Analysis of Trends and Forecasts In Coffee Prices and Consumer Consumption In the Northeast and United States

by

D. Bonnell
University of Delaware
Department of Food and Resource Economics
Newark, DE

U. C. Toensmeyer
University of Delaware
Department of Food and Resource Economics
Newark, DE

J. R. Bacon
University of Delaware
Department of Food and Resource Economics
Newark, DE

A. Perez
University of Delaware
Department of Food and Resource Economics
Newark, DE

Introduction

In the five years ending in 1985/86, U.S. net imports of coffee averaged 32 percent of total imports of the International Coffee Organization (ICO) net importer member nations. The ICO consumer members account for approximately 90 percent of total world imports. Although the percentage has declined from the approximately 50 percent of world imports held in the 1950s, the United States is still the largest total and net importer of coffee in the world. As such, the direction of the trend in U.S. coffee consumption can have a strong bearing on the world trend.

Imports of green coffee into the United States are dominated by Brazilian (with unwashed mild arabicas) and Colombian coffee (colombian mild arabicas), as would be anticipated given the dominance of these two exporting countries along with the rate of absorption required in the United States. Moreover, Indonesia is the largest supplier of green robustas used primarily in the manufacture of soluble or instant coffee.

Per capita coffee consumption in the United States peaked in 1962 at 3.12 cups per person per day; declining almost steadily, it reached 1.76 cups per person per day in 1987. On a per capita basis, the 44 percent decline in coffee consumption was brought about by the growth in U.S. population during that period. Furthermore, loss in consumption was most heavily felt in the 20-29 age group where coffee is in strong competition with soft drinks and increasingly, with fruit juices. Nevertheless, recent years indicate a leveling off in the downward pace of per capita coffee consumption although neither an end in the downward trend

nor signs of a rejuvenation in consumption may be suggested.

The objectives of the study were to determine past and future trends in coffee prices and consumption for the Northeast and the United States and to describe the role of the International Coffee Agreement in affecting supply and demand and price of coffee to the U.S. consumer.

Methodology

Time series models for per capita coffee consumption in the United States and average monthly prices for ground roast coffee in the Northeast and the United States were developed using a nine-year series from 1980 to 1988. The Univariate Box-Jenkins Autoregressive Integrated Moving-Average (ARIMA) procedure in the Forecast Pro software was applied to the series. An ARIMA process is an algebraic statement exhibiting how a time series variable can be statistically related to its past values. Whenever the autocovariance function of a variable becomes a combination of intertemporal decay and truncation such that a zero autocovariance is obtained after p time periods, the function may be expressed as an autoregressive moving-average model of degrees p and q (ARMA [p,q]) and may be specified as:

$$Y(t) = a(i)Y(t-i) + b(j) + e(t) \qquad \text{EQ(1.0)}$$

where y represents the endogenous variable, a and b are parameter estimates, t is a time subscript, p and q denote the number of lags and e is a white noise error term. The statistical concept of correlation is used to estimate the relationship between observations within the series.

The ARIMA procedure is a highly recommended forecasting technique. In fact, when compared to individual econometric forecasts and expert opinion methods, the ARIMA performed substantially better in terms of price forecasting and tracking price movements (Brandt & Bessler). Moreover, ARIMA models are most applicable to short-term forecasting, placing more emphasis on more recent than distant past observations.

The use of a stationary time series is a condition in ARIMA analysis. The stationarity assumption simplifies the theory underlying ARIMA models and helps ensure that useful estimates of the parameters are generated from a moderate number of observations (Pankratz). The series is stationary when its mean, variance and autocorrelation are essentially constant through time.

Many non-stationary series encountered in economic applications can be transformed into a stationary series through the differencing procedure. This procedure deals with the calculation of successive changes in the values of a data series to eliminate any linear trend. The transformed series using an appropriate differencing operation most often has a mean of zero.

The estimated Autocorrelation Function (ACF) and the estimated Partial Autocorrelation Coefficient (PACF) were guides in choosing the appropriate ARIMA models. The estimated ACF calculates a correlation coefficient for each set of ordered pairs (Y_t, Y_{t+k}) and was generated using the standard formula:

$$r_k = \frac{\sum_{t-1}^{n-k} (Y_t - \bar{Y})(Y_{t+k} - \bar{Y})}{\sum_{t=1}^{n} (Y_t - \bar{Y})^2} \qquad \text{EQ (2.0)}$$

where r_k was a notation for the estimated ACF, Y_t for the value at period t, Y for mean value, n for the number of time periods.

