An Analysis of the World Coffee Market*

Sung Y. Kwack
Howard University
Byung S. Lee
Howard University
B. Mutagwaba
University of Darest-Salaam

Fluctuations in the prices of primary commodities have caused variations in the export earnings of many developing economies. Because their economies have depended heavily on the earnings from those commodities, it is important to understand how prices of primary commodities are determined. This paper offers a theoretical model to explain the behavior of the world coffee market which makes a clear distinction between the inventory market and the flow market for commodities in affecting price. Then, the model is tested empirically to determine its ability to predict market results and to estimate the impacts on the world coffee market of a change in income and prices in the major importing economies

I. Introduction

Fluctuations in the prices of primary commodities have caused variations in the export earnings of many developing economies. This has created a great concern among economists and policy makers of a certain countries because their economies have depended heavily on the earnings from those commodities.[1] From a policy point of view, therefore, it is important to understand how prices of primary commodities are determined and why they vary so much.

A few earlier studies have analyzed both theoretical and empirical aspects regarding the determination of commodity prices.[2] For example, Adams (1981) and Adams and Behrman (1979) showed that

*We thank E.C. Hwa, John T. Bennett and Toni Osei for valuable comments.

[1]See Bhagwati (1986) and Johnson (1967).

[2]A very good reference on the market behavior of primary commodities like coffee and sugar and extensive empirical analyses includes Adams and Klein (1978) and Adams and Behrman (1978).

[Seoul Journal of Economics 1988, Vol. 1, No. 4]

the prices are determined by the change in inventories generated from the flows of consumption and output. Recently, Hwa (1985) showed empirically that prices are determined by inventories as well as the factors determining demand and output. Antonini and Kwack (1987) presented a theoretical discussion of the fundamental stock-flow nature of commodity price determination within a general theoretical framework which makes a clear distinction between the inventory market and the flow market for commodities.

In this paper, we offer a theoretical model to explain the behavior of the world coffee market which includes the role of inventory in affecting price. Then, the model is tested empirically to determine its ability to predict market results and to estimate the impacts on the world coffee market of a change in economic conditions in the major importing economies.

Section II of this paper describes the characteristics of the world coffee market. Section III sets up a theoretical model of the coffee market and analyzes the responses of the market to a shift in the demand for consumption and inventories. Section IV discusses the empirical results of the model. Section V provides a summary.

II. Characteristics of the World Coffee Market

Coffee is produced in tropical climates (mainly in Third World Nations) having mean temperatures of 80 degrees Fahrenheit and an average annual rainfall of about 50 inches. Each species of coffee has its own distinct taste. When processed for consumption as a beverage, arabica tastes better than robusta, but further soluble processing partially evens out the difference between the two. In Brazil, farmers dry coffee cherries in the sun and then remove the skin, leaving the coffee bean. In most other Latin American countries, cherries are pulped and fermented, the skin is removed, and the beans are dried. This results in good tasting coffee. This is why there is a distinction between washed and unwashed arabicas.

From 60-70 percent of the world's coffee is produced in Brazil, Colombia, El Salvador, Guatemala, Ivory Coast, and Indonesia. Arabica is mostly produced in the Western Hemisphere, while about 75 percent of robusta production comes from Africa, Asia, and Oceania. The coffee year is measured from April to March in Brazil and Indonesia, from July to June in Philippines and Tanzania, and from September to August in Ivory Coast.

New plantings of coffee require a period before they produce; two to three years for robusta and four to five years for arabica. Thus decisions on the capital stock (coffee trees) are made in response to producers' expectations about price and profit. However, changes in output as a result of these decisions do not occur for several years. Decisions on care and harvesting affecting output in the short-run are based on material and labor costs.

Yield depends on tree age, care, type of area, production cycle, weather and pest control. Coffee trees, especially arabica, have a two-year bearing cycle; they tend to bear light and heavy corps in alternate years. This cycle is not always consistent due to variation in weather and tree maturity. Coffee production dropped sharply to 52.6 million 60 kg bags in 1965 because of an earlier severe frost in Brazil. In the following year the coffee market recorded a high output of 82.2 million 60 kg bags aided largely by the recovery from frost in 1966 and a high output in Africa. Frost caused output of only 59.9 million 60 kg bags in 1971 followed by a recovery, especially in Brazil and Colombia, and high output in 1980-82 period.

The main consumers of coffee are the developed countries. They import over 70 percent of the world's output. Western Europe is the largest coffee consuming region in the world. Domestic consumption is substantial in Brazil, India, Indonesia, and Mexico. Most exports are in the form of beans, although Brazil has the greatest share of soluble coffee exports among the producers. There is greater demand for robusta coffee in soluble form rather than as beans, due to its better taste.

