

Knowing the Value of Coffee: Institutional Design and the Value of Information

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Introduction

Market for Coffee in Mexico

The Value of Quality to Processors and Producers

Quality in an Agricultural Market

Choosing Quality - Agronomic inputs and Grading

Choosing Quality and Quantity

Market Based Institutions to Improve Quality Signals

Market Channels in Mexico

Different Market Instruments

Vertical Integration

Lateral Integration

Cooperatives

Conclusions

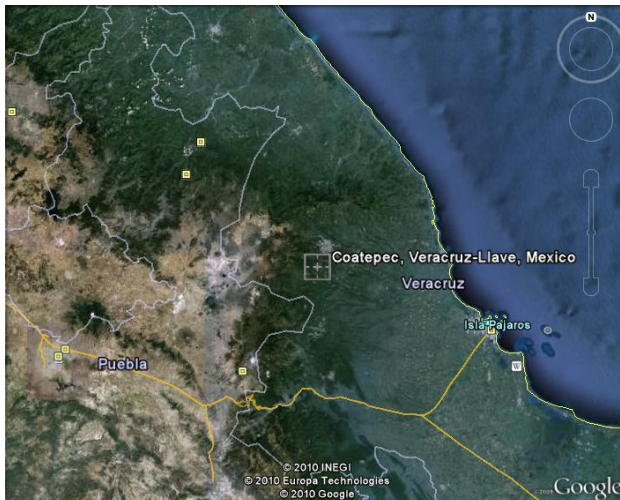
Agricultural Economics and Product Markets

- ▶ Agricultural economics has typically proceeded from the notion that agriculture represented the last bastion of pure competition.
 - ▶ Large numbers of producers offering homogeneous product to a large number of consumers could characterize production agriculture.
- ▶ Recent trends in agriculture have eroded this perception.
 - ▶ While there are still a large number of consumers, there has been significant concentration in agribusinesses between farmers and consumers.
 - ▶ The assumption of product homogeneity can now be questioned.

Coffee Production in Veracruz

- ▶ Historically, Mexican coffee production represented a profitable alternative crop in the state of Veracruz.
- ▶ The city of Coatepec maintains grand houses built by the coffee trade in colonial times.
- ▶ Land redistributions during the twentieth century reduced the average size of each farm to 5 hectares.
- ▶ My conjecture is that smaller units eliminated the incentive structure that allowed for return to quality.

Map of Coatepec



Traditional Models of Quality

- ▶ Tomek and Robinson (1981) raise the issue of quality within the context of grades for agricultural produce.
 - ▶ Tomek and Robinson describe grades for agricultural commodities based on observable characteristics related to consumer preferences.
 - ▶ Consumer preferences on quality can be used to signal producers regarding the appropriate size of grapefruit or finish on beef cattle.
- ▶ This exposition is highly stylistic and abstracts away from questions of the value of grading to an industry in general.

Producer Value of Quality

In order to formalize the value of quality, consider the optimization problem facing coffee processors

$$\begin{aligned}\pi &= p_1 x_1 + p_2 x_2 + p_3 x_3 - wE \\ \text{st } x_1 + x_2 + x_3 &= x_T \\ \{x_1, x_2\} &= F(x_T, E, z_1) \\ \frac{x_1}{x_1 + x_2} &= \theta(z_1)\end{aligned}\tag{1}$$

- ▶ π - processor profit
- ▶ x_1 - high quality coffee
- ▶ x_2 - low quality coffee
- ▶ x_3 - ungraded coffee
- ▶ p_1 - price of high quality coffee
- ▶ p_2 - price of low quality coffee
- ▶ p_3 - price of ungraded coffee
- ▶ w - cost of effort to grade coffee
- ▶ E - level of effort to grade coffee

Producer Value of Quality - Continued

$$\begin{aligned} \{x_1, x_2\} &= F(x_T, E, z_1) \\ \frac{x_1}{x_1 + x_2} &= \theta(z_1) \end{aligned} \tag{2}$$

- ▶ $F(x_T, E, z_1)$ is the function representing the tradeoff between high quality and low quality coffee.
- ▶ $\theta(z_1)$ the amount of input z_1 affects the ratio of high quality coffee to total coffee.

