Structural Change, Rents Transferring and Market Power in the International Coffee Market: A Time Series Analysis

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Introduction

In recent years, Vector Error Correction (VEC) models have been applied to examine the dynamics of food and fiber markets. These applications have considered issues such as market efficiency in temporal and spatial dimensions (Sabuhoro and Larue, 1997; Yang and Leatham, 1998), pricing strategies under oligopoly (Vickner and Davies, 2000), as well as price spreads of agricultural commodities (Chang and Griffith, 1998). This work shows how the use of VEC models can be extended to examine the dynamics of market structure and market power in international trade of agricultural commodities, focusing on the case of coffee.

In developing countries, the value of coffee exports ranks second after oil, making this commodity an important source of foreign exchange. The international coffee market has experienced substantial changes in recent years. Before 1990, most coffee exporting countries were part of the International Coffee Agreement (ICA) which fixed a system of export quotas to meet a target price above competitive prices (Bates, 1997). Importing countries supported ICA probably because they saw it as an efficient way to provide assistance to developing countries (Bohman, Jarvis and Barichello, 1996). In 1990, however, ICA was eliminated and exporters relied on competition to maintain or gain market share in international markets. We hypothesize that ICA's elimination did not lead to competitive markets but instead to a transfer of market power from exporting countries to international wholesalers. The data are monthly coffee prices (dollars per pound) for the period January/1982 through January/2000 in the New York Stock Exchange (international price) and the consumer price (retail price) reported by the U.S. Department of Agriculture.

The study follows three steps to assess the changes in the international coffee market. First, Box-Jenkins techniques are applied to examine the underlying stochastic process of producer and retail coffee prices time series. These analyses contribute to identify differences in price formation before and after ICA's suspension. Next, a VEC model is estimated to analyze the long-run relationship between retail and producer coffee prices. Changes in the gap between these two variables (the marketing margin) indicate transfers of rents between economic agents participating in the international coffee market. Finally, tests of weak exogeneity on producer and retail prices contribute to determine whether exporting countries became price-takers after 1990.

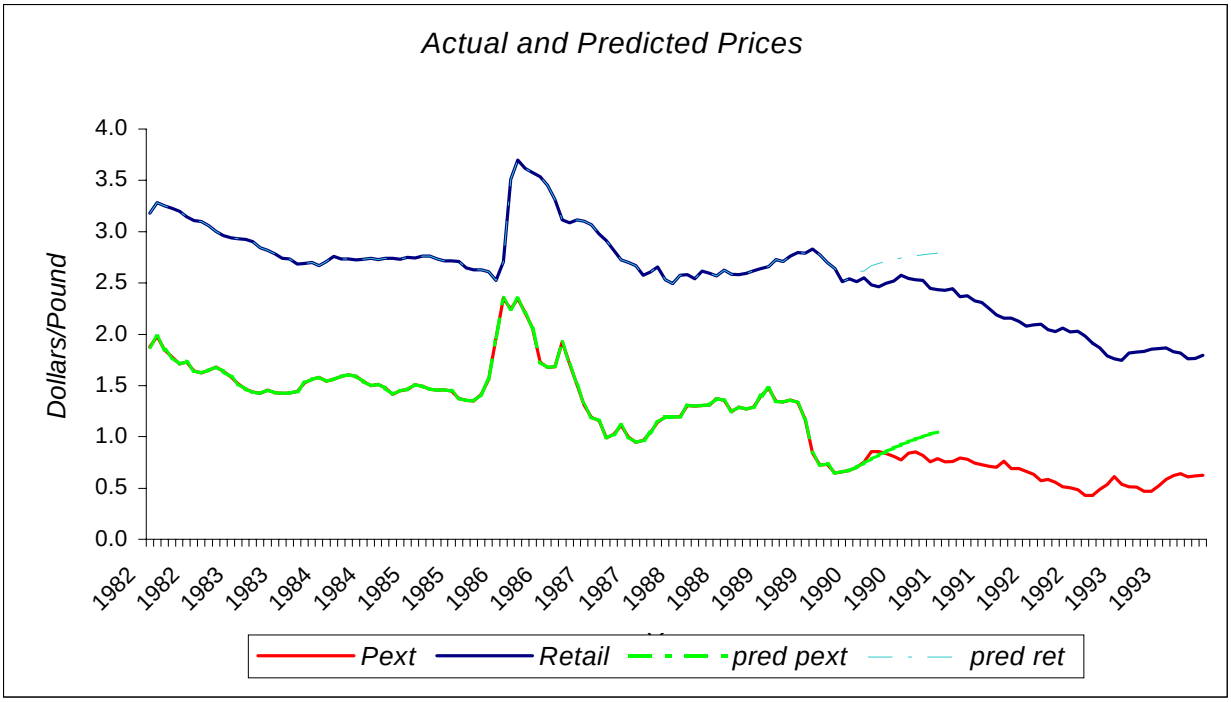
Findings suggest that ICA's elimination affected the stochastic process of producer prices, while that for retail prices did not change. Furthermore, the VEC model estimators indicate that the gap between retail and producer prices have increased in the long-run. If the process of price formation has changed and transfer of rents has occurred, the question is what the resultant market structure is. Under ICA, exporting countries behaved as an oligopoly, and as a consequence exporting countries endogenized prices while consumers were price-takers. The tests of weak exogeineity for producer prices indicate that exporting countries lost market power after 1990. Changes in formation of international prices, increased marketing margins and loss of market power show a transfer of rents from coffee exporting countries to international wholesalers.