Coffee bean prices have fluctuated greatly over the years, like the prices of other beverages. The world coffee price is greatly influenced by the change in output of Brazil, the biggest coffee producer. Brazil's low production in 1977 contributed to very low world production (60.9 million bags) and a record high price of 262.9 cents per pound. A record high price during 1976-77 caused output to increase after a period of four years. A sharp decline in the coffee price in 1980-82 can be accounted for by over production in Colombia and Brazil, stagnant demand, and slow income growth in the industrialized countries.

The International Coffee Agreement established quotas for global and individual countries as a device to stabilize coffee prices after World War II.[3] The Agreement serves to keep prices from falling

[3]For the Coffee Agreement, see Akiyama and Duncan (1982, pp. 33-9) and for general

below a certain level or rising above an agreed limit. The first agreement was signed in 1941, with export quotas imposed as a tool for supporting prices. When its effectiveness appeared to diminish, another agreement was signed in 1962, which succeeded in halting declining prices; it was renewed in 1968. A new international commodity agreement was signed in 1976. The main measures of this agreement are global quotas set each year based on world consumption, production, and the expected change in stocks. The sharp decline in coffee prices in 1980 indicated the vulnerability of quota policies to market expectations, changes in demand, and high interest rates. In 1981 quotas were again introduced to halt declining prices. By and large, commodity agreements have managed to control prices within limits, especially defending the floor price by reducing or even suspending quotas when prices are low.

III. Structure of the Coffee Market

Analysis of the global coffee market must consider production, consumption, and inventories. The profit is the major variable determining the production of coffee. Using current profit as a proxy variable for the current as well as expected future profit, the profit function can be expressed as:

$$\pi = \pi(P, Q, P_q, X_1) \tag{1}$$

where π = profit level, P = price of coffee, Q = rate of production of coffee, P_q = price(s) of factor input(s), X_1 = other exogenous variable. By Hotelling's lemma, the supply function is derived from (1) as:

$$Q = Q(P, P_q, X_1), \quad \partial Q/\partial P > 0, \quad \partial Q/\partial P_q < 0 \cdot \tag{2}$$

Consumers are assumed to determine their consumption in order to maximize their utility subject to their budget constraint. The maximization problem is as follows:

$$\max U(C, S \mid X_2) + \lambda(Y - PC - P_s S) \tag{3}$$

where C = rate of coffee consumption, S = substitutes of coffee (juice, soft drinks, etc.), P_s = price(s) of substitutes(s), Y = the consumer's income, λ = a lagrange multiplier, and X_2 = other exo-

Commodity Agreements, Law (1975).

genous variables. Then the demand function is derived as:

$$C = C(P, P_s, Y, X_2),\ \partial C/\partial P < 0,\ \partial C/\partial P_s > 0,\ \partial C/\partial Y > 0 \quad (4)$$

Inventories are held for transaction and speculative motives. Inventories for transactions are assumed to be an increasing function of consumption. The desire to hold inventory for speculation depends on the differential between the current and future expected price and the interest cost of holding inventories. Thus, the demand for inventories, H, can be expressed as:

$$H = H(C, P, P^e, r, X_3),\ \partial H/\partial C > 0,\ \partial H/\partial P < 0,$$
$$\partial H/\partial P^e > 0,\quad \partial H/\partial r < 0 \quad (5)$$

where $H =$ the demand for stocks of coffee inventories, $P^e =$ the price expected to prevail at a future time, $r =$ interest rate, and $X_3 =$ other exogenous variables.

Together with equations (2), (4) and (5), an identity is introduced to complete the model. The identity is that at any point in time an excess of production over consumption must be equal to a change in the inventories.

$$H_{t-1} + Q_t = H_t + C_t \quad (6)$$

Equations (2), (4) and (5) are written in linear form to simplify our derivations later:

$$Q_t = a_1 P_t - a_1 P_{qt} + a_2 X_{1t} + U_{1t}, \qquad a_1 > 0 \quad (7)$$

$$C_t = -b_1 P_t + b_2 Y_t + b_3 P_{st} + b_4 X_{2t} + U_{2t}, \qquad b_1, b_2, b_3 > 0 \quad (8)$$

$$H_t = c_1 C_t - c_2 P_t + c_2 P_t^e - c_3 r_t + c_4 X_{3t} + U_{3t},\ c_1, c_2, c_3 > 0 \quad (9)$$

