove prohibitive and, apart from the difficulties of raising and/or retiring any loans obtained for the purpose, the government concerned may wish to give thought to the social costs and benefits of the action. For it may well be that the money is better spent promoting other aspects of social welfare than on the diversification of rural production. Thus, the existence of an alternative line of economic activity, which permits diversification, may be a necessary, though not sufficient, condition for adopting a policy of contracting production.

Turning now to the calculated price flexibilities, we noticed previously that the estimate obtained for each of the subclasses of coffee was substantially below unity. The

coefficient for milds had an unexpected sign, so we indicate the order of magnitude involved with the coefficients of the other two coffee subclasses. Based on the logarithmic function these were for brazils and robustas, respectively, -0.35 and -0.27. These flexibility coefficients may be more familiar if translated into elasticities, provided for convenience we make the simplifying assumption that all cross price flexibilities are zero. The suggested lower bounds of price elasticities are -2.9 for brazils and -3.7 for robustas. Thus, it is probable that individual coffee varieties are appreciably price elastic. This may not be true of all coffees viewed as a single commodity mainly because in this case good substitutes for coffee are limited. However, for the individual coffee varieties, the size of the suggested elasticities means that consumption can be helped by price reduction. To show how this works, we assume the fixity of income and zero cross-elasticities with respect to milds and robustas. Than, a one percent decrease in the price of brazils would raise consumption by approximately 3 percent, according to the elasticities stated above. This increase in consumption can be met if the producers of brazils have

adequate stocks which can be immediately mobilized. Brazil's exchange earnings from coffee would grow relative to the earnings of the producers of other varieties.

Three factors are relevant in a policy of price reduction for any coffee variety: the unit cost of production, the duration of price reduction, and the attitude of producers of rival varieties. As Rowe suggests, there is a substantial gap between average total cost of production and current market prices; therefore, cost factors may not offer a constraint on price reduction within an appreciable range.[1] If the price decrease is maintained for a long time it could have an impact on consumer preference, turning the latter away from other coffee varieties. The producers of these other varieties are unlikely to remain indifferent to this development and would probably cut their selling prices in retaliation. This could develop into a general price war among coffee producers and if unchecked could wreck the industry. Because robusta producers are often considered to have the lowest unit cost of production it might be felt they would be in the best position to weather any price war

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[1] J.W.F. Rowe, The World's Coffee, op. cit., p. 173.

that might ensue. However, these countries have not developed a domestic industrial base comparable to that of their competitors in Latin America and are probably more dependent on coffee earnings for this purpose. Thus, their ability to cut prices is also limited.

The Coffee Study Group, which paved the way for the International Coffee Agreement, recommended, among other things, a gradual reduction of the level of green coffee prices as a way of stimulating consumption.[2] Since the prices of all coffee varieties will be reduced together, the preceding discussion of the implications of price elasticities is not helpful in illustrating what will happen to the consumption of any particular coffee variety in this case. And since our analysis was not concerned with the trade demand for total green coffee we are in no position to determine what impact a general price reduction will have on the consumption of total green coffee. Much depends on the elasticity of total trade demand; if this is elastic a small price reduction can raise consumption substantially and is, in fact, the right policy to follow on economic grounds.

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[2]J.W.F. Rowe, Primary Commodities in International Trade, op. cit., p. 180.

On the other hand, with an inelastic trade demand a large price reduction would be necessary to raise consumption appreciably but would also mean a decrease in total receipts. It seems safest to assume that a price reduction would lower the maximum quantity producers would wish to put on the market. This could be a way of creating pressure on producers to limit production because at the lower prices the less efficient coffee farms would be forced out of the industry. In this connection notice our previous point regarding the economic and social difficulties that production control would cause. In light of these it occasions no surprise that the proposal for price reduction was not adopted in the International Coffee Agreement.

Before discussing specific aspects of the policies of the Coffee Agreement it is, perhaps, useful at this juncture to recapitulate the problems to which these policies are directed as well as the goals envisaged. With these in clear relief, it may be easier to appraise the means used for their effectiveness.

Coffee Trade Problems - A Recapitulation

Like most primary agricultural commodities entering into international trade, green coffees, particularly under free

market conditions, have been subject to excessive price fluctuation. Attempts by several producing countries to limit price movements through the restriction of market supply have had only limited success. In the case of robustas, price fluctuation has been severe because of unrestricted marketing, at least prior to the implementing of the 1962 Coffee Agreement. In the main price fluctuations have been due to inevitable changes in output as was noted in Chapter II.

A second problem, also originating on the supply side, concerns the persistent excess productive capacity in the producing countries, especially Brazil.[3] When this is taken in conjunction with the problem of supply variability mentioned above, the result is more pronounced movement of prices along a declining long-period trend. In spite of this, new additions to capacity are made by producers especially in times when the market shows an improvement. The new plantings begin to bear after a lag of 4-5 years, worsening the downward pressure on the long-term price level and producer incomes.

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[3]By persistent excess productive capacity we are referring to the large number of productive resources (labor, land, real or monetary capital, etc.) still engaged in coffee farming even though supply has been outstripping consumption at prevailing market prices. This has caused growing surplus accumulation in some of the producing countries.

The fact that dwindling returns per unit of output have not brought about a substantial curtailment of output signifies the low opportunity cost of factors of production engaged in coffee farming. So long as the marginal returns to the factors exceed their low salvage values their retention in coffee production is economical. But the failure to curb output stems from other factors as well; namely, the ambivalence of national production policies. Many producing countries recognize the need to reduce the existing capacity and have formulated programs of action for this purpose. Some countries have, however, attached conditions on the implementation of such programs, requiring that all other producing countries do likewise. For example, Brazil offered in 1962 to uproot two billion trees provided that all other producers would undertake similar actions.[4] Certain other countries were willing to reduce acreage but not necessarily production, the intention being to improve their efficiency and competitive position. Thus, Venezuela with 825,000 acres in 1961 planned to remove 100,000 acres by 1965, but over the same time, production was expected to increase to about 1,500,000 bags (approximately, 132 pounds each)--an increase of 15 percent.[5] At the time the United Nations Coffee

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[4]Brazilian Bulletin (New York), August 1, 1962.

[5]Foreign Crops and Markets (U.S.D.A., May, 1962), p. 10.

Conference met in 1962, total stocks accumulated in the producing countries were estimated at around 76 million bags, of which roughly 60 million occurred in Brazil which is more than a year's total world exports of all coffees.[6]

Another possible source of difficulty relates to the negative income flexibility with respect to the U.S. demand for nonpremium coffees (brazil and robustas), as our analysis indicated. Since the U.S. is the biggest consumer of coffees in the world, the apparent signal for policy is reduction of production. It is,however, possible that other parts of the world, namely Europe and the developing countries themselves, may not in the near future attain a level of national income which will induce a strong preference for premium coffees. The consumption of brazils and robustas may continue to grow in such countries; more so if there are no tariff or fiscal barriers on coffee imports and consumption. Further, the spread of instant coffees to these areas can help the demand for nonpremium coffees. Given these probable developments in countries outside the United States, the reduction of production, which the U.S. market situation indicates with respect to nonpremium coffees, can be substantially offset.

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[6]J.W.F. Rowe, Primary Commodities in International Trade (Cambridge University Press, 1965) p. 179.

Competition between different varieties has been growing in intensity especially since 1950 (See Table 4 in Chapter II). As would be expected, the estimates of demand flexibilities with respect to price turned out to be low, implying reasonably high price elasticity of demand for individual varieties. This underscores the problems and risks which face individual or groups of producing countries attempting to "stablize" prices through unilateral supply retriction programs. Actions of this kind undertaken by major Latin American producers may be partially responsible for the successful entrance of robustas in the coffee market of the last decade.

The terms of trade of the coffee-producing countries is also mentioned as one of the major problem areas. The issue is well-stated in an article by Prebisch in which he sought to prove the secular tendency of the terms of trade to turn against primary producers, specifically the develop-countries.[7] Prebisch saw the root of the problem in the power of organized monopoly interests -- the trade unions and industrialists of the advanced nations. He remarked,

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[7]Raul Prebisch, "The Economic Development of Latin America and Its Principal Problems", (Economic Bulletin for Latin America, Feb., 1962.) p. 1.