Prices Structures and Structural Change in the Coffee Market

Figure 1 suggests that falling coffee prices through 1995 were the result of a long-run trend not related the termination of the export quota system in 1990. Tests of structural change

confirm this result.[1] Nevertheless, examination of the stochastic processes of price time series yields a different result.

Figure 1. Actual Versus Predicted Coffee Prices



The first step is to examine the stochastic processes of retail and international price series. The Box-Jenkins iterative process of identification, estimation and diagnostic checking for the period 1982-2000 lead to an ARIMA(5,1,1) and ARIMA(0,1,1) for international (or

[1] Models explaining international and retail prices as dependent variables were regressed with their own lags and production levels. Chow tests were not significant even at the 10% level and the dummy variable measuring the impact of the coffee agreement was not significant in any specification.

producer) and retail prices respectively.[2] These specifications result in white noise residuals, minimize the Akaike Information Criterion as well as the Schwarz Bayesian Criterion, and yield significant estimated coefficients. In addition, according to the Dickey-Fuller tests both international and retail price time series are integrated of order one, *I(1).*

An alternative to traditional structural change tests (i.e., Chow) is the use of Box-Jenkins techniques to test whether price formation in the international coffee market changed after 1990. In particular, one can use information prior to 1990 to forecast subsequent monthly prices and compare them to actual prices for those months. Another possibility is to breakdown the analysis into two periods (before and after 1990) thus testing for differences in the stochastic process of prices between periods. These two approaches were performed. Figure 1 shows actual and predicted prices for the twelve months following the elimination of the export quota. It shows that the model predicted increased prices after 1990 when in fact both retail and producer prices continued falling. Although many other factors explain the gap between actual and forecasted prices, these forecasts contribute to characterize the problem and to further study changes in price formation.[3]

Applying Box-Jenkins techniques to price time series before and after ICA's dissolution leads to interesting results. Considering producer prices, the underlying process for the periods 1982-1989 and 1990-2000 can be represented as an ARMA(1,1) and an ARIMA(5,1,0), respectively. As expected, these results suggest that something did change in the formation of

[2] Coffee prices in the New York Stock exchange are considered the price received by exporting countries.

[3] The confidence interval for ARIMA processes is increasing in the number of forecasts and measurement errors also lead to deviations from actual price time series.

producer prices after the elimination of the quota system. In contrast, the stochastic process of retail prices is the same ARIMA(0,1,1) for the two periods. Consequently, the relationship between producers and retail prices was also affected by the elimination of the coffee agreement.

