Quality Incentives in Informal Markets: The Case of Ecuadorian Cocoa

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Abstract

We investigate the economic importance of implicit quality incentives in an agricultural market that lacks the institutional capacity for measuring quality verifiably. We measure the magnitude of implicit price premiums for quality, and we distinguish empirically between hedonic-pricing and implicit-contracting motivations for observed incentives. We find price premiums comparable in magnitude to premiums observed in other agricultural markets where quality is measured verifiably. Premiums are highest for relatively low-value but highly-informative quality characteristics, and buyers who are informationally close to farmers implicitly reward actions that affect unobservable quality characteristics. We conclude that implicit contracting is used to provide quality incentives comparable in magnitude to what is provided through more explicit means in formally organized markets.

Key words: quality, incentives, implicit contracts, cocoa.

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Introduction

This paper investigates the economic importance of implicit incentives in spot-market exchange. We study the market for farm-level production of Ecuadorian cocoa where product quality is highly valued, but where there is no institutional capacity for measuring quality verifiably. Inside a firm, repeated interaction among employees and managers can sustain self-enforcing implicit incentives to motivate high performance. In market transactions, where repeated interaction does not occur or is less predictable, third-party quality measures often condition spot exchange to support quality provision by suppliers. The market for Ecuadorian cocoa is unique in that the retail product exhibits a high degree of quality differentiation, but the raw input is produced in an institutional setting that does not support formal quality measurement or explicit contracting. In this setting, how are incentives provided to farmers to produce high-quality cocoa beans? In the absence of formal quality measurement and explicit contracts, are actions taken by farmers to improve cocoa quality compensated by buyers? Which actions are compensated and by what type of buyer? Finally, how do price premiums for quality (assuming they exist) under implicit contracts in the Ecuadorian cocoa market compare with those that are observed in other agricultural markets where formal quality measurement and explicit contracts are used?

Theoretical work on implicit incentives has focused mostly on transactions inside firms, or on "career concern" models where managerial performance is noncontractible, but nevertheless informative about an agent's ability to market participants (Gibbons and Waldman 1999, Holmstrom 1999). Although "spot exchanges" are typically described as anonymous transactions, if market participants interact and know one another, information about a given producer's expected quality may be transmitted in the market to provide implicit quality incentives. Independent producers may be motivated by "market concerns" of this sort. For example, hedonic studies that investigate the equilibrium relationship between price and product characteristics (Rosen 1974, Ohta and Griliches 1976) have been used by several authors to examine the marginal value of product characteristics in various agricultural markets (e.g., Gorman 1980, Parker and Zilberman 1993, Espinosa and Goodwin 1991). However, the structure of implicit incentives provided in these two models are qualitatively different. With a full-information hedonic model, there is no role for informativeness in quality signals. In contrast, an agency-theoretic model can imply high reward for a low value, but strongly informative signal.

The purpose of this paper is to determine the extent to which farmers in Ecuadorian cocoa markets are rewarded for producing high quality cocoa beans. Further, we distinguish empirically between implicit market incentives (hedonic pricing) and implicit *ex ante* contracting. Even if not measured verifiably, a buyer who subjectively determines that a given farmer's beans are high quality is willing to pay a relatively high price. In equilibrium, this will provide farmers an incentive to produce high quality even if there is no *ex ante* agreement. This is different than an implicit contract where, for example, a buyer and seller have an informal agreement involving specific actions that the farmer will take to improve quality, even if quality cannot be measured verifiably.[1] We measure quality premiums provided by buyers, and test for the presence of *ex ante* contracting. We do this by regressing transaction price on buyer and seller characteristics, product quantity and location in the transaction, current average spot price, and various measures of farmers' cultivation and post-harvest practices. Significance of the last set of regressors, and premium structures that reflect the informativeness of quality signals, provide evidence of implicit contracting.

[1] Note that we are considering implicit incentives, as in the career concerns literature, as a kind of implicit contract.

Our work contributes to the implicit contracting and career concerns literature in two ways. First, we extend the framework conceptually by applying it to market transactions outside the context of the "employment relationship." Second, we provide empirical evidence on the economic importance of implicit incentives. We contribute to the literature on hedonic pricing in agricultural markets by identifying the dual role of quality signals as measures of value and signals of agent actions. Finally, in the context of economic development, we provide evidence on the economic importance of institutions for verifiable quality measurement.

Consistent with hedonic pricing, we find higher prices for relatively high-quality outcomes. This is the case, for example, with the post-harvest drying and fermenting of cocoa beans. We find evidence of implicit contracting in three sets of results. First, we find that high-value characteristics are rewarded less than low-value characteristics. Fermentation, a practice that is essential to developing bean flavor and color, receives a premium of about one third that of drying. As we describe below, this outcome can be explained by the much higher informativeness of drying. Intuitively, although proper fermentation is more important than drying in developing overall bean quality, it is also more difficult to assess at the point of purchase. Second, we find that buyers who are informationally close to famers, unlike buyers who purchase at distant spot markets, reward actions that affect unobservable quality attributes such as flavor. For example, farmers who are members of producer associations are rewarded for moderating irrigation. Finally, we find that tree-height control, a cultivation practice that affects unobservable quality attributes, is compensated in the market independent of the type of buyer. Overall, price premiums for quality-enhancing actions of cocoa farmers are similar in magnitude to those provided to farmers in other agricultural markets where quality is measured formally.

In what follows, we begin by presenting a theoretical motivation that guides our empirical analysis. The second section presents the empirical background, followed by the sampling strategy, the empirical model, and the results section. The final section concludes.

Theoretical Framework

In this section we first derive the price premium under explicit contracts as a benchmark based on Holmstrom and Milgrom's (1987) model. Second, we present some characteristics of the price premium under implicit contracts based on MacLeod's (2003) and Kvaloy's (2006) models and we compare them with the price premium under explicit contracting. Third, we present the price premium under hedonic pricing and compare it with the previous models. Finally, we derive testable predictions from these models. For simplicity, we do not derive testable predictions for the implicit contracting model since Kvaloy (2006) has shown that the predictions are similar to the ones obtained from the explicit contracting model. The only exception is that the price premium is restricted to a range.

Explicit Contracts

In this type of contracts performance is verifiable (therefore is contractible) by a third party, for example, a court of law. The risk-averse agent (farmer) makes an unobservable choice of effort e. Effort in this case corresponds to the actions taken by the farmer for cocoa quality production. Effort stochastically determines the agent's outcome: cocoa quality. Let,

$$q(e,x) = e + x + v$$

where q is quality and x and v are random noises with $E(x) = 0$, $E(v) = 0$, $Var(x) = \sigma_x^2$, and $Var(v) = \sigma_v^2$. The noise that reflects how effort is determining quality, or production noise, is x and the noise from the buyer's measurement is v, i.e. the buyer by observing the cocoa beans can "guess" more or less precisely if some actions were conducted and this introduces error.

The principal offers a contract to the farmer described by,

$$p(q) = \alpha + \beta q$$

where α is a base price and β is a performance-contingent payment (we will also refer to it as a bonus), and both are meant to be paid ex-post. Effort is costly. Let $c(e)$ be the cost of effort with $c'(e) > 0$ and $c''(e) > 0$.