> ...the underdeveloped countries maintained, in the prices which they paid for their imported manufactures relative to those which they obtained for their own primary products, a rising standard of living in the industrialized countries, without receiving, in the price of their own products, a corresponding equivalent contribution towards their own standard of living.

Many articles critical of Prebisch have since appeared.[8] The keynote of the criticms center around data inadequacy, failure to allow for quality changes in industrial goods or for the huge investments in research and development, and the vastly improved efficiency of modern transportations. But writing recently in the FAO report, Gerda Blau presented further evidence supporting Prebisch's main case. She was convinced that at least since 1954 the primary exporting countries have been faced with a slow deterioration in their terms of trade resulting from an unfavorable trend of commodity prices in relation to the price of manufactures.[9] Whatever the true position is, there is no gain-saying in

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[8]See, for example, Virgil Salera, The New Coffee Agreement - Facts and Issues" Inter-American Economics Affairs, Vol. 15, No. 4, (Spring, 1962) p. 55.

[9]International Commodity Arrangements and Policies (FAO Commodity Policy Studies, 16, Rome, 1964) p. 7.

the fact that Prebisch's writings captured the minds of many statesmen and public officials in the developing nations. At the United Nations Geneva Trade Conference in 1964 the common theme of the delegates from these countries was "trade, not aid".[10]

Prebisch further implied that the failure of the underdeveloped countries to provide an effective countervailing power against the monopoly interests with which they contend in international trade was due to their large numbers, geographical dispersal, and the small size of their enterprises. To these may be added the possibility that their commodities are close substitutes, as in the case of the subclasses of coffee. The cartel character of the International Coffee Agreement is presumably a way of overcoming the organizational handicaps of producers and we now wish to examine the Agreement in more detail.

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[10]At this U.N. Trade and Development Conference in Geneva, the underdeveloped countries argued that in their view the most suitable and desirable form of aid was prices for their exports stabilized at as high a level as is reasonably possible. Apparently, such a 'subsidy' to be paid directly by consumers of the importing countries was preferred because of its greater assurance. Response to solicitations for loans, both public and private, was considered quite disappointing.

International Coffee Agreement - Goals[11]

The stated objectives sought through the Coffee Agreement are as follows:

(i) to achieve a reasonable balance between supply and demand on a basis which will assure adequate supplies of coffee to consumers and markets for coffee to producers at equitable prices, and which will bring about long-term equilibrium between production and consumption;

(ii) to alleviate the serious hardship caused by burdensome surpluses and excessive fluctuations in the prices of coffee to the detriment of the interests of both producers and consumers;

(iii) to contribute to the development of productive resources and to the promotion and maintenance of employment and income in the Member countries, thereby helping to bring about fair wages, higher living standards, and better working conditions;

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[11] International Coffee Agreement, 1962) United Nations Economic and Social Council, August 31, 1962) pp. 1-2.

(iv) to assist in increasing the purchasing power of coffee-exporting countries by keeping prices at equitable levels and by increasing consumption;

(v) to encourage the consumption of coffee by every possible means; and

(vi) in general, in recognition of the relationship of the trade in coffee to the economic stability of markets for industrial goods, to further international cooperation in connection with world coffee problems.

These objectives of the coffee pact are generally similar to those of other commodity arrangements, except perhaps for their high note of ambition. As different forms of organization may be used in pursuance of these objectives, it was part of the task of the International Coffee Study Group to recommend the most suitable form of organization. Because of this it is useful to evaluate the standard types of commodity agreements for their applicability to coffee problems.

Evaluation of the Standard Types of Commodity Agreements

The international buffer stock scheme, initially recommened by the Coffee Study Group, is probably the least suitable for

tackling coffee trade problems. An obvious factor against its use is the enormous funds which will be required for purchasing and holding coffee stocks. In a buffer scheme prices are stabilized by a central agency through an obligation to buy whenever the world price falls below a prescribed minimum and to sell when the price rises above a prescribed level. The problems associated with such a scheme center around the difficulty of forecasting the prospective relationship between supply and demand in the short and long-run, securing agreement over the range of prices that will preserve long-run equilibrium, and obtaining adequate finances to permit the manager of the scheme to carry out his functions promptly. The best known example of a buffer stock arrangement is the International Tin Agreement. This agreement came to grief when in 1958 prices crashed drastically and the manager exhausted his cash reserves without succeeding in halting the crash. A buffer stock scheme would be an open invitation to further expansion of coffee-producing capacity; the very ailment that should be cured. Besides, green coffees deteriorate in quality with prolonged storage; so it would be difficult to find buyers for them.

A second type of Commodity is based on a system of multi-lateral contracts. Essentially this consists of an

obligation on importers and exporters to buy or sell certain guaranteed quantities at stipulated maximum and minimum prices whenever the free market price reaches or exceeds these limits. For reasonable effectiveness the agreement must cover a high proportion of the total trade in the commodity and the price spread should not be too wide or it gives no protection to the export earnings of producers. It is obvious that this type of agreement does not come to grips with the basic illness of the coffee industry. Moreover, it would be an extremely difficult task setting a realistic price range that will preserve market demand patterns. Unless this pattern is preserved, producers of a particular type of coffee may be hurt more than others, and those on whom the burden falls may not be responsible for existing surpluses.

The last type of agreement involves <u>export-quota restrictions</u> on the producing countries. Again, to be effective much depends on its comprehensiveness in terms of the extent to which it can count on the support of important producers and importers, actual or potential, and on the presence of good substitutes. Other common features include a policy for limiting production, the participation of

importing countries, and discrimination by importing members against nonmember producing countries to to discourage producer withdrawals and/or pressure nonmember producers into joining the pact. The International Coffee Agreement belongs in this calss and because of its importance in this study it will be discussed further in the following section.

The International Coffee Agreement

Organization and Administration

The main governing body of the international organization is the Coffee Council in which all members of the organization are represented. The 14-member executive board consists of seven elected member exporters and seven elected member importers. Exporting members of the Council account for about 97 percent of the total world coffee exports and the importing members up to 90 percent of all coffee imports. All exporting members together hold 1,000 votes, same number as the combined total for the importer members, but no one country shall hold more than 400 votes. Only the United States has this maximum vote permissible for an individual member.

The allocation of votes to the exporting countries was based on assigned basic export quotas, the latter being

determined by member's contribution to total coffee production during an agreed base period. For the member importers votes were allocated in proportion to the average volume of their respective coffee imports in the preceding three-year period. All major decisions of the Council are carried by a two-thirds vote of importing members and exporting members voting separately.

As the principal instrument for achieving its aims, the Council prescribes price limits beyond which world prices shall not be permitted to move and backs this up by fixing annual export quotas for member countries. Total annual export quotas are determined as the difference between projected consumption and the probable volume of exports by nonmembers. This annual total is then allocated to members in proportion to their basic quotas. Recognizing that prompt quota adjustments need to be made within the coffee year and at the same related to price changes, the Council recently adopted a resolution permitting the executive director to increase or decrease quotas according to the direction of change of a new price index in the prescribed range of 32-44¢ per pound.[12]

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[12]Details of the procedure for quota adjustments and the new price index may be obtained from Annual Coffee Statistics 1964 (Pan American Coffee Bureau, New York) p. 4.

Appraisal of the Agreement

The operation of the Agreement has brought out the usual problems of political and administrative feasibility. The economic effects are much harder to judge because they take a long time to work themselves out into the open but, perhaps, an economist is in a position to anticipate what they are likely to be.

