The Economics of Quality in the Specialty Coffee Industry:
Insights from the Cup of Excellence Auction Programs

by

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A thesis submitted to the Graduate Faculty of
Auburn University
in partial fulfillment of the
requirements for the Degree of
Master of Science

Auburn, Alabama
May 7, 2012

Keywords: specialty coffee, economics, commodities, sustainability, hedonic models,
truncated maximum likelihood estimation

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Abstract

This study estimates price determinants for specialty green coffee auctions using records from the 2004-2010 Cup of Excellence programs hosted by the Alliance for Coffee Excellence. Similar to a paper by Donnet et al. (2008), I use a hedonic price function to determine the implicit prices of sensory and reputation aspects of coffee quality. The former study is limited by missing variables and uncorrected truncation in the dependent variable. I include the necessary additional variables and estimate the function using a truncated maximum likelihood estimation technique. While sensory quality has a strong effect on price, the highest premiums stem from obtaining a top rank compared to other coffees from the same country, and North American buyers are more responsive to sensory quality than buyers in Asian and European markets. Truncated maximum likelihood estimation produces more normally distributed errors and reveals OLS estimates to be biased toward zero.

Acknowledgements

I wish to thank Susie Spindler, Executive Director of the Alliance for Coffee Excellence, for her insights into the coffee market and the Cup of Excellence programs. Further insights were obtained through fieldwork in Matagalpa, Nicaragua in November 2011, funded by the York International Scholars Program. I offer my sincere thanks to the Auburn University Office of International Agriculture and to the owners and staff of Selva Negra Coffee Estate for their cooperation.

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1. Introduction

Coffee is predominantly consumed in developed nations and produced mostly by smallholder farms in impoverished tropical regions. It is perhaps unsurprising, then, that the industry has long been a testing ground for efforts in sustainable agriculture and trade. Most farmers live in rural areas with poor infrastructure and little market access, resulting in an information asymmetry that often puts them at a disadvantage (Daviron and Ponte, 2005; Fafchamps and Hill, 2008). Farmers must also make production input decisions years and sometimes decades before prices are realized, leading to considerable price uncertainty. This problem is exacerbated by a pervasive lack of credit, financing, and hedging opportunities available to farmers (Gemech et al., 2011). These problems stand in stark contrast to the images of wealth and class associated with drinking coffee in consuming nations (Ponte, 2002; Roseberry, 1996). Daviron and Ponte (2005) have termed this dichotomy the "coffee paradox," and they offer a thorough discussion of how the situation came to be.

The majority of existing economic studies on coffee focus on certification labels, mostly testing if the claimed market access and price premiums help farmers secure enough income to sustain their land and families. Bolwig et al. (2009) find organic certification premiums to be substantial in Uganda, and Bacon (2005) finds that many farmers in Nicaragua viewed Fair Trade participation as the primary factor allowing them to keep their farms through the crisis period after 1999. However, the vast majority of recent studies find that certifications are unable to offer farmers a legitimate way out of poverty (Bacon, 2008; Barham et al., 2011; Beuchelt and Zeller, 2011; De Janvry et al., 2010; Weber, 2011).

I add to the literature on sustainable coffee production in two primary ways. First, rather than researching the effects of certification labels, I offer valuable information on price determinants to specialty coffee producers and organizations. By providing this information to producers I aim to combat the information asymmetry that often prevents them from efficiently allocating their resources. Second, Donnet et al. (2008) used a portion of the same data set used in this paper to estimate price determinants via the ordinary least-squares method. In the spirit of Tomek (1993), I attempt to replicate their model with the updated and expanded data set. I also estimate a model with additional variables and employ a truncated maximum likelihood estimation to more accurately measure price determinants in this model.

The paper is structured as follows: section 2 describes the specialty and boutique coffee markets, section 3 presents the Cup of Excellence programs, section 4 describes the basics of the hedonic method, section 5 presents the data and individual models, and section 6 discusses the results. The paper concludes with a discussion of the models' implications in section 7.

2. Specialty and Boutique Coffee Markets

Coffee "beans" are the dried seeds of the coffee tree. These trees grow up to 20 feet tall and produce a red or yellow-orange ripe berry. The berries consist of 4 parts: the outer skin called the "pulp," the inner fruit called "mucilage," the husk called the "parchment," and the inner seed called the "bean." Removing the outer three layers typically happens in one of three ways. Dry processed coffees are picked and immediately spread out on patios to dry in the sun. Once the fruit and skin have sufficiently dried, the coffees are dehulled, simultaneously removing the dried skin, fruit, and husk. Semi-washed or "pulped-natural" coffees are those whose skin has been removed mechanically but are otherwise dry processed. Washed coffees are depulped then left in fermentation tanks overnight to remove the mucilage. They are then washed with fresh water and dried in the sun before being dehulled. The processed and dried seeds are referred to as "green coffee" and are exported in this form.

Commercially grown coffee consists of two tree species, *Coffea arabica* and *Coffea canephora.* The latter species, called "robusta," is high-yielding, high in caffeine, and highly resistant to disease; it is also more bitter. The former species is more fragile and grows best in higher altitudes, typically 1000-5000 feet above sea level where the climate is mild. This "arabica" coffee forms the basis of most commercial coffee blends and is the sole species used for brands based on cup flavor and aroma. Some brands further distinguish themselves based on the unique flavor characteristics of individual farms or growing regions. These quality- and origin-focused brands make up the so-called specialty coffee market.