The estimated PACF is basically similar to the estimated ACF although it also considers the effect of intervening observations. It can be calculated as follows:

$$\phi_{ll} = r_1$$

$$\phi_{kk} = \frac{r_k - \sum_{j=1}^{k-1} \phi_{k-1,\, j}\, r_{k-j}}{1 - \sum_{j=1}^{k-1} \phi_{k-1,\, j}\, r_j}, \qquad (k = 2, 3,\ldots) \qquad \text{EQ (3.0)}$$

where ϕ_{kk} is the estimated PACF and $\phi_{kj} = \phi_{k-1,\, j} - \phi_{kk}\, \phi_{k-j,\, k-j} (k = 3, 4,\ldots., j = 1, 2,\ldots,k - 1)$.

When the theoretical ACF of a stationary series decays and damps out toward zero at the same time that its theoretical PACF rapidly drops off to zero, after p time periods, the lag length of the last PACF spike equals the AK order. Alternatively, the theoretical ACFs of moving-average processes, processes that include past random shocks, cut off to zero after a certain number of spikes while their theoretical PACFs decay toward zero. The lag length of the last ACF spike equals the MA order (q) of the process.

The optimal number q AR(p) and MA(q) lags were based on the Schwarz Criterion (BIC) whose function is to balance complexity and goodness of fit of the model. The fit of the models was also evaluated using the coefficient of determination (R^2), a measure of the projection of the variation in the forecasted variable that was captured by the forecast.

Empirical Results

Based on the Schwarz Criterion, an ARIMA (1,0,1) was selected to best describe coffee prices in the Northeast and the United States. The monthly average coffee prices are therefore affected by coffee prices one month back and the corresponding random shocks in the model with the same lag period. The ARIMA procedure was unfit in describing the behavior of per capita coffee consumption in the United States. The consumption forecasts were unreliable because the model generated the same monthly consumption value for the forecast period 1988 to 1990. No alternative procedure was applied in estimating a per capita consumption model for coffee.

The estimated coefficients for the Northeast and the U.S. coffee prices are presented in Table 1.

The numbers inside the parentheses and brackets are the T-ratios and standard errors corresponding to the coefficient estimates, respectively. Basing judgment on the R^2 values obtained in the model estimation process (Northeast, 89%; and United States, 94%), the price models had a high degree of accuracy in predicting actual coffee prices over the period 1980 to 1988. The high R^2 values indicated that a high proportion of the variation in the forecasts were explained by the variable being forecasted. Table 2 presents the comparison between the actual and predicted Northeast and U.S. coffee prices for 1988.

The ability of the two price models to closely replicate the actual coffee prices implies that the models can be used in generating out of sample forecasts. The forecast values for coffee prices in 1989 and 1990 with the corresponding 95 percent confidence limit are presented in Tables 3 and 4, respectively.

Implications

The trends in coffee prices and per capita coffee consumption have significant implications on the overall market prospects for coffee. Coffee is an important commodity in international trade because it is second in rank to oil as an earner of foreign exchange in developing countries. International trade in coffee is dominated by the International Coffee Organization (ICO) whose members, consisting of both producing and nonproducing countries, comply with a coffee quota system under the International Coffee Agreement (ICA). However, only until recently (July 1989), the ICA fell apart since the United States, a major importing member nation of the ICO, disagreed on the two-tier pricing method of the agreement.

Per capita coffee consumption in the United States gradually decreased from 2.02 cups per person per day in 1980 to 1.76 cups per person per day in 1987. U.S. ground roast annual average coffee prices were $3.14 per pound in 1980 and stabilized at approximately $2.50 per pound until 1985; then they increased to $3.40 per pound in 1986 and decreased to $2.79 in 1987. Increasing preferences for other beverages such as fruit juices and soft drinks have been observed over the years as consumers become more aware of the negative health effects of caffeine. The presence of more substitutes implies that coffee is a more price sensitive commodity.

Based on the assumption that the ICA is still in effect, the downward trend in the 1989 and 1990 forecasts for coffee prices can be generally explained by changes in tastes and preferences as more and more consumers become more health conscious. In addition, the long time existence of the ICA indicates the possibility of promoting overproduction in the long run. In a perfectly competitive market, production investment is regulated by price. In a market regulated by export quotas that are adjusted up or down by prescribed prices, however, the price signal to reduce production is diluted (Bonnell 1988). The structure regulations set by the ICA encourages individual nations to invest in production because noninvestment would cause a reduction in their export market share.