To begin with, it is clear that the interests of exporters and importers may conflict particularly over such issues as the fixing of price limits. In this situation the bargaining power of the participants is important, for upon it will depend the extent to which they can succeed in obtaining measures favorable to their national interests. In turn this may determine the willingness of participants to abide by collective decisions or to use the machinery provided for seeking solutions to their felt needs. The major source of power in the Coffee Council is the vote; therefore, it is a matter or prime importance that votes be allocated as objectively as possible, with due regard to the economic nature of the problems being solved. As stated above, votes were allocated to exporter members to reflect the level of their individual production during a base period. Since some exporting countries have been having persistent overproduction

it seems a contradiction of purpose that this was allowed to swell the size of their vote. This vote can be used to frustrate certain measures that bear down on surplus productive capacity. The robusta countries, be it noted, opposed the two-year base period (1960-62) on which basic quotas (and hence votes) were determined, arguing instead for a four-year base period because of recent small crops in their countries. Obviously, they, too, missed the economic nature of the problem they were tackling. Another weakness in the vote allocation procedure is that no account is taken of the differential rates of growth of demand for the various coffee subclasses. It might have made more economic sense to attempt a projection of the demand (say, a 5-year period projection) for each coffee variety; then determine variety quotas on this basis, and, finally apply a production criterion to assign individual country quotas. In this way countries maintaining excessive productive capacity would receive fewer votes than they now have in the Coffee Council and this could mean more international pressure to limit their domestic production.

On the side of importing members, we note that the size of the United States vote gave her an unshakeable control

over major decisions of the Council, such as annual quota adjustments. We observed earlier that all such major Council decisions require two-thirds majority vote of the exporting members and the importing members voting separately. With her 400 votes the U.S. can veto any major decision to which she is opposed even if all other members are in favor of it. Thus, the very survival of the Agreement depends on the good sense and liberality of the United States. Some degree of apprehension is justified because of the impact of U.S. reactions to the Cuban revolution on the International Sugar Agreement.[13] By this, we do not imply an indictment of these reactions, for economic problems of any significance at all cannot be tackled unless within the larger setting of a political economy.

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[13]Early in 1960 the U.S.A. reduced Cuba's preferential import quota by 700,000 tons--about 25 percent of Cuba's basic quota under the International Sugar Agreement. By the end of the year, the U.S. prohibited all imports from Cuba. Cuba contracted with and disposed of about 4.9 million tons through the communist countries. When at the Geneva Conference in 1961, Cuba demanded that this 4.9 million be added to her quota of 2.4 million--a sum which exceeded the combined quotas of all other countries--the request was turned down. The Conference ended in a deadlock, and with it the regulation of the Sugar market. For more on this issue, see J.W.F. Rowe, Primary Commodities in International Trade (Cambridge University Press, 1965) pp. 176-77.

The vagueness of the concept of 'equitable price' is widely recognized yet it occurs with monotonous regularity in commodity price agreements. Some attempt was made in the Coffee Agreement to crystallize the idea by stipulating that the general level of coffee prices should not be allowed to decline below the 1962 level. But what makes the 1962 price level so equitable is difficult to determine. And it may further be asked, equitable from whose point of view? Since 1958 the downward pressure on prices had been growing in intensity as more surplus stocks piled up year after year. To dam up prices at the 1962 level might appear 'equitable' in a short-run sense from the point of view of producers. Possibly, also, consumers with long memories might be pleased to pay a price that was roughly half of the 1954 peak. However, the important question left unanswered was how the prescribed level tied in with the other aim of preserving the long-run equilibrium trend between the forces of supply and demand.

There is further cause for concern about the economic effects of the price arrangement, since, if successful, it could hinder desirable reallocation of resources away from the coffee industry in those countries where overproduction is a major problem. From previous comments regarding the

economic and social problems that would face governments attempting to control production, it is apparent that the most effective restraint on production would be lower market prices. With lower prices producers themselves may voluntarily limit production by reducing the number of weeding operations, fertilizer and pesticide applications, harvesting of distant farms or those with poor yields. Refraining from further planting will ultimately reduce long-run production.

The attitude of consumers to the price policy of the Agreement may be sampled from an editorial of the Washington Post (Dec. 26, 1961). The Post saw in the policy an "ominous parallel" to the domestic U.S. farm support problem. It argued that the less efficient producing countries would use the system to seek an excessive share of the total market at the expense of the more efficient. Distortions would continue both between producing countries and within them in that the movement of resources out of coffee to more productive activities is discouraged. The Post called for the withdrawal of surplus resources and the diversification of rural production as the only realistic remedy. More

recently, the Financial Times of London (Nov. 18, 1965) commented:

> The Coffee Council's success can be measured not only by the rise in coffee prices but also by the fact that it has dammed up a gigantic world coffee surplus ----. The International Coffee Agreement quite openly exists to exact higher prices from consumers in order to provide higher incomes to producers, most of whom are developing nations.

To be sure, the Post's analogy to the domestic U.S. farm policy was more than mere analogy. For certain senators from Hawaii had actually introduced a bill in the U.S. Senate seeking a price-support scheme for the island's coffee similar to that for the basic commodities.[14] Apparently scared of growing competition from Hawaii's industry supported by the U.S. Treasury, some Latin American exporters launched a vigorous campaign for a similar action on their own coffees.

Turning now to the provisions in the Coffee Agreement for achieving long-run equilibrium between production and consumption, we find the Council pursuing a set of policies calculated to please member producers. The Council was to

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[14]V.D. Wickizer, "International Collaboration in the Coffee Market", Food Research Institute Studies, Vol. 4, No. 3, (Stanford University, 1964) p. 294.

recommend production goals for the exporting countries; formulate a policy on stock holdings; promote the consumption of coffee, and study the creation and use of an International Coffee Fund. Members were to endeavor to prohibit the sale and advertisement of products under the name of coffee if such products contained less than the equivalent of 90 percent green coffee as the basic raw material. Exporting countries were required to scale down their output and maintain a level of stocks consistent with the goals prescribed by the Council with a view to bringing about long term equilibrium between production and consumption. But the Agreement left it to the exporting members to devise and follow their own procedure, presumably in deference to individual circumstances. However, governments of exporting countries were expected to submit periodic reports of actions taken and the results achieved. As a reward for satisfactory performance, the country concerned would be given special consideration in relation to quota adjustment and financial assistance from the International Coffee Fund.

All this demonstrates the well-know inability of Commodity Agreements to enact otherwise useful policies whose execution might conflict with the internal policies of influential member states. For instance, though the Council was to assign

production targets this could only be done in consultation with the member involved. The implication is that in some way the Council's hands are not quite free on the issue of production control. Strong national interests continue to plague the Council's efforts, with the robusta producers relentlessly pressing for higher quotas. But dissatisfaction with quotas has not been confined to this group of countries. Even before the Agreement went into effect Brazil, holder of the largest surpluses, unilaterally offered a discount price for roasters in the U.S. using 100 percent Brazilian coffee in the manufactured product. The discount offer was subsequently withdrawn after warnings that the action might prevent ratification of the Agreement by the U.S. government.

The Coffee Council planned to set up a Coffee Fund which would be subscribed by members on a voluntary basis. Payments out of the fund were intended for financing the withholding of stocks in excess of the member's export quota. Without doubt this was no measure calculated to expedite desirable reallocation of resources. The inconsistency in policy was apparently recognized later in a 1965 Brazilian proposal calling for a World Coffee Diversification Fund, financed by

exporting members on the basis of a formula yet undecided. Such a fund, if established, would obviously be very useful to those countries willing to embark on production diversification but unable to raise the necessary funds on their own. It is, however, difficult to see how producers of rival varieties, with no significant surplus problems of their own, can be expected to surrender part of their scarce hard foreign earnings to subsidize production diversification in Brazil which apparently will be the main beneficiary in view of the cost of her domestic eradiction scheme noted in Chapter II. The decision whether or not to participate in the Diversification Fund will probably be swayed mostly by short-run considerations because of the short life of most Commodity Agreements.