Equations (6) ~ (9) can be solved for four endogenous variables, Q_t, C_t, H_t, and P_t. In the short run where expected future price and the existing stock are predetermined, the solutions of endogenous variables are given in a matrix form, ignoring the X_{it} and U_{it}:

$$\begin{bmatrix} Q_t \\ C_t \\ H_t \\ P_t \end{bmatrix} = \frac{1}{a_1 + b_1 + b_1 c_1 + \dot{c}_2} \begin{bmatrix} d_{11} & d_{12} & d_{13} & d_{14} & d_{15} & d_{16} \\ d_{21} & d_{22} & d_{23} & d_{24} & d_{25} & d_{26} \\ d_{31} & d_{32} & d_{33} & d_{34} & d_{35} & d_{36} \\ d_{41} & d_{42} & d_{43} & d_{44} & d_{45} & d_{46} \end{bmatrix} \begin{bmatrix} P_{qt} \\ Y_t \\ P_{st} \\ P_t^e \\ r_t \\ H_{t-1} \end{bmatrix} \quad (10)$$

TABLE 1
EFFECTS OF CHANGES IN EXOGENOUS VARIABLES

	Short-Run				Long-Run			
	ΔQ	ΔC	ΔH	ΔP	ΔQ	ΔC	ΔH	ΔP
ΔY	+	+	?	+	+	+	+	+
ΔP_s	+	+	?	+	+	+	+	+
ΔP_q	−	−	−	+	−	−	−	+
Δr	−	+	−	−	0	0	−	0
ΔP^e	+	−	+	+	0	0	+	0

Notes:1. Short-run effects are from Equations (10) and long-run effects are from Equations (14).
2. Positive (negative) effects are shown by + (−).

where $d_{11} = -a_1(b_1c_1 + b_1 + c_2)$, $d_{12} = a_1b_2(1 + c_1)$,
$d_{13} = a_1b_3(1 + c_1)$, $d_{14} = a_1c_2$, $d_{15} = -a_1c_3$,
$d_{16} = -a_1$, $d_{21} = -a_1b_1$, $d_{22} = b_2(a_1 + c_2)$,
$d_{23} = b_3(a_1 + c_2)$, $d_{24} = -b_1c_2$, $d_{25} = b_1c_3$,
$d_{26} = b_1$, $d_{31} = -a_1(b_1c_1 + c_2)$, $d_{32} = b_2(a_1c_1 - c_2)$,
$d_{33} = b_3(a_1c_1 - c_2)$, $d_{34} = c_2(a_1 + b_1)$,
$d_{35} = c_4(a_1 + b_1)$, $d_{36} = b_1c_1 + c_2$, $d_{41} = a_1$,
$d_{42} = b_2(1 + c_1)$, $d_{43} = b_3(1 + c_1)$, $d_{44} = c_2$,
$d_{45} = -c_3$, and $d_{46} = -1$.

In the long-run equilibrium, $H_t = H_{t-1}$ and $P_t = P_t^e$, so that equations (6) and (9) become:

$$Q_t = C_t, \tag{11}$$

$$H_t = c_1C_t - c_3r_t + c_4X_{3t} + U_{3t}. \tag{12}$$

In the matrix form the model in the long-run state can be written as follows.

$$\begin{bmatrix} 1 & 0 & 0 & -a_1 \\ 0 & 1 & 0 & b_1 \\ 0 & -c_1 & 1 & 0 \\ 1 & -1 & 0 & 0 \end{bmatrix} \begin{bmatrix} Q_t \\ C_t \\ H_t \\ P_t \end{bmatrix} = \begin{bmatrix} -a_1 & 0 & 0 & 0 \\ 0 & b_2 & b_3 & 0 \\ 0 & 0 & 0 & -c_3 \\ 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} P_{qt} \\ Y_t \\ P_{st} \\ r_t \end{bmatrix} \tag{13}$$

This gives the long-run values for the tour endogenous variables:

$$\begin{bmatrix} Q_t \\ C_t \\ H_t \\ P_t \end{bmatrix} = \frac{1}{a_1+b_1} \begin{bmatrix} -a_1b_1 & a_1b_2 & a_1b_3 & 0 \\ -a_1b_1 & a_1b_3 & a_1b_3 & 0 \\ -a_1b_1c_1 & a_1b_2c_1 & a_1b_3c_1 & -(a_1+b_1)c_3 \\ a_1 & b_2 & b_3 & 0 \end{bmatrix} \begin{bmatrix} P_{qt} \\ Y_t \\ P_{st} \\ r_t \end{bmatrix} \tag{14}$$