Summarizing, in contrast with the conclusions obtained from conventional tests, Box-Jenkins procedures indicate that ICA did make a difference in the formation process of producer prices. It is possible that conventional tests of structural change are inconclusive because coffee prices were falling substantially prior to ICA's dissolution and therefore, they fail to identify changes in the trend of the price time series. Accordingly, prices followed a different dynamics after 1990. Examination of the stochastic properties of individual time series indicate the need to characterize the dynamics of the relationship between producer and retail prices and the subsequent transfer of wealth between the economic agents participating in the coffee market.

Prices Relationship and Rents Transferring

The analysis above led to the conclusion that both producer and retail price series are *I(1)*. According to Engle and Granger (1986), it is possible for a linear combination of these two series to be *I(0)* (i.e., stationary). In that case, the series are said to be cointegrated. Therefore, a restricted Vector Autoregression (VAR) is adequate. In this case the most appropriate is a Vector Error Correction (VEC) model because it allows for identification and testing of the long-run relationship between series as well as the dynamic adjustment towards equilibrium. Furthermore, the VEC model can be used to test for exogeinity to examine the capacity of producers to influence prices. The VEC model specification is as follows:

$$\Delta IP_t = \alpha_0 + \alpha_1 \Delta IP_{t-1} + \alpha_2 \Delta RP_{t-1} + \phi_1 (IP_{t-1} - \gamma RP_{t-1}) + \varepsilon_{1t} \qquad (1a)$$

$$\Delta RP_t = \beta_0 + \beta_1 \Delta IP_{t-1} + \beta_2 \Delta RP_{t-1} + \phi_2 (IP_{t-1} - \gamma RP_{t-1}) + \varepsilon_{21t} \qquad (1b),$$

were IP_t and RP_t are international and retail prices respectively; γ is the long-run relationship between price series; ϕ_1 and ϕ_2 are the adjustment coefficients; and ε_1 and ε_2 are the random errors. The cointegration test shown in Table 1 suggests the presence of one cointegrating equation since the trace value (119.06) is higher than the critical value (19.99). According to the test, the model does not have linear drift because the *p-value* for the chi-squared statistic does not allow rejecting the null of linear drift different from zero.

Table 1. Johansen Cointegration Test Results

Cointegration Rank (No linear drift in the process)					
H_o: Rank=r	H_A: Rank>r	Eigenvalue	Trace	Critical Value	
0	0	0.3912	119.06	19.99	
1	1	0.0535	8.89	9.13	
Test of No-linear Drift when Rank=r					
Eigenvalue Rank	Eigenvalue on Restricted	Eigenvalue	Chi-Square	DF	Prob>ChiSq
0	0.3912	0.3892	0.88	2	0.6426
1	0.0535	0.0527	0.20	1	0.6532

Although these results are intuitive (i.e., retail and producer prices move together), the possibility of a long-run gap between producer and consumer prices would suggest continuous transfer of profits. The VEC model results presented in Table 2 contribute to examine the long-

run relationship and the adjustment between retail and international prices. The long-run coefficients (1 and 1.157 for international and retail prices respectively) indicate that in the long-run retail prices move away from international prices suggesting that transference of rents have occurred in coffee market. This divergence between international and consumer prices implied by a coefficient of 1.157 means that exporters obtained increasing profits throughout the period 1982-2000. However, it is not possible to reject the null hypothesis that this coefficient equals one or that the commercialization margin was constant. Adjustment coefficients imply that retail prices adjust to long-run patterns while international prices have a certain degree of exogeinity. In fact, the VEC model has a strong explanatory power for retail prices but not so for producer prices.

Table 2. Vector Error Correction Model Parameter Estimates

Long Run Parameters	
IP	1.0000
RP	-1.1574
Adjustment Coefficients	
IP	0.0671
RP	0.1341

	Dependent Variable: Change in Price	
Variable	International Price (IP)	Retail Price (RP)
Intercept	0.118 (0.04)[a]	0.244 (0.00)
Adjustment Coefficient	0.067 (0.03)	0.134 (0.00)
ΔIP_{t-1}	0.148 (0.07)	0.276 (0.00)
ΔRP_{t-1}	0.016 (0.08)	0.347 (0.00)
R^2	0.088	0.495
Prob>F	0.000	0.000

[a] Significance levels are in parenthesis.

