Journal of Agribusiness

John C. Bergstrom, Editor

Volume 33 Number 1 Fall 2015

Articles

Journal of Agribusiness 33, 1 (Fall 2015)

Price Adjustment and Market Power in the Colombian Milds Coffee Market

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The coffee industry has been characterized by a few large buyers as well as lower and more volatile producer prices since the 1990s. This paper investigates the price adjustment between producer and world coffee prices along the supply chain of coffee. The results show that the producer price and the world price are adjusted asymmetrically and the causality is unidirectional from the world price to the producer price. Market power, a possible explanation for the asymmetric price adjustment, significantly affects the price relationship between upstream and downstream prices. These results have important implications for policy-makers and producers. Better organization of coffee producers can increase their bargaining power with the buyers in the market, which may result in higher prices at the farm level.

Key words: Colombian milds, market power, price adjustment

According to the International Coffee Organization (ICO), the cost of production has been rising in many coffee-producing countries during the past years. World coffee bean prices have shown large fluctuations (Figure 1).

Farmers sometimes sold coffee at a price that did not cover costs (Mehta and Chavas, 2008). In the literature, this situation is termed as the "coffee crisis" (Daviron and Ponte, 2005). In contrast, consumer prices have increased, and have not fluctuated as much as producer coffee bean prices (Figure 2).

Consumers can now choose from a variety of coffee offerings including various roasting, brewing, and grinding methods, packaging, and flavorings. The emergence of organic, fair-trade, and sustainable coffees in specialty markets have given rise to a "coffee boom" in coffee-consuming countries such as the United States, Italy, Germany, and Sweden (Daviron and Ponte, 2005; Durevall, 2007; Rotaris and Danielis, 2011). Figures 1 and 2 depict the divergent trend of coffee prices in the coffee-producing and -consuming countries.

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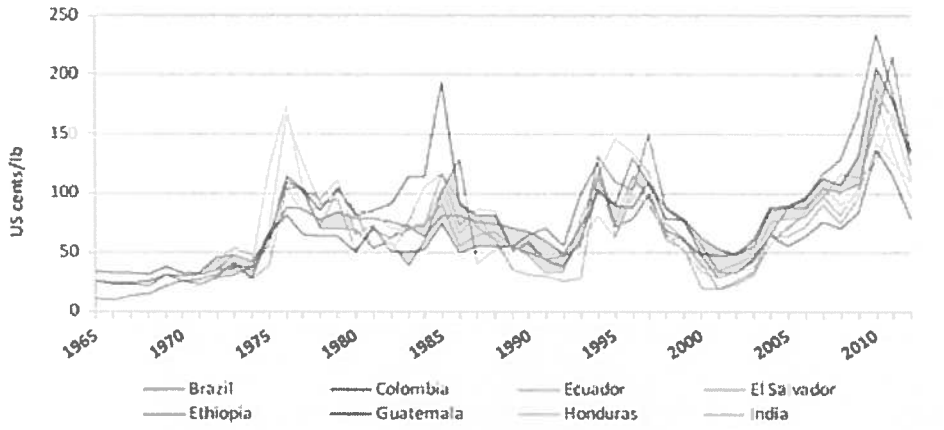

Figure 1: Prices Paid to Growers in Selected Coffee Exporting Countries
Source: International Coffee Organization