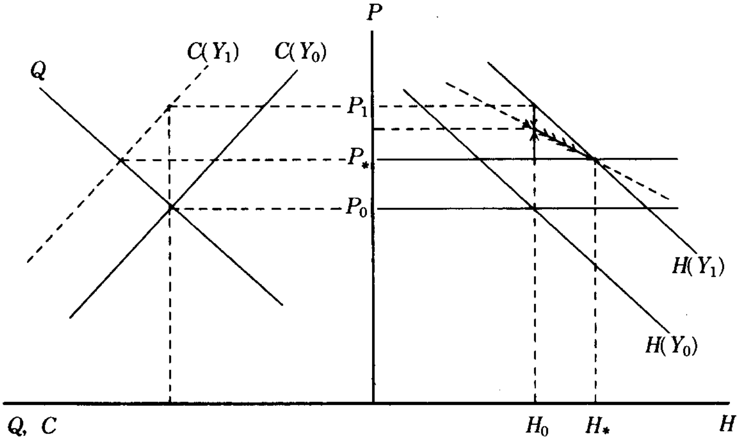

FIGURE 1

Based on equations (10) and (14), Table 1 summarizes the effects of a rise in foreign real income, the price of substitutes, the cost of production, the expected price, and the interest rate in both the short-run and the long-run. In the table, the signs of d_{32} and d_{33} are a priori indeterminate, depending upon the sign of $(a_1c_1 - c_2)$. A rise in either foreign income or the price of substitutes leads to a rise in the amount of coffee consumed, the demand for inventory, and the price of coffee. The rise in the coffee price stimulates production but affects the demand for inventories negatively. It is not clear whether the induced rise in production outweighs the induced decrease in the demand for inventory. In the short-run, it is likely that the effect on production is small and the effect on the inventory demand is large. But the effect of a change in price tends to rise over time, whereas the effect on inventory declines over time as the expected price is induced to rise. Thus, it is reasonable to assume that the signs of d_{32} and d_{33} are negative in the short-run, but positive in the long-run.

Consider a shift in demand for consumption caused by a rise in foreign income (and the price of substitutes). An increase in foreign income from Y_0 to Y_1 in Figure 1 will shift the consumption schedule from $C(Y_0)$ to $C(Y_1)$. At the initial price P_0 and inventory stock H_0, consumption exceeds output and a higher level of consumption raises the desired holding of inventories and reduces inventory. A rise in the demand for inventory results in a rise in the price level from P_0 to P_1. This rise in the price will cause a decrease in the

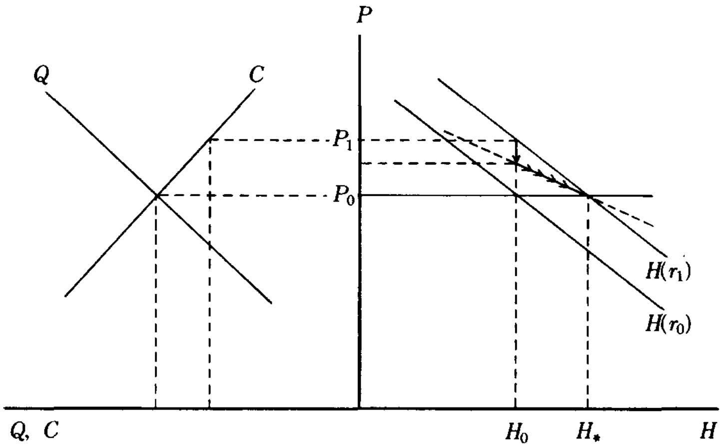

FIGURE 2

amount consumed and an increase in the output produced which in turn reduces the price level and raises inventory. This process will continue until the amount desired for consumption equals the amount produced and a long-run equilibrium is reached. In the long-run equilibrium, consumption, output, price and inventory holdings at P_* and H_* are higher than the levels that existed before the change in foreign income.

When the cost of production rises, it reduces the amount of output supplied at the existing price by shifting the production schedule. This results in a rise in price and a fall in both the inventory stock and consumption. After the adjustment of inventory and price is complete in response to a shift in the supply of output, the price is higher and consumption and inventory stock are lower in the long-run equilibrium. The above two cases show that any shift in demand for consumption or shift in supply function changes the price of coffee, consumption and output in the short-run as well as in the long-run.

