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Introduction

The issue of market power–the ability to influence price or quantity flow in the marketplace–is quite important in agriculture. Farmers often face market power, which can significantly affect their well-being and the allocative efficiency of these markets. At one level, one is interested in investigating whether or not market power is *actually* being exercised. High industry concentration is not a sufficient condition for exercising market power. Furthermore, market power may be exercised in nonconcentrated industries in the presence of legally binding arrangements on price and/or quantity, such as those under federal marketing orders and marketing boards. At another level, one is interested in identifying the sources of market power to provide useful information to the policy-making process.

Perhaps, the most plausible conceptual and empirical approach to measuring and testing the degree of market power is provided by Appelbaum. Assuming identical marginal costs and conjectural variation elasticities across firms, Appelbaum developed an econometric model that converts the price/marginal cost gap to a measurable and testable oligopoly index. The approach has been applied to the U.S. beef-packing industry (Azzam et al., Schroeter) and marketing orders (Taylor and Kilmer). Other approaches have been applied to tomatoes (Just and Chern; Melnick and Shalit), and cigarettes (Sumner). Although the focus of previous work has been on "measuring and testing," a comprehensive empirical analysis of the sources of market power and the effects of international commodity agreements on domestic market power is lacking.

This paper develops a methodology for measuring, testing, and identifying the sources of oligopsony power in the Haitian coffee market. The methodology is based on the work of Appelbaum, but is adapted to the oligopsonistic case. Other novel features include supply response of a perennial crop, accounting for the export and domestic markets, institutional changes, and endogenizing the number of exporters in the market.

Conceptual Framework

The Haitian Coffee Market

The Haitian coffee market provides a good case study for measuring the degree and determining the sources of market power. Aside from the Haitian government, which sets export taxes and prescribes licensing requirements to intermediaries, there are five major participants in the Haitian coffee marketing chain: producers, primary intermediaries (speculators), exporters, domestic wholesalers, and consumers.[1] In 1984, there were approximately 250,000 producers, 800 speculators (primary intermediaries), 18 exporters, and several thousand domestic wholesalers operating in the market (Seguino).

The average Haitian coffee producer is a small multiproduct farmer who can best be characterized as a peasant. Intermediaries who buy coffee from the farmers are called "speculateurs" (herein called speculators). Speculators provide coffee growers with credit needed for harvesting and even for personal needs, and the loans are repayable in coffee or money. The effective interest rates on these loans have been reported to be as high as 100 percent per year (Seguino). Speculators handle coffee for both the domestic and export markets.

Coffee for the domestic market is handled by domestic wholesalers who buy coffee from speculators and sell it to local merchants. Many wholesalers and merchants not only deal in coffee but also distribute other agricultural commodities. Also, wholesalers are very mobile and are not bound to any particular speculator for their capital or coffee supply needs. Although the speculators also buy coffee from the peasants for the export market, they essentially act as agents of the exporters. For instance, a survey reports that 66 percent of the speculators interviewed are tied to particular exporters who provide them with interest-free credit (Capital Consult). The same survey reported that 86 percent of speculators perceived that the exporters set the farm-gate price. The remaining 14 percent perceived that the price was set by the exporters as a result of world prices. On the world market, however, exporters are price takers, since Haiti accounts for less than .01 percent of total world exports. In 1960, coffee exporters formed an association that, in 1977, established an internal quota system to coordinate their purchases for export.

A key difference between the domestic and export markets is that buying for the export market involves considerable barriers to entry due to the informal arrangements between exporters and speculators and between speculators and growers and the large financial requirements for entering the coffee export trade successfully, estimated to be at least $1 million in the late '70s (Girault). Very few entrepreneurs in Haiti–where the per capita income is approximately $200 per year–have access to this amount of capital or can bear the risk of such a relatively large investment. Buying for the domestic market is relatively competitive mainly due to arbitrage in wholesaling and the much larger number of wholesalers vis-a-vis exporters. Under this situation, collusive behavior may arise to the extent that exporters recognize their mutual interdependence. According to Markham, collusive price leadership works best when products are close substitutes and are amenable to a single price policy; this appears to be true for the Haitian coffee market.

Graphical Analysis

Figure 1 conceptualizes the foregoing situation in the domestic and export markets. Borrowing from the dominant firm theory, supply for exports (Q) is derived as the residual of total supply (Q^s) after purchases by wholesalers for domestic consumption (Q^d). This curve is shown on the left panel along with the respective *perceived* marginal input or factor cost associated with coffee. To maximize profits, exporters should set a price of coffee so that their perceived marginal input cost equals their value of marginal product. This point corresponds to price P^* paid to the farmers and the Q* level of exports (see competitive equilibrium at the point where Q=VMP).