The term "specialty coffee" was originally used to classify the market niche where coffees are valued for their distinctive individual characteristics rather than their ability to be blended into a standardized product (Daviron and Ponte, 2005; Pendergrast, 2010). As this market has grown in popularity, what was once a niche market is becoming mainstream and increasingly hard to classify (Petkova, 2006). Ponte (2002) defines specialty coffees as those distinguished from "industrial blends" by their high quality, limited availability, or added flavorings and special packaging. Other researchers add coffees with sustainability labels to this group (e.g. Wollni and Zeller, 2007). Broadly speaking, "specialty coffee" has transitioned from referring to a reasonably unique market segment into a term describing any coffee that is set apart from the norm. In this paper, I use the term to refer strictly to those coffees distinguished on the basis of quality and uniqueness of origin, thus agreeing with the definition proposed by the Specialty Coffee Association of America (SCAA, 2007).

Some specialty firms have felt it necessary to adopt another term to further distinguish themselves from what is now the norm of specialty coffee. These firms constitute a niche market within specialty coffee referred to as "boutique" coffee. Boutique coffees are the modern equivalent of the specialty coffees of the late 1980s and early 1990s, i.e., they are distinguished and valued for their refined flavor, unique growing region, and especially their limited availability (cf. Kubota, 2010 and Roseberry, 1996). For roasters desiring to participate in this niche, procurement of such unique and high quality coffees is often very difficult. Likewise the farmers who grow these coffees must seek out buyers willing to pay adequate premiums for quality. The proliferation of the Internet has provided a solution to this, and many boutique coffees are now purchased through online auctions (Donnet et al., 2011). These auctions are sometimes hosted by individual farms, but are most often hosted by marketing organizations such as the Association for Coffee Excellence.

3. The Cup of Excellence Programs

The Cup of Excellence (CoE) programs are competitions designed to allow farmers the opportunity to test their best quality lots against those of other farmers from the same country. The Association for Coffee Excellence (ACE) hosts these programs each harvest season and entry is free to any farm or cooperative within the participating country. Lots submitted to CoE go through a rigorous elimination process where coffees are "cupped" by recognized national and international coffee graders and scored based on quality (Cupping refers to the process of roasting, grinding, brewing, and tasting coffees according to exact and standardized parameters to ensure consistent results). Submitted coffees must pass three rounds of elimination—any coffee discovered to have a defect in any round is dropped from the competition. Those obtaining a quality score of 84 or above out of 100 in the final round are given the prestigious *Cup of Excellence Award,* and the award-winning coffees are then ranked according to score (i.e. the highest scoring coffee in a given program is awarded first place, the next highest quality score receives second place, etc.). The winning coffees are then entered into an online auction[1].

The CoE programs constitute a top-tier market for quality coffee, and prices in these auctions are on average 4.5 times higher than the International Coffee Organization (ICO) composite price. The resulting benefit of these prices to producers is clear, especially considering that participation in the program carries little opportunity cost—submitted lots are small, and any lots that fail to win the CoE competition are returned to the farmer who can then sell them through existing channels. Moreover since ACE is a non-profit organization and predominantly funded by roaster/importer members, they are able to transmit the vast majority of auction prices directly to the producer (cf. Talbot, 1997).

The auctions are of eBay style, where bidders' identities are secret and bids are ascending. Bidders have access to complete information for each coffee including farm/cooperative name, growing altitude, and processing methods as well as quality score, cupping notes, and rank. They may also purchase small samples to cup before bidding. Bidders in these auctions are roasters and importers from around the world.

4. The Hedonic Method

Consuming coffee is a predominately sensory experience. As discussed in section 2, the specialty coffee industry places primary focus on the beverage's flavor as a determinant of value, and industry organizations increasingly draw comparisons between specialty coffee and fine

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[1] For more information on the competition and auction, visit the Cup of Excellence website at "http://www.cupofexcellence.org/WhatisCOE/FAQs/tabid/178/Default.aspx"

wine. It is therefore natural that the existing efforts to analyze specialty coffee prices have employed a hedonic price framework, a practice well established in the wine industry (Donnet et al., 2008, 2010; cf. Oczkowsky, 2001). I continue and seek to improve upon this trend.

The theoretical background for hedonic price models is extensive, with seminal efforts by Rosen (1974) and subsequent applications to vastly diverse subject areas such as housing (Hite et al., 2000; Smith and Huang, 1995), wages (Hwang et al., 1998), and agricultural commodities (Bowman and Ethridge, 1992; Buccola and Iizuka, 1997; Chang et al., 2010). Hedonic price theory stipulates that a good be viewed as a composite of its utility-bearing characteristics;

(1.1) $z = (z_1, z_2, \dots, z_n)$

where z_i is the amount of characteristic *i* present in good z. The price of z is thus given as

(1.2) $p(z) = \quad (z_1, z_2, \dots, z_n),$

and the implicit or *hedonic* price of characteristic *i* is defined as

(1.3) $\frac{\partial p}{\partial z_i} = p_i(z_1, z_2, \dots, z_n).$

This framework gives us the ability to isolate the effects on price of individual characteristics while holding all other variables constant. In the present context of specialty coffee, the hedonic method therefore gives us tremendous insight into the value placed on characteristics such as cup flavor or tree variety. It also gives us the ability to quantify the value of reputation characteristics such as altitude, lot size, and country of origin. As discussed in sections 1 and 2, this knowledge is of paramount importance to growers who must constantly estimate the returns of investment in quality control, planting locations, or new harvesting methods.

Since this study is concerned with discovering consumer preferences for certain characteristics of coffee, there may arise potential complications of differing markets in the same data set. Sixteen percent of the coffees were purchased by multiple buyers; buyers in Norway and Finland purchased over eleven percent; the U.S. and Canada account for another twenty-two percent; Japanese and Chinese buyers purchased over fifty percent. Assuming these can be pooled into a single market would be unwise due to the differences in coffee consumption culture between the regions[2]. I discuss the inclusion of this information in section 5.3.