Results are different when the analysis is split into two periods (before and after 1990). Table 3 summarizes the long-run and adjustment coefficients for international and retail prices for the periods 1982-2000, 1982-1990 and 1990-2000. The first column is the results from Table 2, the second shows the characteristics of price relationships during ICA and, for comparative purposes, the third shows the consequences of eliminating the export quota regime. The Table shows that coffee producers transferred their rents to traders after 1990 as indicated by a decreasing long-run relationship (0.81) between consumer and international prices. In contrast, international prices were an increasing fraction of retail prices during the period when the export quota system was in place (1.65). Note the evolution of the long-run coefficient for producer prices from 1.65 for the period 1982-1990 to 0.8 for 1990-2000. These findings suggest that after 1990 the marketing margin increased so economic rents were transferred form producers to wholesalers.

Table 3. Long-Run Parameters and Adjustment Coefficients at Different Periods

Period	**1982-2000**	**1982-1989**	**1990-2000**
	Long Run Parameters		
International Price	1	1	1
Retail Price	-1.1574	-1.6562	-0.8097
	Adjustment Coefficients		
International Price	0.0671	0.0529	0.1590
Retail Price	0.1341	0.1225	0.3192

Exogeinity tests and Market Power

Under ICA's export quota system exporters operated under oligopolistic competition with price-setting power. From a time series perspective, producer prices were determined exogenously while retail prices were conditioned to movements in the supply side (endogenous).

This fact is illustrated in Table 3 by the small adjustment coefficient of international prices (0.06) when compared with that for retail prices (0.13). Therefore, for the whole period of analysis, retail prices adjusted to changes in international prices. This exogeinity means that producers had the ability to set prices and in turn wholesalers transferred price changes to consumers. However, splitting the series into two periods indicate substantial changes in the adjustment coefficients. Table 3 shows that after 1990, producer prices became highly responsive to market trends as expressed by the change in the adjustment coefficient from 0.05 to 0.16 for 1982-1989 and 1990-2000 respectively.

Table 4. Weak Exogeneity Tests Results

	Probability > Chi Squared		
Period	1982-2000	1982-1989	1990-2000
International Price	0.0618	0.2207	0.0716
Retail price	0.0001	0.0008	0.0001

A test of weak exogeinity helps to further demonstrate this conclusion. Table 4 reports the results showing the probability to reject the null hypothesis of weak exogeinity for both series based upon the adjustment coefficients. For the period 1982-2000, evidence shows that at a 10% significance level, producers did not have the ability to set prices. However, dividing the series into two periods (before and after ICA's elimination), the model results suggest that exporters set prices during the period 1982-1989, thus reflecting their market power. In contrast, for the period 1990-2000, they became price takers in the sense that prices are given exogenously to them. This change implies market power losses faced by producers after the coffee agreement breakdown. This finding, together with the fact that the stochastic process of retail prices did not

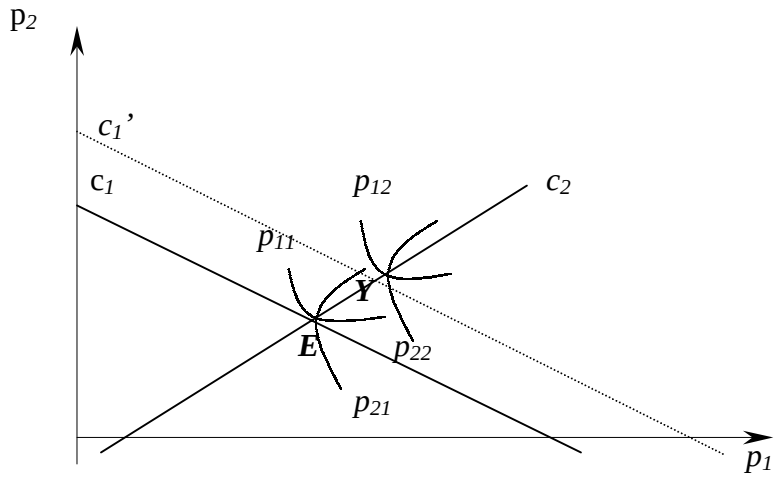
change, support the hypothesis that the elimination of the export quota regime resulted in a transfer of economic rents from exporting countries to international wholesalers.