A further complication arises when one considers the export quotas imposed by the International Coffee Agreement (ICA). Presumably, if the ICA cartel is effective in raising the world price of coffee, the value of marginal product of coffee for exports increases, shifting from the VMP curve to $VMP_{0,1}$. Q_0^{ica} denotes an effective quota that results in a lower level of exports and a lower farm-gate price of coffee (P_0^{ica}), compared with the (P^*, Q^*) or (P^{**}, Q^{**}) solutions. Whether the international cartel is effective in raising world prices does not alter the basic conclusions from the analysis, because the quota solution will prevail with VMP or $VMP_{0,1}$. An ineffective quota is depicted at Q_1^{ica}. In sum, if an export quota is binding the quota will dictate a constrained equilibrium in the export market. If a quota is ineffective, the exporters would operate where their perceived marginal input cost equals their value of marginal product.

A Mathematical Model

For the purpose of this paper, market participants are aggregated into three groups: exporters, coffee growers, and domestic wholesalers. Coffee growers are price takers, and their market supply is given by $Q^s = f(P, Z^s)$, where Q^s is quantity of coffee supplied, P is coffee price received, and Z^s is a vector of relevant variables other than the price of coffee. Domestic consumers are also price takers, and their derived market demand is given by $Q^d = g(P, Z^d)$ where Q^d is the quantity of coffee consumed domestically, and Z^d is a vector of other relevant variables that affect demand. Letting the domestic wholesalers be competitive, the coffee supply available for exports is given by $Q^s - Q^d = Q$. Let q_i denote the amount of coffee bought by the i^{th} exporter and let the total amount bought by all exporters be given by $Q = \sum q_i (i = 1, \cdots, N)$. The exporters' profit-maximization problem is given by

$$\max \pi_i = P_w(1 - t^a)q_i - C^i(q_i) - Pq_i \tag{1}$$

where P_w is the f.o.b. world price of coffee received by exporters t^a is the tax rate on coffee exports imposed by the Haitian government, and C^i is the intermediary's processing and handling cost. The first-order condition for profit maximization is

$$\frac{\partial \pi_i}{\partial q_i} = P_w(1 - t^a) - \frac{\partial C^i}{\partial q_i} - P - \frac{\partial P}{\partial q_i} q_i = 0. \tag{2}$$

Applying the chain rule and multiplying and dividing by Q, leads to the perceived impact of coffee expenditures through change in prices, given by

$$\frac{\partial P}{\partial q_i} q_i = \frac{\partial P}{\partial Q} \frac{\partial Q}{\partial q_i} q_i \frac{Q}{Q} = \theta_i \frac{\partial P}{\partial Q} Q, \tag{3}$$

where $\theta_i = (\partial Q/\partial q_i)(q_i/Q)$ is the conjectural variation elasticity, an exporter's perception of the change in purchases by all exporters in response to a 1 percent change in own purchases. Analogous to Appelbaum's conjectural elasticity, θ_i ranges from 0 for perfect competitive behavior to 1 for perfect collusion or monopsonistic behavior. Rewriting equation (2),

$$P_w(1 - t^a) - \frac{\partial C^i}{\partial q_i} - P(1 + \frac{\theta_i}{\eta}) = 0, \tag{4}$$

where η is the price elasticity of market supply available for exports. To maximize profits, an exporter equates net value of marginal product (first two terms) to *perceived* marginal input cost (last term). To measure oligopsony power, consider the analogue of the Lerner index for the i^{th} intermediary and use equation (4) to obtain

$$L_i = \frac{VMP_i - P}{P} = \frac{\theta_i}{\eta}, \tag{5}$$

where VMP_i is the after-tax value of marginal product of q_i previously defined. L_i ranges from 0 for perfect competition to $1/\eta$ for a monopsonist.[2] This measure is the buying power analogue of Appelbaum's measure of oligopoly power. An aggregate Lerner index, computed from the individual intermediaries' Lerner indexes is given by

$$L = \sum_i \frac{\theta_i}{\eta} s_i, \tag{6}$$

where $s_i = q_i/Q$ is the intermediary's share of the coffee market. At equilibrium let the marginal marketing cost and conjectural variation elasticity be the same across intermediaries ($\partial C^i/\partial q_i = mc_i = mc_j = mc$ and $\theta_i = \theta_j = \theta$ for all i *and* j).[3] An aggregate price-setting behavior of intermediaries, based individually on equation (4) can be described as

$$P^* = \frac{P_w(1 - t^a) - mc}{(1 + \frac{\theta}{\eta})}. \tag{7}$$

Equation (7) depicts pricing behavior when an export quota imposed by the International Coffee Agreement is not effective. If this quota is effective, the constrained solution occurs at a price at which the ICA quota (Q^{ica}) equals supply available for exports, namely P^{ica}. More generally,

$$P = \min\{P^{ica}, P^{*}\}, \tag{8}$$

where P^{ica} is the price obtained under the ICA quota ($Q^{ICA} = Q$) and P^{*} is the price obtained from equation (7). Oligopsony power is measured by the aggregate Lerner index ($L = \theta/\eta$) or in the case of binding ICA quotas, the constrained Lerner index can be measured by (VMP-P)/P.