5. Data and Model Identification

The CoE records for each lot include the final auction price (before transportation costs), quality score, cupping notes, extensive farm data including growing conditions and processing methods, and the buyers' names. Donnet et al. (2008) use a similar data set to estimate hedonic prices in coffee, spanning the 2003-2006 CoE auctions. I update the data to include auctions through 2010. In 2003, the lower limit on quality score for entrance into the program was 80, not 84, and only three countries participated in that year. I elected to drop observations from 2003 and analyze data from 2004-2010. To these data I add the ICO composite price index at time of auction and the region in which each buyer is located (obtained from business directories or the firm's individual website). Since the data span seven years, including periods of both low and very high international commodity prices, I correct all prices in the data set for inflation using the Producer Price Index. Like Donnet et al. (2008), I divide the variables into sensory, reputation, and "macro" correction variables. The tastes and aroma sensory aspects of each coffee are captured in the quality score. The reputation variables are country, growing area, altitude, tree variety, and certification label. Correction variables are ICO composite price, year, and buyer location. Summary statistics are presented in Table 1.

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[2] This insight comes from Susie Spindler at the Alliance for Coffee Excellence and is supported by discussions found in Daviron and Ponte (2005).

Worthy of note is the small number of certified coffees in the data set, which may be due to a number of reasons. Fieldwork in Nicaragua leads me to believe that many farms become Organic or Rainforest Alliance certified at the request of buyers[3], thus implying an existing relationship between buyer and producer. Since a primary benefit of participation in the CoE is a direct transaction between producer and roaster/importer, producers already satisfied with their buyer relationships may choose not to seek out new ones through CoE. Fair trade certifications do not appear in the data set since fair trade labels are meant to insure the equitable *sale* of coffee. In other words, farms in the data set may be members of fair trade cooperatives, but since CoE is an independent market, the fair trade label does not apply and is not observed.

I estimate four hedonic price models on these data. In model 1 I estimate Donnet et. al's (2008) model on my updated data set via the OLS method. Model 2 expands the specification to include the necessary variables. Model 3 estimates the same specification as model 2 using a truncated maximum likelihood estimation. Model 4 also uses a truncated MLE and includes additional interaction terms.

5.1 Model comparisons to Donnet et al. (2008)

For comparison, I first replicate the only known hedonic model applied to specialty coffee. Donnet et al. (2008) regress auction price on quality score, rank, country of origin, tree variety, number of bags, ICO price, and year. Since the quality score determines the rank, dummies are used for 1st, 2nd, 3rd, and 4th ranked coffees to avoid multicollinearity. The dependent price variable is logged as usual, as are number of bags and ICO price. Quality score

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[3] Though I am unaware of any studies directly observing this tendency (or lack thereof), there is strong theoretical justification for the buyer-initiated nature of certifications in the global value chain literature. See Gereffi et al. (2005), Ponte and Gibbon (2005), and McEwan and Bet (2009).

is left in linear form for ease of interpretation. Donnet et al. (2008)'s model can be formally written as

(2) $$\ln{(P_i)} = \beta_0 + \beta_1 Q_i + \sum_j \beta_j \;\;_{ij} + \sum_k \beta_k C_{ik} + \varepsilon_i$$

where P_i is the auction price of the i^{th} coffee, Q_i is the quality score, the R_{ij} are the j reputation variables, and the C_{ik} are the k macro correction variables. I estimate this model using ordinary least-squares regression with the updated data set and report the results in Table 2, Column 1.

5.2 Inclusion of Additional Variables

I now turn my attention to missing variables that may bias the results of the model in section 5.1. The model assumes a linear relationship between quality score and price; I expect the relationship to be nonlinear. The high-end quality of CoE coffees implies buyers would obtain noticeably decreasing marginal returns from quality score. Thus I expect a nonlinear relationship and henceforth include a squared term for quality score. I also include growing altitude in the following models. Altitude has been used as a proxy for coffee quality (Wollni and Zeller, 2007), but I expect altitude to be a reputation variable in its own right, as coffees are often marketed by roasters and importers to be "mountain" or "high grown" coffees (Daviron and Ponte, 2005; Roseberry 1996).

Donnet et al. (2008) consider the number of bags in a given lot as a proxy for the exclusivity of owning that coffee, and in that sense consider it a reputation characteristic. I note another possibility: since CoE coffees constitute the boutique niche, we must remember that most buyers are predominantly active in more mainstream channels. Thus they may have a lower willingness to pay for boutique offerings through CoE. This is to say that a roaster, wishing to add a unique coffee to their product line, may prefer to buy a smaller quantity and still retain the marketing advantage of offering CoE award-winning coffees. That being said, Donnet et al. (2008) are insightful in their recognition that buyers highly value exclusivity and availability in niche markets. To further investigate this concept I include the coffee growing area in the regressions, hypothesizing that buyers prefer coffees from smaller farms because of their unique and exclusive nature.

Also missing from the model in section 5.1 are the variables for Organic and Rainforest Alliance certifications. I assume this is because so few coffees in the data available to Donnet et al. (2008) carry such certifications. From 2004-2006 only 1.3% of all coffees were Certified Organic and less than 0.5% were certified through Rainforest Alliance. In the updated data I have over 3% Certified Organic and nearly 2% Rainforest Alliance Certified; thus I include the variables in models 2-4. Clearly, if the newer data have more certified coffees, I should investigate if the value of these certifications has increased over time; however, I am still limited by the small number of observations for these coffees and cannot adequately measure the interaction of time and certifications here.

5.3 Buyer Location as a Correction variable

I now discuss a class of variables sometimes considered to be outside the realm of hedonic models: buyer characteristics. Indeed the defining aspect of hedonic theory is that the observed price of a good can be disentangled to reveal the implicit prices of its characteristics (Rosen, 1974). Including buyer information in the model, then, would seem to assume that buyer characteristics are in fact characteristics of the good itself. To make such a connection would be nonsensical, and I argue that including buyer location into this model does not violate the assumptions of hedonic theory.