Producer's Decision Problem

Assuming that effort in grading is expended efficiently, this formulation becomes

$$\begin{aligned} \max \pi &= p_1 x_G \theta(z_1) + p_2 x_G (1 - \theta(z_1)) + p_3 x_3 - C(x_G) \\ \text{st } x_G + x_3 &= x_T \end{aligned} \quad (3)$$

$x_G = x_1 + x_2$ - The amount of coffee graded. The share of high and low quality coffee is determined by the quality input z_1 .

$$\begin{aligned} L &= p_1 x_G \theta(z_1) + p_2 x_G (1 - \theta(z_1)) + p_3 x_3 - C(x_G) \\ &\quad + \lambda (x_T - x_G - x_3) \end{aligned} \quad (4)$$

Kuhn-Tucker First Order Conditions

$$\frac{\partial L}{\partial x_G} x_G = \left(p_1 \theta(z_1) + p_2 (1 - \theta(z_1)) - \frac{\partial C(x_G)}{\partial x_G} - \lambda \right) x_G = 0$$

$$\frac{\partial L}{\partial x_3} x_3 = (p_3 - \lambda) x_3 = 0 \quad (5)$$

If both x_G and $x_3 > 0$ then we can solve the first-order conditions for λ to yield

$$p_1 \theta(z_1) + p_2 (1 - \theta(z_1)) - \frac{\partial C(x_G)}{\partial x_G} = p_3 \quad (6)$$

Kuhn-Tucker First Order Conditions for Boundary Solution

$$\frac{\partial L}{\partial x_G} x_G \Rightarrow p_1 \theta(z_1) + p_2 (1 - \theta(z_1)) - \frac{\partial C(x_G)}{\partial x_G} - \lambda \leq 0$$

$$x_G = 0 \Rightarrow \theta(z_1) + p_2 (1 - \theta(z_1)) - \frac{\partial C(x_G)}{\partial x_G} - \lambda < 0$$

$$x_G > 0 \Rightarrow \theta(z_1) + p_2 (1 - \theta(z_1)) - \frac{\partial C(x_G)}{\partial x_G} - \lambda = 0 \quad (7)$$

$$\frac{\partial L}{\partial x_3} x_3 \Rightarrow p_3 - \lambda \leq 0$$

$$x_3 = 0 \Rightarrow p_3 - \lambda < 0$$

$$x_3 > 0 \Rightarrow p_3 - \lambda = 0$$

Graded and Ungraded Value of Coffee

Focusing on the graded and ungraded value of coffee

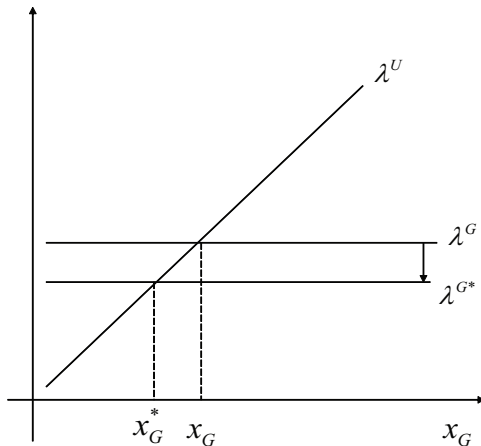
$$\lambda^G = p_1 \theta(z_1) + p_2 (1 - \theta(z_1)) - \frac{\partial C(x_G)}{\partial x_G} \quad (8)$$

$$\lambda^U = p_3 (x_T - x_G)$$

- ▶ λ^G is the value of graded coffee
- ▶ λ^U is the value of ungraded coffee

Note that $p_3 (x_T - x_G)$ is the traditional downward sloping demand curve for ungraded coffee.

Graphical Representation of Quantity of Coffee Graded



Two Ways to Increase Quantity of High Quality Coffee

- ▶ This representation yields two ways to increase the quantity of high quality coffee marketed on the international market and, hence, the price received for coffee in the Mexican market.
 - ▶ Improve agronomic practices leading to an increased share of coffee graded high quality
 - ▶ Decrease the cost of grading coffee.
- ▶ While processors allocate coffee between markets, producers choose agronomic practices.

Quantity/Quality choice

- Economic implications of improved agronomic practices

$$\pi = p_1 x_G \theta(z_1) + p_2 x_G (1 - \theta(z_1)) + p_3 x_3 - C(x_G) - w_1^* z_1 - w_2^* z_2$$

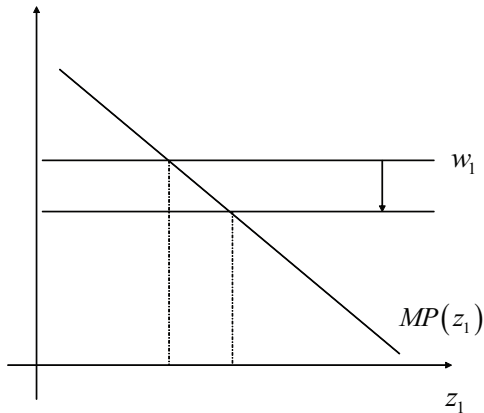
$$st \quad x_3 + x_G = x_T(z_1, z_2)$$
(9)

