Artigo

Mathematical model for mexican coffee market

G. Guerra Galindo
Professor, Facultad de Economía., Universidad Veracruzana, México. E-mail: gguerrag@yahoo.com

Charles B. Moss
Professor, Food and Resource Economics, Institute of Food and Agricultural Sciences, University of Florida. E-mail:: cmoss@fred.ifas.ufl.edu

Abstract

The assumption that the production of quality coffee is more expensive than the production of coffee of less quality, also that market failures in the transmission of quality signals to producer lower the average quality of coffee produced industry. Used its simultaneous equations in three stage lest square found it, that some variable were significant as size of producer affect the share sold cherry, the quality affect the international green coffee price of México means when quality of cherry, then increase the share sold of green coffee. But has no evidence that market power concentration affect the share prices of green coffee.

Key word

Quality, cherry, green, coffee price, altura, and prima, size of producer, market power concentration.

Resumo

A afirmação que a produção de café de qualidade é mais cara que a produção de café de menor qualidade, também que mercado falha na transmissão de sinais de qualidade para os produtores baixarem a qualidade média do café produzido. Ao usar equações simultâneas em mínimos quadrados de três estágios, descobriu-se que algumas variáveis foram significantes: o tamanho do produtor afeta a parcela de café cherry vendida, a qualidade afeta o preço internacional de café verde do México, e a qualidade da cherry aumenta a parcela vendida de café verde. Mas, não há evidencia que a concentração de poder de mercado afete a parcela de preços do café verde.

Palavras chave

Qualidade, cherry, green, preço do café, altura, e prima, tamanho do produtor, concentração de poder de mercado.

México is the world's fifth largest coffee producer with 5% after Brazil 27%, Colombia 14%, Indonesia 7% and Viet Nam 6%. México produces the *arabica* variety classified within the *other milds* group. Coffee is produced on total of 761,161 hectares in twelve states. This area is cultivated by 282,593 growers with an average of 2.7 ha./producer during 1990-1997. the primary producing states are Chiapas, Veracruz and Oaxaca with 76.4% of the total production. In agricultural sector of México the coffee accounts for 20.4% of export income, as such it is the second largest commodity after horticulture with 23.9%, therefore coffee represent the main activity in the agricultural sector. The industrial organization of the Mexican coffee industry is complex with a multitude of producers, processors and wholesaler. This complexity may hinder the ability of the domestic coffee industry to expand its markets at home or abroad. In order to salvage production, those groups mix different quality coffee beans together, missing the opportunity to practice price discrimination across different quality standards. For example, higher quality coffee would be priced higher. If groups of production followed a strict classification, Mexican coffee could receive higher prices and would not have to depend upon volatile prices caused by uncertainty in the future world supply of coffee bean, in particular the production behavior of Brazil and Colombia. In part due to the low production of the principal producers and ecological, economic and social problems, shipments to these countries (Brazil and Colombia) have decreased the supply of coffee in the international market in the wake of a relative stable consumption level, the prices have increased. In addition the industrial structure of coffee production in Mexico is such that the price signals regarding quality are typically not transferred to farmers. Another reason for the reduction in quality might be the dominance of small farmers, who don't have their own processing plant.

Instead they have established relationships with large national traders or foreigners, therefore that hand of cherry coffee, is process and until sold. The farmer then receives the ultimate sales price for the coffee less the cost of transformation and storage. This situation provides only a little percentage for the farmer, some cases this process has been successfully. This aspect is an important outcome from the concentration in the processing of coffee. Data from the Consejo Mexicano del Café indicates that there are only ten enterprises that export more that 57% of coffee. In summary we can say in general that the problems are of producer organization and quality selection of coffee.

Given the importance of price premium in signaling the return to quality. This study will examine the pricing mechanism for coffee in Mexico. The first stage will examine of the current market channels focusing on potential imperfect competition processors. This examination will focus on the failure the pricing mechanisms that fail to send the appropriate price signals with regard to coffee quality. Building on the models of imperfect competition and next examine how another organization such as producer cooperatives or state trading enterprises may be used to reorganize producer is a very that benefits the coffee industry in Mexico.