First, recall from section 3 that buyers in this market are not the end users of the good and therefore do not derive utility from consuming the sensory and reputation qualities. Rather they purchase coffees as production inputs and receive returns from providing those qualities to their customers. In this sense the good for which roasters and importers pay is the resulting profit, which is generated by their ability to match the coffees' characteristics with the preferences of their customers.

Correspondingly, modeling a market with a single equation, regardless of the context or model used, is to assume a relatively homogeneous market. In other words, if a large group of buyers values a certain characteristic more than other groups, the resulting estimate reflects the proportional size of the group as well as the extent to which that group values the characteristic. This is a form of selection bias, and including buyer variables as corrections is well established in the literature (Bowden, 1992; Ekeland et al., 2004; Pollak and Wales, 1981).

Correspondence with ACE's Executive Director leads me to believe that the data may suffer from this selection bias. Asian, predominantly Japanese, roasters and importers account for over half of all coffees in the data set. In this region coffees are often marketed under the CoE brand in order to communicate quality. North American roasters, however, typically purchase high quality coffees such as those in the CoE in order to increase the quality of their own brands (Spindler, 2012). This is to say that Asian roasters value the CoE award itself more than North American roasters—Asian roasters are self-selecting into the market.

To correct for these effects and those discussed in section 5.2, I write my second model as follows:

(3.1) $\ln(P_i) = \beta_0 + \beta_1 Q_i + \beta_2 Q_i^2 + \sum_j \beta_j R_{ij} + \sum_k \beta_k C_{ik} + \sum_m \beta_m L_{im} + \varepsilon_i$

where the R_{ij} now include altitude, growing area, and dummy variables for Organic and Rainforest Alliance certifications. The L_{im} are dummy variables for buyer location. Here and in subsequent models, I scale the quality score to range 1-17 rather than 84-100 to aid efficient estimation. For comparison to the model in section 5.1, I estimate equation (3.1) via OLS and report the results in Table 2, Column 2.

5.4 Truncated Regression Model

The primary econometric hurdle lies not in model identification but rather in the distribution of the dependent variable. Any coffee submitted to the CoE program must obtain a quality score of 84 or higher in order to appear in the auction, and thus the distribution of price is truncated. The problem is partially masked by the fact that the truncation point varies for each of the 48 auctions in the data set—when the pooled data is viewed, the distribution displays no obvious truncation point (Figure 1.1). Formally, the truncation lies not in price but in the quality score, where no coffees scoring under 84.00 are observed. This causes an incidental truncation of auction prices taking the form

$$(4) \qquad y = \begin{cases} y* & \text{when } q \geq 84 \\ \text{unobserved} & \text{when } q < 84 \end{cases}$$

where y is the price of a submitted lot, $y*$ is the observed price, and q is the quality score. The problem can be seen clearly when viewing each auction individually—the price distributions for the 2005 Nicaraguan auction and 2009 Brazilian auctions, as examples, are shown in Figure 1.2.

Since the point of truncation varies, I have a situation similar to the New Jersey Income Tax Experiment where the income truncation point depended on number of people in the household (Hausman and Wise, 1976). I therefore expect all OLS estimates to be biased toward zero and estimate the model using a truncated maximum likelihood method (Hausman and Wise, 1977; Maddala, 1983). I estimate equation (3.1) using this method and report the results in Table 2, Column 3.

5.5 Additional Interaction Terms

The final model includes interactions between key variables. I interact quality and buyer location to investigate how the different markets respond to quality score. I also interact country of origin and tree variety. Nearly all varieties are present in each country, but certain countries focus on particular varieties, and have even attempted to build brand recognition for their favored variety. For instance, the vast majority of coffees from Nicaragua are of the caturra variety, and the Republic of El Salvador has launched advertising campaigns in popular trade press touting their bourbon coffees (Café de El Salvador, 2009). Including every interaction between variety and country of origin would make the model unnecessarily cumbersome. I therefore only include interaction terms for caturra coffees in Nicaragua, bourbon coffees from El Salvador and bourbon coffees from Brazil for comparison. Explicitly,

(3.2) $\ln(P_i) = \beta_0 + \beta_1 Q_i + \beta_2 Q_i^2 + \sum_j \beta_j R_{ij} + \sum_k \beta_k C_{ik} + \sum_m \beta_m L_{im} \quad \sum_n \beta_n I_{in} + \varepsilon_i$

where the I_{in} are the interaction terms for each coffee *i*. Results are presented in Table 2, Column 4.

Figure 1.1:
Distribution of Pooled Prices

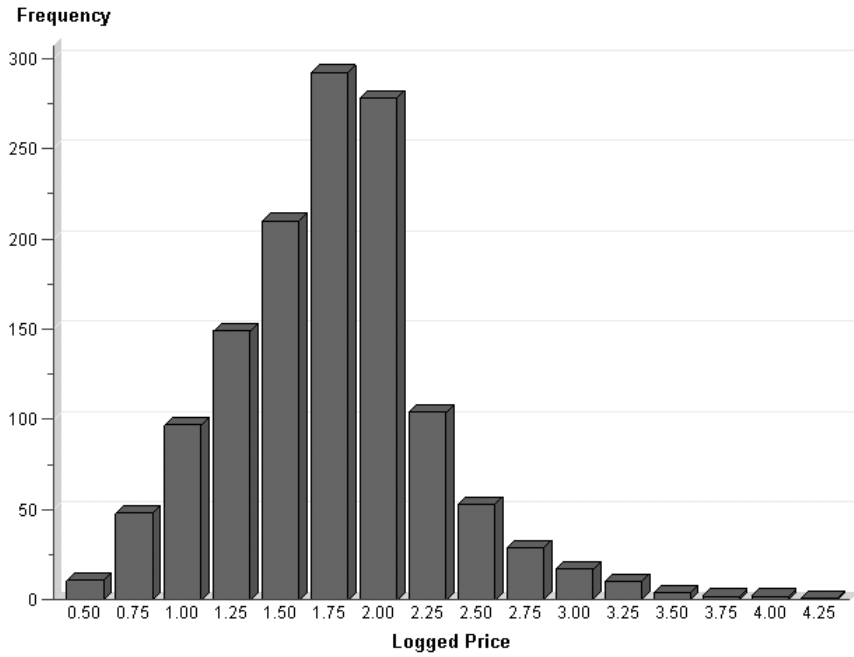


Figure 1.2:
Distribution of Prices in the 2005 Nicaraguan and 2009 Brazilian auctions