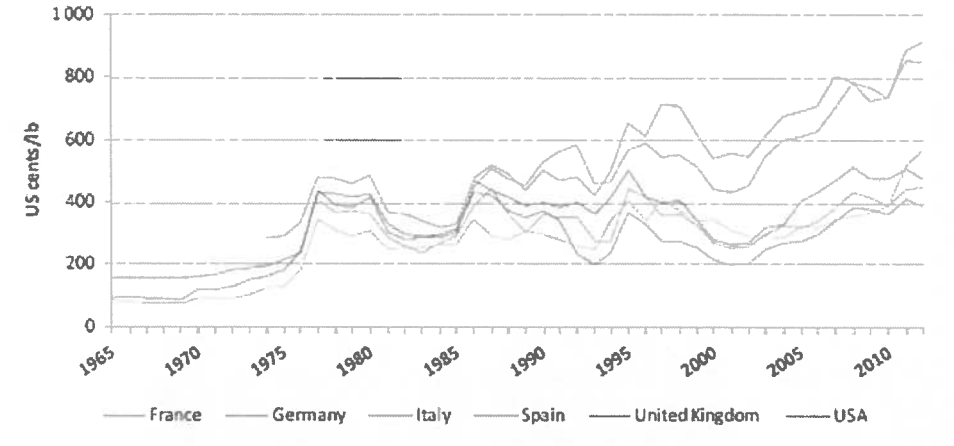

Figure 2: Prices Paid by Consumers in Selected Coffee Importing Countries
Source: International Coffee Organization

The coexistence of a "coffee crisis" and a "coffee boom" is referred to as the "coffee paradox" in the global coffee value chain (Daviron and Ponte, 2005). This is due to the fact that the coffee sold by producers and the coffee drunk by consumers are two very different products. Coffee beans pass through as many as five different entities in the global coffee market—farmer, local intermediary, exporter, roaster, and retailer—before consumption (Daviron and Ponte, 2005).

Asymmetric price adjustment and market power are possible explanations for the existence of the "coffee paradox" between the upstream and downstream coffee prices. In reality, the coffee market is characterized as an oligopsony, where a few large companies such as Starbucks, Kraft Foods, Proctor and Gamble, and Nestlé dominate the coffee industry. The largest share of the total value added created within the coffee value-chain is in the importing countries (Daviron and Ponte, 2005). Labor costs, packaging costs, and processing costs are also potential important determinants of coffee prices. Income generated in the coffee chain is mostly retained in consumer countries, while net returns to producers have been declining since the 1990s (Ponte, 2002).

Coffee is a heterogeneous commodity with multiple varieties, and different types of coffee are processed in different ways. Abaelu and Mandersc (1968) constructed a nine-equation model of the U.S. coffee market for three coffee varieties—Colombian Milds, Robusta, and Brazilian Naturals—to analyze the structural mechanisms underlying the U.S. coffee industry. Results showed that demand for each coffee type was reasonably price-elastic, and the three types were mutual substitutes.

Vogelvang (1992) investigated the long-run relationship between the indicator prices of major varieties of coffee defined by the ICO, using Johansen co-integration tests. The results showed that prices of washed Arabica coffee (Colombian Milds) and other Arabicas were co-integrated. Also, Robusta and Arabica coffee prices were found to be co-integrated.

Milas, Otero, and Panagiotidis (2004) examined the relationships among four different varieties of coffees: unwashed Arabicas, Colombian Milds, other Mild Arabicas, and Robusta. They identified two cointegrating relationships affecting the long-run dynamics of the four types of coffee prices. Their results showed that the short-run adjustment was faster when prices were high compared to when prices were low. Krivonos (2004) showed that the transmission of price signals from world markets to coffee growers worked quite well after the implementation of coffee sector reforms in the late 1980s and early 1990s. All the above studies emphasize that, for price analysis, it is necessary to focus on a specific coffee type.

The objective of this study is to test the presence of market power in the coffee market within a price-adjustment framework. The empirical analysis is couched in a vector error correction model and a theoretical framework is adopted to test the existence of market power. This article focuses especially on Colombian Milds coffee, which is noted for its high quality and is mostly produced in Colombia. Colombian Milds is the highest quality "washed" type of Arabica coffee beans. It has a richer taste and stronger aroma than other types (Gonzalez-Perez and Gutierrez-Viana, 2012).

In order to explore the difference in price adjustment between the upstream and downstream prices of Colombian Milds coffee, the downstream coffee price (designated

"world price" in the remainder of this paper), is calculated based on the daily spot prices of different subdivisions of coffee types. The upstream price is that which is paid to coffee farmers. The results of this study show that the price adjustment is asymmetric. Although these results do not preclude the existence of oligopsony power, they indicate one should look for market power in consumer markets.

The rest of this article is organized as follows: The next section covers a theoretical framework for a test of market power in the Colombian Milds coffee market. This is followed by a description of the data used in the analysis. The subsequent section presents a vector error correction model which is combined with the theoretical market power framework for the price analysis. Finally, the results and conclusions of this study are presented.