Interpretation of Results Using a Framework of Imperfect Competition

Findings of the time series models developed above can be interpreted in a theoretical framework of imperfect competition. The results suggest that coffee is a differentiated tradable good in an imperfect competitive market. Therefore, game theory can be applied to represent the behavior of economic agents participating in this market. The ICA export quota system is a collusion of producers associated with a Cournot model of imperfect competition. After 1990, however, a transition towards price competition took place. As a result, a Bertrand competition model is more appropriate to examine the international market for coffee after the elimination of the quota system.

As in most agricultural products where producers are not directly involved in marketing, intermediaries play an important role in the export of commodities from developing countries. These international wholesalers influence the coffee market by adding value and making products available to consumers in importing countries. Furthermore, international wholesalers often form oligopolies able to influence quantities and prices in international markets. Consequently, if wholesalers agree to reduce supply, they can achieve higher profits through higher prices while maintaining their market shares. But there is also a relationship between wholesalers and producers given by prices. The higher the producer prices, the lower the wholesaler profits are because of constraints imposed by oligopolistic competition. The interaction between exporting countries and international wholesalers can be examined using a Bertrand competition scheme (Figure 2).

Figure 2. Bertrand Model of Imperfect Competition



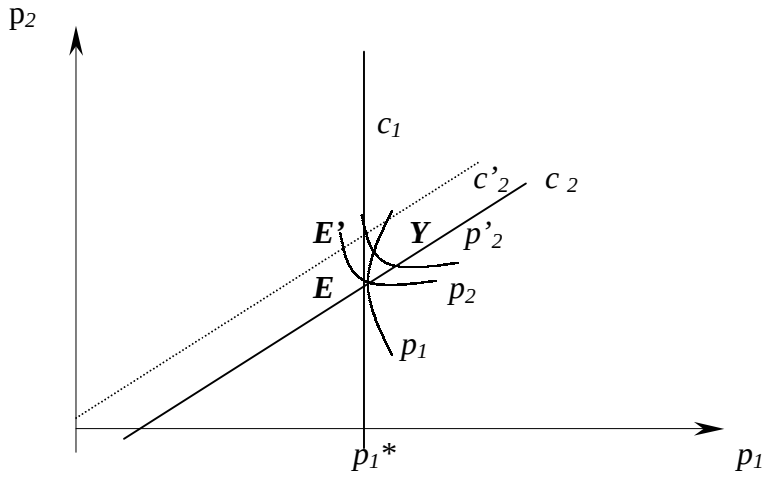
In Figure 2, the vertical axis represents the wholesaler price and the horizontal axis represents the producer price. Producer profits increase with the price received by its production, so the reaction curve for producers (c_1) is downward sloping. Wholesaler profits increase with the retail price and with price negotiation with producers. Then the reaction curve *(c_2)* is upward sloping. Equilibrium is reached where iso-benefit curves for both agents meet with the optimal prices conditioned to the other agent's decision is at point *E*. Note that profits to both producers and wholesalers increase when the reaction curve c_1 shifts to the right.

If producers set prices beyond this equilibrium then wholesaler profits decrease. If wholesaler prices increase moving from iso-profit curve p_{11} to p_{12}, an increase in production takes place (a shift in the reaction curve to c_1*'*) leading to welfare gains from employment and income. These welfare gains are independent of the rate of profits, which can change and lead to re-distribution of welfare between economic agents. This uncertain outcome comes from the new iso-profit curve *(p_{22})* associated to the resultant reaction curve *(c_1'*). Furthermore, region ***Y*** in

Figure 2 shows that it is possible to increase profits for both agents through price and/or output agreements. This was the case of ICA, which was an export quota regime supported by importing countries for political reasons.

The findings suggest that exporting countries lost market power after 1990, when coffee producers became price-takers in international markets. Since they could not continue to influence prices, the reaction curve of producers is vertical and there is not an expansion path for their profits (Figure 3). In this context, the alternative for exporting countries to increase their profits is to shift their reaction curve, which implies either technological improvement or market share gains. For wholesalers however, it is possible to increase profits by lowering producer prices without sacrificing market share.

