Staff Paper

Price Determinants in Top Quality E-Auctioned Specialty Coffees

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Abstract

The US specialty coffee industry has grown from $1 billion in 1990 to $11 billion in 2006 and is expected to continue to grow into the foreseeable future. This growth particularly depends on prices coordinating the specialty coffee supply chain through two-way information exchange between roasters and producers. We analyze the determinants of specialty coffee prices by estimating a hedonic price function for specialty Central and South American coffees traded at e-auctions. We hypothesize that since specialty coffee is a differentiated product, prices will be determined by both sensory and reputation attributes. The results show that prices are influenced by the quality rating, which is a sensory variable, and by the quality rankings established in the cupping competition previous to the auction, the country of origin and the coffee variety, which are reputation variables. In addition, the macro variables, harvest year and commodity price were found to be significant.

Keywords: Specialty coffee, hedonic price analysis, differentiated food pricing, sensory attributes, reputation attributes.

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1 Introduction

The specialty coffee industry experienced an explosive growth in the 1990s driven by the roasters and retailers' investments in product innovation and market segmentation, hence increasing value added in the coffee supply chain (Ponte, 2001; Lee, 2006). The US specialty coffee market grew from $1 billion in 1990 to $11 billions in 2006, according to the Specialty Coffee Association of America (SCAA), the National Coffee Association (NCA) and Mintel group industry reports (Hillside Agricultural Program, 2002; California Libraries Association Conference, 2005; Lee, 2006).

Specialty coffees are different from the commodity coffee in that they give consumers a distinctive experience of aromas, flavors and mouthfeel in each cup for a higher price. The expansion of specialty coffee is related to the increased connoisseurship about taste profiles and the production conditions and practices related to them (Davids, 2002; Arvidson, 2003; Ganes-Chase, 2006). As the specialty market continues to grow, coffee firms face the challenge of increasing their high quality procurement sources. Electronic auctions (e-auctions) have successfully addressed this challenge in recent years and play an important role in discovering and trading top quality coffees (United Nations, 2003). This paper uses hedonic analysis to understand the market values of specialty coffee attributes, especially those attributes associated with expert third-party evaluations and production reputations of specialty coffees traded in e-auctions.

Coffee is a product that lends itself to differentiation. There is a wide diversity of flavors and aromas that emerge from different coffee growing soils and climates, tree varieties and cultivation and processing methods. Flavors and aromas constitute the coffee 'sensory attributes' because they refer to quality aspects that are perceived by the senses. Similar to grapes, the genetic strain of the coffee plant and its unique adaptation to the environment profoundly influence the character of the final product (Arvidson, 2003; Davids, 2004). Coffee sensory attributes are evaluated through cupping which is the sensing of aromas, flavors and body through olfaction, gustation and mouthfeel, respectively (Lingle, 2001).

The soils and climates, varieties and growing methods by which coffees are produced constitute 'reputation attributes'. Reputation attributes in coffee cannot be assessed directly in the cup but refer to production conditions and processes, such as the region of origin, variety, altitude, rainfall, cultivation and milling practices. These attributes are conveyed by words and speak of a relationship between the sensory attributes and the coffee production conditions and methods.

The display of attributes places coffee in a widening spectrum of differentiated food products which include wines, beers, and cheeses among others (Roseberry, 1996). Similar to other specialty food products, the distinctive attributes of specialty coffee might be difficult to directly appraise and value for consumers and even for producers or processors. The aroma and flavor of a particular coffee cannot be known until it is consumed. Sometimes even after consumption, quality cannot be appraised, which is

usually the case of inexperienced consumers. This situation is characterized by imperfect information and is the primary reason why the pricing of specialty food products depends on reputation attributes, which in turn allows supply chain participants to make rational assumptions about the intentions and future behaviors of each other (Nelson, 1970; Kreps and Wilson, 1982; Shapiro, 1983; de Figueiredo, 2000; Carriquiry and Babcock, 2004). While sensory attributes can be appraised only at consumption, reputation attributes can be identified prior to consumption and therefore constitute quality signals.

Understanding what determines price in specialty coffee is crucial to developing a sustainable industry. The prices paid by specialty coffee buyers is a crucial element of supply chain coordination. On the one hand, what buyers pay for the beans informs growers about the consumers' quality preferences so they can direct production practices towards obtaining the desired attributes. On the other hand, the transmission of price to consumers informs them about the resources involved in producing the attributes they desire. This two way information flow allows the supply chain to respond to increasingly stringent demands from consumers while simultaneously stimulating demand by transmitting information on different flavor profiles resulting from different origins and production conditions.