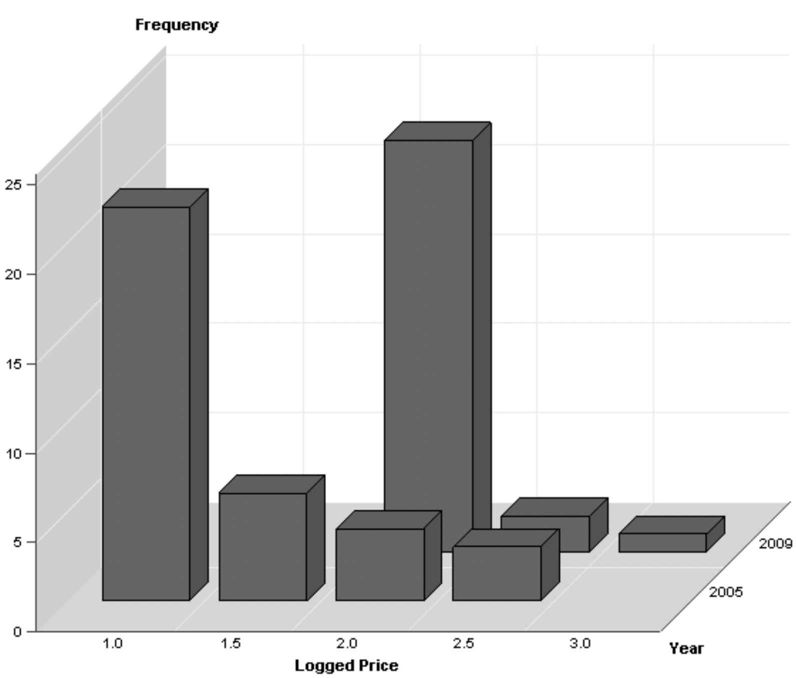


Table 1:
Summary Statistics

Variable	Obs.	Mean	Std Dev	Min	Max
Auction Price (2011 US$/pound)	1039	5.993	4.733	1.200	80.22
ICO Composite Price (2011 US$)	1039	1.323	0.324	0.805	2.300
Quality Score (0-100)	1039	87.00	2.413	84.00	95.69
Growing Altitude (Meters)	1039	1471	234.3	600	22100
Growing Area (Hectares)	1039	30.56	60.88	0.280	893
Lot Size (70kg Bags)	1039	24.35	13.40	9	145
Brazil	1039	0.086	0.280	0	1
Bolivia	1039	0.109	0.311	0	1
Colombia	1039	0.194	0.396	0	1
Costa Rica	1039	0.024	0.153	0	1
El Salvador	1039	0.189	0.391	0	1
Guatemala	1039	0.078	0.268	0	1
Honduras	1039	0.140	0.347	0	1
Nicaragua	1039	0.181	0.385	0	1
Bourbon Variety	1039	0.213	0.409	0	1
Caturra Variety	1039	0.476	0.500	0	1
Catuai Variety	1039	0.003	0.054	0	1
Typica Variety	1039	0.071	0.257	0	1
Pacamara Variety	1039	0.001	0.031	0	1
Other Variety	1039	0.228	0.420	0	1
Mixed Varieties	1039	0.126	0.126	0	1
Certified Organic	1039	0.035	0.183	0	1
Rainforest Alliance Certified	1039	0.024	0.153	0	1
North American Market	1039	0.218	0.413	0	1
Scandinavia Market	1039	0.113	0.316	0	1
European Market	1039	0.102	0.302	0	1
Asian Market	1039	0.504	0.500	0	1
Other Markets	1039	0.021	0.144	0	1
Buyer Cooperation	1039	0.170	0.376	0	1

Table 2:
Model Results

	(1) Updated Data Equation (2) OLS	**(2) Additional Variables** Equation (3.1) OLS	**(3) Truncated Model** Equation (3.1) MLE	**(4) Truncated Model with Interactions** Equation (3.2) MLE
Sencory Variables				
Quality Score	0.085*** (0.005)	0.093*** (0.016)	0.250*** (0.024)	0.250*** (0.024)
Quality Score2		-0.002 (0.002)	-0.012*** (0.002)	-0.012*** (0.002)
Reputation Variables				
Altitude		0.015*** (0.005)	0.023*** (0.008)	0.023*** (0.008)
Logged Growing Area		0.015* (0.008)	0.020 (0.012)	0.022* (0.012)
Logged # of Bags	-0.356*** (0.301)	-0.356*** (0.030)	-0.546*** (0.050)	-0.551*** (0.050)
First Place	0.809*** (0.053)	0.857*** (0.069)	0.897*** (0.078)	0.872*** (0.079)
Second Place	0.275*** (0.051)	0.304*** (0.056)	0.318*** (0.064)	0.323*** (0.065)
Third Place	0.212*** (0.049)	0.229*** (0.050)	0.232*** (0.058)	0.249*** (0.058)
Fourth Place	0.163*** (0.048)	0.166*** (0.048)	0.149*** (0.056)	0.156*** (0.056)
El Salvador	-0.276*** (0.038)	-0.321*** (0.040)	-0.310*** (0.058)	-0.406*** (0.095)
Costa Rica	-0.437*** (0.070)	-0.485*** (0.073)	-0.525*** (0.105)	-0.529*** (0.122)
Colombia	-0.055 (0.052)	-0.121* (0.062)	-0.372*** (0.094)	-0.381*** (0.114)
Guatemala	0.180*** (0.047)	0.120** (0.052)	-0.167** (0.084)	-0.241*** (0.104)