Econometric Procedures

Coffee production involves two features: potential production and the proportion of potential production that is harvested. When the reduced form equation for the coffee supply model presented by Wickens and Greenfield is modified, coffee production in Haiti can be specified as

$$Q_t^s = \beta_0 + \sum_{i=0}^{m} \beta_{i+1} P_{t-i} + \sum_{j=m+1}^{s} \beta_j D_{t-j} + \sum_{k=s+1}^{r} \beta_k S_{kt} + \beta_l Q_{t-1}^s - \beta_m Q_{t-2}^s + U_t^s \tag{9}$$

where D_{t-j} denotes hurricanes occurring in year $t - j$, S_k is the price of substitute k, and lagged quantities capture the biennial cycle and past investments. Domestic consumption is modeled as

$$Q_t^d = \alpha_0 + \alpha_1 P_t + \sum_{j=2} \alpha_j Z_j^d + U_t^d, \tag{10}$$

where Q_t^d is total quantity consumed domestically, P_t is the farm level price of coffee, and Z^d denotes other variables affecting demand. When equations

(9) and (10) are used, the price elasticity of supply available for export is given by

$$\hat{\eta}_t = \frac{\partial Q_t}{\partial P_t}\frac{P_t}{Q_t} = \varepsilon_t^s \frac{Q_t^s}{Q_t} + \varepsilon_t^d \frac{Q_t^d}{Q_t} > \varepsilon_t^s, \tag{11}$$

where $Q_t = Q_t^s - Q_t^d$ and denotes exports, and ε_t^s and ε_t^d are the price elasticity of equations (9) and (10) in absolute value. In other words, the price elasticity of supply for exports becomes greater as domestic consumption grows.

To operationalize equation (7), all variables and parameters can be obtained, except for θ, the conjectural elasticity. A novel feature of this paper is identifying and testing the sources of oligopsony power by introducing more plausible explanatory variables than past studies. Previous studies have modeled conjectural elasticity as a function of input prices (Appelbaum; Schroeter; Taylor and Kilmer) or a function of a concentration ratio (Azzam, Lopez).[4] More specifically, the conjectural elasticity is presumed to be determined by

$$\theta_t = \lambda_0 + \lambda_1 N_t + \lambda_2 Y_t + \lambda_3 \sigma_t^y + \lambda_4 BOARD_t + \lambda_5 QUOTA_t, \tag{12}$$

where N_t is the number of exporters, a measure for market structure and potentiality of collusion. Y_t and σ_t^y are producer's income level and variability from farm activities, including coffee, to account for oligopsony power attributable to financing by intermediaries. Lundahl notes that the rural credit interest rate is linked to peasant's income risk. $BOARD_t$ accounts for the establishment of the Haitian Exporters Board Association in 1960, a potential mechanism for collusion among the exporters. $QUOTA_t$ accounts for the establishment of the Quota Administration Association by exporters in 1977, which coordinates *internal* export quotas among exporters different from the *external* quotas imposed by ICA. The expected signs of the parameters are $\lambda_1, \lambda_2, < 0$ and $\lambda_3, \lambda_4, \lambda_5 > 0$. The magnitudes of these parameters represent the direct proportion by which the Lerner index of oligopsony power changes with changes in these variables.

A serious estimation problem may arise from the endogeneity of the number of exporters in equation (12). Cutthroat competition, persistent losses, and bankruptcies among exporters before the 1960s fostered the creation of the Board Association. Despite this, the number of exporters has been slowly declining in recent decades. Adapting the work of Clarke and Davies, it is presumed that the number of exporters is a function of the degree of collusion, the price elasticity of export supply, and the variation in costs across firms. In addition, export taxes are included because heavy export taxes may have been responsible for pushing fringe exporters out of the market. When the variation in costs across exporting is assumed to be constant (i.e., captured by an intercept term), a linear version of the determinants of the number of exporters is given by

$$N_t = \gamma_0 + \gamma_1 \theta_t + \gamma_2 \hat{\eta}_t + \gamma_3 t_t^a + \gamma_4 N_{t-1}, \tag{13}$$

where θ_t is the proxy for the degree of collusion, $\hat{\eta}_t$ is the price elasticity of export supply (equation 11), t_t^a is the tax rate on coffee exports, and N_{t-1} accounts for partial adjustment in entry and exit. Substituting equation (12) into (13) and solving for N_t yields the following expression:

$$\begin{aligned} N_t &= (1 - \gamma_1 \lambda_1)^{-1} \{ \gamma_0 + \gamma_1 (\lambda_0 + \lambda_2 \gamma_t + \lambda_3 \sigma_t^y + \lambda_4 BOARD_t + \\ &\quad \lambda_5 QUOTA_t) + \gamma_2 \hat{\eta}_t + \gamma_3 t_t^a + \gamma_4 N_{t-1} \}. \end{aligned} \tag{14}$$