E-auctions, in particular the Cup of Excellence (CofE), expanded the known flavor profiles and quality ranges in coffee and created awareness of previously unknown suppliers (Cox, 2005). A distinguishing feature of these auctions is the high level of prices achieved that are considered to have influenced the structure of the coffee market,

including its price formation (United Nations, 2003). For example, the winning coffee in Brazil for 2005 attained a record price of $49.75 per pound, more than 40 times the International Coffee Organization (ICO) composite price index ($1.15 per pound) for the Brazilian Natural Arabicas during the auction month, which is the common benchmark price. This study is the first to analyze the information conveyed in the form of implicit prices of both sensory and reputation attributes in the prices paid by specialty coffee buyers.

This paper examines specialty coffee pricing of the top quality e-auctions by applying a hedonic price model to data drawn from the CofE auctions. We hypothesize that specialty coffee prices are influenced by both sensory and reputation attributes since specialty coffee is a highly differentiated specialty food product. Specifically we expect that the quality ratings in the cupping competitions (sensory attributes), and the country of origin, variety and competition ranking (reputation attributes) to affect the price of specialty coffee.

The paper proceeds with a review of the literature on hedonic price models and their application to specialty foods such as wines. Next, we describe the specialty coffee e-auctions. Then we present our empirical specialty coffee hedonic price model, followed by the presentation and discussion of the results. In the final section we recap what has been learned and address limitations and further research.

2 Hedonic Approach and Applications to Specialty Food Products

An approach to studying the relationship between prices and quality attributes is the hedonic analysis of prices. The analysis consists of modeling the price of individual products as a function of various attributes that can be encountered in them in order to estimate the implicit or marginal prices of such attributes. If the estimated implicit price is not significantly different from zero, then the attribute is not valued by consumers. Possibly, the earliest reference to this approach is Waugh (1928). Waugh analyzed individual prices of asparagus, tomatoes and cucumbers using their physical attributes such as color, size of stalks, shapes, maturity, uniformity, and similar factors, in order to determine consumers' marginal valuations of these attributes. The quality attributes analyzed by Waugh were all sensory. He viewed this type of analysis as of great practical value for growers to adjust production to the market demand.

Later, the approach advanced from the developments of the demand theory for quality attributes and the statistical methods applied to the hedonic regression. In 1966, Lancaster presented a theory of consumer utility based on preferences over the characteristics rather than over goods and hence, goods then can be viewed as a bundle of characteristics desired by consumers. In 1974, Rosen presented a model of product differentiation based on the hedonic prices of attributes empirically estimated as the relationship between the observed prices of products and the specific amounts of individual attributes associated with them. Hedonic price functions relate to both the underlying supply costs and the underlying demand preferences for individual attributes and hence they do not identify the structure of either (ibid.). In this view, a significant and large implicit price may not

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reflect consumers' high valuation of an attribute, but rather a high cost incurred in producing that attribute. However, if the supplied quantity is exogenously determined, the regression of price on quantity may be used to estimate the demand elasticity (Schultz, 1938).

Hedonic price analysis has been extensively applied to the wine industry. Oczkowski (1994) found that the prices of Australian wines were determined by the quality, cellaring potential, grape variety, region, vintage, and producer size. The author termed grape variety, region, vintage, size of 'objective' or tangible attributes and overall quality and cellaring potential of 'subjective' or intangible attributes. Oczkowski argues that the marketing implication of knowing implicit prices of attributes for producers is that they can evaluate the implementation of practices leading to attaining a particular attribute. In turn, implicit prices can be useful to consumers since they evaluate their purchases relative to these average values of attributes made available from wine guides or the newspapers (ibid.).

Combris et al. (1997) applied the hedonic approach to Bordeaux wines at the retail level. The authors observed that Oczkowski (1994)'s analysis was lacking sensory quality variables and regressed prices on 'objective' attributes appearing on the label of the bottle and sensory attributes from olfactory and gustatory examinations by independent experts. Combris et al. found that Bordeaux wine prices are largely determined by the objective variables including color, vintage, and appellation of origin, but not by sensory variables. The authors provide an explanation in terms of imperfect information; consumers can

more easily assess objective attributes compared to sensory attributes, hence their purchasing decision is influenced by the former.

Other studies indicate that quality ratings by experts are indeed significant in determining wine prices but objective attributes, which are far easier to identify than sensory characteristics, are the most influential. Ashenfelter et al. (1995) found the prevailing weather during the growing season to be most influential on Bordeaux wine prices. Their study shows that 83 percent of the variation in vintage wine prices is explained by the four variables: age of the wine, average temperature during the growing season, rainfall in August and September and rain in the winter preceding the vintage. They conclude that "great vintages for Bordeaux wines are the years in which August and September, are dry, the growing season is warm, and the previous winter has been wet" (Ashenfelter et al., 1995). Landon and Smith (1997) highlighted the important role of group designations of origin and classification schemes such as, the cru, grand cru and so on, which they consider collective reputation variables, in determining prices of Bordeaux wines. The authors argued that consumers form their predictions of the quality of an individual firm's output using information on the quality of the output produced by similar firms. Combris et al. (2000) found that the most influential attributes for Burgundy prices were the ranking of grand cru, premier cru, communale and regionale, and the vintage (year of bottling). Lecocq and Visser (2003) also found for Bordeaux and Burgundy wines that the objective attributes appearing on the bottle label, ranking, vintage and appellation, were largely responsible for determining wine prices while sensory attributes had a small influence. Troncoso and Aguirre (2006) found grape variety and valley of origin to be the