The certainty equivalent is the expected payoff minus the risk premium. The risk premium represents the minimum willingness to accept compensation for the risk. Then, the farmer's certainty equivalent is,

$$CE_f = E(p) - c(e) - \frac{1}{2} rVar(p)$$

$$= \alpha + \beta e - c(e) - \frac{1}{2} r\beta^2(\sigma_x^2 + \sigma_v^2)$$

where $r = -U''(\bar{p})/U'(\bar{p})$ is the coefficient of absolute risk aversion. The buyer's certainty equivalent is,

$$CE_b = E\big(p_b q - p(q)\big)$$

$$= p_b e - (\alpha + \beta e)$$

where p_b is the price that the buyer receives for the cocoa beans.

If the agent maximizes his certainty equivalent, he gets,

$$\beta = c'(e)$$

which corresponds to the farmer's incentive compatibility constraint. Plugging this result in the certainty equivalent of the farmer, allows us to solve for α. After plugging in α into the certainty equivalent of the buyer, we maximize the buyer's certainty equivalent subject to the farmer's incentive compatibility constraint,

$$Max_e \left\{ p_b e - c(e) - \frac{1}{2} r \beta^2 (\sigma_x^2 + \sigma_v^2) \right\}$$

$$\text{s.t. } \beta = c'(e)$$

From which we get,

$$\beta^* = \frac{p_b}{1 + rc''(e)[\sigma_x^2 + \sigma_v^2]}$$

So, the price premium depends negatively on the farmer's risk aversion, on the production variance, and on the measurement variance; and it depends positively on incentive responsiveness which represents the effect of the bonus on effort provision ($1/c''(e)$).

Similar results hold under implicit contracting as shown by Kvaloy (2006). Given that and for simplicity, we develop our analytical results based on the explicit contracting model even though we do not observe explicit contracts in the marketing of cocoa beans in Ecuador at the producer level.

Implicit Contracts

In this type of contract the agent's performance is not verifiable or too costly to verify by a court of law even though quality is observable by both parties. Another important characteristic of implicit contracts is that the provision of effort is affected by self-enforcement. Self-enforcement means that the present value of today's relationship is affected by the value of the continuation of the relationship in the future. A contract is self-enforcing if the cost of reneging today is higher than the future value of continuing the relationship. In addition to the participation and incentive compatibility constraints, we have an additional constraint: the self-enforcing constraint. This means that under implicit contracts we expect to see lower range of premiums compared to explicit contracts (MacLeod 2003 and Kvaloy 2006).

Hedonic Pricing

In the hedonic pricing hypothesis, goods are valued for their utility-bearing characteristics and hedonic prices are the implicit prices of these characteristics (Rosen 1974).

Quality is represented by a vector of quality attributes $\boldsymbol{q}$. The market price of cocoa beans varies with different attributes and is represented by the hedonic price function $p(\boldsymbol{q})$. This function is determined by the supply and demand of cocoa beans and, fundamentally, by the distributions of consumer preferences and producer costs.

Assume consumers purchase one unit of (processed) cocoa beans with n attributes $\boldsymbol{q}$ ($q = q_1, q_2, \ldots, q_n$) and have a concave utility function of $U(\boldsymbol{q}, x; \boldsymbol{\gamma})$ where x represents consumption of all other goods and $\boldsymbol{\gamma}$ is a vector of parameters that characterize an individual consumer. Consumers have a constrained budget where y is their income. Suppose the price of x is equal to one. Their budget constraint is $y = p(\boldsymbol{q}) + x$. The joint distribution of y and $\boldsymbol{\gamma}$ is $F(y, \boldsymbol{\gamma})$. Consumers maximize their utility subject to their budget constraint and get the following first order conditions,

$$\frac{\partial p}{\partial \boldsymbol{q}} = p_{\boldsymbol{q}} = \frac{U_{\boldsymbol{q}}(\boldsymbol{q}, y - p(\boldsymbol{q}); \boldsymbol{\gamma})}{U_x(\boldsymbol{q}, y - p(\boldsymbol{q}); \boldsymbol{\gamma})} \qquad (1)$$

Equation (1) shows that optimality is achieved by purchasing cocoa beans with the desired set of attributes. We can also see that the marginal price of attributes equals the marginal rate of substitution between income spent in cocoa beans' attributes and forgone income (income spent in x). The distribution function that characterizes the demand for cocoa beans can be derived using $F(y, \boldsymbol{\gamma})$ and the n first order conditions in (1).

Producers have a convex cost function $C(M, \boldsymbol{q}; \boldsymbol{\theta})$ where M is the number of units of cocoa beans with attributes $\boldsymbol{q}$ that the farmer produces. $\boldsymbol{\theta}$ is a vector of parameters that characterize an individual producer, for example, different technologies, education, or factor prices, and it has a distribution $G(\boldsymbol{\theta})$. Each farmer maximizes profit by choosing M and $\boldsymbol{q}$ optimally. Note that both consumers and producers are price takers meaning that they take the functional form of $p(\boldsymbol{q})$ as given. Producers maximize,

$$p(\boldsymbol{q})M - C(M, \boldsymbol{q}; \boldsymbol{\theta})$$

and get the first order conditions,

$$p_{\boldsymbol{q}} = \frac{C_{\boldsymbol{q}}(M, \boldsymbol{q}; \boldsymbol{\theta})}{M} \qquad (2.1)$$

$$p(\boldsymbol{q}) = C_M(M, \boldsymbol{q}; \boldsymbol{\theta}) \qquad (2.2)$$

Marginal revenue from additional attributes equals marginal cost of production per unit of cocoa beans sold as we can see in first order conditions (2.1). First order conditions (2.2) indicate that quantities of cocoa beans are produced up to the point where the implicit price function of attributes or unit revenue equals the marginal cost of production, evaluated at the optimum combination of attributes. The distribution function that characterizes the supply of cocoa beans can be derived using $G(\boldsymbol{\theta})$ and the first order conditions in (2).

Equilibrium $p(\boldsymbol{q})$ is found when the market quantity demanded of cocoa beans with attributes $\boldsymbol{q}$ equals the market quantity supplied. The shape of the hedonic price function depends on the distributions of characteristics of demanders and suppliers (Epple 1987).

Model Predictions

We assume that the implicit contract (if any) takes the form,

$$p(q) = \alpha + \beta q$$

where, for simplicity, q represents one quality attribute;[2] α is a payment that is independent of performance and it represents outside options, for example, the higher the bargaining power of the agent the more outside options he has; β is a performance-contingent payment and is a function of the price that the buyer gets (p_b), the farmer's risk aversion (r), the production variance (σ_x^2), the quality measurement variance (σ_v^2), and incentive responsiveness ($1/c''(e)$). The relationship between β and the price the buyer gets is expected to be positive; the relationship with risk aversion and the production and measurement variances is expected to be negative, and the relationship with incentive responsiveness is expected to be positive. We do not test this model structurally but we use it to guide our empirical analysis. The main predictions that we care about are the relationship of the bonus with the price that the buyer gets and with the variance of production and of quality measurement.

[2] We will consider more than one quality attribute in the empirical analysis but for simplicity here, we think of q as one quality attribute instead of a vector, to avoid having a multidimensional contract. If we need to consider more attributes, we will assume the contract treats each performance measure independently.

In addition, under implicit contracts, we expect a lower range of premiums (represented by β_{IC}) compared to the magnitude of premiums under explicit contracts (represented by β_{EC}). That is, we expect $\beta_{IC}^{*} < \beta_{EC}^{*}$.