Substituting equation (12), and using the price elasticity of supply obtained via equation (11), we obtained an econometric version of equation (7) which denotes market equilibrium in the absence of binding ICA export quotas:

$$P_t^* = \frac{P_w(1 - t_t^a) - mc_t}{(1 + (\lambda_0 + \lambda_1 N_t + \lambda_2 Y_t + \lambda_3 \sigma_t^y + \lambda_4 BOARD_t + \lambda_5 QUOTA_t)/\hat{\eta}_t)} \tag{15}$$

where λ_j represents the parameters to be estimated in this equation. Given the possibility of a dichotomous market solution, under nonbinding or binding ICA export quotas, let the observed farm-level price be given by

$$P_t = \psi P_t^{ica} + (1 - \psi) P_t^*, \tag{16}$$

where P_t^{ica} is the prevailing price under a binding export quota and P_t^* is the unconstrained market solution given in equation (15). To account for the dichotomous solution, a dichotomous variable, denoted by ψ, is introduced. ψ is a binary variable that equals 1 in years where the ICA quota was binding an otherwise higher level of exports and it equals 0 in years where there was no ICA quota or where despite having a quota, exports were significantly below the ICA quota anyway. If the ICA quota is binding, then P_t^{ica} corresponds to the observed farm-gate coffee price. However, if the ICA quota is nonbinding, then P_t^{ica} is above the observed price which is given by P_t^*.

Data and Estimation

The model was applied to aggregate time-series data for the Haitian coffee market for the years 1954 to 1984. Major data sources included Seguino for coffee production and prices, export volume and number of firms, and marketing costs. USAID reports provided information on hurricanes. Other data came from Capital Consult on further farm data and reports by the International Coffee Organization on international trade arrangements.

Observed production was presumed to be a function of lagged and current coffee prices, current price of corn and beans (crops competing for harvesting labor), recent hurricanes, and past levels of production (biennial cycle). The effects of coffee prices and hurricanes were assumed to follow polynomial distributed lagged forms. The quantity consumed domestically was specified as a function of farm-level price of coffee, gross domestic product (a proxy for consumers' income), and the Haitian Consumer Price Index (a proxy for the price of other commodities). The demand function was specified in double-logarithmic form.

Equations (9) and (10) contain P_t as a regressor which, given the endogeneity of this variable, may result in biased and inconsistent parameter estimates if the ordinary least squares technique is applied. The general instrumental variable estimator (GIVE), discussed by Harvey, is applied to P_t by regressing it on a set of exogenous variables and using the predicted value (P_t^{IV}) as an instrumental variable.[6] Thus, P_t^{IV} replaced P_t in equations (9) and (10) to assure consistent estimates and supply and demand parameters were estimated via ordinary least squares.

The supply and demand results were used to compute the price elasticity of export supply in equation (11). Because equation (11) contains variables that are endogenous to the pricing equation, instrumental variable (IV) estimates for these variables were used to compute export supply elasticity.[7] A farmers' income Laseypres index was constructed based on price data and a Haitian coffee farm model.[8] Since this index is partially based on farm-level coffee price–the dependent variable in this equation–an instrumental (GIVE) variable was used in place of the income index. Standard deviation of the GIVE income estimate based on three lagged periods was computed to denote farm income uncertainty. Class variables were utilized for the $BOARD_t$ and $QUOTA_t$. Perfect foresight by exporters was assumed by making $\psi = 1$ for periods where exports fell within 10 percent of the export ICA quota. Because the ICA quotas were found to be binding only in four years of the sample, they were excluded from the final estimation sample, making equation (15) rather than (16) the relevant one for estimation.

Equations (14) and (15) constitute a recursive system given that N_t is the dependent variable in the first one and a regressor in the second. In addition, the equations contain nonlinear parametric restrictions. Given this, the parameters in both equations were estimated with the Full Information Maximum Likelihood technique because it is the only known efficient estimator for simultaneous models that are nonlinear in their parameters.[9] Results are presented in the following section.

Empirical Results

Parameter estimates and selected statistics for the total domestic supply and demand functions (equations (9) and (10)) are presented in Table 1. In general, these results were plausible and consistent with theory. The critical slope parameters were significant at the 5 percent level and had the expected signs. Furthermore, the supply parameter estimates are consistent with the findings of Wickens and Greenfield.