most important price determinants of Chilean wines in the US market. From these results, they interpret that the most important management decisions in wine are the choice of alternative locations and varieties at the moment of planting a vineyard.

Combris et al. (2000) provide two types of arguments to explain why quality grading by experts is not an irrefutable measure of quality. One holds that tastes converge to a consistent quality measure as long as there are a sufficiently large number of juries, in which case, the grading would also be an 'objective' quality indicator. Quality measures that do not reach an irrefutable measure of quality do so because they do not have enough graders. In contrary, the second view states that tastes are irreducible, so grades represent a compromise between different opinions which are not representative of the actual subsets of preferences and hence their weakness. However, this does not mean that there is a conflict between the two sets of variables, sensory and objective. Objective attributes boost prices by highlighting some of the effects of sensory variables (Combris et al., 2000). Lecocq and Visser (2003) argued that the debate on how much weight should be placed on the importance of sensory versus reputation results in a 'puzzle' for pricing specialty food products.

Conversely, Schamel and Anderson (2003) emphasized the significance of sensory quality ratings from respected wine magazines for premium wines from Australia and New Zealand. The authors point to the influence of wine experts, like James Halliday, on shaping consumers' preferences. Moreover, the authors analyzed the evolution of implicit prices over the years. They found that regional reputations were increasingly significant

for Australia and not for New Zealand, indicating an intensifying regional quality differentiation, and that cool-climate regions also have an increasing positive impact on prices signifying the preference shift for wines of these origins.

This paper draws on the previous wine studies specifically to identify and construct explanatory variables for coffee prices. Specialty coffee attributes are analogous to quality wine ratings and rankings; distinctions between wine regions (e.g. Bordeaux vs. Burgundy); and wine varieties (e.g. Merlot vs. Sauvignon). We also draw on the wine hedonic studies to interpret the implicit prices of attributes and infer implications on the supply chain participants. Although the cases of wine and specialty coffee are analogous in many ways, there are some differences that need to be taken into account. The most important is that while wine studies use retail price data and information on attributes from wine reviews and consumers' guides, the data set for this paper is from cupping competitions and following auctions at the processing (roasting) level in the supply chain.

3   E-Auctions of Specialty Coffee

Beginning in 1999, the trade and promotion of specialty coffee beans have been particularly successful through e-auctions as considered by their participating buyers and sellers (United Nations, 2003). Specialty coffee e-auctions, such as the CofE, involve two parts: 1) a cupping competition in which the sensory attributes of coffees are evaluated, and 2) an e-auction in which coffees are sold to the highest bidder.

E-auctions are a one time event that takes place once or twice a year after coffee harvest in other participating countries. All events take place following a schedule that is known

in advance every season (Fig. 1). Coffee growers submit samples of their coffee lots to enter the cupping competition. The competition consists of three stages: a pre-screening stage to pre-select the best of all entries and two cupping and scoring stages where national and international jurors successively evaluate the pre-selected coffees using the CofE cupping form (Howell, 2005).

The quality rating and technical description for each coffee lot are made available to potential buyers together with information about the coffee farm and grower. In addition, samples of the coffee lots are shipped to potential buyers so they can perform the coffee tasting first-hand. The coffee lots are auctioned on-line in a one-time event. During the auction, the lot numbers are displayed on the auction website. Buyers present bids that are shown to all participants. Buyers can see their bids on the screen or can check later via e-mail how their bids compare with those of other bidders (United Nations, 2003). After the winning bid is determined, the auction manager facilitates the arrangements for payment and delivery. In the CofE, approximately 80 percent of the price accrues to the grower while the rest is for transportation and exporting and importing charges.