We test for evidence of the hedonic pricing by analyzing if some attributes (or actions conducted by farmers) receive price premiums. We also want to learn which of those actions receive higher premiums. Suppose we want to compare two quality attributes, F and D, F for fermented cocoa beans and D for dried. The former is highly valued by consumers compared to the latter. According to the hedonic model this would mean a higher implicit price for attribute F compared to attribute D. According to this model, this would also be the case if the cost of fermenting cocoa beans is higher than the cost of drying cocoa beans. However, if measurement variance is higher for attribute F than for attribute D, this could offset the hedonic pricing effect resulting in a higher price premium for an attribute that is less valued by consumers. A similar case could occur if the action of fermenting beans affects cocoa bean quality less predictably than the action of drying the beans i.e. if fermentation has higher production variance than drying. Although we cannot empirically disentangle the last two effects from each other—measurement variance from production variance—, we can distinguish between the hedonic pricing hypothesis and the implicit incentives hypothesis if the premium for a low-value characteristic is higher than the premium for a high-value characteristic. Providing evidence against hedonic pricing would imply that implicit incentives matter for quality production.

The hedonic pricing model assumes full information. So, actions such as cultivation practices and post-harvest practices that affect observable quality attributes should be compensated in the market according to this model. Therefore, evidence of compensation by buyers for actions that affect unobservable quality attributes such as flavor and fat content, also provides evidence against hedonic pricing and in favor of implicit incentives.

Further, the type of buyer will help us identify the presence of implicit contracts. If informed buyers i.e. those that can observe actions that affect quality that other buyers cannot observe, compensate farmers for those actions, we can conclude that there is evidence of implicit contracts in the cocoa market. This would also provide evidence against the hedonic pricing hypothesis since only some buyers—the more informed ones— would compensate certain actions and other less informed buyers would not.

Empirical Context: Cocoa in Ecuador

Cocoa Quality and Quality Investments

The Codex Committee on Cocoa Products and Chocolate is responsible for elaborating world-wide standards for cocoa products. This Committee has defined that cocoa of merchant quality must be: fermented, thoroughly dry, free from smoky beans, free from abnormal or foreign odors, free from any evidence of adulteration, reasonably uniform in size, reasonably free from broken beans, fragments and pieces of shell, and be free from foreign matter (Codex Committee on Cocoa Products and Chocolate 1969, cited by ICCO 2009). So, the handler's quality characteristics are based on flavor and purity attributes. These characteristics are observable on average for a given lot. However, there is no formal quantification of distribution within lot. Visual inspection provides very imprecise sense of distribution. A processor's assessment of a particular parcel of beans includes a broader definition of cocoa quality. Key criteria are: flavor, purity, consistency, yield of edible material, and cocoa butter yield and its characteristics (ICCO 2009).

In the Ecuadorian cocoa market, intermediaries grade cocoa beans very informally based on weight, moisture content, foreign matter and defects, including diseases.[3] These are determined by the intermediary's experience and "eyeball" quality standards. We conducted a survey of 33 intermediaries in the same areas in which we conducted the farmer survey. Ninety seven percent of the intermediaries reported discounting the price paid to the farmer based on moisture content; 91% on the presence of Frosty Pod (*Moniliophtora roreri*), a fungus; 82% on impurities; 42% on fermentation; 27% on the presence of diseases other than Frosty pod; 12% on variety; and 9%

[3] We refer to 'intermediaries' as any cocoa bean buyer from the intermediary that buys at the farm-gate to the exporter.

on bean size. Therefore, most intermediaries interviewed discounted the price based on moisture content and the presence of fungus and foreign matter.

In Table 1, we relate cocoa quality, specifically quality attributes, to actions/investments that the farmer can conduct to improve quality. We consider that some of these investments may be more permanent than others, that is, these investments could be conducted in the short-run (seasonally) or in the long-run. We care more about actions or investments that the farmer could modify in the short-run because they are easier/cheaper to conduct. The type of buyer might have different levels of observability of farmer actions, so we also include the type of buyer in Table 1. From this Table we can see that most investments can be controlled by the farmer in the long-run. We can also note that the investments that the farmer can control in the short-run are likely to be unobservable by buyers. These investments correspond to the cultivation practices. These are not observable by off-farm intermediaries and could be observed by buyers that have a relationship with the farmer. The rest of the short-run investments such as fermentation and drying are observable by buyers. When we say 'observable' we do not mean 'perfectly observable'. Instead, we mean that the buyer can make a good guess regarding that action. For instance, the farmer can guess if fermentation and drying were conducted, however, the buyer is not likely to guess the exact technique and the length of each activity. Another thing to notice from this Table is that investments that affect bean color and flavor can be observed by all types of buyers. For example, by examining the beans an intermediary can distinguish if the variety is *Nacional* or the hybrid CCN-51, if cocoa beans were fermented, and if they were dried.

We have not included all the possible actions/investments in Table 1. Some other investments that may also matter are cultivation practices such as organic production; harvest timing and technique (for disease control); pod breaking after harvest but before fermentation (timing and technique used to avoid contamination of beans); selection or cleaning of beans after drying; packing and storage (use of clean bags and correct storage to avoid contamination); the fermentation technique (number of days, adequate turning, use of appropriate container); and the drying technique (type of drying surface, natural or artificial, and turning) (ICCO 2009).

Table 1. Cocoa Quality Attributes, Long-Run and Short-Run Investments, and Potential Observability of Investments by the Type of Buyer

Actions/ investments	**Attributes**	**Controllable by farmer**		**Observability according to type of buyer**		
		Long-run	***Short-run***	***On-farm intermediary***	***Association***	***Off-farm intermediary***
Pre-planting						
Variety	• color, flavor, bean size, bean weight, husk thickness	yes	no	yes	yes	yes
Location	• bean size, bean weight, fat content, ripening	yes	no	yes	yes	maybe
Cultivation practices						
Pruning & tree-shaping	• bean size, crop health	yes	yes	maybe	maybe	no
Fertilization	• bean size	yes	yes	maybe	maybe	no
Irrigation	• bean size, fat content, flavor	yes	yes	maybe	maybe	no
Pesticides application	• crop health	yes	yes	maybe	maybe	no
Harvest						
Harvest timing	• ripening	yes	yes	yes	yes	yes
Post-harvest practices						
Fermentation	• color, flavor	yes	yes	yes	yes	yes
Drying	• color, flavor, mold development	yes	yes	yes	yes	yes

Source: Own elaboration based on Luna *et al* 2002, Reyes *et al* 1999, Rosero 2002, Afoakwa 2010, and personal experience.

Cocoa Production and the Marketing Chain

There are two general categories of cocoa beans in the world: “fine or flavor” and “bulk” or “ordinary”. Total fine or flavor cocoa production is just under 5% per year of the world’s cocoa bean production (ICCO 2012). Ecuador is the largest producer of “fine or flavor” cocoa beans in the world producing over half of the world’s production. Anecdotal evidence from Ecuador suggests that the cocoa premium over the New York Stock Exchange price of fine or flavor cocoa beans is 20% to 30%. However, cocoa premiums fluctuate with market prices (Byskov and Scheu 1991).

In Ecuador, approximately 360,000 hectares of cocoa are cultivated by approximately 90,000 farmers (INEC 2006). Most of these farmers are relatively poor and operate on less than 10 hectares of land (according to representatives from non-governmental organizations in Ecuador).[4] Their incomes are largely dependent on agricultural production with almost half generated by the sale of cocoa beans. Eighty five percent of cocoa production occurs in the coastal plain region of Ecuador. The three most important provinces for cocoa production are Guayas, Los Ríos, and Manabí which together account for 72% of total cocoa production (INEC 2006).