Table 2 contains the parameter estimates for the equations of the number of exporters and pricing behavior (equations (14) and (15)). All the estimated coefficients for the number of exporters were significant at the 10 percent level and, 3 out of 5 were significant at the 5 percent level, and all had the expected sign. While the conjectural elasticity–a proxy for degree of collusion–can be expected to have a negative sign to reflect entry deterrence by incumbent firms, a positive sign in the results here may reflect exit deterrence by incumbent firms via collusion.[10] The negative effect of export supply elasticity on the number of exporters was confirmed. Since coffee production in Haiti has been stagnant for the most part while domestic consumption has grown significantly, the price elasticity of export supply has increased while the quantity of coffee available at a given price has decreased. The decline in the volume of exports is thus followed by a decline in the number of exporters necessary to sustain the export market. The export tax rate was also confirmed as an important force driving exporters out of business. Finally, the coefficient associated with the lagged number of exporters indicates a relatively high degree of friction or partial adjustment in export entry/exit decisions.

Four out of six of the estimated coefficients of the pricing equation (conjectural elasticities parameters) were significant at the 5 and 10 percent levels. The number of exporters was found to have a negative and significant effect (at the 5 percent level) on the conjectural variation elasticity and, thus, a positive effect on price. This result confirms the conventional structure-conduct-performance paradigm of industrial organization in that strategic pricing behavior is more likely to occur the more concentrated the industry is. The results also support Lundahl's argument that risk rather than income level may result in market power in informal credit markets. The level of farmers' income was found to have a negative but insignificantly different from zero effect (at the 10 percent level) on conjectural elasticity. This insignificant result is consistent with the fact that the share of coffee in farm income has been declining due to expansion in the production of grains (Seguino) which has weakened the market power position of coffee intermediaries. Farm income variability (standard deviation of income) had a positive and significant effect (at the 5 percent level) on conjectural elasticity, and, thus, a negative effect on farm-level coffee price. The direction of the effect indicates that producers' preference for security is a significant source of oligopsony power.

The impact of the creation of the Export Board Association ($BOARD_t$) failed to show a significant impact on conjectural elasticity. It should be noted that the creation of the Board occurred during a time when exporters were exiting the market. The increase-in-concentration effect may have already been captured by the N_t variable. Also, the creation of the board coincided with stiff increases in export taxes (1960-63 had the highest tax rates in the sample), which also affected concentration. The creation of the internal-quota administration mechanism within the Board Association ($QUOTA_t$), however, shows a positive and significant effect (at the 5 percent level) on conjectural elasticity and, thus, a negative effect on farm-level coffee price. Unlike the board, this institutional change was not followed by an increase in export taxes. The quota mechanism also allows more *explicit* collusion among exporters than the board itself because exporters agree on the magnitude of an internal quota assigned to each exporter.

Table 3 presents the estimates of conjectural and export supply elasticities and the resulting Lerner indexes. In general, the conjectural elasticities were found to be moderate and their mean value (.08) was comparable to those estimated from other studies that have used the Appelbaum approach. For example, the mean value of the conjectural elasticities reported by Taylor and Kilmer for the Florida celery industry was .083, while Appelbaum reported .037 mean conjectural elasticity for the textile industry. Azzam et al. and Schroeter reported lower conjectural elasticities for the U.S. meat-packing industry (.024 in both cases). The regional estimates for the same industry reported by Schroeter (.099) and those for the tobacco and machinery industries (.402 and .200) reported by Appelbaum are higher than the ones reported here. Note that for the years where the ICA quotas were effective the estimated conjectural elasticity was higher than in other years. Thus, given the structure and institutions in the Haitian coffee market, effective international coffee cartels result in greater collusion among exporters in agreeing how to share the ICA quota. The ultimate consequence of this is lower farm-level prices.

Although the Lerner indexes varied substantially from year to year, there is no apparent trend. Reflecting the effects of the ICA quotas on conjectural elasticities, these indexes were higher in the years of effective ICA quotas. Their mean value was .551 for the years when the ICA quotas were effective vis-a-vis .357 in other years. To the knowledge of the authors, the only available and comparable *oligopsony* indexes are those presented by Schroeter. His estimates were much lower than the ones reported here (.0661 for the regional and .015 for national meat packing). Nonetheless, the *oligopoly* indexes reported by Appelbaum were much lower (rubber, textile, and electric machinery), except for the one for the cigarette industry (.65). Finally, the lack of trend in the Lerner index ($L_t = \theta_t/\eta_t$) may be due to the fact that both the conjectural and export supply elasticities (θ_t and η_t) have been generally increasing over the sample period.

Concluding Remarks

This paper presents a methodology for measuring the degree and determining the sources of oligopsony power, utilizing the Haitian coffee market as a case study. Other features of the model developed include the incorporation of more plausible explanatory variables for pricing behavior than previous work, linkages to the world market, and endogenization of the number of exporters operating in the market.