The enforcement of the export quotas assigned to member countries has also proved very difficult. The maintenace of prices at artificial levels in the consuming markets probably increased the attraction of smuggling. Thus, it has been suggested that substantial quantitites of nonquota exports probably pass through nonmember countries, lose their identity as to source, and then emerge in the domestic markets

of member countries.[15] Starting April 1966, the Council required a certificate of origin or re-export on coffees grown in member producing countries and sent to a nonmember country or area. Previously, certificates of origin were only required for coffee imports from member countries. But there is still an obvious loophole in the new ruling, for there is no obligation on nonmember exporting countries to prove the original source of their coffee exports. What if some members forward some of their merchandise through these countries? There exists in this situation the theoretical risks associated with producer cartel arrangements: nonmembers can severely undermine the market position of members unless the importing countries cooperate with the cartel by proscribing, or at least limiting, their imports from nonmembers of the cartel. So far there is no indication that importing members have actually banned or reduced imports from sources outside the international cartel. The Agreement explicitly states that members are free to sell or purchase coffees with the "minimum of interference to normal trade channels". The Council has now initiated discussions aimed

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[15] Wall Street Journal, April 18, 1966, p. 24.

at bringing nonmember producers into the organization. But should they refuse to join the organization they will remain a source of threat to its survival since it might not be po-sible to effectively limit trade between members and non-members.

Achievements and Outstanding Problems

The Coffee Council has achieved a measure of success in its determination to work for the elimination of artificial barriers on consumption--quantitative, tariff, and fiscal. For instance, France is reported to have abandoned its quantitative controls on coffee imports. Other European countries, among them Finland, Sweden, and the Federal Republic of Germany have reduced tariffs and/or internal taxes on processed coffee.[16] This is certainly an achievement of major significance, for the FAO has estimated that complete abolition of taxes and duties on coffee might induce an 11 percent increase in imports by 1970, mainly in the European Economic Community. Furthermore, if prices and the

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[16]First Annual Report of the President of the United States on the International Coffee Agreement (Washington, D.C., 1966) p. 12.

consumption of imports were to remain unchanged, this would represent a gain of over $100 million in the exchange earnings of the coffee-exporting countries.[17]

That some success has been achieved is also conceded by the Wall Street Journal, one of the most outspoken critics of the coffee pact. In April 18, 1966, the Journal noted that the present agreement, which went into effect in October 1963, has kept prices relatively stable after years of boom-and-burst gyrations. But it added:

> a sharp rebound in world coffee production threatens to swell surpluses in the warehouses of producing lands to the highest level ever--the huge overproduction does threaten to throw the mechanisms of this global pact out of gear.[18]

The Journal further reported that the U.S.D.A. estimated world output of coffee, available for exports, would climb to 63.8 million 132-pound bags in the year ending September 1966, up 74 percent from the subpar 1964/65 crop of 36.7 million bags and just less than the record high of 66.4 million set in 1959/60. Current carryover stocks probably stand at

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[17]FAO, Monthly Bulletin of Agricultural Economics and Statistics, (December 1962), Vol. 11, No. 12, p. 10.

[18]Wall Street Journal, April 18, 1966, p. 24.

around 79 million bags compared with 81 million in September 1963. The additions to accumulated stocks from the 1965/66 production amounted to 14 million bags, out of which Brazil alone accounted for 10 million.

The cardinal conclusion to be derived from the statistics in the preceding paragraph is that the Coffee Council has hardly made a start on the basic production adjustment problem of the industry, even though it may have scored some temporary success in relation to the stabilization of prices.

Summary and Alternative Proposals

The basic problem of the world's coffee industry is overproduction. No International Commodity Agreement, maintaining price at an artificially high level, has to date proved an effective instrument for promoting desirable reallocation of productive resources away from the 'problem industry'. On the contrary, they have encouraged additional commitment of resources as well as sheltered enclave economies.

International Commodity Agreements generally assume that the demand for the commodity concerned is inelastic. A given percentage increase in price is accompanied by a less than proportionate decrease in the quantity of the commodity demanded,

other factors being unchanged. Consequently, a price decrease reduces the total earnings from the commodity. Such an assumption of inelastic demand with respect to total coffees is however questionable if extended to green coffee varieties. This study suggests that the import demand for individual varieties of coffee is substantially elastic. Therefore, to expand consumption and total receipts for any one variety, economic theory suggests that the price of that variety be reduced while holding income and the prices of the other two constant. However, since any unilateral action on a regional basis will probably touch off a price war, action pertaining to price reduction may be handled successfully only by a competent international body and this should be done in a way that will not disrupt the relative demand relationship between different coffee varieties. If successfully implemented, the quantity of each coffee variety demanded by consumers may rise. At the same time the maximum quantity which the suppliers involved would wish to put on the market is reduced because of stabilization effects and this lower quantity can be provided by more efficient farmers.

Lastly, the fact that International Commodity Agreements are prone to short periods of life--no doubt because of

inherent administrative and political difficulties--limits their effective use in solving long-term problems, as we observed earlier in connection with the International Coffee Diversification Fund. Moreover, the political motivation of the Coffee Agreement calls for concern about the way the economy of the developing nations as a whole ought to be aided. Regional concentration of economic aid engendered by a politically-inspired agreement might appear "unfair" to other deserving nations not able to obtain similar terms. A pertinent question arising out of this thought is whether there are alternative ways of tackling the coffee problem, that is, apart from an international commodity agreement.

Short-term Approach to the Coffee Problem

Given an efficient domestic monetary and fiscal system, the producers of coffee can be protected from fluctuations in their incomes. Consequently, the main impact of world coffee price gyrations is on the external earnings of the governments of the producing countries. With a rapidly growing demand for imports, many of these governments have recurring balance of payments difficulties. The question to be asked is whether there are other remedies apart from coffee price stabilization through an international cartel.

Shortfalls in export receipts can be moderated by loans on liberal terms from the International Monetary Fund (IMF). Indeed, the IMF does provide facilities for temporary loans of this nature.

Compensatory fiance is another promising avenue, possibly along the lines recommended by a U.N. panel of experts who investigated the problem.[19] Briefly, the experts called for the establishment of a Development Insurance Fund. The industrially advanced countries would contribute a percentage of their national income while the low-income primary producing countries contribute a fixed percentage of their export receipts. Claims on the Fund are to be open to all members and would be paid automatically under certain circumstances. Such claims would be based on the decline of export proceeds in a particular year as against the average of three preceding years, and would cover a proportion (say 50 percent) of the shortfall in excess of a minimum shortfall of 5 percent for which no compensation is payable. The experts proposed the use of

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[19] International Compensation for Fluctuations in Commodity Trade, (New York, United Nations, 1961). For an excellent summary of the panel's proposals, see FAO's International Commodity Arrangements and Policies, op. cit., p. 18.

one or a combination of two approaches to the settlement of claims: In one case, claims are to be treated as cash payments carrying no obligation for future repayment; in the other case, payments are contigent loans to be repaid if the export proceeds of the subsequent five years are high enough to permit it but not otherwise. In an FAO report, Blau observed that the adoption of such a scheme would not in itself deal with the causes of underlying problems, but it would give partial protection to underdeveloped countries against the e-fects of short-term fluctuations and also against an unfavorable trend of commodity prices, not only in relation to any particular commodity, but to commodities in general.[20] And Miss Lovasy has advocated the broadening of the concept of compensatory financing to include variations in the accumulation and depletion of national reserves of gold and foreign exchange.[21] She argues that in the context of balance of payments analysis

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[20] International Commodity Arrangements and Policies, Ibid., p. 18.

[21] G. Lovasy, "The International Coffee Market: A Note", IMF Staff Papers, Vol. 9, 1962, p. 226.

reserve movements, loans and repayments, and unilateral transfers of various sorts can all in principle be used to offset fluctuations in a country's external receipts, and thus permit some stabilization of imports. So enlarged, the idea of a "Development Insurance Fund" should prove as attractive to developed countries as to the underdeveloped ones.

Long-term Approach

The solution of the long-term problem of the coffee industry, excess capacity, necessarily involves a resolutely aggressive action. The producing countries concerned must be prepared to pull themselves out of their difficult situation by their own bootstraps with such external aid as they can obtain toward that end. Economic development thinking in many of the emerging nations heavily emphasizes export-crop production as the only level for "take-off", apart from industrialization itself. Because of the recognized need to hurry the process much stress is placed on crops with substantial turnover of foreign exchange, with little reflection on the long-run consequences.