Cocoa is marketed through both traditional and specialized marketing chains. Specialized chains are involved in the marketing of highly differentiated, identity-preserved goods such as organic, fair trade, and rain forest alliance products. The marketing of these products is usually attributable to farmer associations that directly export cocoa beans to international buyers. The traditional marketing chain has various stages of intermediation providing farmers with several alternative outlets: farm-gate, local intermediaries, exporters or wholesalers at larger city centers.

[4] We are not allowed to release the identity of people surveyed or interviewed because if IRB requirements.

Ninety five percent of cocoa products (mostly cocoa beans) are exported; only 5% are for national consumption.

Empirical Strategy

Sampling Strategy

Field research was conducted in Ecuador in two phases from May to August of 2006. First, we conducted in-depth semi-structured interviews with 46 agents involved in the cocoa market to gain a broad understanding of the market. After the interviews, we conducted a survey of 327 farmers in the three major cocoa producing provinces of Ecuador: Los Ríos, Manabí, and Guayas.[5] We collected data mainly on the farmers' most recent cocoa sale, their farm and household characteristics, and any cocoa production activities that are believed to affect cocoa quality, which we refer to here as investments or actions. Stratified sampling methods were used to identify survey respondents. We identified the most important cocoa producing areas of the country; within those areas, we selected communities with access to three levels of market infrastructure: the first level of infrastructure permits communities to have better access to markets, for instance by offering a higher number of buyers and sellers and proximity to cocoa markets; the second level of infrastructure offers communities a medium level of market access; and the third level of market infrastructure offers communities poor access to markets. Within those communities, we selected farmers with the help of a non-governmental organization (NGO) that was active in the area. While true random sampling was not possible, efforts were

[5] As noted in the empirical context, we also conducted a survey of 33 intermediaries located in the provinces of Guayas, Los Ríos, and Manabí.

made to get as representative a sample as possible by targeting potential respondents who both were and were not affiliated with or beneficiaries of the NGO which assisted in data collection.

Estimation Strategy

In order to estimate whether quality incentives are economically important we run a regression of the price paid to the farmer by the intermediary in his most recent sale of cocoa beans on actions conducted by the farmer to produce cocoa quality. We denote the price by p and the vector of actions by $actions$. In this regression, we also control for characteristics of the transaction ($tran$) as well as farmer characteristics (hh). Using ordinary least squares (OLS) we estimate,

$$p_i = \alpha_i + \sum_j \beta_j actions_{ij} + \sum_k \gamma_k tran_{ik} + \sum_l \lambda_l hh_{il} + \varepsilon_i$$

where α is a constant and ε is an error term. The vector of actions is composed of cultivation practices, post-harvest practices, variety, and location. The cultivation practices were conducted by the farmer during the season previous to his most recent sale and include infected-pod elimination, irrigation, tree-height control, and organic certification. The post-harvest practices include fermentation and drying of cocoa beans. The possible varieties of cocoa beans that the farmer could cultivate were *Nacional*, CCN-51, “other”, or a combination of varieties. We create dummy variables for those farmers that cultivate only *Nacional* variety which is high quality variety but low yielding; and those that cultivated only CCN-51, which is a hybrid variety that is low quality but high yielding. Regarding location, the farmers surveyed were mainly located in the provinces of Los Ríos, Manabí, and Guayas; a few farmers hailed from other nearby provinces such as El Oro and Azuay. We create a dummy variable for each of the main provinces.

The vector of transaction characteristics is composed of the type of buyer or market outlet, the International Cocoa Organization (ICCO) daily price of cocoa beans, and the quantity sold during the farmer's most recent sale.[6] The type of buyer or market outlet includes dummy variables for selling at the farm-gate, selling to a local intermediary or exporter, and selling to a farmer association. We have the exact date of each farmer's most recent sale, so we use the ICCO daily price of cocoa beans to account for variations in price that are due to reasons other than quality investments. In order to avoid potential endogeneity problems, we lag this price by two days.

The vector of household characteristics is composed of farm size (as a proxy for household income); availability of motorized transportation infrastructure (car, pick-up, or motorcycle); household size; education and age of the household head, and a proxy for cultivation ability.

The proxy for cultivation ability is based on a test that we conducted of the most common cocoa pests and diseases. The proportion of questions answered correctly out of the number of questions made is the test score. We conducted a workshop about pests and diseases at the same time the survey was being conducted. About one third of the sampled farmers responded the survey before attending the workshop, so those are considered "not treated" and the ones that responded the survey after attending the workshop are the "treated." We need to control for the workshop effect on the response to the test to see if there is an effect of cultivation ability on the price received by the farmer.

We take into account the possibility of selection of farmers into the different market outlets. So, before running our price regression we estimate the probability of selling to three different

[6] The ICCO daily price for cocoa beans is calculated based on the New York Stock Exchange market price.

market outlets: farm-gate, intermediary or exporter, and farmer association. We group the farmers who sold to a local intermediary and those who sold to an exporter during their most recent sale. We do this because, in terms of the buyer's observability of the farmers' actions, we think these buyers are not fundamentally different.

We estimate the probability of selling to the different market outlets through a Multinomial Logit regression and we calculate bias corrections based on Dubin and McFadden (1984). Bourguignon *et al* (2007) test different approaches through Monte Carlo simulations and find that the Dubin and McFadden's approach is one of the preferred approaches for selection correction. Bourguignon *et al* (2007) also show that selection bias correction based on the Multinomial Logit model can provide fairly good correction for the outcome equation, even when the independence of irrelevant alternatives (IIA) hypothesis might not hold. We incorporate the bias correction terms into the OLS price estimation. For selling at the farm-gate we use the distance to the nearest paved road as the identifying variable. Farmers that are more isolated are more likely to sell at the farm-gate. For selling to an intermediary or exporter we also use the distance to the nearest paved road as the identifying variable. Farmers that were less isolated were more likely to sell to an off-farm intermediary or exporter. We believe the distance to the nearest paved road affects the price paid to the farmer only through its effect on having sold cocoa beans to an intermediary at the farm-gate or to an intermediary or exporter located off-farm.[7] For selling to a farmer association we utilize membership in a cocoa farmer association as the identifying variable. We think this is a good identifying variable since it affects the price paid to the farmer only through selling to a farmer association. Notice that not all the farmers that were members in cocoa farmer associations sold their cocoa beans to an association;

[7] Unfortunately we do not have the actual distance to the buyer.

also not all farmers that sold to a farmer association belonged to one (see descriptive statistics below).

We use a Boxcox test to find the appropriate variable transformation. According to this test, it is better not to transformation the variables than to use the log transformation. Even though the Boxcox test suggests not taking logarithms of right-hand-side variables, we log-transform a few of these variables for the linearity assumption, required in linear regression, to hold.

Description of the Data

Statistics describing the variables we use in our estimations are presented in Table 2 and are described below. The quality investments questions in the farmer survey were asked for the last season which is the season previous to the farmer's most recent cocoa sale. Regarding cultivation practices, 65% of farmers in the sample reported eliminating infected pods, 24% irrigating their plots, 24% controlling the height of the cocoa trees, and 8% having an organic certification. As to post-harvest practices, 70% of farmers in the sample reported fermenting their cocoa beans and 86% drying their cocoa beans before selling them. Sixty eight percent of farmers in the sample only cultivated the *Nacional* variety, whereas 6% only cultivated CCN-51; 22% had both *Nacional* and CCN-51 and the rest, had another variety or a combination of this third variety with *Nacional* and/or CCN-51. Twenty eight percent of farmers in the sample were located in the province of Guayas, 30% in Los Ríos, 36% in Manabí, and 5% in other provinces (mainly Azuay and El Oro). Guayas is the province where the city of Guayaquil is located and Guayaquil has a port through which cocoa products get exported. The province of Los Ríos, which is landlocked, also exports its cocoa products through Guayaquil. While Manabí has a port, it does not export cocoa products through it. Manabí's cocoa products also get exported through the port of Guayaquil.