4   Specialty Coffee Hedonic Model

Following the hedonic approach, we propose that the price paid by buyers is a function of the information that is available to them when submitting their bids. Thus, the price of the i-th specialty coffee is a function of the value the buyer attaches to its attributes Z_{ij} ($j=1,\ldots,m$), i.e. both sensory and reputation attributes according to our hypothesis. Thus, the hedonic regression for specialty coffee has the following form:

$$f(Pi) = \beta_0 + \Sigma_j f(Z_{ij})\,\beta_{ij} + \Sigma_j f(Z_{iw})\,\beta_{iw} + \varepsilon_i$$

where $i=1,...,n$ are the observed specialty coffees, P_i is the price of the i-th coffee, Z_j are the j-th variables representing sensory attributes and Z_w are the w-th variables representing reputation attributes and ε_i is an independently distributed error term with mean 0 and variance σ^2. The functional form will be tested not imposed, hence $f(P_i)$ is either the identity function $f(P_i) \equiv P_i$ or the natural logarithm function $f(P_i) \equiv \ln P_i$. Similarly, $f(Z_{ij})$ and $f(Z_{iw})$ are the identity function, the logarithm function or a dummy variable which takes on the value 1 if the characteristic j is present for the i-th observation or 0 otherwise. We use a Box-Cox test for guidance to determine which variables need to be transformed for appropriateness of the functional form. We test for joint significance of dummy variables and then estimate the hedonic regression using ordinary least squares (OLS) robust estimation. The estimated β_j are the implicit prices for the attributes.

4.1   Data

Our data set includes 541 observations from 21 CofE e-auctions. The purchase prices for specialty coffee range from $1.20 to $49.75 with an average of approximately $4 per pound. The sensory and reputation explanatory variables are the information on the coffee lots and the production characteristics available to potential bidders from the CofE website which includes one sensory variable, 1) the quality rating in a 100 point scale; the following reputation variables: 2) quality ranking, a dummy variable indicating if the coffee came in the first, second, third, fourth or lower than forth place in the competition; 3) country of origin, a dummy variable indicating whether the coffee is from Bolivia, Brazil, Colombia, El Salvador, Honduras or Nicaragua; 4) coffee tree variety, a dummy variable indicating Bourbon, Catuai, Caturra, Pacamara, Typica or Other variety; 5)

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available quantity of coffee, the size of the coffee lot in bags; and two macro variables: 6) competition year, a dummy variable indicating 2003, 2004, 2005 and 2006; and 7) the price of commodity coffee, the monthly averages of the International Coffee Organization (ICO) for the corresponding auction month and coffee groups[i]. All these variables are exogenous and available to buyers previously to the auction bidding.

Table 1 shows the summary statistics of these variables. The quality ratings range from 80 to 96 with an average of 86.70[ii]. The reputation variables include the quality ranking, the country of origin, and the tree variety. The quality ranking is constructed by ranking the coffees from first to last according to their quality rating and it captures the relative placing of a coffee within the competition. Country of origin and variety serve to characterize the market status of coffees in terms of a relative differentiation within the specialty coffee sector much in the same way as in the wine industry, e.g. Bordeaux versus Burgundy or Merlot versus Cabernet. The size of the coffee lot is the number of bags that are sold together, indicating the total availability of a particular coffee. Year indicates to which harvest the coffee belongs. Commodity prices provide a benchmark from which to obtain a specialty premium relative to commodity coffee.

4.2   Functional Form

Since the results of the hedonic approach often depend critically on the functional form, it is advisable to base the choice on relevant statistical procedures (Halvorson and Pollakowski, 1981). Following Rodríguez (2002), we first use the Box-Cox procedure as a guidance on whether a transformation, e.g. logarithmic, is needed for our specialty

coffee hedonic model. Then, we use the best transformations suggested by results of the Box-Cox procedure to estimate the hedonic model through ordinary least squares (OLS).

We are interested in possible transformations of the dependent and the independent variables that would be most appropriate for the specialty coffee hedonic model. Specifically, we are interested in the linear, log-linear, and log-log functions. The log-linear form is largely the most used in hedonic analysis since it facilitates the interpretation of the estimated coefficients: they are the marginal prices of the attributes expressed in percentages. From the Box-Cox test results we reject the linear form and find no evidence to reject the log-linear and log-log specifications (Table 2).

In selecting among the acceptable functional forms, we follow Halvorson and Pollakowski's recommendation to resort to theoretical grounds if possible or to convenience in dealing with the problem at hand. Thus, we choose a linear function of the quality rating to interpret the coefficient as semi-elasticity (the percentage change in price due to a one-point increase in the jury quality score). Similarly, we choose to log-transform the quantity and the commodity price since the interpretation of the marginal prices for these variables is more meaningful in terms of elasticities.

4.3   Explanatory variables

We follow a Chow procedure to test the joint significance of the groups of explanatory variables: quality rankings, harvest years, countries of origin, and varieties. From the test results we find that all groups are jointly significant at the 1% level of statistical significance (Table 3). Thus, we are able to confirm that the proposed model

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specification, containing the groups of variables quality rankings, countries of origin, coffee tree varieties, and harvest year, is appropriate. Reference variables for each group are: Lower for ranking, indicating a position lower than Fourth; Brazil in for country of origin; Bourbon for tree varieties; and 2003 for harvest years.