Empirical Models

The empirical models, given the two strands of literature developed, we want to estimate two models.

a. Following the discuss of game theory the market for lemons, and the model of producer size from chapter IV, we hypothesis that,

$$S_{cp} = \frac{S_c}{S_p} = \alpha_0 + \alpha_1 Sz_p + \alpha_2 \underline{P}_G + \varepsilon$$

S_c is the amount marketed in cherry, S_p is the amount market as pergamino so S_{cp} is the rate of relation cherry / pergamino, Sz_P is the average size of the producer and P_G is the average price received by farmers. We anticipate that,

$\alpha_1 \leq 0 \rightarrow$ as farms small, more market as cherry

$\alpha_2 \geq 0 \rightarrow$ as the estimated price increase the quality premium

b. Next model equation is the rate of price between price of Mexican green coffee and price U.S. retail.

$$\frac{P_G}{P_{USr}} = \beta_0 + \beta_1 C + \beta_2 Q_{ty} + \beta_3 M_{Exp}$$

P_G is the price of green Mexico exports, P_{USr} is the world or U.S. retail, C is the concentration (Entropy), Q_{ty} is rate of sale altura / prima quality, M_{Exp} is the quantity export by Mexico.

$\beta_1 \geq 0 \rightarrow$ coefficient of concentration as the market power.

$\beta_2 \geq 0 \rightarrow$ coefficient of rate quantity sale altura and prima quality.

$\beta_3 \geq 0 \rightarrow$ coefficient of Mexican exportation.

c. The third model equation is the rate sale quantity of altura and prima coffee quality.

$$Q_{ty} = \delta_0 + \delta_1 S_{cp} + \delta_2 P_{Q/USr}$$

S_{cp} is the rate between price cherry and pergamino, and $P_{G/Usr}$ is the relation of green price and US retail.

$\delta_1 \leq 0 \rightarrow$ coefficient of rate sale cherry and pergamino by producer

$\delta_2 \geq 0 \rightarrow$ coefficient of rate sale by processor green and US retail.

I used the program of Statistic Analysis System (SAS) with regression model, these equations can be estimate simultaneously at the aggregate level.

Theorical Model Used

Although most of the previous work are in context of single-equation models, even a cursory look through almost any economics textbook shows that much of the theory is build on sets, or systems, of relationships. Familiar examples include market equilibrium, models of the macroeconomic, and sets of factors or commodity demand equations. Whether one's interest is only in a particular part of the system or in the system as a whole, the interaction of the variables in the model will have important implications for both interpretation and estimation of the model's equations, Greene (2000).

There are situations where there is a two-way flow of influence among economic variables, that is one economic variable affects another economic variable(s) and is, in turn, affected by it (them). This is the case of our model. This is typically referred to as a simultaneity problem. In this case the economic equilibrium implies a simultaneous solution of two or more economic relationships, the simultaneous problem raises several problem in empirical investigation. First, estimation of the equations separately leads to a simultaneous equations bias. This bias is compounded by its persistence in large sample. As result of the bias, several econometric procedures have been developed for system regressions. These include two stage least squares (2SLS), three stage least squares (3SLS) and indirect least square (ILS). While each procedure solves for the simultaneous equations bias, 3SLS or iterative three stage least squares (IT3SLS) has desiring asymptotic properties.

Application of only of these procedures requires that the mathematical restrictions on the model specification. Specification. Specifically, the model must be specified in a way that separates the economic effect of the simultaneously determined variables. These restrictions are typically referred to as identification restrictions.

The order condition of identifiably

A necessary but not sufficient condition of identification, know as the **order condition,** Gujarati (1995) said it may be stated in two different but equivalent ways as follows, the necessary as well as sufficient condition of identification bravely:

Definition A. In a model of M simultaneous equation in order for an equation to be identified, it must exclude *at least* M-1 variables (endogenous as well as predetermined) appearing in model. If it excludes exactly M-1 variables, the equation is just identified. If it excludes more than M-1 variables, it is over identified.

Definition B. In model of M simultaneous equations, in order for an equation to be identified, the number of predetermined variables excluded from the equation must not be less than the number of endogenous variables include in that equation less 1, that is.

$$K - k \geq m - 1$$

if K – k = m – 1, the equation is just identified, but if K – k $\succ$ – 1, it is over identified.