Table 2, continued

	(1) **Updated Data** Equation (2) OLS	(2) **Additional Variables** Equation (3.1) OLS	(3) **Truncated Model** Equation (3.1) MLE	(4) **Truncated Model with Interactions** Equation (3.2) MLE
Honduras	-0.360***	-0.407***	-0.496***	-0.572***
	(0.042)	(0.047)	(0.069)	(0.090)
Nicaragua	-0.189***	-0.222***	-0.280***	-0.452***
	(0.044)	(0.045)	(0.066)	(0.099)
Bolivia	-0.067	-0.128**	-0.238***	-0.278***
	(0.051)	(0.058)	(0.088)	(0.108)
Caturra	-0.013	0.016	0.031	-0.037
	(0.028)	(0.030)	(0.046)	(0.057)
Catuaí	-0.056	-0.045	0.166	0.159
	(0.158)	(0.157)	(0.206)	(0.206)
Typica	-0.016	0.002	-0.039	-0.062
	(0.039)	(0.038)	(0.062)	(0.064)
Pacamara	0.158	0.243	0.527	0.523
	(0.266)	(0.263)	(0.349)	(0.346)
Other	0.018	0.049	0.091**	0.104**
	(0.021)	(0.026)	(0.036)	(0.045)
Mixed		-0.072**	-0.132**	-0.131**
		(0.035)	(0.053)	(0.054)
Organic		0.025	0.029	0.023
		(0.048)	(0.068)	(0.068)
Rainforest Alliance		0.007	-0.084	-0.080
		(0.056)	(0.085)	(0.085)
Correction Variables				
2005	0.046	0.012	0.076	0.098
	(0.065)	(0.064)	(0.094)	(0.095)
2006	0.115**	0.092	0.202**	0.216**
	(0.058)	(0.057)	(0.083)	(0.084)
2007	0.379***	0.342***	0.352***	0.369***
	(0.061)	(0.061)	(0.091)	(0.091)

Table 2, continued

	(1) **Updated Data** Equation (2) OLS	(2) **Additional Variables** Equation (3.1) OLS	(3) **Truncated Model** Equation (3.1) MLE	(4) **Truncated Model with Interactions** Equation (3.2) MLE
2008	0.370*** (0.062)	0.350*** (0.062)	0.446*** (0.090)	0.465*** (0.091)
2009	0.683*** (0.100)	0.644*** (0.099)	0.815*** (0.150)	0.850*** (0.151)
2010	1.105*** (0.150)	1.048*** (0.149)	1.116*** (0.220)	1.172*** (0.222)
Logged ICO Price	-0.338* (0.191)	-0.241 (0.189)	-0.149 (0.277)	-0.212 (0.278)
Buyer Variables				
Asian Market		-0.070*** (0.019)	-0.120*** (0.028)	-0.133** (0.064)
Scandinavian Market		0.051* (0.028)	0.072* (0.037)	0.226** (0.090)
European Market		0.040 (0.030)	0.037 (0.042)	0.221** (0.089)
Other Market		-0.149** (0.059)	-0.254** (0.031)	-0.163 (0.249)
Buyer Cooperation		0.017 (0.023)	0.027 (0.031)	-0.011 (0.035)
Interactions				
Score*North American				0.013** (0.006)
Score*Asian				0.011 (0.011)
Score* Scandinavian				-0.025 (0.015)
Score*European				-0.030* (0.016)

Table 2, continued

	(1) **Updated Data** Equation (2) OLS	(2) **Additional Variables** Equation (3) OLS	(3) **Truncated Model** Equation (3) MLE	(4) **Truncated Model with Interactions** Equation (3) MLE
Score*Others				-0.022 (0.074)
Nicaraguan Caturra				0.180** (0.089)
Salvadoran Bourbon				0.020 (0.067)
Brazilian Bourbon				-0.147 (0.093)
N	1039	1039	1039	1039
R2	0.752	0.765	-	-
Log Likelihood	-	-	416.7	427.4
AIC	-	-	-757.5	-760.8

*** Significant at 99% Confidence, ** Significant at 95% Confidence, * Significant at 90% Confidence

6. Model Results

Comparing the four models reveals much about the proper estimation of these data. The two most prominent effects seen in Table 2 are that Donnet et al. (2008)'s model lacks important variables and that OLS estimates in model 2 are uniformly biased toward zero when compared to the truncated MLE in model 3. The difference in performance between the OLS and truncated MLE techniques is even more obvious when inspecting the residuals. OLS models 1 and 2 have significantly non-normal residual distributions, revealing a violation of the Gauss-Markov assumptions, whereas the truncated maximum likelihood estimations produce considerably more normal residuals—Kolgomorov-Smirnov tests fail to reject a normal distribution at 95% confidence for model 3 and at 99% confidence for model 4. Beyond this, a clear trend in residual values exists for model 2, as can be seen in Figure 2.1. The truncated MLE technique produces considerably more random residuals, displayed in Figure 2.2.

With these econometric issues settled, the hedonic prices of each characteristic can now be analyzed. In models 3 and 4 the relationship between quality score and price is nonlinear and consistent with the theory of diminishing marginal returns. About the mean score of 86.94, model 3 predicts an additional quality point increases price by 20.9%. On the high end of quality, say about a score of 95, an additional point only increases price by 10.6%. Obtaining the highest rank carries the highest premium at well over 100%[4] more than coffees not ranked in the top four. By contrast, obtaining second place only carries a premium of just over 30%. This is somewhat surprising, considering the average difference in quality score between first and second ranked coffees is only 1.21 points.