In general, the empirical results supported the model specified and the various hypotheses drawn from the literature on sources of oligopsony power and determinants of the number of firms. The more significant sources of oligopsony power in the Haitian coffee market were found to be the number of exporters (concentration), farm income variability (a partial proxy for credit needs), and the creation of a quota-adminstration system among exporters. Although the degree of oligopsony power and conjectural variation elasticities were found to be moderate, they increased when export quotas imposed by the International Coffee Agreement binded exports.

The results also point out some interesting conclusions on the determinants of the number of exporters. Collusion among exporters was found to be a significant mechanism for keeping themselves in business in face of a declining export supply market. Thus, while a lower number of exporters increase pricing collusion in the market (via conjectural elasticities), the effect of collusion on the number of the exporters is positive. The main reasons for exporters going out of business are the high export taxes imposed by the Haitian government and the fact that farm-level export supply has become more price-elastic as domestic consumption has grown faster than the relatively stagnant total farm supply.

The analysis helps clarify several important consequences of government policy alternatives in the Haitian coffee market. Conventional economic theory suggests that higher export taxes shifts down the exporters' derived demand for coffee resulting in lower farm-gate prices under nonzero farm-level price elasticity of supply. An additional hidden cost is that higher taxes put fringe exporters out of business, increase concentration in the market, and thus result in greater collusion among remaining exporters and even lower farm-gate prices. The lack of access to competitive financing in rural areas not only results in supranormal finance charges by intermediaries, but also in lower farm prices via oligopsony power generated by these financial arrangements. The exporters' board and internal quota administration are important purchase coordination mechanisms that were apparently created with the purpose of deterring the exiting of exporters. Although effective international cartels are usually beneficial to member countries, their impact on income redistribution among market participants needs to be qualified. In the case of the Haitian coffee market (characterized by a large number of peasant farmers, a relatively small number of exporters and the exercise of oligopsony power) the export quotas imposed by the International Coffee Agreement which are effective in restraining exports have an adverse impact on farmers as they accentuate oligopsony power and result in lower farm-gate prices.

FOOTNOTES

1 Coffee is the main cash crop of Haiti, accounting for 36 percent of the value of exports. The Haitian government imposes a tax on exports every year, which has ranged between 16 and 43 percent of the export price of coffee between 1959 and 1984. The government also issues licenses to all intermediaries.

2 In the oligopoly case presented by Appelbaum, the Lerner index (the ratio of conjectural variation elasticity to price elasticity of demand) ranges from 0 to 1 because an economically rational monopolist operates in the elastic portion of the demand curve. In the oligopsony case, there is not an equivalent situation. Under nonnegative price elasticity of supply, the lower bound on the Lerner "index" is 0 and the upper bound is $1/\eta$. The Lerner index will be greater than 1 under perfect collusion ($\theta = 1$) and price-inelastic supply. An intuitive way of thinking about the L-index for the oligopsony case is that it expresses the noncompetitive markup ($VMP_i - P$) as a percentage of the price paid to the suppliers (P).

3 The assumption of equality of marginal marketing costs across intermediaries ensures equality of value of marginal products as well, an analogue to Appelbaum's assumptions of equality of marginal costs in the oligopoly case. This assumption implies constant marginal processing costs, which in terms of Figure 1 implies a flat VMP curve. However, the basic conclusions regarding the analysis (the VMP-farm price gap) still hold. Points along the VMP curve coincide in terms of the vertical axis but not in terms of output levels. Likewise, VMP and farm-gate price points are still distinguishable. The assumption of equal conjectural elasticities at equilibrium does not imply that all intermediaries have the same conjectural *functions*. This point was argued by Appelbaum in the oligopoly case and Schroeter in the oligopsony case. Both assumptions allow industry-level analysis.

4 Connor et al. (pp. 237-239) review a few studies in which farm prices are linked to concentration ratios of food manufacturers. Brandow points out over 10 sources of market power in the food industry applicable to the selling case and to a lesser extent to the buying case. These sources include large financial resources, geographic extension over local markets, membership in an oligopolistic core, concentration, elasticity of demand for the industry's product, and structure of buyers–especially their size and number.

5 Coffee is sometimes smuggled from the Dominican Republic into Haiti and since this figure is not formally reported, it may cause some discrepancies in the data.

6 Farm-level coffee price was regressed on the world price of coffee, the price of corn, the price of beans, a dummy variable for hurricane, gross domestic product, time, population, and the consumer price index. The obtained R^2 was 0.98.

7 The empirical version for the computation of export supply elasticity (equation (11)) was given by $\hat{\eta}_t = \hat{\beta}_1 P_t^{IV}/\hat{Q}_t + |\hat{\alpha}_1|\hat{Q}_t^d/\hat{Q}_t$, where $\hat{\beta}_1$ and $\hat{\alpha}_1$ are the estimated slope and elasticity for supply and demand, P_t^{IV} as defined before, and $\hat{Q}_t$ and $\hat{Q}_t^d$ are also IV-predicted values for these variables. The instruments used for the latter two were lagged endogenous variables, time, CPI, and population.