Rank condition of Identification

In a model containing M equations in M endogenous variables, an equation is identified if and only if *at least* one nonzero determinant of order (M – 1)(M – 1) can be constructed from the coefficients of the variables (both endogenous and predetermined) exclude from that particular equation but included in the other equations of the model.

Three-stage least squares (3SLS)

3SLS these analysis is the equations with the universe o the variance matrix. In essence 3SLS is a generalized least squares modificated to 2SLS along the term of Sellner's seemingly unrelated regression. Because the nonpherical disturbances in different equations, however, these estimates can differ from the 2SLS estimates and can in fact be more efficient, Kennedy (1989).

In this study, I will use iteration three stage least squares IT3SLS can be viewed as the – of 2SLS and seemingly unrelated regression. 2SLS study the system by estates two data of regression. First, the procedure estates the endogenous variable, or the variable simultaneous determined is the model as a function of the exogenous variable, or the variable whose are not determined is the model. These estimated values are then used as instrument to estimate the final form of the model, this procedure was first suggested by Theil, H (1957).

The 3SLS procedure can be as follows:

Stage 1: calculate the 2SLS estimates of the identified equations.

Stage 2: use the 2SLS estimates to estimate the structural equations' errors, and then use these to estimates to estimate the contemporaneous variance-covariance matrix of the structural equation's errors.

Stage 3: apply GLS to the large equation representing all the identified equation of the system.

As indicated earlier, 3SLS is one of several procedures that can be used to estimate a system of equations. The 3SLS estimator is consistent and in general is asymptotically more efficient than the 2SLS estimator. If the disturbance in the different structural equations are uncorrelated, so that the contemporaneous variance-covariance matrix of the disturbance of the structural equations is diagonal, 3SLS reduces to 2SLS. Compare 3SLS with ILS,

Compare 3SLS with ILS. The properties of ILS estimators**.** The estimators of the reduced-form coefficients are consistent and under appropriate assumption also best unbiased or asymptotically efficient. Do these properties carry over to the ILS? It can be shown that the ILS estimators inherit all the asymptotic properties of the reduced-form estimators, such as consistency and asymptotic efficiency. But proprieties such as unbiased ness do not generally do not generally hold true. The estimators are consistent. IT3SLS builds into the 3SLS by consisting the fact that the variance matrix applied to the 2SLS estimator is conditioned on inefficient parameter estimates. Thus, IT3SLS iterates by updating the variance matrix using the 3SLS results to estimate the system. This iterates process stops once the variance matrix becomes stationary face iterates one iterates to next.

Model used of Measures Theory

Measures of concentration are used to answer cross sectional questions concerning the variation in concentration among industries in a given time period, time series questions concerning changes in concentration in a particular industry over time and questions that incorporate both time series and cross sectional information Hall & Tideman (1967). They have set forth a few desirable properties of measures of concentration and shown that with respect to these properties there are better measures of concentration and shown that with respect to these properties there are better measures than the popular concentration ratio. $HH = \sum P_t^2$ and $TH = 1/(2\sum iP_i) - 1$ satisfy all properties. HH and HT share with CR the property that there is more than one distribution of firms which can generate a given value of index (Herfindahl-Hirschman index-HH).

In communication theory and the physical sciences, *entropy* is a measure of the degree of disorder, uncertainty, or randomness in a system Horowitz & Horowitz (1968). Suppose there are *i* = I,…, n possible events that can occur. Let the probability of occurrence of the i^{th} event be denoted by p_i. The entropy in the system, or the disorder or freedom of choice, is defined to be the negative of the weighted average of logarithms to the base 2 of the p_i where the p_i are the weights. In symbols ***H*** is given by:

$$H = -\sum p_i \log_2 p_i$$

$$HH = \sum S_i^2$$

$$E = -\sum S_i \ln S_i$$

There would seem to be ready, useful, and intuitively appealing analogy between the entropy of a communication source and the *competitiveness* of an industry. The greater is the degree of competition, the greater the uncertainty as to which of a given number of firms will secure the business of a buyer chosen at random.