[4] Since the dependent variable is logged, the percentage impact of dummy variable i is calculated as $e^{\beta_i - 0.5*se(\beta_i)} - 1$, multiplied by 100% (Maddala, 1996).

Altitude has a significantly positive effect on price, confirming the expectation that buyers view altitude as an important reputation characteristic. Farm size (growing area) has a positive coefficient at 90% confidence, possibly indicating that buyers prefer larger farms rather than smaller, i.e. more exclusive, farms as supposed. However, the statistical relationship is fairly weak. Country-of-origin variables also perform similarly across models, with all countries except Guatemala taking equal or lesser prices compared to the base group of Brazil. This may be due to the fact that the CoE programs originated in Brazil in the late 1990s and thus may carry more brand recognition. It may also be the case that, given Brazil's historical reputation for lower quality production, ultra-high-quality coffees from this nation appear more unique and interesting to buyers (Chaddad and Boland, 2009).

A prominent difference between the previous study and these models is the performance of the year and ICO price variables. Donnet et al. (2008) use 2003 as the base year and find only 2005 to be different in nominal price. I use 2004 as the base and observe real prices to be increasingly higher through 2010 in all models. This indicates an increasing demand for CoE coffees and is perhaps a result of continuing marketing efforts from ACE. It is also likely that the year variable estimates are influenced by the increasing popularity of specialty coffees in general, an effect not captured by the other macro correction variable of ICO composite price. The coefficient for ICO price is significantly negative in the first model, indicating that coffees traded in commodity markets are complements to CoE coffees. This is expected since CoE coffees constitute only a small portion of the coffees purchased by any given roaster, and the rest are often purchased in commodity markets. While this result is intuitive, the relationship is not observed to be statistically significant in models 2 through 4, which correct for missing variable bias.

It should be noted, however, that the effects of the year, country, and ICO price variables cannot be perfectly disentangled. Auctions generally occur within a 4-hour period, and thus the ICO price does not vary during the auction since it is a general market composite. Thus for any given year and country in the data, variation in ICO price only occurs when there is more than one auction during that year. While this prevents perfect multicollinearity, it may cause the ICO price variable to appear insignificant as the effects of commodity market conditions are mostly captured in the year variables.

Additional terms to account for differing slopes between countries could be used to separate these effects, but these would add considerable bulk and the model would quickly become unwieldy. An alternative method may be to define an individual equation for each country and estimate a Seemingly-Unrelated Regression. However, the truncation of price limits my ability to use this technique, as I am unaware of any existing methods of estimating a truncated SUR.

Buyers value small lots sizes considerably more than previously realized, with a 1% increase in quantity causing a 54.6% reduction in price per pound according to model 3. This indicates that buyers value either or both the exclusivity of small lots and the convenience of a smaller overall monetary commitment while retaining the prestige of buying these award-winning coffees.

Another prominent result in all models is that tree variety has very little effect on price. This presents an important difference between the coffee industry and the wine industry to which it is often compared. Hedonic analyses of wine prices show that consumers consider some varieties such as Cabernet Sauvignon to be superior to others (Schamel and Anderson, 2003). Coffee consumers do not share this preference for tree variety. This is not to say that variety is irrelevant, as I find the less-common varieties to jointly carry slightly higher prices than the base variety of Bourbon. However, I consider this to be confirmation that buyers value *uniqueness* rather than the varieties themselves.

Interactions between country of origin and tree variety offer additional insight to the industry. While individual varieties may not significantly influence price, I have supposed that country-specific varieties may carry a reputation for being of high quality. This seems to be the case for Caturra coffees in Nicaragua, which carry a 14.5% premium over Caturras from other countries. However, I find no price premiums for Bourbon coffees from El Salvador despite advertising efforts to the contrary.

I also observe no relationship between auction price and certification labels. The small number of coffees so labeled in the data set perhaps affects the statistical significance of the estimates for Certified Organic and Rainforest Alliance Certified labels. However, this is the only known study to measure the premiums associated with certification labels while rigorously correcting for coffee quality. As such I cannot ignore the implication that in high-priced, high quality markets like the CoE, certification labels offer the producer no price premiums. Beuchelt and Zeller (2011) support the conclusion that premiums are smaller in high price conditions.

Perhaps the most significant difference between this study and others is the inclusion of buyer location as a correction variable. While the primary purpose of including these variables is to properly isolate the effects of quality on price, additional information can be gleaned. Model 3 shows Asian buyers pay an average of 12% less than the base group of North American buyers. This supports the argument in section 5.3 that Asian buyers are self-selecting into the market due to their higher value for the CoE brand itself.

Model 4 allows me to account for differences in how buyers in each market respond to changes in quality. The additional insight, however, comes at the cost of model 3's ease of interpretation. From equation (3.2) and the values given in Table 2, column 4, the marginal implicit price of quality is given as

$$(4) \qquad \frac{\partial(\ln P)}{\partial(Q)} = 0.250^{***} - 0.012^{***}(Q) + 0.013^{***}(NA) + 0.011(Asia) - 0.025(Scand) - 0.030^{*}(Europe) - 0.022(Others)$$

where lnP is the logged price, Q is the quality score, and NA, Asia, Scand, Europe and Others denote the binary variables for buyers in North American, Asian, Scandinavian, European and Other markets, respectively. The asterisks denote statistical significance as in Table 2. About the mean quality score of 86.9, equation (4) shows that North American buyers pay 21.6% higher prices for an additional point in quality score. Asian buyers pay only 20.3% higher for an equivalent increase in quality. Scandinavians and buyers in other markets pay similar premiums to Asian buyers, and European buyers pay only slightly higher for quality. This supports the effect discussed in section 5.3, namely that Asian roasters rely more on the CoE award itself as a marker of quality while North American roasters rely more on quality score.