A Theoretical Market Power Framework

Economic theory suggests that profit-maximizing firms in competitive markets adjust their price symmetrically to input cost decreases or increases. Downstream prices include the upstream prices plus any margins at each level (Dahl and Hammond, 1977). In absence of external shocks, an economic equilibrium relationship among the prices exists. External shocks to downstream or upstream prices trigger short- and long-run adjustments towards the long-run equilibrium. In the real world, however, farmers at the beginning of the value chain and consumers at the other end are much less concentrated than the processors and retailers in the intermediate stages of the marketing chain. This leads to asymmetric bargaining power among the market participants (Fałkowski, 2010; Kinnucan and Forker, 1987; Miller and Hayenga, 2001). A test developed by Lloyd et al. (2003) was employed to investigate how imperfect competition and market power affect the price spread in vertically linked markets. Their results showed that the null of perfect competition could be rejected in most of the products they investigated.

The price spread model in a competitive industry is represented as follows:

$$\mathrm{WP} = \mathrm{PP} + \mathrm{M} \tag{1}$$

where WP and PP are world and producer prices, respectively, and *M* represents the marketing costs. The price spread model with exogenous shifters is shown as:

$$\mathrm{WP} = \gamma_0 + \gamma_1 \mathrm{PP} + \gamma_2 \mathrm{M} + \gamma_3 \mathrm{D} + \gamma_4 \mathrm{S} \tag{2}$$

where D and S are the exogenous demand and supply shifters, respectively. γ_i *(i=0, 1, 2, 3, 4)* are coefficients in the equation (2). The expected signs for the coefficients are

$\gamma_1 > 0$, $\gamma_2 > 0$, $\gamma_3 > 0$, and $\gamma_4 < 0$. Lloyd et al. (2009) point out that demand shifters increase the retail producer price spread while supply shifters decrease it. Therefore, γ_3 is expected to be positive and γ_4 negative. Expected signs for γ_1 and γ_2 are positive since they contribute positively to the retail price without being influenced by market power.

A few applications of the Lloyd et al. analysis to agricultural products have been examined. Fałkowski (2010) tested for market power in the Polish milk sector and found that the behavior of prices is consistent with the use of market power by the downstream sector. Liu (2012) suggested that the spread between producer and retail prices was not consistent with perfectly competitive behavior and thus might be caused by the oligopsony power in Finnish food retailing. Cavicchioli (2010) found the existence of market power in the Italian fluid milk supply chain over the period of 1996 to 2008. A similar test was also used by Kinnucan and Tadjion (2014) for the U.S. beef and pork sectors. The hypothesis of competitive market clearing was rejected for pork, but not for beef. In this research, we combine the coffee price adjustment analysis with the new test for the existence of market power and imperfect competition to study the Colombian Milds coffee market.

Market shocks affect price formation and further impact the price spread. In a perfectly competitive case, the downstream and upstream price spread is dependent on all sorts of marketing costs including transportation, management and labor costs, advertising, menu costs, and related taxes. The exogenous shifters may affect either producer or world prices separately, but they should not influence the formation of the price spread in a perfectly competitive market. This study applies this framework in the context of a Vector Error Correction Model.

Data Description

This study uses 276 monthly observations for producer and world prices for Colombian Milds as well as marketing costs, and demand and supply shifters for the January 1990 to December 2012 time period. Producer price is the farm-gate price reported to the ICO by the national coffee authorities and constitutes all grades purchased from the growers (ICO, 2012). The world price is calculated by the ICO, which provides an overall benchmark for the price of green coffee of all major origins and varieties received for raw coffee beans.