The specification form of the IT3SLS to be estimate is

The model used above we transformed in following it:

$$LnS = \alpha_0 + \alpha_1 LnS_Z + \alpha_2 LnP_M$$

$$pratio1 = \beta_0 + \beta_1 Entropy + \beta_2 LnQ_{TY} + LnM_{EXP}$$

$$LnQ_{TY} = \delta_0 + \delta_1 LnS + \delta_2\, pratio1$$

Variables Endogenous; LnS, LnQ_{TY}, *pratio1*

Variable Exogenous; LnS_Z, LnP_N, *Entropy*, LnM_{EXP}

Parameters;

$$\alpha_0, \alpha_1, \alpha_2, \beta_0, \beta_1, \beta_2, \delta_0, \delta_1, \delta_2$$

Relations; $S = S_C / S_P$,
$Q_{TY} = Q_A / Q_P$

Pratio1 = log (P_M / P_W)
LnS = log (S_C / S_P)
LnS_Z = log (sizeprod)
LnP_G = log (pgreenm)
LnQ_{TY} = log (Q_A / Q_P)
LnM_{EXP} = log (Mexexp)

Table 1 – Data for Regression.

MexExp	Pcherry	Ppergam	PGreeanM	PGreenC	USARet	Entropy	Herf	SizeProd	QlityA	QlityP	Scherry	Spergam
117120	1.2378	1.3933	2.723	3.01	5.51	1.9108	0.1794	259.8	15.8	65.2	75	25
110760	1.4749	1.5074	3.073	3.58	4.44	1.9004	0.1832	259.8	14.3	65.7	75	25
186540	1.1472	1.2420	2.066	2.66	4.55	1.9114	0.1813	257.3	15.9	65.1	74	26
174180	1.3719	1.4868	2.557	2.97	4.49	1.9170	0.1809	254.8	16.1	64.6	72	28
178920	1.5275	1.6878	2.502	2.79	4.68	1.9224	0.1805	253.5	15.9	64.9	70	30
221580	1.8113	2.0162	2.806	2.95	4.73	1.9664	0.1697	248.3	16.2	64.1	70	30
230580	1.5124	1.6964	2.485	2.98	6.11	1.9336	0.1814	242.8	15.7	65.3	66	34
152940	1.5519	1.6435	2.628	3.48	5.20	1.9398	0.1666	242.3	14.2	67.8	75	25
224340	1.5101	1.6989	2.366	2.94	5.04	1.9348	0.1809	236.1	12.9	70.1	73	27
261540	0.7833	0.9307	1.617	2.89	5.45	1.9350	0.1732	232.0	14.7	67.4	70	30
210360	1.5159	1.7166	1.828	2.42	5.26	1.9080	0.1814	233.5	12.2	69.8	75	25
187360	1.2071	1.3146	1.422	1.74	4.98	1.9284	0.1727	230.8	12.7	69.3	75	25
183600	1.0268	1.1288	1.479	1.81	4.57	1.9507	0.1669	225.4	12.3	69.8	75	25
189000	1.0249	1.1402	2.313	2.35	4.79	1.9273	0.1743	220.4	11.9	70.2	78	22
195420	2.6796	2.9746	3.470	3.91	6.33	1.9467	0.1672	215.9	12.7	70.5	78	22
274740	1.7870	2.1680	2.416	2.96	4.87	1.9437	0.1654	212.1	12.6	73.4	76	24
262860	2.6621	3.1531	3.265	3.29	6.08	1.9250	0.1759	208.6	15.9	65.0	77	23
232920	2.7205	3.1531	3.309	3.63	6.45	2.0666	0.1538	209.6	15.1	60.7	78	22
245100	1.5545	1.8651	2.247	3.66	5.41	2.0068	0.1781	207.8	18.1	61.7	79	21
315507	1.5072	2.0425	2.365	2.97	6.56	1.9219	0.1973	206.5	15.2	68.9	80	20

Table 2 – Results Nonlinear IT3SLS Summary of Residual Errors.