8 Following Franzel and Martin, farm income of a typical coffee grower was divided into three categories: coffee, corn, and beans. The income shares for each category, provided by Franzel and Martin, and time-series on commodity prices were used to extrapolate farm income through the benchmark year (1983) and through the entire observation period. This *ad hoc* procedure was necessary due to unavailability of data on coffee farm income.

9 A necessary but not a sufficient condition for a recursive system is that the equation-error covariance matrix is diagonal or, conversely, that the off-diagonal elements are zero. This property was tested with the covariance matrix obtained from the FIML results. The Lagrangian multiplier test of Breusch and Pagan rejected the zero error covariance hypothesis at the 5 percent level.

10 A tentative conclusion from this is that collusion may be a way of retaining firms in a declining market. It would be interesting to test this hypothesis in the U.S. agricultural industry. Commodities that have been cartelized through federal or state marketing orders (some fruits, vegetables, and dairy products) for example, have shown more stability in numbers of producers than other types of subsectors, such as corn and wheat production where the absence of supply coordination may have allowed competitive market forces and economies of scale to reduce the number of production units.

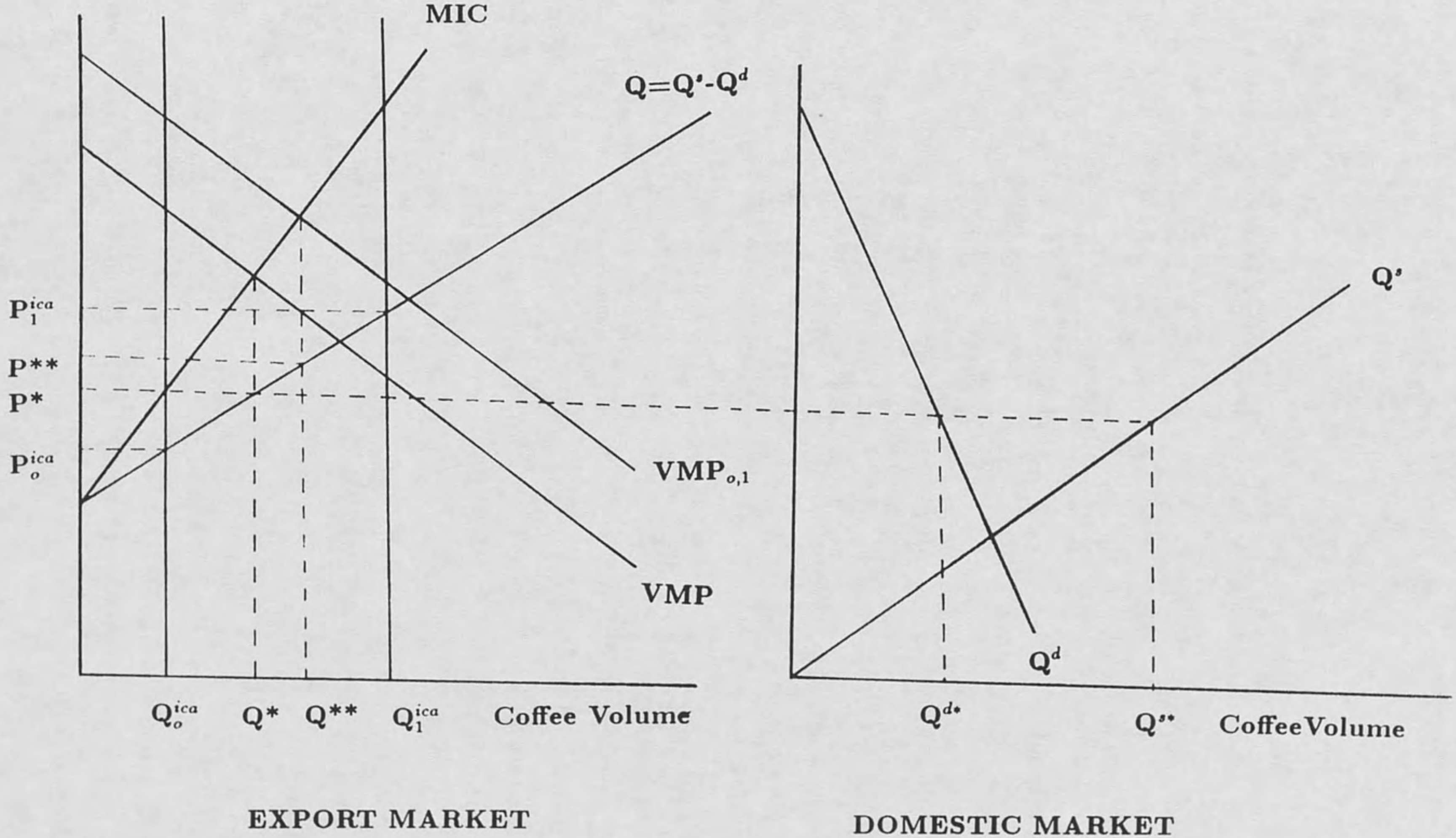

Figure 1. The Haitian Coffee Market as a Collusive Export Oligopsony

Table 1. Coefficient Estimates for the Demand and Supply Equations

Equation	Variable	Notation	Coefficient Estimate	Standard Error	R^2
Supply	Intercept	1	1064.963**	194.008	0.52
	Coffee Price Lag 0	P_t^{IV}	44.473**	18.096	
	Coffee Price Lag 1	P_{t-1}^{IV}	71.156**	28.873	
	Coffee Price Lag 2	P_{t-2}^{IV}	80.051**	32.482	
	Coffee Price Lag 3	P_{t-3}^{IV}	71.156**	28.873	
	Coffee Price Lag 4	P_{t-4}^{IV}	44.473**	18.046	
	Corn Price	S_{1t}	-1084.466	403.978	
	Bean Price	S_{2t}	-83.245**	23.522	
	Hurricane Lag 0	D_t	-65.644**	27.717	
	Hurricane Lag 1	D_{t-1}	-49.233**	20.789	
	Hurricane Lag 2	D_{t-2}	-32.822**	13.859	
	Hurricane Lag 3	D_{t-3}	-16.411**	6.929	
	Quantty Lag 1	Q_{t-1}	-.438**	.176	
	Quantity Lag 2	$-Q_{t-2}$	.109	.180	
Demand	Intercept	1	1.856**	1.540	.66
	Log of Coffee Price	$\ln(P_t^{IV})$	-.286**	.093	
	Log of GDP/CPI	Z_1	-.137	.292	
	Log of CPI	Z_2	.580**	.202	