The average price at which farmers sold their cocoa beans during their most recent sale was US$61 per quintal (one quintal equals 100 lbs) with a standard deviation of US$14. The average ICCO daily price was US$76 per quintal of cocoa beans with a standard deviation of US$4. These prices are not comparable since the latter has transportation costs embedded. As to the type of buyer or market outlet, 13% of farmers in the sample sold their cocoa beans at the farm-gate, 72% sold to a local intermediary, 6% sold to an exporter, and 9% sold to a farmer association. The average quantity sold during their most recent sale was three quintals with a standard deviation of five.

Among the farmers surveyed, the mean farm size was 19 hectares, of which seven were dedicated to the cultivation of cocoa trees. However, cocoa cultivation was concentrated among smaller farmers as indicated by a median farm size of nine hectares, of which four hectares were cultivated with cocoa trees.[8] The average cocoa producing household had an annual income of US$4,628, of which 80% came from the sale of agricultural products and 44% from the sale of cocoa beans. The average household per capita annual income (adjusted for household size) was US$1,383. This was 21% of the national average income of US$6,630 for 2006 (gross national income per capita, purchasing power parity) (World Bank, 2012). Households were relatively small, with a median of four members. The mean education of the household head was seven years, with a standard deviation of five years. This means that, on average, cocoa farmers completed primary school and one year of secondary school and, in some instances, they received a high school degree. Cocoa farmers were also relatively old, with an average age of 51

[8] Because of the large variation in farm size and to comply with the linearity assumption in linear regression, we use its log transformation in the estimations.

and a standard deviation of 12 years. The average of farmers' cultivation ability was 39% with a standard deviation of 20%. This means that farmers responded on average 39% of the questions correctly in a test of pests and diseases. The median of the proxy for cultivation ability was 44%. Twenty seven percent of farmers owned a motorized means of transportation. If we were to consider the actual means of transportation used for the farmer's most recent cocoa sale we would not have data for the farmers that sold at the farm-gate. In addition, ownership of a means of transportation is less endogenous to the price paid in the last sale than the actual means of transportation used.

The distance to the nearest paved road had a median of four kilometers, a mean of seven kilometers, and a standard deviation of 14 kilometers. Farmers who sold at the farm-gate were located at a median distance of seven kilometers from a paved road and farmers who sold to an intermediary or an exporter were located at a median distance of three kilometers from a paved road. Thirty one percent of farmers in the sample were members of a cocoa farmer association. Of those, 23% sold their cocoa beans to a farmer association in their most recent sale. Considering only the farmers that sold to a farmer association, 79% of them belonged to a cocoa farmer association.

Table 2. Descriptive Statistics on Quality Investments, Characteristics of the Farmer's Most Recent Cocoa Beans Sale, and Characteristics of Cocoa Farmers

Variables	**Unit**	**Median**	**Mean**	**Std. dev.**
Quality investments: pre-planting				
Variety *Nacional* only	1= cultivated only *Nacional*		68%	
Variety CCN-51 only	1= cultivated only CCN-51		6%	
Los Ríos	1= Los Ríos		30%	
Manabí	1= Manabí		36%	
Guayas	1= Guayas		28%	
Other province	1= Other province		5%	
Quality investments: cultivation practices				
Infected-pod elimination	1= eliminated infected pods		65%	
Irrigation	1= irrigated cocoa trees		24%	
Tree-height control	1= controlled tree height		24%	
Organic certification	1=had organic certification		8%	
Quality investments: post-harvest practices				
Fermentation	1= fermented cocoa beans		70%	
Drying	1= dried cocoa beans		86%	
Characteristics of Most Recent Transaction				
Price of sale	US$/Quintal	60.00	60.95	14.13
Quantity sold	Quintal (1 quintal = 100 lbs.)	1.50	2.74	4.55
Type of market outlet	Farm-gate		13%	
	Local intermediary or exporter		78%	
	Farmer association		9%	
ICCO daily price lagged	US$/Quintal	75.41	75.75	4.43
Household Characteristics				
Farm size	Hectares	9.00	18.79	36.43
Owns a motorized means of transportation	1= Household owns a motorized means of transport		27%	
Household size	Number	4.00	4.53	2.15
Education of household head	Years	6	6.85	4.45
Proxy cultivation ability	% test questions correct	44%	39%	20%
Age of household head	Years	52	51.14	12.27
Distance to paved road	Kilometers	4	6.66	13.54
Cocoa farmer association	1= member cocoa association		31%	

Results and Discussion

After taking potential selection of farmers into the different market outlets into account, we find higher prices for quality outcomes. So, quality is rewarded implicitly in informal markets. This is consistent with existing hedonic pricing literature. Departing from hedonic pricing, we find that high-value characteristics are rewarded less than low-value characteristics; informed buyers reward actions that affect unobservable quality attributes (flavor and pesticide content); and, regardless of the type of buyer, tree-height control— an action that affects unobservable quality attributes— is also rewarded in the market. These three findings provide evidence for implicit contracting. Furthermore, we calculate price premiums for different actions conducted by the cocoa farmers and find substantial implicit rewards for quality.

We estimate the probability of participation in the different market outlets through a Multinomial Logit regression, from which we calculate the selection correction variables that we input as regressors in the OLS regressions presented below (see Table A1 in Appendix). The possible market outlets considered are the farm-gate, the off-farm intermediary or exporter, and the farmer association. For selling at the farm-gate we use the distance to the nearest paved road as the identifying variable. Farmers that are more isolated are more likely to sell at the farm-gate since the coefficient is positive and significant at 10% level. For selling to an intermediary or exporter we also use the distance to the nearest paved road as the identifying variable. Farmers that are less isolated are more likely to sell to an off-farm intermediary or exporter since the coefficient is negative and significant at 10% level. In order to estimate the probability of selling to a farmer association, we use membership in a cocoa farmer association as the identifying variable. Being a member in a cocoa farmer association significantly increases the probability of selling to a farmer association.

Selection does not seem to be an issue since none of the selection correction coefficients included in the OLS regressions is significant (see Table A2 in Appendix). Indeed, when comparing the uncorrected OLS regression with the corrected OLS regression we only observe a few changes: the fermentation and drying dummies become less significant (5% to 10% significance level and 1% to 5%, respectively) and ownership of a motorized means of transportation becomes less significant (5% to 10% significance level). The changes in significance could also be due to the fact that the standard errors in the uncorrected regression are estimated with robust standard errors while the standard errors in the corrected regression are estimated using the bootstrap method.