Equation	DF Model	DF Error	SSE	MSE	Root MSE	R-Square	Adj. R-Sq
LNS	3	17	0.33358	0.01962	0.14008	0.4819	0.4209
PRATIO1	4	16	2.87828	0.17989	0.42414	1.6340	2.1279
LNQTY	3	17	0.51946	0.03056	0.17480	0.0091	0.1278

Where S is the relate quantity of cherry coffee sold to pergamino coffee sold, S_Z is the average size of producers P_M is the price of Mexican green coffee, P_W is the US retail price of coffee, Pratio1 is the ratio of Mexican green price to US retail price, Entropy is the measure of concentration of Mexican export firms, Q_{TY} is the ratio of altura coffee sold to prima coffee sold (a measure of quality), Q_A is the quantity of altura coffee sold and Q_P is the quantity of prima coffee sold, ***ln*** denote the notation logarithm . in this study ***ln*** (S), ***ln*** (Q_{TY}) and ***ln*** (Pratio1) are endogenous and ***ln*** (S_Z), ***ln*** (P_M), entropy and ***ln*** (M_{EXP}) are exogenous. In this model, pratio1 and Q_{TY}, quality, are simultaneously determined. The data for the estimation are presented in table 1.

This part presents the results of the empirical model described before applied the data give in the same chapter. In general the results show that the size of producer determine share of sold cherry, when the quality increases the price of green coffee increase, Mexican processors have not been able to extract additional returns from market power and if share sold cherry decrease increase the quality of coffee green.

Results of the Full Estimated Model

The regression results from the *simultaneous equation model in three stage least squares* of residual errors are presented in table 2. In same form of IT3SLS parameter estimates results are presented in table 3. In most of variables the F-statistics for these models are significant at the 5% level.

Table 3 – Results Non linear IT3SLS Parameter Estimates.

Parameter	Estimate	Approx. Std. Err.	**T Ratio**	Approx. $\Pr ob \succ \lvert T \rvert$
	Share of cherry coffee			
α_0 (Constant)	9.284042	2.14831	4.32	0.0005**
α_1 (Producer size)	-1.519176	0.39277	-3.87	0.0012**
α_2 (Price of green)	0.085404	0.12469	0.68	0.5026
	P_{MCE} Ratio			
β_0 (Constant)	1.316296	5.45009	0.24	0.8122
β_1 (Entropy)	0.273074	1.61943	0.17	0.8682
β_2 (Quality)	2.280190	0.96308	2.37	0.0308**
β_3 Exports	0.070749	0.07054	1.00	0.3308
	Quality			
δ_0 (Constant)	-1.118629	0.29824	-3.75	0.0016**
δ_1 (Share of cherry)	-0.064566	0.18660	-0.35	0.7336
δ_2 (Price ratio)	0.438559			

** Denotes significance at the 5% level.

Table 3. show the results of value estimate, error standard, T ratio, probability (T) of parameter in the equation models, where in the

The number of observation used twenty, missing zero, statistics for system to objective 0.5947 and objective*N 11.8931.

The size of producer significantly affects the share sold of cherry coffee. This means when the size of producer increase the share sold of cherry. However the price of green coffee has no significant effect or the share of cherry coffee sold.

The market concentration of processors in Mexico has no effect on the relative price of Mexican coffee, whereas the relative quantity of altura to prima has significance on the price ratio for Mexican coffee means when the quality of coffee increases. The price first it is share of sold cherry coffee ($parameters\alpha_i$), second is share of sold of green coffee in relation of roost coffee in the international market ($parameters\beta_i$), and the last one is the quantity sold of altura and prima quality ($parameter\delta_i$)of Mexican green coffee increase. On the other hand the quantity Mexican export has no affect the share of price. Thus, Mexican does not significance affect the world market price. The share of cherry coffee sold has no significance in the quality. However, an increase the share cherry sold decrease the overall quality of Mexican coffee. In addition, the relative price of Mexican coffee has significance effect in the quantity of altura quality so when decrease the price of green coffee the quantity of altura quality decrease relative price of Mexican coffee, whereas the relative quantity of altura to prima has significance on the price ratio for Mexican coffee means when the quality of coffee increases. The price of Mexican green coffee increase. On the other hand the quantity Mexican export has no affect the share of price. Thus, Mexican does not significance affect the world market price. The share of cherry coffee sold has no significance in the quality . however, an increase the share cherry sold decrease the overall quality of Mexican coffee.