- z_2 is an input which increases the quantity of the output but does not affect the quality.
- Forming the Lagrangian and taking the derivative with respect to each input level yields

$$\frac{\partial x_T(z_1, z_2)}{\partial z_1} = \frac{w_1 - (p_1 - p_2) \frac{\partial \theta(z_1)}{\partial z_1} x_G}{\lambda}$$

$$\frac{\partial x_T(z_1, z_2)}{\partial z_2} = \frac{w_2}{\lambda}$$
(10)

Use of Quality Enhancing Inputs



Choice between Inputs

- ▶ The general results seem to be consistent with economic intuition
 1. The optimal level of grading equates the price in the domestic market with the gain in the foreign market net of the cost of grading, and
 2. Producers have an incentive to produce quality coffee through higher average prices.
- ▶ The observed fact of declining quality in the Mexican coffee market could be the result of
 - a. declining world prices for export coffee,
 - b. increased domestic demand for ungraded coffee, or
 - c. increased prices of quality enhancing inputs. However, other factors relating to market structure may also contribute to the decline in quality.

The Case of a Small Producer

- Assume that the producer is very small

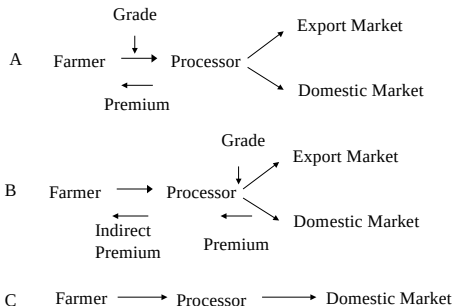
$$\lim_{m \rightarrow \text{large}} \frac{\partial \theta(z_{11}, z_{21}, \dots, z_{m1})}{\partial z_{i1}} = 0 \Rightarrow \frac{\partial x_T(z_{i1}, z_{i2})}{\partial z_{i1}} = \frac{w_1^*}{\lambda} \quad (13)$$

- So the producer uses no quality augmenting input

Coyotes

- ▶ The sector is composed to two components
 - ▶ Small farmers who farm less than 3.5 hectares, but represent 78 percent of the producers.
 - ▶ Larger farmers who account for 80 percent of the coffee production in Mexico.
- ▶ Marketing channels
 - ▶ Smaller farmers sell their output through a series of middlemen called coyotes who then sell coffee to large processors.
 - ▶ Large farmers who sell directly to processors (or more typically undertake the first stage of processing themselves) to garner higher prices.

Alternative Marketing Channels for Mexican Coffee



Stylized Marketing Instruments

- ▶ The institutions examined in this study are
 - ▶ Vertical Integration
 - ▶ Lateral Integration
 - ▶ Cooperatives
 - ▶ Integration by contracts

Basic Vertical Integration Formulation

- Gain from Vertical Integration

$$\begin{aligned} \pi^* &= [p_1 x_G^* \theta(z_1^*) + p_2 x_G^* \{1 - \theta(z_1^*)\} + p_3 x_3^* - w_1 z_1^* - w_2 z_2^* - C(x_G^*)] \\ &\quad - [p_1 \tilde{x}_G \theta(\tilde{z}_1) + p_2 \tilde{x}_G \{1 - \theta(\tilde{z}_1)\} + p_3 \tilde{x}_3 - w_1 \tilde{z}_1 - w_2 \tilde{z}_2 - C(\tilde{x}_G)] \\ st \ x_G^*, x_3^*, z_1^*, z_2^* &\Leftrightarrow \frac{\partial x_T(z_1, z_2)}{\partial z_1} = \frac{w_1}{\lambda} - \frac{(p_1 - p_2) x_G}{\lambda} \frac{\partial \theta(z_1)}{\partial z_1} \\ \tilde{x}_G, \tilde{x}_3, \tilde{z}_1, \tilde{z}_2 &\Leftrightarrow \frac{\partial x_T(z_1, z_2)}{\partial z_1} = \frac{w_1}{\lambda} \end{aligned} \quad (14)$$

- ▶ We know that $\pi^* \geq 0$ since $x_G^* \geq x_G$, $x_3^* \leq x_3$, $z_1^* \geq z_1$ by the internalization of market failure.
- ▶ I conjecture that $\lambda^* \geq \lambda$ since more project is sold in the higher priced market.
- ▶ If $\lambda^* \geq \lambda$ $z_2^* \geq z_2$.