In light of the recent termination of the ICA, coffee prices have been unstable and generally falling in the short run because producers can sell at quantities higher than the set quotas, i.e., selling at prices below the set agreement. Efforts are, however, being made by the United States and Colombia to reinstate international quotas on coffee exports to support world coffee prices.

Table 1

Parameter Estimates, T-Ratios, and Standard Errors for the Northeast and U.S. Coffee Price Models, 1980-1988.

Parameter	Estimated Coefficient	
	Northeast	United States
A[1]	0.87132 (9.359) [0.093931]	0.951439 (10.728) [0.088690]
B[1]	-0.338800 (-3.436) [0.098606]	-0.480524 (-5.484) [0.087620]
CONSTANT	0.331853	0.133836
R^2	0.892	0.940
BIC	0.114282	0.085909

Source: Calculations

Table 2

Actual and Predicted Average Monthly Prices Per Pound of Ground Roast Coffee In the Northeast and United States, January - December 1988.

Month	Actual		Predicted	
	NE	US	NE	US
1	2.715	2.635	2.639	2.566
2	2.730	2.665	2.744	2.674
3	2.710	2.634	2.727	2.665
4	2.783	2.699	2.709	2.625
5	2.863	2.729	2.804	2.737
6	2.872	2.735	2.869	2.726
7	2.909	2.784	2.858	2.740
8	2.958	2.834	2.907	2.804
9	2.927	2.840	2.950	2.845
10	2.975	2.855	2.897	2.834
11	2.952	2.892	2.974	2.860
12	3.063	2.925	2.920	2.901

Source: Calculations

Table 3

Predicted Average Monthly Coffee Prices in the Northeast and the United States, January - December 1989

Month	Forecast		Lower (95%)		Upper (95%)	
	NE	US	NE	US	NE	US
1	3.073	2.920	2.845	2.757	3.302	3.100
2	3.034	2.920	2.673	2.620	3.394	3.220
3	2.999	2.912	2.563	2.532	3.434	3.293
4	2.968	2.904	2.482	2.464	3.454	3.346
5	2.941	2.897	2.420	2.408	3.463	3.387
6	2.918	2.891	2.370	2.361	3.465	3.420
7	2.897	2.884	2.331	2.321	3.463	3.447
8	2.879	2.878	2.298	2.286	3.459	3.470
9	2.862	2.872	2.271	2.255	3.454	3.489
10	2.848	2.866	2.249	2.228	3.442	3.518
11	2.836	2.861	2.230	2.203	3.442	3.524
12	2.825	2.856	2.214	2.182	3.436	3.530

Source: Calculations

Table 4

Predicted Average Monthly Coffee Prices in the Northeast and the United States, January - December 1990

Month	Forecast		Lower (95%)		Upper (95%)	
	NE	US	NE	US	NE	US
1	2.815	2.851	2.201	2.162	3.430	3.540
2	2.807	2.846	2.189	2.144	3.425	3.549
3	2.800	2.842	2.180	2.128	3.419	3.556
4	2.793	2.838	2.172	2.113	3.414	3.562
5	2.787	2.834	2.164	2.100	3.410	3.568
6	2.782	2.830	2.158	2.088	3.406	3.572
7	2.778	2.826	2.153	2.077	3.402	3.576
8	2.774	2.823	2.149	2.067	3.399	3.579
9	2.770	2.820	2.145	2.057	3.396	3.582
10	2.768	2.817	2.141	2.050	3.394	3.584
11	2.765	2.814	2.139	2.041	3.391	3.586
12	2.762	2.811	2.136	2.034	3.389	3.588

Source: Calculations

Summary and Conclusions

In general, the coffee price models for the Northeast and the United States had a high degree of accuracy in predicting the actual prices in the period 1980 to 1988. There was a general downward trend in the out-of-sample forecast values generated by the two models for the period 1989 to 1990. Changes in coffee per capita consumption were explained by a decrease in coffee demand due to changes in consumer tastes and preferences rather than to price. The trend in the forecast prices, on the other hand, is attributed to the export quotas set by the International Coffee Agreement. The possibilities of reinstating the export quotas may be one solution to increase coffee prices in the short run.

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