5   Interpretation of Results

Table 4 shows the robust OLS estimation results of the specialty coffee hedonic price model and the implicit price of the significant variables[iii]. The sensory variable quality rating; the reputation variables: First, Second and Third quality ranking, El Salvador, Honduras and Nicaragua origins and quantity, and the macro variables commodity price and year 2005 are significant at 1% level. The reputation variables Fourth ranking, Colombia origin and Pacamara variety are significant at 10%.

The quality rating is highly significant indicating the importance of experts' evaluation in determining coffee prices. This is not surprising given the structure of the e-auction; the bidding is largely based on the previous evaluation in the cupping competition. In addition, the jury members are usually buyers and thus the willingness to pay expressed at the auction coincides with the preferences expressed in the quality rating. The price premium for a one point increase in the 100-point quality rating scale is 7.7%; i.e., a 5 point increase in the quality rating translates into almost 40% increase in the price. Given that quality ratings in the CofE supply chain range from 80 and 95, this represents a fairly high price differentiation range with respect to sensory quality. Whether this 7.7% impact per percentage point provides a great incentive for the producers to adopt quality

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improvement practices depends on the production effort involved in each particular case, i.e. the individual grower's cost function.

The price premium for winning the first prize in the cupping competition is 153 percent relative to the places lower than fourth. The second, third and fourth places also have a highly significant impact on prices of 45, 42 and 20 percent respectively. These implicit prices indicate that competition winning coffees are highly valuable for specialty buyers. Winning a competition is a quality signal that can be easily conveyed to consumers. Indeed, CofE roasters are using the CofE winners' logo on their coffees and educating consumers about cupping competitions and outstanding coffees. This is an extra value in addition to the value that the coffee already has from a high quality rating. Thus, the ranking in the cupping competition constitutes a crucial reputation variable. The fact that a coffee is first, second, or third among all coffees of its group has an important marketing value throughout the supply chain that roasters are eager to purchase and capitalize on. Moreover, note that these premiums are above and beyond the premium paid for just being qualified as a specialty coffee versus commodity coffee, indicating that the differentiation within specialty coffees is likely to be meaningful for consumers similar to what rankings are in wines –grand cru, premier cru and cru. The markets emphasis on relative performance in which relatively small or no differences between absolute quality result in substantial differences in incomes for the first place winners allows this market to be characterized these as a 'winner-take-all' market (Rosen, 1981; Frank and Cook, 1995).

When examining the country dummy coefficients, Bolivian specialty coffees attain the same price as the Brazilian coffee. Columbian, El Salvador, Nicaraguan and Honduran specialty coffees, however, receive prices that are 10, 15, 20, and 35 percent lower, respectively. Thus, the country of origin constitutes a reputation variable that provides valuable information to buyers.

With respect to the coffee tree varieties, Pacamara has a positive implicit price of 24 percent with respect to the reference variety Bourbon, indicating the preference of buyers for this type of tree. Although specialty buyers clearly value diversity, they might be explicitly supportive of more rare and difficult to grow varieties, as is the case of Pacamara.

The last reputation variable is quantity availability which is negatively associated with the quantity available. The quantity coefficient of -0.38 represents the price elasticity of demand and it is negative but inelastic. On one hand this is suggesting a value for exclusivity of specialty coffee consumption, i.e. the higher the availability of the coffee the less valuable it is. On the other hand, the price reduction is less than proportional indicating that sellers of the product can increase revenue by increasing quantity.

When examining the year dummies, specialty coffee prices do not appear to have changed with respect to 2003 except for 2005 when prices were 24% lower on average. We termed this a macro variable because to denote the scale of factors influencing the coffee prices in all countries in a given year. The commodity price estimate indicates that

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the specialty coffee premium is pegged to the commodity price. This means that specialty

producers are subject to the price fluctuations depending on macro supply and demand

factors affecting coffee. The coefficient of 0.58 indicates that for every one percent

increase in the commodity price we have a 0.58% increase in the specialty price.

Specialty coffee producers can expect higher prices as the commodity price goes up and

they can also expect lower premiums for quality as the commodity price increases.

6   Conclusion

Our hedonic analysis of the specialty coffee e-auction data supports our hypothesis that

prices are determined by both the coffee sensory attributes measured through cupping and

coffee reputation attributes, which include the first places in the cupping competition

winners, country of origin, and incipiently tree variety. From the results we offer four

main conclusions: the modeling of specialty coffee explicit prices, the dominance of

quality rankings, the meaning of reputation attributes as quality signals and the

implications of implicit prices of attributes on supply chain coordination.

First, the hedonic equation of specialty coffees traded at the CofE e-auctions shows that

sensory and reputation attributes combine additively to determine the overall price; high

sensory quality plus high reputation quality results in extraordinarily high coffee values.

It is the combination of all outstanding attributes that result in super-premium prices as in

the case of the Brazilian and Colombian winners in 2005.