Figure 3. Bertrand Model Illustrating Exporting Countries' loss of market power



Note that in region **Y** (Figure 3), wholesalers can increase profits (along reaction curve c_2) without changing the profit for producers by moving from the iso-profit curve p_2 to p'_2 without changing producer's iso-profit p_1, or can even improve the producer price for higher profit levels. However, oligopolistic competition limits the wholesaler's price-setting capability

and the equilibrium stays at point ***E***. Therefore, reductions are more likely than increases in producer prices. Furthermore, long-run changes in prices or in marginal revenue of the firms might shift the wholesaler's reaction curve to the left. In that case, the wholesaler can obtain all the benefits of such shift by moving to the iso-profit curve p'_2 while holding producer prices fixed at p_1*. The model's results favor the representation in Figure 3.

This relationship between wholesalers and producers may be presented analytically as

$$p_1 = \alpha_0 - \alpha_1 x_1 + \alpha_2 x_2 \qquad (2a)$$

$$p_2 = \beta_0 - \beta_1 x_2 - \beta_2 x_1 \qquad (2b),$$

where p_1 is the producer price, p_2 is the retail price, x_1 and x_2 are production and retail sales respectively. Increases in output reduce prices as measured by the price elasticity α_1. Producers' behavior is different from that of the wholesaler because higher demand levels positively affect the producer prices as measured by α_2. In the second equation, β_0 represents the long-run retail price and β_1 represents price elasticity of demand. β_2 is the cross price elasticity in the international market and provides a measure of producer's market power.[4]

Equilibrium prices are obtained from profit optimization for producers and wholesalers,

$$p_1 = \frac{(\alpha_0 + m_1)}{2} - \frac{1}{2}\frac{\alpha_2}{\beta_1}(p_2 - \beta_0) \qquad (3a)$$

$$p_2 = \frac{(\beta_0 + m_2)}{2} + \frac{1}{2}\frac{\beta_2}{\alpha_1}(p_1 - \alpha_0) \qquad (3b)$$

[4] β_2 shows the ability of producers influence prices and can be associated with negotiation power.

Note that in the case of producer prices above the equilibrium, wholesalers transmit the differential to the consumer as measured by the expected positive coefficient β_2 / α_1. In contrast, producers face lower prices when market prices deviate from the long-run equilibrium. This is due to both, the lower quantity demanded because of higher prices as well as the unilateral scheme of profit transmission from wholesalers to producers established in this model. Consequently, producers experience the impact of depressions in quantities and do not have the ability to affect prices.

The empirical model supports this framework of analysis. The cointegration tests indicate that that the system moves towards the long-run equilibrium (point *E* in Figure 3). The slow adjustment of international prices implies that $\alpha_2 / \beta_1 \rightarrow 0$ and thus the reaction curve resembles a vertical line, which validates the analysis above. Furthermore, exogeneity tests indicate that producers have lost the ability to influence prices and that the long-run marketing margin is increasing.

Conclusion

This study uses time series techniques to identify structural changes in international markets of agricultural commodities. These techniques might be an attractive alternative relative to structural models when data is scarce and when prices satisfy certain stochastic conditions such as the presence of cointegrated series. The benefits of using a VEC model, which is a restricted type of VAR models, are that it allows for the identification of the long-run relationship between price time series and for examining the process of adjustment towards the

equilibrium. Additionally, the paper showed how the results obtained from time series analysis can be interpreted in a Bertrand model of imperfect competition.

Time series techniques were applied to examine changes in the international coffee market resulting from the elimination of the export quota agreement in 1990. The findings show that the stochastic process of price formation did change after 1990. Furthermore, the VEC model estimators indicate that the long-run gap between retail and producer prices have increased. Additionally, tests of weak exogeineity for producer prices indicate that exporting countries lost market power after 1990. Changes in formation of international prices, increased marketing margins and loss of market power suggest the occurrence of welfare re-distribution from coffee exporting countries to international wholesalers.

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