This practice has generally led to overinvestment which is, to a great extent, responsible for the problems of the export-crop industries. Despite these problems, little change has occurred in the pattern of investments in the agricultural sector apparently because of rising need for foreign exchange. Thus, as mentioned earlier, despite the downward pressure on the long-period price trend, productive capacity has been extended when temporary improvement occurred in the market situation. On the other hand, reduction of production to counteract declining prices is difficult because coffee trees are fixed assets and this means retention of existing resources in the industry so long as the marginal returns to the resources exceed their salvage values. That overproduction will remain a major problem in the next decade is demonstrated by recent projections by the International Coffee Organization (Table 13).

Unless the diversification of production, especially rural production in which present coffee farmers have special aptitude, is pursued vigorously the wasteful use of resources will continue. In this context the domestic segment of the agricultural sector can play a strategic role. But investments in new techniques, agronomic research, and extension are

required; so are improvements or developments in food storage, processing and distribution, both temporarily and spatially. These are all vital parts of a virile domestic front; an increased food production can take away some of the inflationary pressures associated with extensive development spending.

Selective industrialization of the rural economy offers further outlet for surplus coffee resources. For instance, handicraft, cottage industries, and certain food-processing industries can be sited in the rural areas to absorb displaced labor and capital withdrawing from coffee and other rural occupations. Two important advantages of rural industries result from the fact that they obviate the need for urban migration and, secondly, necessary skills can be acquired in a relatively short time, thus avoiding much of the costs arising from loss of present incomes and retraining for urban jobs.

Table 13. Estimated World Total Production, Domestic Consumption, and Import Requirements of Coffee for the Period 1965/66 to 1974/75

(thousand 60-kilo bags)[1]

	1965/66	1966/67	1968/69	1969/70	1970/71	1971/72	1972/73	1973/74	1974/75
Total Production	77,650	75,250	79,800	86,400	83,100	83,100	83,100	83,100	83,100
Domestic Consumption	15,878	16,545	17,964	18,718	19,490	20,306	21,155	22,044	22,981
Exportable Production	61,772	58,705	61,838	67,682	63,610	62,794	61,945	61,056	60,119
Export Market	48,200	49,395	51,876	53,162	54,500	55,873	57,281	58,724	60,204
Difference:									
Annual	13,572	9,310	9,960	14,520	9,110	6,921	4,664	2,332	-82
Cumulative	--	22,882	46,582	61,102	70,212	77,133	81,797	84,129	84,044

Source: Quoted in "First Annual Report of the President of the United States on the International Coffee Agreement", (Washington, D.C., 1966), p. 20. Estimates for 1967/68 are not available.

CHAPTER VI

SUMMARY AND CONCLUSIONS

This study developed a set of structual relationships to explain the behavior of the United States green coffee market. Very few econometric studies of this market have been attempted in the past and none has been concerned with illuminating its sectoral characteristics and inter-connections. World coffee trade differentiates three basic types -- milds, brazils, and robustas -- each possessing certain technical properties peculiar to itself. These properties are a major determinant of relative demand and, consequently, to improve our understanding of the commodity market the analyst should recognize the trade differentiation of coffee varieties. Briefly stated, the purpose of this study is to clarify the nature of the economic relationships between coffee varieties and the factors influencing the determination of their market prices.

This task requires the use of simultaneous equation approach. Two such equation systems were formulated; namely Submodel 1, which deals with the relationship between robustas and arabicas, and Submodel II, which separates the three

varieties listed above. Essentially, each model consisted of an aggregate market demand function, export supply function and a stock demand relation for each of the basic coffee varieties indicated in the model. In each case, the price-making factors were assumed to be generally similar, except that in the robusta price relation it was considered that the production of instant, rather than regular ground, coffee was a more plausible explanatory variable, as indicated by secondary sources. The connecting link between the varieties in the model was through the price variable; that is to say, each of the demand functions contains an explanatory price variable relating to the closest rival variety. Thus, the import function of milds contained a price variable for brazils; robusta import function contained a price variable for brazils, and the import function of brazils contained a price variable for milds. The details of the economic and statistical models formulated are given in Chapter III together with a discussion of their rationale.

Five alternative estimators were employed to fit Submodel II while only the Ordinary Least Squares (OLS) was applied to Submodel I because of incpmplete disaggrega-tion of the commodity. Theoretically, the OLS estimator is

inappropriate for fitting either model. It was nevertheless used in this study for the purpose of obtaining a set of coefficient estimates for comparing with similar sets obtained by simultaneous equation methods. The latter class of estimators include Two State Least Squares (TSLS), Limited Information Single Equatin (LISE), Three State Least Squares (3SLS), and Iterative Three Stage Least Squares (I3SLS). The last two estimators employed the 2SLS estimates as their starting estimates, though any other set of unbiased estimates could have been used.

Generally, the coefficient estimates obtained were reasonably satisfactory, and the 3SLS-estimated prices followed the time path of the observed price series. Because of desirable asymptotic qualities the 3SLS estimates were interpreted most fully and were also the basis for comparing other sets of coefficient estimates. Not unexpectedly, the LISE estimator performed very poorly, yielding very small and, in some cases, negative "R^2" values. The LISE coefficient estimates also differed substantially from other estimates. However, some variation also occurred among equivalent estimates obtained from other estimators. These variations were attributed largely to three possible factors:

- effects of multicollinearity, specification errors, and errors in variables. The last factor is especially important because, as mentioned in Chapter III, the documentation of international trade statistics on green coffees is known to be rather poor. Depending therefore on their sensitivity to these errors and to multicollinearity, results obtained by various estimators could differ substantially.

In the I3SLS procedure the coefficient estimates converged in the arithmetic functional relation but not in the logarithmic relation. The total number of iterations applied was, respectively, 66 and 70, averaging in each case 3.79 seconds per iteration. Failure to obtain convergence in the logarithmic relation was probably due to the very low value of several coefficients (for example, 1.46×10^{-7}) which changed continually throughout the iteration process.

The principal findings and conclusions of the study are as follows:

a) As constructed, the economic model confirmed that milds and brazils are substitute goods within a significant range. The same is true of the

relationship between brazils and robustas. Overall, therefore, the dominant economic relationship among the three coffee varieties is one of competition.

b) Premium coffees (namely, the milds) are normal goods while the non-premium coffees (brazils and robustas) are probably inferior goods in the current U.S. market. Thus, with relative prices constant, an increase in per capita U.S. disposable income could lead to an increase in the consumption of milds over non-premium coffees. The obverse situation would mean that during a recession or a period of declining incomes greater quantities of lower quality coffees might be consumed and the use of milds might decline. With respect to policy implications, growth in the U.S. income with relative prices constant signals the necessity to reduce or control the production of brazils and robustas since the U.S. takes up to 50 percent of the total green coffees entering international trade. However, it is unlikely that in the near future the level of the national income of other

parts of the world (including the underdeveloped countries themselves) would rise to the extent that a marked preference for premium coffees is indicated. It is possible that the consumption of brazils and robustas will continue to grow in other parts of the world in the foreseeable future and this could largely offset the lower per capita consumption indicated by the U.S. market demand.

c) No evidence was obtained that seasonal factors have a significant influence on the U.S. green coffee import demand. Dummy variables for seasons were included in the demand equations but did not significantly improve the statistical fit obtained without them.

e) A significant connection was found between the production of instant coffee and robusta prices in the U.S. market. The relative cheapness of robustas and the "stretch effect" of instants (that is, higher cup yield per lb. of green coffee) probably contributed to the relative decline of coffee imports from Latin American sources. Given

further spread of instants, particularly to Europe and other parts of the world, robustas may continue to gain an increasing share of the world coffee market if current relative prices are maintained.