Consistent with hedonic pricing, we find higher prices for quality outcomes. This is the case, for example, of the post-harvest practices of fermentation and drying of cocoa beans. As we can see in the first column in Table 3, fermenting cocoa beans increases the average price received by the farmer also by three dollars and drying cocoa beans increases the average price received by the farmer by nine dollars, *ceteris paribus*. The fact that fermentation and drying are rewarded in the market is also consistent with the measurement variance prediction. The measurement variance prediction says that measures that are more informative about actions are more likely to be compensated in the market. Since we observe the actions, the prediction would be: actions that are easier to measure through observing the beans are more likely to be compensated. By observing the cocoa beans the buyer can make a good guess regarding the action of fermentation and drying. Unfermented beans are purple and with a smooth texture and fermented beans are brown and have cracks. So, the measurable attributes are color and texture. Drying of cocoa beans is evaluated through moisture content by touch and sight.

Departing from hedonic pricing, we find that high-value characteristics are rewarded less than low-value characteristics. For instance we find that the price premium for fermentation is 6% while the price premium for drying cocoa beans is 15%. Fermentation affects flavor development more than drying if both of these activities are correctly undertaken (Lima *et al* 2011). Therefore, from a hedonic perspective, we would expect the coefficient on fermentation to be larger than the coefficient on drying. However, we find the opposite. This result could be explained in different ways. One potential explanation is that the sampling noise is higher in measuring fermentation (through color and texture) than in measuring drying (through moisture content). We could also explain a higher price premium for drying in terms of incentive responsiveness, $1/c''(e)$. Drying may be easier to undertake than fermentation, so the action of drying could be more responsive to incentives than the action of fermenting cocoa beans. Another possible explanation is that the cost of drying might be higher than the cost of fermenting cocoa beans. We do not have cost information but we know the length of fermentation and drying. The average number of fermentation days is 2.09 and that of drying days is 2.17. The results of a t-test, with 95% confidence, indicate that the means of the lengths of fermentation and drying do not differ.

Given that we have information on the length/intensity of fermentation and drying, we rerun the OLS regression of the price paid to the farmer in the last sale, but instead of including binary variables for the post-harvest practices as regressors we use the number of fermentation and drying days (see Table 4). Again, we control for potential selection of farmers selling to the different market outlets (see Table A3 in Appendix for the first step estimation results). It is interesting to note that the identifying variable for selling to an intermediary or exporter off-farm— distance to the nearest paved road— becomes more significant (1% significance level) than in the first step regression of the OLS regression with post-harvest dummies (10% level).

We can observe from these results that it does not matter how long farmers dry their cocoa beans as long as their beans are dried. Either farmers dry their beans or not and there are huge discounts for not doing so, as shown in Table 3. Different is the case of fermentation, where the intensity is rewarded in the market since it is positive and significant at 5% level (in the regression with no interactions). For every extra day of fermentation farmers receive on average 1.4 more dollars per quintal, everything else constant.

We include interactions of the type of buyer with significant quality actions to see if the type of buyer matters (see Tables 3 and 4). We do this because we think that buyers can observe actions differently and can have different types of relationships with farmers, for example, long-term relationships (implicit contracts). We find that informed buyers reward some actions that affect unobservable quality attributes (flavor and pesticides content). For example, we find that selling to a farmer association and irrigating cocoa plots reduces the average price received by the farmer by 12 dollars in the regression with post-harvest dummies and by 11 dollars in the regression with post-harvest intensities, *ceteris paribus*. Cocoa trees grow in tropical and sub-tropical climates in which rainfall is usually well-distributed throughout the year, so that trees can grow under rain-fed conditions (Afoakwa 2012). Only in cases of drought, irrigation becomes necessary. Under normal climate conditions, irrigation may cause over-watering of trees which can subsequently produce root rot (Crane *et al* 2009). Another effect of over-watering cocoa trees is a diluting effect of chemical compounds that may affect flavor and fat content. These effects may explain why associations punish irrigation.

We also find that selling at the farm-gate and having an organic certification increase the average price received by the farmer by 25 dollars, everything else constant (see Table 3). However, this interaction becomes insignificant in the regression with post-harvest intensities. The rest of the interactions between type of buyer and actions conducted by the farmer are insignificant.

In general, when a buyer evaluates the quality of the bean, the signal that he gets is non-informative about the action of irrigation or about the action of organic production (unless farmers show an organic certificate to buyers). This is also a non-hedonic result since the type of buyer seems to matter. In other words, the type of relationship that farmers have with buyers affects the price they receive. We do not know if this occurs because buyers observe the producer's field (have more information about how effort is affecting quality) or if they made an explicit agreement in the previous period that the farmer did not comply with. In any case, the interesting result here is that the type of relationship with the buyer matters in terms of what actions are rewarded (or punished) in the market. Farmers in long-term relationships with their buyers, who have more information about the farmer's actions and their fields than other buyers, have the opportunity of getting compensated (or punished) for actions that they would not otherwise.

Departing from hedonic pricing, we also find that tree-height control, an action that affects unobservable quality attributes, is compensated in the market. Tree-height control is positive and significant at 5% level in both OLS regressions, with post-harvest dummies and with post-harvest intensities (see Tables 3 and 4). Conducting the practice of controlling tree height increases on average the price received by the farmer by four dollars, *ceteris paribus*.

Table 3. OLS Regressions of the Price Paid to the Farmer including Interactions between Farm-gate and Association with Significant Quality Variables*

Dependent var: Price paid to the farmer (per quintal)	No interaction	Irrigation interaction	Tree-height control interaction	Fermentation interaction	Drying interaction	Organic certification interaction
	b/se	b/se	b/se	b/se	b/se	b/se
Infected-pod elimination	-1.812 (2.181)	-1.781 (2.238)	-1.818 (2.204)	-1.718 (2.178)	-1.495 (2.213)	-2.081 (2.150)
Irrigation	-2.150 (2.346)	-0.473 (2.544)	-2.243 (2.345)	-2.189 (2.333)	-2.489 (2.375)	-2.388 (2.285)
Tree-height control	3.582** (1.704)	3.343** (1.698)	2.981 (1.999)	3.597** (1.758)	3.739** (1.733)	3.837** (1.681)
Fermentation	3.341* (1.950)	3.291* (1.937)	3.655* (1.944)	3.829* (2.049)	3.279* (1.980)	2.811 (1.968)
Drying	9.152** (4.519)	9.982** (4.734)	9.460** (4.635)	12.377** (5.136)	16.831* (8.881)	11.725** (4.785)
Organic certification	9.643* (5.159)	9.101* (5.200)	10.080* (5.316)	10.460* (5.375)	10.579** (5.342)	-4.910 (9.197)
Only Nacional variety	0.485 (1.858)	0.589 (1.851)	0.648 (1.878)	0.577 (1.835)	0.781 (1.830)	0.168 (1.883)
Sold to association	4.017 (4.663)	8.753 (5.960)	4.280 (5.117)	8.354 (6.583)	11.476 (8.191)	2.540 (7.072)
Sold at the farmgate	1.185 (2.469)	1.211 (3.249)	0.149 (2.718)	3.760 (4.147)	7.587 (7.527)	-0.310 (2.369)
International price in quintals	0.509*** (0.178)	0.469*** (0.178)	0.519*** (0.183)	0.513*** (0.180)	0.475** (0.185)	0.496*** (0.177)
Log farm size	0.963 (0.900)	1.093 (0.916)	0.894 (0.924)	0.967 (0.896)	1.029 (0.895)	0.725 (0.910)
Motorized infrastructure	2.813* (1.657)	3.080* (1.619)	2.666 (1.700)	2.870* (1.641)	2.979* (1.619)	2.257 (1.574)
Selection corr. association	0.123 (0.291)	0.093 (0.284)	0.122 (0.305)	0.152 (0.295)	0.187 (0.300)	0.330 (0.307)
Selection corr. farmgate	-0.069 (0.734)	-0.097 (0.716)	-0.021 (0.778)	0.041 (0.748)	0.187 (0.789)	0.261 (0.710)
Interaction association		-12.000* (6.463)	-0.801 (9.651)	-7.536 (7.183)	-10.891 (8.954)	15.244 (12.690)
Interaction farmgate		-0.039 (5.744)	5.003 (4.628)	-3.046 (5.242)	-7.081 (8.154)	25.370** (12.433)
Number_of_obs	283	283	283	283	283	283
Adjusted_R-sqr	0.299	0.308	0.296	0.298	0.300	0.317

*Corrected for potential selection of farmers selling to different markets using Dubin and McFadden selection correction (1984). The standard errors are bootstrapped. Location dummies are included in all estimations. We controlled for farmer and household characteristics: household size, education and age of the household head, proxy for farmer cultivation ability (test score), if received workshop before survey (treated), and interaction between treated and test score. We also controlled for log of quantity sold in the last sale (quintals) and we included a constant term.