Second, the dominance of the quality ranking as the variable with the highest economic

impact indicating that relative performance is more important than absolute performance,

as measured by the quality rating. This phenomenon is the salient feature of the 'winner-take-all' markets.

Third, reputation attributes conveys information on quality that although reliant on the sensory quality it is different from it. While the quality rating speaks to the quality of aroma, flavor and body, the quality ranking recognizes the consensus process to achieve it and of the value of the quality certification thereby attained. The reputation of the origin gives information that enhances the sensory experience by giving meaning and a foundation to build on the concept that the coffee has been grown where conditions and practices are best for growing coffee. This idea that there are unique combinations of conditions that might be difficult to reproduce is what lies behind the marketing concept of 'limited edition'.

Fourth, the implication on supply chain coordination is that while the quality rating is relatively more difficult to be interpreted by non-expert consumers, the reputation information is easily used to market specialty coffees. Thus, reputations can be used by buyers in their marketing strategies as identifiable quality signals to consumers. The communication of these attributes to the final consumer through marketing strategies creates an appreciation of the role of coffee growers in determining the final product quality. In turn, implicit prices inform producers about the product characteristics that are most attractive to consumers, thus providing the producers with a feedback signal of the demand. This top quality e-auction specialty coffee market contrasts with the commodity in which the evaluation system is based on characteristics of the bean and not the cup.

Hence specialty coffee markets provide individual incentives to produce higher quality coffee. Producers can use this information to match their production environment and methods to the most appropriate specialty market segment. Overall, this two-way information flow through implicit prices enhances the integration of production methods into the specialty coffee supply chain and sustainability of the industry.

Finally, we expect new results from hedonic analysis of specialty coffee prices as the industry evolves and more data becomes available. New specialty coffee regions may become important as production programs result in successful specialty coffee production or as the micro-climates change as the global weather changes. Varieties may also become more desired as roasters and consumers develop coffee connoisseurship. Specialty coffees might be or become preferred by characteristics that we have not included in this study (aroma, flavor, acidity and body alone). In particular, from this study it remains to be analyzed whether altitude and the weather during the coffee growing season are significant quality signals as is the case for wines. The impact on prices of certifications and coffee processing at the grower level also remains to be tested.