The motivation for using the world price instead of retail price is to capture the price link of the green coffee before it goes to the retail market. The greater the amount of transformation and the greater the additions to the farm product in the final consumer product, the more difficult it becomes to identify and measure the margins for individual farm products (Dahl and Hammond, 1977). For example, white bread may include wheat

flour, eggs, sugar, and vegetable oil. Similarly, coffee sold at the retail level is not identical to that sold at the farm level, especially for high quality coffee. Therefore, we use green coffee beans which are subject to the smallest degree of processing by the post-farm chain and thus potentially investigate the existence of oligopsony power. Figure 3 shows that the producer price moves together with the world price, and they decline more frequently than they increase. Both Fałkowski (2010) and Lloyd et al. (2009) used an index of wage costs for the agri-food manufacturing industry as a proxy for the marketing costs. Similarly, the manufacturing industry real wage index is a proxy for the marketing costs of coffee (M) in this study. To fill the missing data from August to September 2007, we used the average value of 2007 and then completed the missing data from December 2007 to November 2008 with the mean values of 2007.

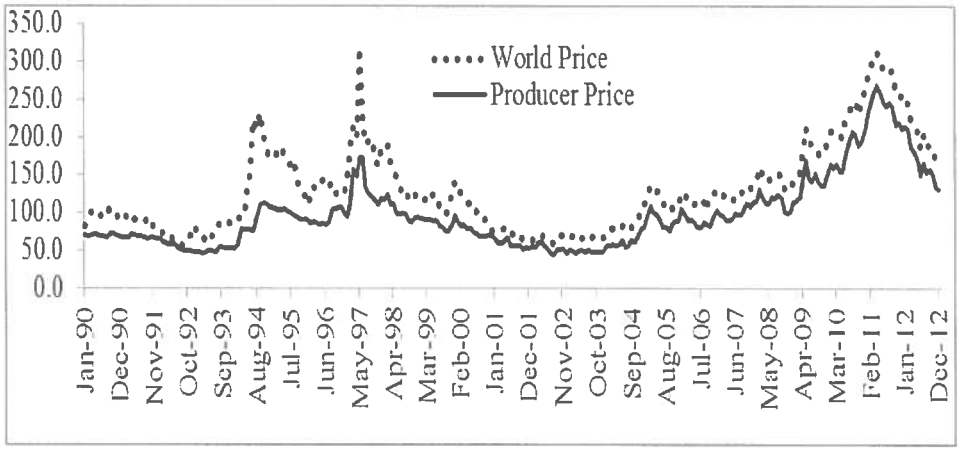

Figure 3. World and Producer Prices of Colombian Milds
Source: International Coffee Organization

The demand shifter is represented by the food retail price index. The consumer purchase index for U.S. ground coffee is used for the demand shifter because the United States is the main market for Colombian Milds coffee, accounting for 54% of Colombian Milds exports in 2013 (ICO, 2013). The supply shifter is approximated by the price index of all goods and services. The real monthly trade-weighted exchange rate for coffee is used for the supply shifter because coffee is mostly a traded cash crop between producer and consumer countries. More details about the actual data are provided in Table 1.

Table 1. Data Definitions and Sources

Label	Variable	Source	Missing Data
WP	World Price	International Coffee Organization	
PP	Producer Price	International Coffee Organization	
M	Manufacturing Industry Real Wage Index	National Administrative Department of Statistics, Colombia	
D	Consumer Purchase Index for the U.S Ground Coffee	Bureau of Labor Statistics, U.S. Department of Labor	Aug-Sep.2007; Dec.2007-Nov.2008; Sep- Dec.2012
S	Real Monthly Trade Weighted Exchange Rate for Coffee	U.S. Department of Agriculture	

Figures 4, 5, and 6 show the details of the marketing costs and the exogenous demand and supply shifters, respectively.