Table 4. OLS Regressions of the Price Paid to the Farmer using the intensity of post-harvest practices instead of binary variables*

Dependent var: Price paid to the farmer (per quintal)	No interaction	Irrigation interaction	Tree-height control interaction	Fermentation days interaction	Drying days interaction	Organic certification interaction
	b/se	b/se	b/se	b/se	b/se	b/se
Infected-pod elimination	-2.519 (2.355)	-2.502 (2.411)	-2.520 (2.384)	-2.530 (2.373)	-2.519 (2.412)	-2.598 (2.335)
Irrigation	-1.592 (2.361)	0.831 (2.633)	-1.656 (2.385)	-1.353 (2.409)	-0.981 (2.494)	-1.779 (2.359)
Tree-height control	3.620** (1.745)	3.543** (1.745)	3.105 (1.990)	3.854** (1.782)	3.543** (1.732)	3.624** (1.741)
No of days fermentation	1.405** (0.609)	1.368** (0.619)	1.495** (0.626)	1.196* (0.651)	1.460** (0.599)	1.362** (0.616)
No of days drying	1.009 (0.857)	0.949 (0.862)	1.047 (0.862)	0.931 (0.900)	0.843 (1.031)	1.011 (0.854)
Organic certification	10.103** (5.149)	9.870* (5.179)	10.399** (5.184)	10.177* (5.502)	11.033** (5.391)	-0.448 (10.418)
Only Nacional variety	0.318 (1.943)	0.245 (1.980)	0.472 (1.971)	0.265 (1.933)	0.330 (1.938)	0.218 (1.931)
Sold to association	-0.657 (4.758)	2.884 (6.069)	-0.533 (5.175)	-1.196 (6.875)	0.007 (6.723)	-1.487 (6.503)
Sold at the farmgate	-1.035 (2.479)	0.435 (3.006)	-1.871 (2.781)	-3.049 (3.663)	-3.793 (4.144)	-2.145 (2.543)
International price in quintals	0.512*** (0.184)	0.475** (0.185)	0.520*** (0.187)	0.499*** (0.186)	0.532*** (0.187)	0.510*** (0.186)
Log farm size	0.665 (0.889)	0.743 (0.900)	0.605 (0.909)	0.745 (0.897)	0.607 (0.922)	0.576 (0.896)
Motorized infrastructure	2.257 (1.697)	2.457 (1.704)	2.142 (1.745)	2.436 (1.727)	2.388 (1.697)	2.054 (1.630)
Selection corr. association	0.163 (0.207)	0.137 (0.210)	0.160 (0.211)	0.160 (0.207)	0.155 (0.211)	0.214 (0.203)
Selection corr. farmgate	-0.208 (0.561)	-0.215 (0.555)	-0.170 (0.564)	-0.221 (0.557)	-0.193 (0.556)	-0.177 (0.565)
Interaction association		-10.865* (6.419)	-0.389 (9.001)	0.103 (1.809)	-1.050 (2.159)	10.847 (13.385)
Interaction farmgate		-4.612 (5.262)	3.860 (4.692)	1.346 (1.428)	1.984 (1.635)	17.570 (13.924)
Number_of_obs	280	280	280	280	280	280
Adjusted_R-sqr	0.290	0.298	0.286	0.288	0.292	0.295

*Corrected for potential selection of farmers selling to different markets using Dubin and McFadden selection correction (1984). The standard errors are bootstrapped. Location dummies are included in all estimations. We controlled for farmer and household characteristics: household size, education and age of the household head, proxy for farmer cultivation ability (test score), if received workshop before survey (treated), and interaction between treated and test score. We also controlled for log of quantity sold in the last sale (quintals) and we included a constant term.

Tree-height control can improve yield, promote upright growth of side branches, help control insects and diseases, and maintain a reachable height for harvesting (ICCO 2009 and ACIAR 2008).

In addition, we find that having an organic certification significantly increases the average price received by the farmer by 10 dollars, leaving everything else unchanged. The coefficient on organic certification is positive and significant at 10% level in the OLS regressions with post-harvest dummies and at 5% level in the regression with post-harvest intensities (see Tables 3 and 4). Organic production affects an unobservable quality attribute: pesticide content. However, if farmers have a certificate to show to their buyers, this would become an observable action and it could be interpreted as a hedonic result. If that certificate is not easily available, this could be a non-hedonic result representing the fact that buyers have additional information about the farmer and the farmer's field.

In terms of our model, we do not have a way to identify α from β in our estimations. So α could represent outside options which could be proxied by farm size. We would expect farmers that have larger farms to have better outside options, for example, through higher bargaining power. Farm size could also be related to risk aversion, so we would expect larger farmers to be less risk averse (low r) so receive a higher premium (β). However, farm size is positive but insignificant in all our estimations (see Tables 3 and 4). A similar argument could be made for motorized infrastructure. Motorized infrastructure is positive and significant in our OLS price regression including post-harvest dummies. On average, having a motorized means of transportation increases the price received by the farmer by three dollars, leaving everything else unchanged (see Table 3). If motorized means of transportation serves as proxy for outside options, farmers that have better outside options get on average a higher price. Same for risk aversion, if motorized means of transportation serves as proxy for risk aversion, farmers that have lower risk aversion get on average a higher price.

With the exception of ownership of a motorized means of transportation, in general, farmer and household characteristics are not significant. Overall, characteristics of the transaction are not significant either, with the exception of the international daily price of cocoa beans that represents the price that the buyer gets (p_b). As expected, this price is positive and significant (mostly at 1% level) in all specifications. Location (province) seems to play an important role in price determination. Producing cocoa beans in the provinces of Guayas or Los Rios is positive and significant at 1% level in all specifications.

Finally, we calculate price premiums for different actions conducted by the cocoa farmers. These correspond to the percentage of the average price that is explained by each of the quality measures. We find substantial implicit rewards for quality. In fact, we find a 6% positive price premium on tree-height control, a 6% positive price premium on fermentation, a 15% positive price premium on drying, and a 16% positive price premium on organic certification. We compare these price premiums with premiums of other agricultural products which are sold through explicit contracts. Hueth and Ligon (2002) find price premiums in processing tomatoes in California of about 10%. Hueth (2012) also finds average price premiums for class I milk in the U.S. of around 5%. Curtis and McCluskey (2003) find price premiums in potatoes in the Columbia Basin between 4% and 12%. McDonald and Schroeder (2000) find price premiums in cattle in different areas of the U.S. of less than 10%. In addition, Fafchamps *et al* 2008 find an average of at least 32% per unit price premium on drying in their pooled regression of different crops in India that are sold without explicit contracts. From these comparisons we can conclude that price premiums under implicit contracts are comparable to price premiums under explicit contracts. So, we do not find a lower range of premiums as compared to explicit contracts. This result suggests that implicit quality incentives matter in markets where observationally there are no explicit incentives for quality production.

