INTERNATIONAL CONFERENCE OF AGRICULTURAL ECONOMISTS
ICAE
29th | Milan Italy 2015
UNIVERSITÀ DEGLI STUDI DI MILANO AUGUST 8 - 14
AGRICULTURE IN AN INTERCONNECTED WORLD

When Higher Quality Does Not Translate to Higher Prices: A Case of Quality and Specialty Coffees from the Cup of Excellence Auctions

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Abstract.

The literature on coffee quantity and price suggests that higher quality coffees earn higher prices in auction markets. However, in the Cup of Excellence (CoE) auctions, the rank of coffees, which is based on quality, yields a higher premium over the quality score alone. Unnoticed in the previous papers, I find that quality for certain ranked coffees does not have a statistically significant effect on the price. Some buyers are selecting lower quality coffees and paying higher prices for these coffees because the coffee is ranked higher than lower ranked but higher quality coffees. The estimates suggest that behavioral economics, namely, the representativeness and the framing heuristics, may explain the price premium for higher ranked coffees. The analysis suggests that bidders are concerned not only with the quality of the coffee that they purchase; they are also considering the qualities of the other coffees in the immediate market.

Keywords: Coffee, Quality, Cup of Excellence, Hedonic Model, Auctions, Truncated Regression, Behavioral Economics

JEL codes: C5, D3, Q13

When Higher Quality Does Not Translate to Higher Prices: A Case of Quality and Specialty Coffees from the Cup of Excellence Auctions

1 Introduction[1]

The literature on coffee quantity and price suggests that higher quality coffees earn higher prices in auction markets. However, in the Cup of Excellence (CoE) auctions, the rank of coffees, which is based on quality, yields a higher premium over the quality score alone (Donnet, Weatherspoon, & Hoehn, 2008; Teuber & Herrmann, 2012; Wilson & Wilson, 2014). Unnoticed in the previous papers, I find that quality for certain ranked coffees does not have a statistically significant effect on the price. More fundamentally, some buyers in the CoE auctions show an inversion of preferences as they pay higher prices for lower quality coffees, across markets. The reversals may be explained by behavioral economics. For example a coffee that garners the first place rank in one market, despite being evaluated as a lower quality coffee compared to lower ranked, higher quality coffees in other markets receives a higher price. Thus, rank appears to dominate the pricing decision of buyers. Another contributing factor to the inversion is the market context. Buyers have differential conceptions of quality for different ranks, which is translated into the price. This result suggests that quality is contextual; that is, quality has to be considered in the context of the quality of the other products in the market (Mullainathan and Shafir, 2013). I find evidence that "thickness" of the market, the number of coffees in the auction, influences the price, and this effect is different by rank. I assert that buyers use rules of thumb or behavioral heuristics to make price decisions. While these heuristics typically generate favorable outcomes, they also generate systematic errors recognized in behavioral economics. In this paper, I explain how preference inversions in coffee auctions are explained by behavioral economics.

2 Background

The Cup of Excellence (CoE) programs provide a series of nationally-based competitions that encourage coffee growers to test their best coffees against other growers in their country. In order to compete, growers have to provide lots to the Association for Coffee Excellence (ACE)

[1] Earlier versions of this paper were presented at Agricultural and Applied Economics Association Meetings in 2014, Cornell University, and University of Georgia. However, the model has been revised substantially from the previous versions.

for "cuppings" by national and international juries. The juries involved in the CoE cuppings are composed of highly trained professionals. Cupping is a process of roasting, grinding brewing and tasting coffees in accordance with a specific set parameters and criteria to support a consistent assessment.

To participate in the CoE, growers submit lots of coffees for consideration. The lots are sampled and go through three rounds of cuppings. If no defects are found in any of the rounds and the sample achieves in the last round of cupping an average quality score of 84 out of 100, the grower receives the Cup of Excellence Award. Her lot is then eligible to participate in the CoE auction (Spindler, 2012, Wilson and Wilson, 2014) [2].

The auctions are eBay-style with ascending bids. Bidders in the auction are roasters and importers from well-established specialty coffee companies mostly from Europe, Japan, North America and Nordic countries. Bidder information is hidden during the auctions. ACE provides bidders information of each lot including farm/cooperative name, growing altitude, processing methods, average quality score, cupping notes, and rank (Donnet et al., 2008). Potential buying firms may purchase small samples to cup before bidding.[3]

For producers participating in the CoE programs, the risk of participation is low with the potential of high returns. If the submitted lot does not survive the rigorous cupping, the grower retains the lot and can sell it through other marketing channels. For lots that participate in the auction, producers can earn prices that on average are 4.5 times higher than the International Coffee Organization (ICO) composite price. Additionally, ACE is a non-profit organization, which is supported by the membership who includes roasters and importers. Thus the larger share of the price attained in the auction is given directly to the producers (cf. Talbot, 1997; Wilson & Wilson, 2014).