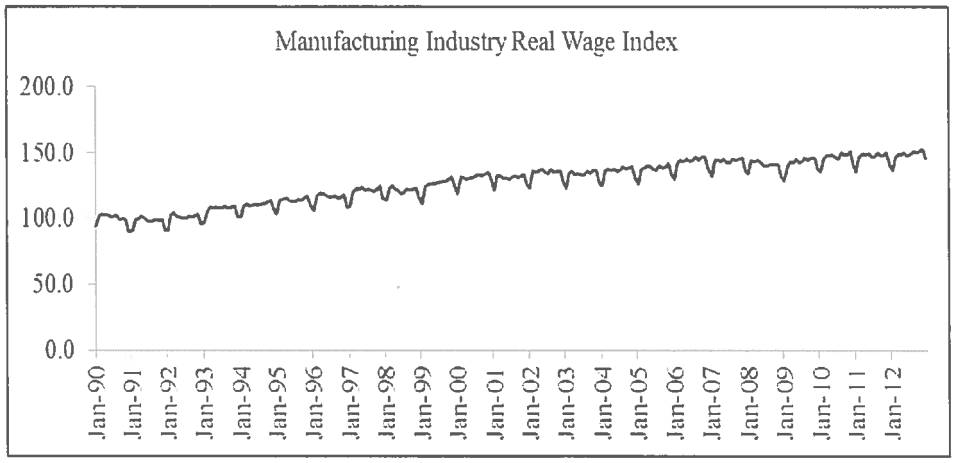

Figure 4. Manufacturing Industry Real Wage Index
Source: National Administrative Department of Statistics, Colombia

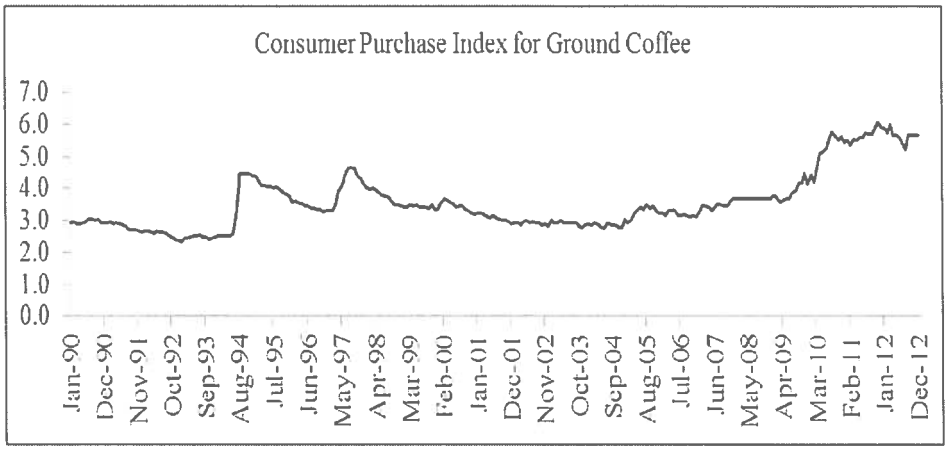

Figure 5. Consumer Purchase Index for Ground Coffee
Source: Bureau of Labor Statistics, U.S. Department of Labor

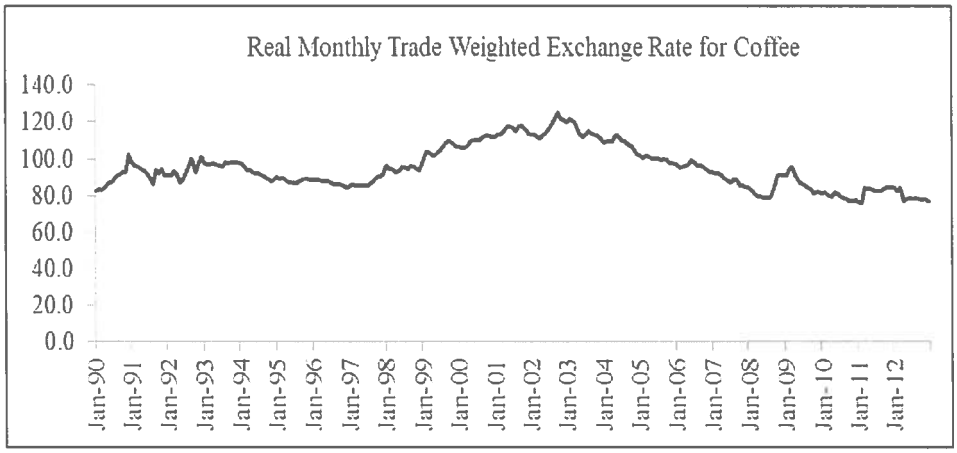

Figure 6. Real Monthly Trade Weighted Exchange Rate for Coffee
Source: U.S. Department of Agriculture

Interestingly, the marketing costs trend is upward and increasing over time, which is consistent with the increasing production costs in the coffee market (ICO, 2012). The descriptive statistics are reported in Table 2.