Figure 2.1
Model 2 residual plot

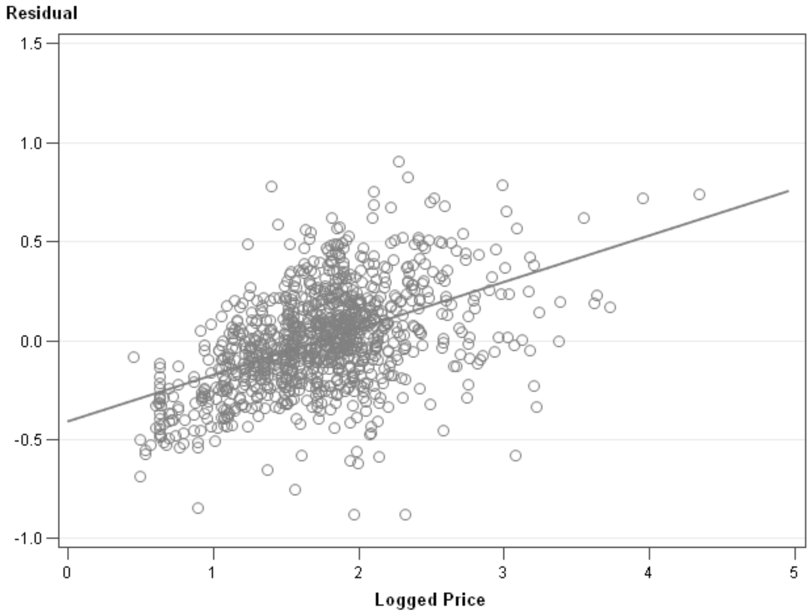
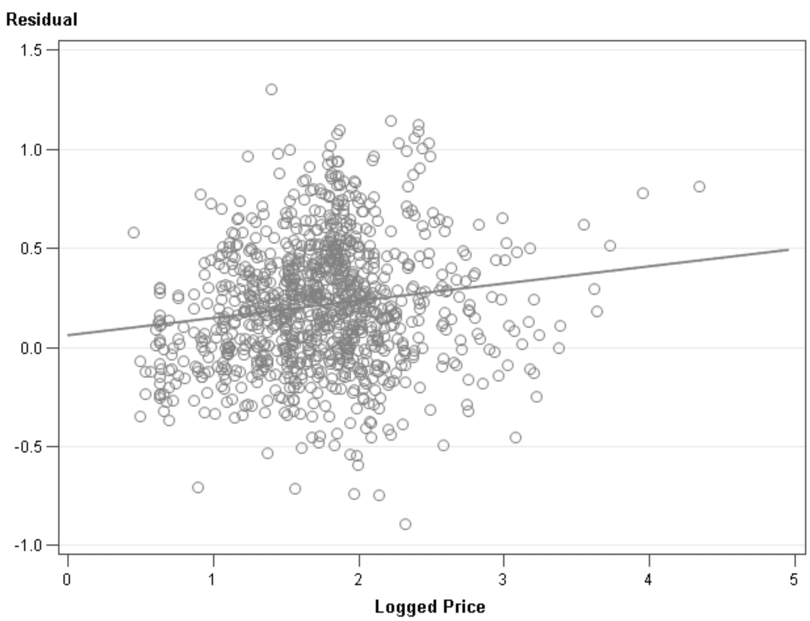


Figure 2.2
Model 3 residual plot



7. Implications and Conclusion

The main goals of this paper have been to accurately estimate hedonic prices of boutique green coffee and to provide coffee professionals, especially producers, with information that allows them to make informed investment decisions. Consider a farmer wishing to sell her coffee in the CoE market. Based on this analysis, what might she do to maximize profit?

First and foremost, the sensory quality of the coffee determines price. Indeed extremely high quality is not only associated with price premiums, but is the primary requirement for entrance into the market. Once the level of quality required for entrance has been obtained, increases in quality pay off in two ways. First, increases in the quality score itself pay off noticeably, but the effect diminishes as quality gets farther from the average. Once in this range, however, the comparative quality (the ranking) becomes increasingly valuable. The single greatest impact on price observed in this data set comes from winning first place in the auction.

Perhaps most surprisingly, the models show that, ceteris paribus, the farmer will maximize profit by keeping quantities small. To illustrate this, assume the farmer has an average quantity of coffee, 25 bags. Each bag is 70kg and the average auction price is $6.63 per pound. After the necessary conversions, this means the total price the farmer could expect is $25,578. Now assume she increases the number of bags in the lot in hopes of higher gross income. An increase of 1% in lot size, ceteris paribus, would mean 25.25 bags sold at $3.01 (54.6% less than $6.63) per pound. This translates to a total price of $11,728—a reduction of more than $10,000 in revenue.

Since this market favors small quantities, the farmer must chose how to separate the CoE submission from the rest of the coffee produced on her land. The taste and aroma attributes of the coffee are of primary importance, and her primary concern should naturally be placed there.

However, the non-sensory aspects of quality should not be neglected. Given equal levels of sensory quality, the farmer should submit a lot from the highest-altitude plot on her farm and work to ensure only one tree varietal is included. Rare or new varieties such as Geisha may garner premiums, but major varieties all bring equivalent prices. It is only important that the submission be of a single variety, as those that are mixed receive 13% lower prices on average.

At first glance, it may seem strange that consumers value unmixed varieties of trees over mixed lots of equivalent quality. To understand this, recall that the very definition of a specialty coffee is one that is differentiated from the norm. Historically, coffees were blended to produce uniformity (Daviron and Ponte, 2005). As argued throughout the literature and seen empirically in my analysis, specialty and boutique markets assign value to coffees that are as unique and "unblended" as possible. This cannot be over emphasized.

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