Consider now a rise in the demand for inventories due to either a rise in the expected price or a decrease in interest rates. As seen in Figure 2, a fall in the interest rate to a level r_1 shifts the demand for inventories to $H(r_1)$. With the existing level of inventory, a rise in price to a level of P_1 equates the demand for inventory to the existing stock. The increase in price tends to reduce the amount consumed and increase output, resulting in an excess supply of output. The excess supply increases the level of inventory stock and lowers the demand for inventory. This causes the price to fall from the level attained before the change in the demand for inventory. As long as the amount desired for consumption is not equal to the output supplied, the price continues to fall and the inventory stock continues to rise. At long-run equilibrium, there are no changes in consumption, output, or price, but inventory rises.[4] This shows that a change in the demand for inventory by exogenous factors like price expectations and interest rates induces a change in consumption, output and prices temporarily, but does not permanently alter them.

IV. Empirical Analysis

The model of four structural equations will be tested with annual data for the world coffee market.[5] Proxy variables for those specified in the model are as follows: $QCF =$ production of coffee, measured in million 60 kg bags, which is the sum of output in a marketing year, mainly October to September for the major eight producing countries, Brazil, Colombia, Guatemala, El Salvador, Ethiopia, Ivory Coast, Indonesia, and Mexico; $PCF =$ world export price of coffee in U.S. cents per pound, which is an average of the prices of Colombian mild arabica, Guatemalan washed arabica, African robusta, and Brazilian unwashed arabica weighted by their respective shares of output; $CPB =$ a measure of the cost of production, which is an average of consumers' prices for two producers, Brazil and Colombia, weighted by their relative shares of output; $CCF =$ consumption of coffee measured in millions of 60 kg bags by the major ten consuming countries, Belgium, Canada, France, Germany, Japan, Italy, the Netherlands, Sweden, the United Kingdom, and the U.S.A.; $GNPCF =$ foreign real income in billions of U.S. dollars at 1980 prices and exchange rates, which is an average of real national

[4]For a detailed discussion on the transition from the short-run responses to long-run responses, see Antonini and Kwack (1987, pp. 48-9). A rise in the expected price leads to the initial overshooting in the price. The agents expect the future reduction in price via an excess supply. This would raise its desired inventories, thereby lowering actual price further, until a new equilibrium is reestablished at the original level of actual price.

[5]The data are from the International Monetary Fund's *International Financial Statistics* for consumer prices, exchange rates, Eurodollar rate and real *GNP*, and from the tapes of the World Bank data originally obtained from the World Bank, *Commodity Trade and Price Trends*, and the U.S. Department of Agriculture, *Foreign Agricultural Circular*, for world consumption, production, inventories, and price of coffee.

products of ten consuming nations weighted by their relative shares of consumption; HCF = world total (producer and consumer) inventory stock measured in millions of 60 kg bags.

Two stage least squares method was first used to estimate simultaneous equations (7)—(9). The initial results indicate that the price of coffee in the current period does not significantly affect the amounts produced and consumed in the current period. Consequently, the model becomes recursive, justifying the use of ordinary least squares to obtain unbiased estimates. The equations estimated by ordinary least squares, using annual data for the period 1968-1982, are as follows:

$$\begin{aligned} log(QCF) = & \underset{(103)}{4.21} + \underset{(3.53)}{0.060} \times \sum_{1}^{6} log(PCF_{-i} / CPB_{-i}) \\ & - \underset{(2.91)}{0.188} \times DUMCF \\ & R^2 = 0.682 \qquad D.W. = 1.86 \qquad SEE = 0.084 \end{aligned} \tag{15}$$

$$\begin{aligned} log(CCF) = & \underset{(0.31)}{0.207} - \underset{(5.11)}{0.203} \times log(PFC_{-1} / PFC_{-1}) \\ & + \underset{(6.23)}{0.631} \times log(GNPCF) - \underset{(1.74)}{0.069} \times DUM75 \\ & R^2 = 0.791 \qquad D.W. = 2.33 \qquad SEE = 0.038 \end{aligned} \tag{16}$$

$$\begin{aligned} log(HCF) = & \underset{(2.94)}{-23.141} + \sum a_i \times log(CCF_{-i}) + \underset{(3.91)}{0.146} \times \sum_{0}^{3} log(PCF_{-i} \\ & / PCF) - \underset{(5.1)}{0.128} \times TREND + \underset{(2.1)}{0.267} \times DUM74 \end{aligned} \tag{17}$$

i:	0	1	2	3	SUM
a_i:	1.77	2.01	1.79	1.12	6.69
t:	(2.77)	(3.56)	(3.06)	(2.67)	(3.54)