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                    ┌─────────────────────────────────────────────┐
                    │            SAMPLES SUBMISSION                 │
                    │  - Growers' participation is free             │
                    │  - Minimum size of 15 bags per lot            │
                    │  - Preparation of samples for cupping competition │
                    └─────────────────────────────────────────────┘
30 days                              │
                                     ▼
                    ┌─────────────────────────────────────────────┐
                    │               PRE-SCREENING                   │
                    │  - Jurors select 150 coffees through visual inspection and cup │
                    │  attributes appraisal                         │
                    │  - Selected farmers move their lot to a warehouse │
                    │  - Auditing firm samples each lot and prepares samples for cupping │
                    └─────────────────────────────────────────────┘
                                     │
                                     ▼
                    ┌─────────────────────────────────────────────┐
                    │               NATIONAL JURY                   │
2-3 days            │  - Host country cupper                        │
                    │  - First round of cupping: select 80 coffees  │
                    │  - Second round: select around 60 coffees scoring 80 and above │
                    └─────────────────────────────────────────────┘
                                     │
                                     ▼
                    ┌─────────────────────────────────────────────┐
                    │             INTERNATIONAL JURY                │
                    │  - Day 1: jury calibrates coffees to a score of 80 points │
                    │  - Days 2 and 3: jurors cup all coffees coming from the national stage in a │
5 days              │  first round of cupping                       │
                    │  - Day 4: second round with top 45 coffees    │
                    │  - Day 5: the top ten scoring coffees are cupped one more time to rank │
                    │  them and establish the winner of the competition │
                    └─────────────────────────────────────────────┘
                                     │
                                     ▼
                    ┌─────────────────────────────────────────────┐
                    │                PRE-AUCTION                    │
                    │  - Bidders registration for getting samples and participating at the │
                    │  auction: auction fee                         │
                    │  - Exporters send sample to registered bidders │
                    │  - Award winners' ceremony                    │
                    └─────────────────────────────────────────────┘
                                     │
                                     ▼
                    ┌─────────────────────────────────────────────┐
                    │                  AUCTION                      │
1 day               │  - Buyers bids on-line                        │
                    │  - Winning bidder and price                   │
                    │  defined                                      │
                    └─────────────────────────────────────────────┘
                                     │
                                     ▼
                    ┌─────────────────────────────────────────────┐
                    │               POST-AUCTION                    │
                    │  - Buyer sends shipping instruction           │
                    │  - Exporter invoices and collects             │
                    │  - Exporter pays producer                     │
                    │  - Exporter pays organizer cost recovery      │
                    └─────────────────────────────────────────────┘
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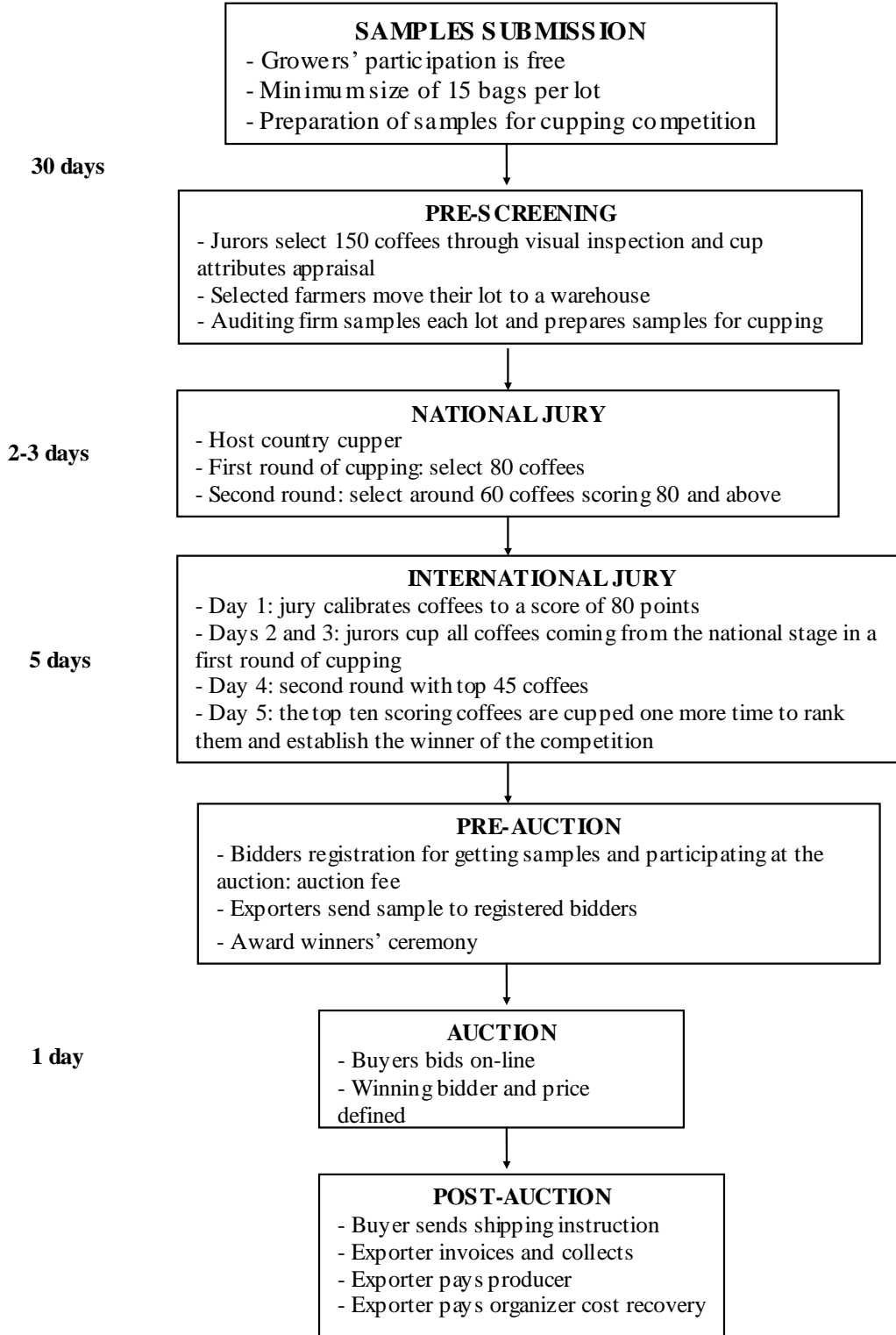
Fig. 1: CofE Auction Schedule. Source: own elaboration.

Table 1: Descriptive Statistics of the Specialty Coffee Data Set from the CofE E-

Auctions: N=541

Variable		Mean/Frequency	Std. Dev.	Min	Max
Dependent Variable					
Price	$/lb	3.97	3.15	1.2	49.8
Sensory Attribute					
Quality Rating	score	86.70	2.80	80.3	95.9
Reputation Attributes					
Quality Rankings					
	First	0.04	0.18	0	1
	Second	0.04	0.18	0	1
	Third	0.04	0.18	0	1
	Fourth	0.04	0.18	0	1
	Lower	0.86	0.35	0	1
Countries					
	Bolivia	0.06	0.24	0	1
	Brazil	0.19	0.40	0	1
	Colombia	0.15	0.36	0	1
	El Salvador	0.20	0.40	0	1
	Honduras	0.17	0.38	0	1
	Nicaragua	0.23	0.42	0	1
Varieties					
	Bourbon	0.25	0.43	0	1
	Catuai	0.19	0.39	0	1
	Caturra	0.38	0.49	0	1
	Typica	0.08	0.27	0	1
	Pacamara	0.06	0.23	0	1
Quantity	Bags	21.25	10.98	9.0	122
Commodity Price	$/lb	0.94	0.24	0.6	1.4
Harvest Years					
	2003	0.21	0.40	0	1
	2004	0.23	0.42	0	1
	2005	0.37	0.48	0	1
	2006	0.19	0.39	0	1