CONCLUSIONS AND DISCUSSIONS

In general, coffee producers in Mexico have seen their price decline relative to the international market price of coffee. Economically, this decline may be attributed to several factors. For example, one explanation could be the rise in market power at the processor and export level, other explanation include the general decline in the quality of Mexican coffee over time. This decline in the quality of coffee may be explained by several factors including the structure of the market for coffee within Mexico and agronomic factors. This study examines this hypothesis. The study develops the traditional models of the effect of market power using simple supply and demand relationships and game theory. Talking, the studied results, increase in market power or the level of concentration reduces the price received by producers. The game theoretic models sup pert the conclusions even if the processors interact in a noncompetition game.

Next, the study developed a model of endogenous quality choice based in the size of coffee producers. The theoretical model () that smaller producers may not have the incentive to differentiate the quality of their coffee. As a result, smaller producers sell through alternative market channels for an average price. Has again game theory can be used to describe the demand slide in market quality that results in this alternative market channel.

Based an these model, this study formulates an empirical model relating the share of coffee marketed as cherry to the size of producers, the quality of coffee to the share marked as cherry and the relative price of Mexican coffee, and the relative price of Mexican coffee as a function of its quality, the concentration is the processors sector and the US retail price of coffee. The results indicate that the average size of the producer has a statistically significant affect in the share of the coffee marketed as cherry coffee. Further, as the size of the producer declines, the share marketed cherry increases as expected.

Similarly, the quality of coffee produced in Mexico is an increasing function of the relative price of Mexican coffee, as expected. On addition, this relation ships is statistically significant. In addition the share of coffee sold as cherry coffee has a negative effect on quality. However, this effect is not statistically significant.

(Timely) the relation price of Mexican coffee is an increasing function of the quality of Mexican coffee and a decreasing function of the market concentration. However the second effect is not statistically significant.

Suggestions for Further Research

Anyway we have another market problem due the international power of Colombia and Brazil, whereas Colombia produce soft coffee, Brazil produce caturra and Mexico another soft and exist empirical experience in Mexico about sold coffee of good quality got premium, in another words, Mexico can not sale it's coffee with the same quality as large main, Mexico need to look into another market of quality because the quantities and prices of Colombia and Brazil affect the volatile price and overall to Mexican coffee, we look in next figure that elasticity of supply and demand for quality coffee (Santoyo, 1994), of Colombia is different to Mexico, when increase a minimum quantity produce of coffee in world side the price increase but affect more to Mexico that Colombia this is due the curves are more inelastic for quality of coffee in Mexico, then Mexican producers and processors need to look for special market whit special quality, We can follow search how much we can increase quantity in quality and which strategic follow for smaller producer.

REFERENCES

Bates, R. H., &DHD, Lien. 1985. **On the Operation of the International Coffee Agreement**, International Organ. 3:553-59.

Fisher, B. S. 1972. **The International Coffee Agreement, A Study in Coffee Diplomacy**. New York: Praeger..

Gilbert, C. L. 1987. **International Commodity Agreements: Design and Performance**, World Devel. 15:591-616.

Grene, W. H. 2000. **Econometric Analysis**. Library of Congress Cataloging in Publication Data. Fourth Edition. U:S: p.p. 692-695.

Gujarati, D. N. 1995. **Basic Econometrics**. Mcgraw-Hill, Inc. New York, p.p:663-670.

Horowitz, A. & Horowitz, I. 1968. "Entropy, Markov Processes and Competition in the Brewing Industry. **Journal of Industrial Economics**, 16:196-211.

Kennedy, P. 1989. **A Guide to Econometrics**. The MIT Press Cambridge, Massachusetts. Second Edition. p.p.134-137.

Marshall, C. F. 1983. **The World Coffee Trade**. Cambridge: Woodhead-Faulker.

Theil, H., 1957. On the Use of Incomplete Prior Information in Regression Analysis **Journal of the American Statistical Institute** vol 25. pp. 41-51; reprinted in Dowling and Glahe (1970).

Vogelvang, E. 1992. **Hypotheses Testing Concerning Relationships Between Spot Prices of Various Types of Coffee**. Free University Press, Amsterdam.