$R^2 = 0.905 \qquad D.W. = 1.42 \qquad SEE = 0.124$

$$HCF_{-1} + QCF + MP = CCF + HCF. \tag{18}$$

The figures in parentheses are t-statistics. R^2, $D.W.$, and SEE are the coefficient of determination adjusted for degrees of freedom, the Durbin-Watson statistic, and the standard error of estimate, respectively. $DUMCF$ is a dummy variable reflecting severe frost in Brazil in 1965, 1969, 1971, and global abnormal changes of weather in 1974, 1977, and 1982 (1 for those years mentioned). $DUM74$ is a dummy variable for extraordinary speculation in the coffee market in 1974 (1 for 1974). $TREND$ is a time trend variable. MP in euqation (18) is the very small amount of coffee products imported for consumption by producing countries (e.g., Braizil's imports of soluble processed coffee) and is treated as exogenous.[6]

The estimate of equation (15) shows that the production of coffee responds very little to a change in price in the short-run and gradually responds over a period of six years, reaching a price elasticity of about 0.4. The estimated price elasticities are similar to those in the short-run and in the long-run, 0.12 and 0.74, estimated by Akiyama and Duncan (1982, p. 15) and Hwa (1985, p. 319). A lagged production variable was used to try to capture the two year yield cycle of production as indicated by Wickens and Greenfield (1973) but without success. The dummy variable for weather is significant as expected in accounting for the effect of weather condition on production. Like the response of production, the price elasticity of consumption for coffee is found to be low, around 0.2, and the income elasticity is similarly low, about 0.6. These estimates are close to those given by Akiyama and Duncan (1982, p. 12) and Hwa (1985, p. 316).[7]

It is assumed that expectations about prices are formed by the holders of inventories in an adaptive Koyck manner; thus, expected prices are dependent upon current and past prices. This Koyck form of expectation is utilized in the estimation of equation (17) for the demand for inventories. The demand for inventories is somewhat inelastic with respect to a change in the expected price relative to the actual price. Further, the elasticity of the demand with respect to a change in consumption is 6, which seems to be very high.[8] The

[6]The inventory data series generated by a benchmark estimate and adjusted to compensate for the discrepancy between production and consumption are called "implied stocks" and utilized in the previous studies (Hwa 1979). However, this approach was not adopted in this paper, partly because our main interest lies in inventory behavior, and partly because the discrepancy between production and consumption is believed to be caused by reexported imports. Counting the processed coffee imported by producing countries for consumption results in double counting. The difference between total supply, $HCF_{-1}+QCF$, and total distribution, $CCF+HCF$, is regarded as imports for consumption by producing countries. Then, net consumption will be $CCF-MP$; it is adopted to avoid double counting.

[7]In a disaggregate study Akiyama and Duncan (1982) found income elasticities to be in a range of 0 to 2.0, zero for the United States and 0.6 for European countries. Price elasticities are from 0.1 to 0.4.

[8]Hwa (1985) uses a price equation which appears to be an inverted equation of the demand for inventories given in this paper. Although the parameter estimates are incomparable, the derived consumption elasticity from the equation of Hwa is about 6.

TABLE 2
THE EFFECTS ON COFFEE OF 1.0% INCREASE IN FOREIGN INCOME (*GNPCF*) AND FOREIGN CONSUMER PRICE (*PCF*)

	Year	$\%\Delta P$	$\%\Delta H$	$\%\Delta C$	$\%\Delta Q$
GNPCF	1	4.89	−0.98	0.63	0.00
	2	2.49	0.27	−0.34	0.28
	3	1.96	0.87	0.12	0.43
	4	1.00	1.67	0.23	0.55
	5	0.01	1.87	0.42	0.61
	Average	2.07	0.74	0.21	0.37
PCF	1	0.00	0.00	0.00	0.00
	2	1.96	−0.49	0.20	0.00
	3	0.41	0.16	−0.19	0.11
	4	0.69	0.22	0.12	0.14
	5	0.53	0.45	0.06	0.18
	Average	0.72	0.07	0.04	0.09

Note: 1. $\%\Delta$ indicates a rate of change of variable due to the shock in percent.

trend variable shows that the demand for inventory tends to decline over time at a rate of 0.12 per year. This negative trend may reflect the development of information and technology which has permitted holding inventories at a minimum cost. The Eurodollar interest rate turns out to be insignificant.

The estimated parameters of equations (15)—(17) above seem to be in line with our prior expectation. The performance of the model in predicting the behavior of the market needs to be examined next. The model is simulated dynamically over the period 1968-1982. From the dynamic simulation results, the root mean squared percentage errors computed for production, consumption, price and inventories are 6.77, 7.74, 35.9, and 10.7, respectively. These statistics and Chart 1 suggest that the model captures the general movements of production, consumption and inventory fairly well. However, price is not traced as closely as desired, perhaps, due to many missing variables such as the stock of coffee trees and labor costs, but they are difficult to quantify.