Table 2. Descriptive Statistics for the Variables, 1990-2012

Variables	Mean	Std.Dev.	Max	Min	Total Observations
World Price	130.98	59.29	318.5	56.18	276
Producer Price	97.97	47.85	268.52	44.57	276
Marketing Costs	127.32	16.49	153.46	89.82	276
Demand Shifter	3.58	0.9	2.35	6.07	276
Supply Shifter	95.32	11.72	76.2	125.6	276

Note: the unit for world and producer price is U.S. cents/lb., the rest are index.

Empirical Methodology

Given the properties of the time series data, the Augmented Dickey-Fuller (ADF) test is used to determine the stationarity of the variables in the model. Then based on a vector autoregressive (VAR) model, the Johansen cointegration test is applied to investigate whether the series are cointegrated. A p-th VAR with exogenous variables x can be written as:

$$(3) \qquad y_t = \upsilon + A_1 y_{t-1} + \cdots + A_p y_{t-p} + B_0 x_t + B_1 x_{t-1} + \cdots + B_s x_{t-s} + \mu_t$$

where y_t is a vector of K variables, each modeled as a function of p lags of those variables, and optionally, a set of exogenous variables x_t. $A_1 \ldots A_p$ and $B_1 \ldots B_p$ are the parameters of the variables in the model. We assume that $E(\mu_t) = 0$, $E(\mu_t \mu_t') = \Sigma$ and $E(\mu_t \mu_s') = 0 \ \forall t \neq s$. Estimation of the parameters of the VAR model requires that the variables in y_t and x_t are covariance stationary. A Granger test is applied to address the issue of weak exogenous after fitting the VAR model (Pesaran, Shin, and Smith, 2000).

If the first differences of all variables that are covariance stationary, we may model the relationship with a vector error correction model (VECM), which captures both the long-run relationship and the short-run adjustment relationship between the producer and world prices. VECM is a dynamic model in which the change of the variables in any period is related to the previous gap from long-run equilibrium. Intuitively, if two variables have a long-run relationship, there must be some force that pulls the equilibrium error back towards zero.

Generally, a VECM takes the following form (Enders, 2004):

$$(4) \qquad \Delta Y_t = \Pi Y_{t-1} + \varphi_1 \Delta Y_{t-1} + \varphi_2 \Delta Y_{t-2} + \cdots + \varphi_{k-1} \Delta Y_{t-k+1} + \varsigma_t$$

where Y_t is a $(K \times 1)$ vector of variables integrated of order 1. Π is a $(K \times K)$ coefficient matrix describing the long-run relationship between the variables in the system. Π can be further decomposed into $\Pi = \alpha\beta'$. β is a $(K \times r)$ vector with parameters of the cointegration equation. α is a $(K \times r)$ vector with adjustment parameters indicating how the variables adjust when the cointegrating equation deviates from its equilibrium. φ_i is a $(K \times K)$ matrix of the short-run parameters measuring the short-run impact of shocks on ΔX_t. ς_t is a $(K \times 1)$ vector of disturbances with zero mean and covariance matrix Σ and is i.i.d. normal over time. According to the theoretical framework presented above, if the vertical market chain for Colombian Milds coffee is perfectly competitive, the producer price and the world price are expected to have a cointegrated relationship with the marketing costs. When the supply and demand shifters enter the model, the null hypothesis of perfect competition can be evaluated empirically within a VECM. Hence, the relationship among the producer price, the world price, and marketing costs is a baseline for the model that incorporates the supply and demand shifters.

Empirical Results

The ADF test was applied to check the stationarity of all the variables in the model. Lag length was selected based on the Akaike Information Criterion (AIC) and Schwartz Bayesian Criterion (SBC). The results in Table 3 show that all variables are non-stationary at levels but, when first-differenced, all the variables are stationary or I (1).