Conclusion

We investigated the economic importance of quality incentives in an agricultural market that lacks the institutional capacity for verifiable quality measurement. Specifically, we investigated if actions taken by farmers to produce cocoa quality were compensated by buyers, the type of actions compensated by buyers that are informationally close to farmers, and we compared the magnitude of price premiums under implicit contracts in the Ecuadorian cocoa market with that of explicit contracts in other agricultural markets. We found that quality is compensated in the market to a significant degree and farmers have incentives to invest in quality production. In addition, we found that high-value characteristics were rewarded less than low-value characteristics, for example, we found a larger premium on drying than on fermentation. In addition, buyers who are informationally close to farmers, unlike buyers who purchase at distant spot markets, reward actions (for example, irrigation and organic production) that affect unobservable quality characteristics. Further, regardless of the type of buyer, tree-height control— an action that affects unobservable quality attributes— is also rewarded in the market. Lastly, we found price premiums comparable in magnitude to premiums observed in other agricultural markets where quality measurement is verifiable. We conclude that implicit contracting is used to provide quality incentives comparable in magnitude to those provided explicitly in formally organized markets.

Our work is not free from limitations. First, the sample was not completely random. Second, we have cross sectional data so we cannot take reputation effects into account. We also do not know the length of the relationship with the buyer. Third, we cannot observe attributes themselves which generates noise between actions and attributes. Fourth, the instrument used to identify the probability of farmers selling to a farmer association might be endogenous. Nevertheless, our paper contributes to the literature on high-value commodities and how quality is rewarded in markets with unverifiable quality measurement. In addition, this paper builds upon previous studies in that it adds the possibility of compensating not only actions that affect observable quality characteristics but also actions that affect unobservable quality characteristics, depending on the information or the relationship with farmers that buyers have. Finally, repeated relationships through implicit contracts with buyers might benefit farmers as well as improved institutions for formal quality measurement.

Further works needs to be done in order to explain who is taking the actions to get higher prices and why are not all farmers undertaking actions to improve quality. Possibly, low-quality producers may have liquidity constraints.

Appendix

Table A1. Probability of Selling to Different Market Outlets; Multinomial Logit (1st step selection correction)*

	Association	Intermediary or Exporter
	b/se	b/se
Infected-pod elimination	3.111***	0.577
	(1.202)	(0.551)
Irrigation	-0.077	-0.225
	(0.987)	(0.664)
Tree-height control	-0.594	0.047
	(1.036)	(0.641)
Fermentation	1.140	0.317
	(1.569)	(0.666)
Drying	-1.458	2.892***
	(1.724)	(0.839)
Organic certification	2.393*	-0.952
	(1.237)	(1.177)
Only Nacional variety	1.533	0.457
	(0.984)	(0.573)
International price in quintals	-0.009	-0.007
	(0.103)	(0.060)
Log farm size	0.867*	0.155
	(0.493)	(0.312)
Motorized infrastructure	1.348	0.159
	(0.942)	(0.617)
Member of a cocoa farmer association	2.998***	0.616
	(1.060)	(0.659)
Distance to nearest paved road	-0.009	-0.045*
	(0.032)	(0.025)
Number_of_obs	292	
LRchi-sqr	0.000	
PseudoR-sqr	0.491	

*We use the farm-gate as the base outcome. Location dummies are included. We did not include the dummy variable for farmers that only cultivate CCN-51 variety because it gets omitted from the estimation since farmers that sell to associations do not produce CCN-51 only. We controlled for farmer and household characteristics: household size, education and age of the household head, proxy for farmer cultivation ability (test score), if received workshop before survey (treated), and interaction between treated and test score. We also controlled for log of quantity sold in the last sale (quintals) and we included a constant term.

Table A2. Price Regressions using OLS correcting for potential sample selection*

	Uncorrected	Corrected
	b/se	b/se
Infected-pod elimination	-1.741	-1.812
	(1.548)	(2.181)
Irrigation	-2.613	-2.150
	(2.286)	(2.346)
Tree-height control	4.335**	3.582**
	(1.686)	(1.704)
Fermentation	4.200**	3.341*
	(2.006)	(1.950)
Drying	10.713***	9.152**
	(3.579)	(4.519)
Organic certification	8.733*	9.643*
	(4.929)	(5.159)
Only Nacional variety	0.542	0.485
	(1.757)	(1.858)
Sold to association	7.562	4.017
	(4.589)	(4.663)
Sold at the farmgate	2.812	1.185
	(2.505)	(2.469)
International price in quintals	0.578***	0.509***
	(0.178)	(0.178)
Log farm size	0.603	0.963
	(0.727)	(0.900)
Motorized infrastructure	3.690**	2.813*
	(1.638)	(1.657)
Selection correction association		0.123 (0.291)
Selection correction farmgate		-0.069 (0.734)
Number_of_obs	293	283
Adjusted_R-sqr	0.289	0.299

*The corrected OLS regression is corrected for potential selection of farmers selling to different markets using Dubin and McFadden (1984) method. The standard errors of the corrected regression are estimated using the bootstrap method. The uncorrected regression is estimated using robust standard errors. Location dummies are included in all the estimations. We controlled for farmer and household characteristics: household size, education and age of the household head, proxy for farmer cultivation ability (test score), if received workshop before survey (treated), and interaction between treated and test score. We also controlled for log of quantity sold in the last sale (quintals) and we included a constant term.

Table A3. Probability of Selling to Different Market Outlets including Post-harvest Intensities instead of Binary Variables; Multinomial Logit (1st step selection correction)*

	Association	Intermediary or Exporter
	b/se	b/se
Infected-pod elimination	3.534***	0.453
	(1.261)	(0.547)
Irrigation	-0.269	-0.063
	(1.037)	(0.666)
Tree-height control	-0.807	-0.226
	(1.109)	(0.642)
No of days fermentation	0.287	0.275
	(0.292)	(0.178)
No of days drying	-0.119	0.671***
	(0.393)	(0.222)
Organic certification	2.462*	-1.128
	(1.298)	(1.232)
Only Nacional variety	1.018	0.569
	(1.029)	(0.564)
International price in quintals	-0.032	0.005
	(0.101)	(0.061)
Log farm size	0.909*	-0.035
	(0.520)	(0.326)
Motorized infrastructure	1.250	-0.033
	(0.986)	(0.627)
Member of a cocoa farmer association	3.428***	0.592
	(1.146)	(0.646)
Distance to nearest paved road	0.112*	-0.102***
	(0.068)	(0.036)
Number_of_obs	289	
LRchi-sqr	0.000	
PseudoR-sqr	0.497	

*We use the farm-gate as the base outcome. Location dummies are included. We did not include the dummy variable for farmers that only cultivate CCN-51 variety because it gets omitted from the estimation since farmers that sell to associations do not produce CCN-51 only. We controlled for farmer and household characteristics: household size, education and age of the household head, proxy for farmer cultivation ability (test score), if received workshop before survey (treated), and interaction between treated and test score. We also controlled for log of quantity sold in the last sale (quintals) and we included a constant term.

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