It is of interest to estimate the effect of a 1 percent exogenous increase in foreign income and foreign consumer prices on the endogenous variables in the coffee market. As seen in Table 2, an increase in foreign income causes on the average over the period of five years the coffee price to increase by 2 percent, production to rise by 0.4 percent and consumption to rise by 0.2 percent. The inventory stock is lowered in the first year as a result of rise in

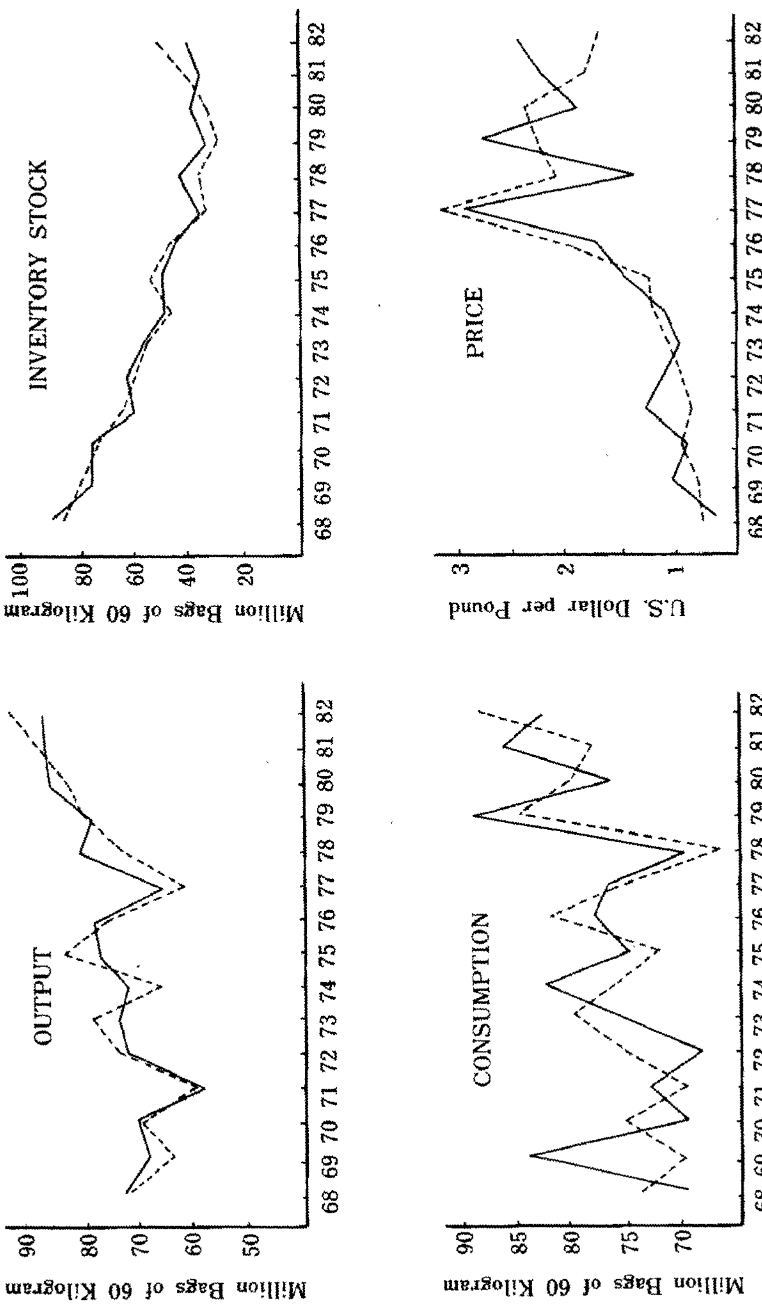

CHART 1
COFFEE MODEL DYNAMIC SIMULATIONS, 1968–1982(—— actual, ---- simulated)

consumption, but increased over time as production rises at a rapid rate. On the other hand a 1 percent increase in foreign consumer prices causes coffee consumption in coffee and price to rise after a time lag of one year by 0.2 and 1.9 percent, respectively. This lowers inventory. However, the initial overshooting of price reduces consumption in the second year and initiates a rise in production in the third year. A continuing excess of production over consumption and resulting increase in inventory tend to push down the rise in the price. As the fifth year passes, price, production, and consumption are increased by 0.6 percent, 0.18 percent, and 0.06 percent, while inventory stock are increased by 0.45 percent. On the average, a one percent rise in foreign prices seems to raise the coffee price 0.8 percent without changing output, consumption, and inventory stock significantly.