Table 3. Augmented Dickey-Fuller (ADF) Test Results

Variables	Levels		First Differences	
	Lag	ADF	Lag	ADF
WP	6(trend)	-1.79	4	-8.37***
PP	2(trend)	-1.86	1	-11.66***
M	12(drift)	-2.05	12	-3.63***
D	2	-1.27	1	-9.45***
S	1	-1.22	1	-11.54***

Note: One, two, and three asterisks indicate statistical significance at the 10, 5, and 1% levels, respectively.

Then the Johansen test was conducted to determine the number of cointegrating equations. The first cointegration test is conducted for the producer price, world price,

and marketing costs, presented in the theoretical equation (1). The second cointegration test is based on equation (2), which includes the producer and world prices, marketing costs, and demand and supply shifters. As reported in Table 4, the trace statistics indicate that there is a single cointegration relationship between the producer price, world price, and marketing costs, but there are two cointegration relationships between the five variables (producer price, world price, marketing costs, and demand and supply shifters).

Table 4. Johansen's Test of the World Price and Producer Price for Colombian Milds

Assumptions	Null Hypothesis	Trace Statistic	5% Critical Value	Eigenvalue
Perfect Competitive	r=1*	8.572	15.41	0.104
	r=2	1.951	3.76	0.024
Imperfect Competitive	r=1	64.13	47.21	0.19
	r=2*	24.66	29.68	0.136
	r=3	8.706	15.41	0.055
	r=4	1.847	3.76	0.025

Note: One, two, and three asterisks indicate statistical significance at the 10, 5, and 1% levels, respectively.

The existence of cointegration indicates that Granger causality should exist at least in one direction (Enders, 2004). The causality refers to the direction of price movements along the supply chain. According to the price determination theory, downstream price changes usually determine upstream price changes. That is, price transmission flows downward along the supply chain. However, the empirical results from Table 5 show that a null hypothesis in that producer price does not Granger-cause world price. This implies that the causality is unidirectional, from the world price to producer price, which is an indication that producers are price takers.

Table 5. Results of Granger Causality Test for the World Price and Producer Price

Null Hypothesis	X^2	Prob>X^2	Results
Grower Price does not Granger-cause World Price for Colombian Milds	3.12	0.078	Fail to reject
World price does not Granger-cause Grower Price for Colombian Milds	15.14	0	Reject

Based on the results of the Johansen test and the Granger causality test, the VECM is estimated. The results are summarized in Table 6 for the long-run relationships and in Table 7 for the short-run speeds of adjustments.

Table 6. The Long-Run Relationships under Perfect and Imperfect Competitive Markets

Assumption	WP	PP	M	D	S
Perfect Competitive	1	-1.032***	0.479***		
		(22.01)	(3.13)		
			0.784**	-1.844***	0.25
	1		(2.53)	(-7.44)	(0.68)
Imperfect		1	-0.122	-1.439***	0.84***
Competitive			(-0.47)	(-7.44)	(-2.76)

Note: One, two, and three asterisks indicate statistical significance at the 10, 5, and 1% levels, respectively, t-values in brackets.

Table 7. The Empirical Estimates of the Speeds of Adjustment

		Perfect Competitive	Imperfect Competitive	
Speed of Adjustment	PP	0.141***	0.165***	-0.207***
		-3.32	-3.54	(-3.77)
	WP	-0.071	-0.008	0.044
		(-1.43)	(-0.15)	-0.68
	M	-0.015	-0.035	0.039
		(-0.82)	(-1.69)	-1.6
	D		0.064***	0.001
			-3.11	-0.07
	S		-0.021	0.014
			(-1.49)	-0.84

Note: One, two, and three asterisks indicate statistical significance at the 10, 5, and 1% levels, respectively, t-values in brackets.

The long-run relationship of the world price, producer price, and marketing costs with the producer price normalized is

$$\ln PP = 0.968^{***} \ln WP + 0.463^{***} \ln M \quad (5)$$

The prices are influenced by the extent of any deviation from the long-run equilibrium. Then at least one of the prices must respond to the magnitude of the disequilibrium. The producer price corrects 14.1% of the previous period's deviation for

the long-run equilibrium. We can conclude that the producer price and the world price respond to the disequilibrium asymmetrically.