f) A critical appraisal of the International Coffee Agreement against a background of the key problems of the world coffee industry led to the conclusion that the organization has major limitations as an instrument for effectively dealing with the fundamental long run problems of the industry. For one thing, its authority needs to be made more effective and comprehensive and, for another, the Agreement has frozen world prices at an arbitrary level and this may hinder desirable reduction of productive capacity at the sources of supply. Some contradiction of purpose seems to exist between the Coffee Council's objectives of freezing prices at the 1962 level and working towards the equation of production and consumption in the long run. Alternative methods are suggested for dealing with short-run fluctuations of exchange receipts, an area in which the Council is said to have scored

some success. The surplus problem is largely a regional problem, Brazil being the most affected. Funds for the diversification of production, voluntarily subscribed by members of the Coffee Agreement, may be difficult to raise. This is so largely because of the short life of most Commodity Agreements. Countries relatively free of the surplus problem may thus be unwilling to participate in the scheme for, if the Agreement fails, they may not have received satisfactory benefits from the fund. In view of this it appears the coffee diversification project is a matter which is best handled by the countries concerned. Through the Agreement international pressure can be applied; for instance, through the allocation of votes. It is suggested that basic export quotas be more closely related to the market demand for individual coffee varieties and these quotas should determine the votes allocated to the exporting members. Present basic quotas, which are based on contributions to the total world coffee production during a prescribed time period, makes no allowance for existing differentials in market demand.

g) Estimates of price flexibility of demand for individual coffee varieties were substantially below unity which implies a reasonably elastic demand. Consequently, it would appear that reduction of the price of any one coffee variety may raise its consumption and the total income derivable therefrom. But the probability is high that retaliatory price cuts will be made by producers of other coffee varieties. While it may or may not stimulate consumption substantially depending on the elasticity of trade demand for total green coffees, a reduction of the general level of coffee prices, suggested by the Coffee Study group, can in due time lead to lower market supply of coffees. The industry would as a result be in the hands of more efficient or low-cost producers.

Finally, we record some of the shortcomings of the model formulated. The model did not satisfactorily explain the behavioral relationships in some segments of the coffee market. There are areas in which, given adequate information, future

research can make an immeasurable contribution to a more complete understanding of the price-making forces in the green coffee market. Specifically, the export supply relations need further clarification. The international coffee market has, historically, been regulated through such devices as export taxes (real and monetary), retention of stocks, exchange controls, fiscal and monetary mechanisms. Time did not permit the present investigator to explore these aspects in any detail but he considers future efforts in this direction well worthwhile.

Also, the stock demand functions need drastic reworking but it may turn out that information necessary for analyzing this function on a coffee-variety basis will not be obtainable. Other useful ideas for improving the model include the suggestion by previous investigators regarding the partitioning of data on the basis of inflationary and deflationary periods. Hopp and Foote suggest that with this refinement better estimates and predictions can be obtained.

Despite these shortcomings, this study has made a positive contribution towards the clarification of the economic relationships in the green coffee market. The technique of simultaneous equations is used to analyze these relationships and the economic parameters derived are economically plausible.

BIBLIOGRAPHY

Articles and Periodicals

Adler, J. H. "United States Import Demand During the Interwar Period", American Economic Review, Vol. 25, June 1945.

Anderson, T.W. and Rubin, H. "Estimation of the Parameters of a Single Equation in a Complete System of Stochastic Equations", Annals of Mathematical Statistics, Vol. 22, 1949.

Behrman, J.R. "Cocoa: A Study of Demand Elasticities in the Five Leading Consuming Countries, 1950-1961", Journal of Farm Economics, Vol. 47, No. 2, May 1965.

Chang, T.C. "International Comparison of Demand for Imports", Review of Economic Studies, Vol. 13, 1945-46.

Christ, C.L. "Simultaneous Equation Estimation: Any Verdict Yet?" Econometrica, Vol. 28, 1960.

Daly, Rex F. "Coffee Consumption and Prices in the United States", Agricultural Economics Research, Vol. 10, No. 3, July, 1958.

Financial Times of London, November 18, 1965.

Goering, T.J. Colombian Agricultural Price and Trade Policies, Universidad Nacional de Colombia, Facultad de Agronomia, Palmira, Colombia, 1961.

Harberger, A.C. "A Structural Approach to the Problem of Import Demand", American Economic Review, Vol. 43, May, 1950.

Hopp, H. and Foote, Richard J. "A Statistical Analysis of Factors that Affect Prices of Coffee", Journal of Farm Economics, Vol. 37, 1955.

Houck, J.P. "The Relationship of Direct Price Flexibilities to Direct Price Elasticities", Journal of Farm Economics, Vol. 47, No. 3, August, 1965.

Journal of Commerce, Febraury 11, 1966.

Kuh, E. "The Validity of Cross-Sectionally Estimated Behavior Equations in Time Series", Econometrica, Vol. 27, January, 1959.

Lovasy, G. "The International Coffee Market: A Note", IMF Staff Papers, Vol. 9, 1962.

Madansky, A. "On the Efficiency of Three-Stage Least Squares Estimation", Econometrica, Vol. 32, No. 1-2, 1964.

Orcutt, G. "Measurement of Price Elasticities in International Trade", Review of Economics and Statistics, Vol. 32, May, 1950.

Prebisch, Raul "The Economic Development of Latin America and Its Principal Problems", Economic Bulletin for Latin America, February, 1962.

Salera, Virgil "Commodity Problems in Latin America", Inter-American Economic Affairs, Vol. 14, No. 1, Summer, 1960.

Taylor, L.D. "Forecasting from Gneralized Stock Adjustment Models", 7th Annual Conference Paper, New York Area Chapter of the American Statistical Association, April, 1965.

Tomek, W.G. "Using Zero-One Variables With Time Series Data in Regression Equations", Journal of Farm Economics, November, 1963.

Wall Street Journal, April 18, 1966.

Washington Post, December 26, 1961.

Wickizer, V.D. "International Collaboration in the Coffee Market", Food Research Institute Studies, Vol. 4, No. 3. Standford University, 1964.

Wood, James E. "The Robusta Situation and Suggested Means of Improving It", August, 1960.

Zellner, A. and Theil, H. "Three-Stage Least Squares: Simultaneous Estimation of Simultaneous Equations", Econometrica, Vol. 30, 1962.

Books

Goldberger, A.S. Econometric Theory, John Wiley & Sons, Inc., 1964.

Hathaway, D.E. Government and Agriculture - Public Policy in a Democratic Society, McMillan & Co., 1963.

Hood, W.C. and Koopmans, T.C. Studies in Econometric Methods, Cowles Commission Monograph 14 and John Wiley * Sons, Inc., 1961.

Johnston, J. Econometric Methods, McGraw-Hill Book Co., Inc., New York, 1960.

Kindleberger, C.P. International Economics, Richard D. Irwin Inc., 1963, Chapter 11.

Rowe, J.W.F. Markets and Men, McMillan Co., New York, 1936.

_____. The World's Coffee -- A Study of the Economics and Politics of the Coffee Industries of Certain Countries and of the International Problem, Her Majesty's Stationary Office, London, 1963.

_____. Primary Commodities in International Trade, Cambridge University Press, England, 1965.

Theil, H. Economic Forescasts and Policy, North-Holland Publishing Co., Amsterdam, 1961.

Vanek, J. International Trade: Theory and Economic Policy, Richard D. Irwin Inc., 1962, Chapter 8.

Wickizer, V.D. The World Coffee Economy with Special Reference to Control Schemes, Food Research Institute, Stanford University, 1943.

Government, FAO, and other Publications

Federal Trade Commission. Economic Report of the Investigation of Coffee Prices, Washington, July 30, 1965.

First Annual Report of the President of the United States on the International Coffee Agreement, Washington, D.C.

U.S. Department of Agriculture. Foreign Agricultural Circulars, 1953-61.

_____. Coffee Situation -- Programs and Policies in Producing Countries, Foreign Agricultural Services, FAS-M-148, July 1963.

_____. Analytical Tools for Studying Demand and Price Structures, USDA Agriculture Handbook No. 146, Washington, Government Printing Office, 1958.

U.S. Department of Commerce. Foreign Trade Reports: U.S. Imports of Commodity by Country of Origin, 1953-61.

_____. Total Inventories of Green Coffee Held by Roasters Importers, and Dealers in the United States, 1953-61.

FAO. The World Coffee Economy, Commodity Bulletin Series, Vol. 33, 196.