Costly Vertical Integration

- Assume that vertical integration increases the cost of each input

$$\begin{aligned}\hat{w}_1 &= w_1 + \delta_1 \\ \hat{w}_2 &= w_2 + \delta_2\end{aligned}\tag{15}$$

$$\begin{aligned}\pi^* &= [p_1 \hat{x}_G \theta(\hat{z}_1) + p_2 \hat{x}_G \{1 - \theta(\hat{z}_1)\} + p_3 \hat{x}_3 - \hat{w}_1 \hat{z}_1 - \hat{w}_2 \hat{z}_2 - C(\hat{x}_G)] \\ &\quad - [p_1 \tilde{x}_G \theta(\tilde{z}_1) + p_2 \tilde{x}_G \{1 - \theta(\tilde{z}_1)\} + p_3 \tilde{x}_3 - w_1 \tilde{z}_1 - w_2 \tilde{z}_2 - C(\tilde{x}_G)] \\ &\quad st \hat{x}_G, \hat{x}_3, \hat{z}_1, \hat{z}_2 \Leftrightarrow \frac{\partial x_T(z_1, z_2)}{\partial z_1} = \frac{w_1 + \delta_1}{\lambda} - \frac{(p_1 - p_2) x_G}{\lambda} \frac{\partial \theta(z_1)}{\partial z_1} \\ &\quad \tilde{x}_G, \tilde{x}_3, \tilde{z}_1, \tilde{z}_2 \Leftrightarrow \frac{\partial x_T(z_1, z_2)}{\partial z_1} = \frac{w_1}{\lambda}\end{aligned}\tag{16}$$

- Under typical assumptions $\pi^* \geq \hat{\pi}$ due to the additional cost.

Limit to Costly Vertical Integration

- Focusing on the quality input, quality will increase if and only if

$$\delta_1 < (p_1 - p_2) x_G \frac{\partial \theta(z_1)}{\partial z_1} \quad (17)$$

Basic Lateral Integration Formulation

- The other alternative is to grow firms until the producer can afford to grade its own coffee

$$\begin{aligned}\pi = & p_1 x_G \theta(z_1) + p_2 x_G \{1 - \theta(z_1)\} + x_3 p_3 - w_1 z_1 - w_2 z_2 - C(x_G) \\ & s.t. \ x_T(z_1, z_2, z_3) = x_G + x_3 \\ & \quad z_3 = z_3^0\end{aligned}\tag{18}$$

$$\begin{aligned}L = & p_1 x_G \theta(z_1) + p_2 x_G \{1 - \theta(z_1)\} + x_3 p_3 - w_1 z_1 - w_2 z_2 - C(x_G) \\ & \lambda [x_T(z_1, z_2, z_3) - x_G - x_3] + \mu (z_3^0 - z_3)\end{aligned}\tag{19}$$

Value of Expansion

- Value of the constrained variable

$$\mu = \frac{\partial x_T(z_1, z_2, z_3)}{\partial z_3} \lambda \quad (20)$$

- If the market price of land per hectare is greater than the value of land in production, then lateral integration through the purchase of land would represent a cost

$$\delta_3 = w_3 - \frac{\partial x_T(z_1, z_2, z_3)}{\partial z_3} \lambda \quad (21)$$

- Where w_3 is the prevailing price of land.

Organization as Cooperatives

- ▶ A typical response to issues of scale in agriculture has been the formulation of cooperatives.
- ▶ New maximization problem

$$L = p_1 x_G \{ 1 - \theta_i(z_1) \} + p_2 x_G \{ 1 - \theta_i(z_1) \} + p_3 x_3 - C_i(x_G) - (w_1 + \delta_1) z_1 - w_2 z_2 + \lambda \{ x_T(z_1, z_2) - x_G - x_3 \} \quad (22)$$

- ▶ Where $\theta_i(z_1)$ represents the effect of z_1 on the value of the pooled output given that there are i farmers in the pool, and
- ▶ $C_i(x_G)$ is the cost of sorting coffee given there are i farmers in the pool.

Market Failure under Cooperatives

- ▶ Pooling produces in this yields a lower minimum pooling level, but the effect on quality may be less than desired.
- ▶ Focusing on $\theta_m(z_1)$ and $\theta(z_1)$ where $m < n$.
 - ▶ We conclude that it may be economically possible to sort coffee for the smaller pool.
 - ▶ Focusing on the quality reaction by the farmer

$$\frac{\partial \theta(z_1)}{\partial z_1} > \frac{\partial \theta_m(z_1)}{\partial z_1} = \frac{\partial \theta(z_{11}, \dots, z_{m1})}{\partial z_{i1}} > \frac{\partial \theta_n(z_1)}{\partial z_1} = \frac{\partial \theta(z_{11}, \dots, z_{n1})}{\partial z_{i1}} \quad (23)$$

- ▶ The effect of quality on input choice is a decreasing function of the number of farms required to form the pool.
- ▶ Relatively more of the quality signal is preserved aggregating four farmers into a cooperative than five farmers.

- ▶ The results show that dominance of small farms in the sector leads to a decreased quality, income, and domestic price of coffee.
- ▶ Quality grading is costly since most coffee is sold in cherry form. Processing to pergamino or parchment coffee allows for the assessment of quality.