Two long-run equilibriums are identified under the null hypothesis of perfectly competitive market conditions. The two cointegrating equations are presented as

$$\ln WP = -0.784^{***}\ln M + 1.884^{***}\ln D \quad (6)$$

$$\ln PP = -0.84^{***}\ln S + 1.439^{***}\ln D \quad (7)$$

The world price moves together with the marketing costs and the demand shifter in the long run. In the short run, the producer price still responds to the disequilibrium of equation (6). In equation (7), the producer price is cointegrated with the supply and demand shifters in the long run and the short-run speed of adjustment is 16.5%, which is the ratio of deviation from equilibrium corrected by the producer price. The world price has no response.

Moreover, the coefficients of the demand shifter in equation (6) and (7) are statistically significant. The supply shifter is also statistically significant with an expected negative sign. According to the theoretical model, the null hypothesis of perfect competition is rejected and we can conclude that market power and imperfect competition exist in the Colombian Milds coffee market. Intuitively, a shift in demand function will increase both producer price and the world price while a shift in supply will cause the price spread to narrow.

Summary and Conclusions

The goal of this study was to explain the "coffee paradox" that exists between the producer price and world price of Colombian Milds. A theoretical framework for testing the null hypothesis of perfect competition and a vector error correction model were adopted to test the potential existence of market power. The null hypothesis of perfectly competitive market clearing was rejected for Colombian Milds. In a perfectly competitive market, the world price, producer price, and marketing costs reach a long-run equilibrium. The estimation of the producer price, world price, and marketing costs were consistent with the theoretical model. The world price moves together with marketing costs and the demand shifter in the long run. The producer price is cointegrated with demand and supply shifters. This implies that market power may affect the long-run relationship between the world price and the producer price. The demand shifter is cointegrated with both the producer price and the world price, while the supply shifter is

only cointegrated with the producer price. The analysis provides arguments on linking price adjustments with noncompetitive market structures.

However, there could be other explanations for these results. Product heterogeneity may affect the speed of transmission. In the past three decades, consumers' loyalties to a certain brand, preferences for country of origin, and environmental concerns have affected demand for specialty coffees. Adjustments or menu costs may play more important roles than market power for asymmetric price transmission (Zachariasse and Bunte, 2003). In addition, long-term contracts may limit the speed of price transmission.

The asymmetric price adjustment indicates that producer price responds more to fluctuations in the supply chain than the world price. This, in turn, has an impact on farmers' production decisions and their ability to adjust to shocks from both downstream sectors and unexpected natural shocks on the supply side. Moreover, consumers who pay a high price for premium coffee cannot fully benefit from a decrease in farm-gate prices and farmers cannot get the benefit of higher downstream prices. This provides explanations for why coffee-consuming countries experience the "coffee boom" while coffee-producing countries suffer from the "coffee crisis."

Theoretically, downstream prices contain upstream prices plus marketing costs, but it does not imply causality. For Colombian Milds, it is the world price that causes the producer price and not vice versa, indicating that producers are price takers. Moreover, when the demand and supply shifters enter the model, the two prices are no longer cointegrated, which implies that the demand and supply shifters influence changes in coffee prices significantly.

The more heterogeneous a product like coffee is, the more space for marketing and value-added activities along the supply chain. An extension of this study would be to test whether the results change with alternative proxies for the shifters. Alternative proxies for demand and supply shifters could dominant price adjustment and influence the results.

The existence of producer organization is a response to the potential buyer power. Winfree and McCluskey (2005) found that producer organizations help build up a collective reputation for regions or specialty products. The Colombian coffee industry is characterized by a high degree of National Federation of Colombia (NFC) intervention. The NFC sets strict quality control schemes to assure premium coffee beans. The NFC mostly benefits the producers, unlike government bureaucrats or exporters in other coffee producing countries (Krivonos, 2004). The NFC can help earn a negotiating position for the domestic producers and lower the bargaining position held by the large buyers. Also, other coffee producing countries can start building similar producer organizations to balance the bargaining market power of the buyers along the coffee supply chain. However, the results of this study show that producers still has a long way to go to organize and increase their benefits from the coffee value chain.

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