___. The World's Coffee, International Institute of Agriculture, Rome, 1947.

___. International Commodity Arrangements and Policies, Commodity Policy Studies No. 16, Rome, 1964.

___. Monthly Bulletin of Agricultural Economics and Statistics, December 1962.

U.N. Economic and Social Council. International Coffee Agreement 1962 (August 31, 1962).

Pan American Coffee Bureau. Annual Coffee Statistics, New York.

APPENDIX A

RESULTS OF SIMULTANEOUS ESTIMATION OF SUBMODEL II (LOGARITHMIC FORM)

Table 14. Submodel II - Logarithmic Form
EQUATION 1. Import Price of Mild Coffees (Colombian Mams) Estimated Coefficients and Associated Statistics

Estimator	Y_2	Y_3	Y_1	Y_4	Constant	X_1	X_2	"R^2"	"D.W."
1. 3SLS	-1	0.9128	0.1342	-0.0730	0.1833	-0.0932	0.1903	0.94	0.52
		0.0993	0.0666	0.0518	0.2782	0.0887	0.2450		
2. 2SLS	-1	0.8030	0.0638	-0.0170	0.4533	-0.0432	-0.0776	0.94	0.36
		0.2099	0.1165	0.0859	0.5898	0.1297	0.5135		
3. OLS	-1	0.8026	0.0598	-0.0055	0.4607	-0.0526	-0.0766	0.94	0.34
		0.1438	0.0779	0.0583	0.3974	0.1254	0.3527		
4. LISE	-1	40.8354	22.8896	-16.2077	-114.6889	6.9957	97.8172	-281.53	1.87
5. I3SLS	-1	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.		

n.c. (not calculated): In the course of iteration the system turned out to be unstable. This is presumably why convergence of the estimates was not achieved.

Table 15. Submodel II - Logarithmic Form
EQUATION 4. Import Price of Brazils (Santos 4) Estimtaed Coefficients and Associated Statistics

Estimator	Y_3	Y_2	Y_5	Y_7	Constant	X_1	X_2	"R^2"	"D.W."
1. 3SLS	-1	0.8493	-0.3498	0.0989	0.5688	0.0084	-0.6484	0.89	2.14
		0.1004	0.0494	0.0560	0.2783	0.1012	0.2230		
2. 2SLS	-1	0.6827	-0.3007	0.0626	0.9535	0.0739	-1.0050	0.90	1.93
		0.2637	0.1218	0.1366	0.7144	0.2050	0.5338		
3. OLS	-1	0.6551	-0.0993	0.1249	0.1639	0.0344	-0.2027	0.98	0.90
		0.0964	0.0349	0.0437	0.2988	0.0854	0.2501		
4. LISE	-1	0.8021	-0.5030	-0.0731	0.6857	0.2096	-0.8104	0.67	2.14
		0.4863	0.2246	0.2520	1.3176	0.3782	0.9846		
5. I3SLS	-1	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	

n.c. = not calculated

Table 16. Submodel II - Logarithmic Form
EQUATION 7. Import Price of Robustas (Ambriz 2AA and Ivory Coast Superior)
Estimated Coefficients and Associated Statistics

Estimator		Y_6	Y_3	Y_8	Y_9	Constant	X_{10}	X_2	"R^2"	"D.W."
1.	3SLS	-1	0.6027	-0.2720	-0.0775	0.8614	0.3878	-1.2630	0.90	1.66
			0.2259	0.1416	0.1063	0.6097	0.1594	0.5958		
2.	2SLS	-1	0.5260	-0.2140	-0.1155	1.2702	0.6230	-1.8864	0.91	1.62
			0.3718	0.2036	0.1615	9.9900	0.2311	9.9396		
3.	OLS	-1	0.6458	-0.0685	-0.1454	1.0078	0.4744	-1.6221	0.92	1.15
			0.2429	0.1245	0.0968	0.6789	0.2029	0.6857		
4.	LISE	-1	-0.8477	-1.0700	0.4794	4.7586	0.7972	-4.8671	0.69	1.42
			0.6955	0.3809	0.3020	1.8705	0.4323	1.7577		
5.	I3SLS	-1	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	

n.c. = not calculated

Table 17. Submodel II - Logarithmic Form

Equation (2): Export Supply of Milds

$$\text{Log } Y_3 = -0.1967 + 0.1330 \log X_3 + 0.0775 \log X_4$$

(0.3478) (0.1674) (0.1657)

$R^2 = 0.02$

Equation (5): Export Supply of Brazils

$$\text{Log } Y_5 = 0.1935 + 0.0825 \log X_7 + 0.2856 \log X_9$$

(0.3651) (0.2044) (0.3104)

$R^2 = 0.03$

Equation (8): Export Supply of Robustas

$$\text{Log } Y_8 = 0.0115 - 0.3182 \log X_{11} + 0.9887 \log X_{12}$$

(0.2346) (0.1539) (0.1808)

$R^2 = 0.70$

Equation (3): Stock Demand for Milds

$$\text{Log } Y_4 = -0.1420 - 0.1276 \log X_3 + 0.4606 \log X_5$$

(0.4154) (0.1558) (0.3713

$$- 0.2145 \log X_6$$

(0.0392

$R^2 = 0.53$

Table 17, Cont.

Equation (6): Stock Demand for Brazils

$$\text{Log } Y_7 = 0.9055 + 0.5325 \log X_5 - 0.1844 \log X_7 + 0.0691 \log X_8$$

(0.5924) (0.5655) (0.2065) (0.0691)

$R^2 = 0.10$

Equation (9): Stock Demand for Robustas

$$\text{Log } Y_9 = 0.3687 - 0.4538 \log X_{11} + 1.1440 \log X_{13} + 0.4110 \log X_{14}$$

(0.4245) (0.2819) (0.4623) (0.0868)

$R^2 = 0.67$

APPENDIX B

BASIC DATA USED IN THE ANALYSIS

Table 18. Quarterly Imports of Green Coffees in the United States by Type (1953-61)
(in million lbs.)

Quarter	Colombian Milds Mams	Brazils	French West Africa Robusta	Angola Robusta	Total Robustas
1	160.32	306.70	0.16	12.75	12.91
2	178.27	223.37	0.00	20.64	20.64
3	221.60	299.45	0.00	13.69	13.69
4	180.43	357.06	0.00	34.38	34.38
5	183.98	283.89	5.02	29.76	34.77
6	185.50	193.85	17.68	9.40	27.09
7	163.98	851.80	5.46	4.39	9.85
8	115.48	276.41	2.36	21.87	24.23
9	140.96	168.80	6.52	13.19	19.71
10	126.19	194.60	7.13	10.26	17.39
11	160.32	275.49	5.69	8.62	14.31
12	224.90	378.77	2.98	39.77	42.76
13	177.32	374.88	14.88	23.65	38.53
14	152.95	294.47	10.87	22.92	33.79
15	159.78	372.67	15.67	16.41	32.08
16	112.63	267.26	8.61	39.49	48.10
17	129.82	391.01	22.45	35.18	57.63
18	98.62	219.72	5.23	14.89	20.12
19	167.49	216.31	0.78	14.62	15.41

Quarter	Colombian Milds Mams	Brazils	French West Africa Robusta	Angola Robusta	Total Robustas
20	150.88	348.68	4.99	40.74	45.73
21	122.74	181.24	17.41	20.87	38.28
22	103.03	283.66	11.24	25.10	36.34
23	160.71	189.74	10.23	6.35	16.58
24	175.23	331.20	1.44	40.19	41.63
25	144.13	342.85	13.78	27.98	41.76
26	154.06	286.47	10.92	19.89	30.80
27	198.44	444.30	11.73	16.88	28.62
28	151.35	323.25	8.15	33.37	41.52
29	134.27	260.27	21.65	33.20	54.85
30	113.78	331.82	11.76	25.12	36.87
31	124.69	360.51	20.96	15.21	36.16
32	192.76	272.53	32.52	32.61	65.13
33	158.20	278.40	22.37	35.75	58.12
34	132.70	256.24	21.76	32.06	53.82
35	120.80	285.18	25.05	31.80	56.85
36	127.74	321.89	28.05	36.01	64.06

Source: U.S. Department of Commerce, U.S. Imports Statistics by Country of Origin, (Washington, D.C.)