Table 2: Box-Cox Test of Functional Form for the Specialty Coffee Hedonic Price Model

Box-Cox test[1]	Functional form	
Variables to apply functional form	**Identity**[2]	**Log**[3]
Left Hand Side Only	707.83 (0.000)	1.08 (0.298)
Both Left and Right Hand Side (same coefficient)		
Quality rating	707.52 (0.000)	1.15 (0.284)
Commodity price	703.31 (0.000)	0.98 (0.322)
Lot size	735.41 (0.000)	1.85 (0.174)
Commodity price and lot size	731.03 (0.000)	1.79 (0.181)

[1] X^2 test statistic of the lambda coefficient in the functions $f(P)=P^\lambda$ and $f(Z)=Z^\lambda$

p-values in parentheses

[2] Ho: lambda = 1, or no transformation

[3] Ho: lambda = 0, or log transformation

N=541

Table 3: Chow Test of Differences between Linear Specialty Coffee Hedonic Price

Models

Group of variables tested	R-squared	Chow test[1]
Unrestricted model	0.66	
Restricted models		
	0.59	26.76
Quality rankings		(0.000)
	0.63	15.29
Years		(0.000)
	0.60	18.35
Countries		(0.000)
	0.65	3.06
Varieties		(0.001)

[1]F test statistic

p-values in parentheses

N=541

Table 4: Specialty Coffee Hedonic Model Estimates and Implicit Prices of Attributes

Dependent Variable: log (Price)

			Coefficient	S.E.	Significance	Implicit price (%)
Sensory	Quality rating (%)		0.077	(0009)	***	7.7
Reputation	Quality rankings[1]					
		First	0.877	(0.104)	***	153.2
		Second	0.318	(0.104)	***	44.8
		Third	0.312	(0.078)	***	42.0
		Fourth	0.139	(0.076)	*	19.4
	Country of origin[2]					
		Bolivia	-0.148	(0.096)		
		Colombia	-0.145	(0.079)	*	-10.0
		El Salvador	-0.191	(0.055)	***	-15.1
		Honduras	-0.448	(0.056)	***	-34.3
		Nicaragua	-0.262	(0.063)	***	-20.6
	Tree variety[3]					
		Catuai	-0.056	-0.054		
		Caturra	0.049	-0.069		
		Typica	-0.002	-0.075		
		Pacamara	0.158	(0.095)	*	22.8
		Other	0.002			
	Log Quantity (%)		-0.375	(0.039)	***	-0.375
Macro	Year[4]					
		2004	-0.084	(0.066)		
		2005	-0.326	(0.107)	***	-23.9
		2006	-0.046	(0.093)		
	Log Commodity price (%)		0.589	(0.153)	***	0.589
	Constant		-3.982	(0.741)	***	
		Observations	541			
		R-squared	0.67			

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

1 Dummy variables indicating if ranking 1, 2, 3 or 4, respectively. Base group is rank between 5 and 43.

2 Dummy variable indicating country of coffee origin. Base group is Brazil.

3 Dummy variable indicating coffee tree variety. Base group is Bourbon.

4 Dummy variable indicating auction year. Base group is 2003.

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[i] Brazilian Natural Arabicas for Brazil, Colombian Mild Arabicas for Colombia, and Other Mild Arabicas for Bolivia, El Salvador, Honduras and Nicaragua.

[ii] Note that since potential bidders obtain samples of the available coffees and do their own cupping, their cupping may not necessarily rank the coffees in the same way the CofE cuppers do. It is likely that their bidding and pricing behavior is therefore reflecting the buyers own evaluation of the coffees (Oberthur, 2006) in which case the score and raking of the CofE would serve as a proxy for the buyers own assessment of the coffees.

[iii] In the log-linear function, the coefficient of continuous variables, multiplied by 100, can be correctly interpreted as the percentage variation of the dependent variable in relation to a unitary change in the variable in question. Correspondingly, the percentage impact of the dummy variables can be calculated as: $\exp(\beta_j - 0.5 \text{ s.e. } \beta_j) - 1$, multiplied by 100, being s.e. the standard error of the coefficient β_j. We use the F test to test for joint significance of dummy variables' groups.