V. Concluding Remarks

The behavior of the world coffee market is affected by many factors. On the supply side, cost, quota, and weather conditions are major factors contributing to market results. On the demand side, disposable income and the prices of substitutes in consuming countries are shown to affect results. In addition, shifts in the demand for and supply of inventory by variations in the expected prices and costs are shown to vary greatly the price of coffee. An exogenous rise in the demand for inventories initiates a rise in the price and output of coffee and a decrease in the consumption of coffee in the short-run. In the long-run, however, the price is not affected permanently by the change. Contrary to a shift in demand for inventory, a shift in flow conditions of consumption and production permanently affects the inventory condition which generates a variation in the movement of prices.

Wide variations in coffee prices may encourage intervention by the governments of producing countries in order to stabilize coffee prices and in order to stabilize their export earnings. Export quotas have been used as the main tool for intervention. This study fails to find the significance of the variable representing the Coffee Agreement in affecting the price and quantity in the coffee market. This means that the intervention of the governments through quota has had limited effect in managing the movement of prices.[9] If quota is

[9]The limited effectiveness of the quota on the market is also discussed by Akiyama and

implemented as a means of reducing inventory and production, it would affect the price. But, over time, the cost of holding inventory by the governments would be excessive. Consequently, the governments cannot continue to intervene in the market to control price behavior over a longer period of time.

References

Adams, F. G. "Modeling the World Commodity Markets: Perspectives on the Use of Commodity Market Models for Forecasting and Simulation." *World Bank Commodity Models,* World Bank Commodity Working Paper No. 6. June 1981.

Adams, F. G., and Behrman, J. R., eds. *Econometric Modeling of World Community Policy.* Lexington: Lexington Books, 1978.

Adams, F. G., Behrman, J. R., and Ronald, R. "Measuring the Impact of Primary Commodity Fluctuations on Economic Development: Coffee and Brazil." *American Economic Review* 69 (May 1979) : 164–8.

Adams, F. G., and Klein, A., eds. *Stabilizing World Commodity Markets.* Lexington : Lexington Books, 1978.

Akiyama, T., and Duncan, R. C. *"Analysis of World Coffee Market."* World Bank Staff Commodity Working Paper No. 7. June 1982.

Antonini, A., and Kwack, S. Y. "Price and Inventory Dynamics of Primary Commodities." *International Economic Journal* 1 (Spring 1987) : 43–56.

Bhagwati, J. *The Economics of Underdeveloped Countries.* New York: McGraw-Hill, 1986.

Hwa, E. C. "Price Determination in Several International Commodity Markets: A Structural Analysis." *IMF Staff Papers* 26 (No. 1 1979) : 157–92.

________. "A Model of Price and Quantity Adjustments in Primary Commodity Markets." *Journal of Policy Modeling* 7 (Summer 1985) : 305–38.

Johnson, H. G. *Economic Policies toward Less-Developed Countries.* Washington: Brooking Institution, 1967.

Law, Alston D. *International Commodity Agreements: Setting Performance, and Prospects.* Lexington: Lexington Books, 1975.

Mutagwaba, Benjamin. *Behavior of Primary Commodity Market with an Application to Coffee, Cocoa, and Sugar.* Unpublished Ph. D. Thesis (Howard University), 1986.

Muth, J. F. "Rational Expectations and the Theory of Price Movements." *Econometrica* 29 (July 1961) : 315–35.

Duncan (1982, pp. 35–6). Its effectiveness is expected to be greater when prices are rising. Rising prices provide increasing revenues to producers, and thus, it is easier to get producers to keep the quota at the agreed level.

Newbery, David, M. G., and Stiglitz, J. *The Theory of Commodity Price Stabilization: A Study in the Economics of Risk.* New York: Oxford University Press, 1981.

Rangaranjan, L. N. *Commodity Conflict: The Political Economy of International Commodity Negotiations.* Ithaca: Cornell University Press, 1978.

Salant, Stephen, W. "The Vulnerability of Price Stabilization Schemes to Speculative Attack." *Journal of Political Economy* 91 (February 1983):1-38.

Wickens, M. R., and Greenfield, J. N. "The Econometrics of Agricultural Supply: An Application to the World Coffee Market." *The Review of Economics and Statistics* 15 (November 1973):433-40.

World Bank. *World Bank Commodity Models,* World Bank Commodity Working Paper No. 6. June 1981.