Table 19. Deflated Average New York Spot Prices of Green Coffees (cents per lb.) and Deflated per Capita Disposable Personal Income[1]

Quarter	Colombian Milds Mams	Brazils Santos 4	Angola Anbriz 2AA	Ivory Coast Superior	Disposable Income Per Capita
					(in 1000 $)
1	58.9	57.1	47.9	46.6	2.04
2	56.8	56.6	49.0	-	2.07
3	62.7	61.8	53.1	-	2.08
4	65.6	60.4	50.4	-	2.08
5	82.0	79.5	6.13	47.9	2.11
6	92.8	93.8	78.3	63.7	2.09
7	83.5	83.9	67.5	69.0	2.10
8	76.4	71.9	53.0	60.0	2.12
9	68.5	63.7	54.6	50.4	2.14
10	63.1	58.3	48.0	60.0	2.18
11	68.3	58.7	48.1	47.4	2.23
12	69.7	56.0	41.7	35.8	2.26
13	72.0	56.8	38.0	30.7	2.30
14	74.7	59.0	39.4	32.3	2.34
15	83.2	62.5	43.7	33.3	2.39
16	79.0	64.0	38.9	33.2	2.45
17	73.2	62.5	40.9	34.7	2.48
18	68.0	60.0	42.1	35.2	2.51

Quarter	Colombian Milds Mams	Brazils Santos 4	Angola Anbriz 2AA	Ivory Coast Superior	Disposable Income Per Capita
					(in 1000 $)
19	63.4	55.5	42.7	35.5	2.57
20	55.8	53.5	47.6	33.5	2.56
21	54.0	53.5	41.0	36.4	2.60
22	53.3	49.5	42.1	36.3	2.62
23	51.5	45.5	41.7	38.2	2.67
24	48.7	43.3	34.8	33.6	2.70
25	45.1	38.6	31.8	28.2	2.76
26	45.3	37.2	32.8	28.6	2.82
27	45.2	35.8	31.0	27.1	2.82
28	43.9	35.2	25.9	23.4	2.85
29	44.3	35.7	25.5	20.6	2.87
30	44.2	36.6	26.1	19.5	2.91
31	44.0	35.5	24.1	16.8	2.92
32	42.3	34.6	22.7	18.8	2.92
33	43.3	36.1	20.0	18.3	2.94
34	43.1	36.8	19.3	18.3	2.97
35	42.4	35.0	19.1	18.0	3.03
36	41.5	32.7	19.5	18.2	3.09

[1]Coffee prices were delfated by the BLS index of spot market prices for 22 commodities (1957-59=100) while per capita disposable income was deflated by the BLS consumer price index (1957-59=100). Price data were supplied by the Sugar and Tropical Products Division, U.S. Department of Agriculture, Washington, D.C. Data on U.S. per capita disposable income were obtained from U.S. Dept. of Commerce, Business Statistics, (Washington,D.C., 1965)

Table 20. United States End-of-quarter Inventory of Green Coffees, Estimates of Stocks by Type, Roastings of Regular and Instant Coffees, 1953-61
(in million lbs.)

Quarter	Total End-of-Quarter Inventory	Estimated Stock of Milds	Estimated Stock of Brazils	Estimated Stock of Robusta	Roasting of Regular Coffee	Roasting of Instant Coffee
1	473.53	158.10	302.69	12.74	649.21	85.55
2	466.91	197.13	246.95	22.83	512.83	82.39
3	466.38	193.25	261.14	11.99	541.64	70.77
4	517.84	163.38	323.29	31.17	585.09	83.01
5	549.19	201.05	310.14	38.00	670.43	74.12
6	597.73	272.79	285.07	39.87	448.22	64.06
7	435.96	69.69	362.04	4.23	384.04	61.31
8	395.49	109.76	262.67	23.06	553.97	71.93
9	238.93	102.22	122.40	14.31	538.94	83.93
10	209.96	78.35	120.80	10.81	534.59	72.53
11	191.17	68.10	116.99	6.08	528.04	69.43
12	289.34	100.67	169.52	19.15	580.06	81.44
13	348.48	104.59	221.13	22.76	629.20	116.84
14	348.21	110.66	213.11	24.44	538.83	100.97
15	437.12	123.76	288.49	24.87	532.30	96.65
16	371.23	97.70	231.80	41.73	552.62	113.38
17	456.04	102.60	307.98	45.46	593.23	118.94
18	381.16	111.06	247.42	22.68	540.32	102.79
19	307.47	128.99	166.58	11.90	507.41	98.39
20	391.48	108.31	250.32	32.85	611.97	115.42
21	305.22	109.45	161.61	34.16	601.43	127.94
22	310.77	75.70	208.34	26.73	545.87	109.54
23	241.58	105.78	124.88	10.92	546.66	101.61
24	279.68	89.44	168.98	21.26	614.00	122.91

Quarter	Total End-of-Quarter Inventory	Estimated Stock of Milds	Estimated Stocks of Brazils	Estimated Stock of Robusta	Roasting of Regular Coffee	Roasting of Instant Coffee
25	318.84	86.92	206.73	25.19	644.44	126.74
26	301.38	98.53	183.14	19.71	540.84	118.94
27	432.75	127.91	286.45	18.39	568.09	120.53
28	445.85	130.73	279.22	35.90	622.08	129.12
29	377.98	112.93	218.90	46.15	625.39	146.32
30	387.77	91.43	266.68	29.66	566.51	122.11
31	455.11	108.85	314.68	31.58	546.13	126.35
32	423.89	154.05	217.79	52.05	629.62	134.28
33	392.27	125.42	220.76	46.09	644.16	140.11
34	416.08	124.70	240.78	50.60	580.67	123.30
35	424.84	110.89	261.72	52.21	560.42	122.64
36	372.42	92.60	233.34	46.48	633.72	144.47

Source: End-of-quarter inventory, Roasting of Regular and Instant Coffees are published quarterly by the U.S. Department of Commerce, Total Inventories of Green Coffee held by Roasters, Importers and Dealers in the United States, (Washington, D.C.)

Table 21. Quarterly Available Exports of Green Coffees from Colombia, Brazil, Angola and Ex-Franch West Africa in million lbs. (1953-61)

Quarter	Colombia	Brazil	Angola	Ex-French West Africa
1	197.08	498.53	42.19	40.08
2	203.56	367.71	17.06	24.34
3	246.29	516.65	33.86	29.36
4	230.28	675.37	64.68	30.69
5	229.49	455.54	42.12	65.87
6	209.78	246.95	7.80	40.21
7	168.51	262.16	16.67	48.41
8	153.71	479.21	32.94	50.39
9	155.02	292.58	30.03	55.29
10	166.79	393.90	14.55	60.05
11	206.34	526.43	28.83	39.95
12	247.74	598.52	59.26	31.61
13	191.79	577.89	53.57	84.52
14	180.28	541.65	30.95	51.45
15	159.65	538.60	21.82	61.51
16	138.75	564.40	91.93	64.28
17	152.77	523.13	49.47	76.85
18	112.69	345.62	27.25	50.53
19	189.94	453.16	24.21	51.98

Quarter	Colombia	Brazil	Angola	Ex-French West Africa
20	182.53	571.94	64.42	43.65
21	154.76	318.24	42.86	82.14
22	132.93	448.79	36.90	65.87
23	227.77	407.79	18.25	41.80
24	204.22	530.27	77.51	61.51
25	173.27	559.77	57.67	76.98
26	210.31	426.70	35.71	53.17
27	262.95	762.93	21.96	46.69
28	201.71	556.59	80.82	53.44
29	179.75	503.95	44.31	75.66
30	151.71	548.79	41.14	71.43
31	216.92	667.70	40.21	74.86
32	236.90	503.95	66.66	104.49
33	163.49	497.86	61.24	96.29
34	195.23	461.49	57.93	82.27
35	202.90	667.96	73.15	72.88
36	185.71	616.91	68.12	87.83

Source: Annual Coffee Statistics, 1953-61 (Pan American Coffee Bureau, New York)