Note: Supply and demand parameters were estimated via ordinary least squares. The demand equations were in double-log form. One and two asterisks indicate significance at the 10 and 5 percent levels.

Table 2. Full Information Maximum Likelihood Parameter Estimates of the Number of Exporters and Pricing Equations

Equation	Variable	Notation	Coefficient Estimate	Standard Error
Number of Exporters	Intercept	1	20.735*	11.42
	Conjectural Elasticity	θ_t	69.704**	25.257
	Export Supply Elasticity	$\hat{\eta}_t$	-29.240**	15.192
	Export Tax Rate	t_t^a	-27.606*	16.661
	Lagged Number of Exporters	N_{t-1}	.533**	.275
Pricing	Intercept	1	.203**	.053
	Number of Exporters	N_t	-.008**	.003
	Farmers' Income	Y_t	-.016	.013
	Farmers' Income Variability	σ_t^y	.263**	.133
	Board Association	$BOARD_t$	.016	.014
	Quota Administration	$QUOTA_t$	.052**	.020

Note: The corresponding equations are (14) and (15). Because the ICA quotas were found to be effective only in 4 years, these observations were excluded from estimation. One and two asterisks indicate significance at the 10 and 5 percent levels.

Table 3. Estimated Conjectural and Export Supply Elasticities and Lerner Indexes

Year	Conjectural Elasticity ($\hat{\theta}_t$)	Export Supply Elasticity ($\hat{\eta}_t$)	Lerner Index ($\hat{L}_t = \hat{\theta}_t/\hat{\eta}_t$)	Major Events
1954	.030	.126	.238	Hurricane
1955	.036	.150	.243	
1956	.031	.115	.268	
1957	.045	.162	.278	
1958	.020	.117	.171	
1959	.040	.192	.209	
1960	.053	.114	.466	Creation of Exporters Association
1962	.072	.115	.631	
1963	.091	.206	.443	
1964	.075	.186	.402	Hurricane
1965	.099	.175	.568	Effective ICA Quota/Hurricane
1966	.095	.192	.498	Effective ICA Quota
1967	.064	.211	.302	Hurricane
1968	.061	.161	.377	
1969	.069	.185	.377	
1970	.069	.210	.327	
1971	.170	.189	.636	Effective ICA Quota
1972	.085	.209	.407	
1973	.076	.221	.342	
1974	.061	.232	.264	
1975	.071	.220	.324	
1976	.061	.263	.232	
1977	.138	.460	.299	Creation of Quota Administration
1978	.147	.295	.499	
1979	.104	.300	.346	
1980	.105	.292	.358	Hurricane
1981	.083	.367	.226	
1982	.077	.309	.248	
1983	.136	.271	.501	Effective ICA Quota
1984	.090	.367	.244	

Note: An asterisk indicates the years during which the ICA exports were effective. Thus, the corresponding estimated conjectural and export elasticities, as well as Lerner indexes, were imputed from the constrained solution at the quota level. The year 1961 was excluded due to unavailability of data.

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