3 Previous Analysis of the CoE Auction

Donnet, et al. (2008), Teuber and Herrmann (2012), and Wilson and Wilson (2014) estimate hedonic models of the Cup of Excellence coffee auctions and find evidence that the rank had a higher implicit price or marginal effect on price than the quality score. Donnet, et al. (2008)

[2] 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. Over time the minimum score has increased. For the data used in this analysis the minimum score was 84.

[3] As noted by a former buyer, buying firms may evaluate the coffees with a different scoring method from the Specialty Coffee Association of America (SCAA), which tends to score coffees lower than the CoE scoring method.

argues “This indicates that specialty coffee rankings have an important marketing value throughout the supply chain and that roasters are eager to purchase and capitalize on the quality competitions in general and on the first, second, third, and even fourth places in particular.” (p. 273-274). Teuber and Herrmann (2012) acknowledge the importance of rank and show that rank has an implicit price that is 100 times larger than the implicit price associated with quality. Finally, Wilson and Wilson (2014) note that “relative score, particularly being number one, is more important than having a high quality score in absolute terms.” While these authors recognize this interesting result of rank dominating quality score, none of them explore the underlying issue. The purpose of this paper is to investigate further this surprising result. This paper provides no evidence of the marketing argument of Donnet et al. (2008). However, the paper provides a behavioral interpretation of the results. That is, econometric evidence suggests that buyers are using heuristics of representativeness and framing to make purchasing decisions.

4 Inversion of Preferences

To establish the observed inversion of preferences, let us consider the evolution of price and quality over time. Given the rigor and standardized method of assessing the quality of coffee, the coffee score could be a method to predict coffee prices. Higher coffee scores should lead to higher coffee prices, regardless of time and country. Consider Brazil in 2010. The coffees by rank and prices correspond as expected, though the gap in price between first and second place coffees is substantial. In the same year, the price of the first place coffee is nearly double that of the second place coffee. In all of these examples the rank and price have the expected correlation. However, the first place Brazilian coffee score was 93.91 and earned a price of $25.05 in 2011 USD. The number one Colombian coffee scored slightly higher at 94.92 and received $41.40, a $25.59 premium. However, the top ranked El Salvadorian coffee had a score of 91.05, which is lower than the Brazilian coffee, but the El Salvadorian coffee received a price of $29.41, a price premium of $4.36. Although the auctions are held at different times of the year, conceivably a buyer could purchase both the top Brazilian and the top El Salvadorian coffees. If so, the purchasing pattern reflects an inversion of preferences. This violation of transitivity suggests that bidders are making an error which behavioral economics may explain. According to Suzy Spindler, former Executive Director and founder, of the Alliance for Coffee Excellence, no reversal has taken place. She argues that, in reality, Brazilian coffee with a score of 93 is not the same as a Columbian coffee with a 93. Therefore the evaluation of the coffee score is predicated on the country of origin (cf. Teuber & Herrmann, 2012). This contextualization appears incongruous with the standardized, internationally determined quality score based on the sensory aspects of the coffee. Furthermore, Wilson and Wilson (2014), among others, find empirically this result even controlling for country of origin and varietals.

The intransitivity can be seen over time for the same market. Consider the case of El Salvador. The quality score for first place coffees declined over time: 92.67 in 2008, 91.68 in 2009 and 91.05 in 2010; however, the coffee prices in 2011 dollars for those years were $19.33, $24.63 and 29.41. The intransitivity continues for the second and third place coffees, and inversions are also inconsistent with inflationary pressures or a general trend in coffee prices. Again, this result suggests an inversion of preferences: that is, buyers are paying more for lower quality coffees of higher rank than higher quality coffees of lower rank across markets.

These results call into question the effect of quality on price. As the previous papers provide evidence that quality affects price in aggregate, none of the papers ask is the effect the same for each rank. Does the positive relationship between quality and price hold for each of the ranks? A break down in this relationship by rank may provide some explanation of the reversals. Figure 1 suggests that a surprising breakdown in the price and quality relationship. For first place coffees, a positive relationship appears between quality score and price. However the relationship is weakened in the second and fourth place coffees. More telling, the relationship is negative, though not statistically significant, in the third place coffees.

4.1 Heuristics

One explanation of the inversion is that of representativeness (Kahneman, 2011; Kahneman & Tversky, 1984). An example of representativeness is that agents focus on certain features that look like something in particular and assume that those features represent the true thing. The classic example is the Tom W. problem where respondents are asked to rank the possible major of a graduate student who is intelligent, though not creative, orderly, unsympathetic, interested in science fiction, etc. Given those features, many respondents rank computer science as the most likely field of Tom W. However, this field is generally smaller than the humanities, education, social science, etc. (Kahneman, 2011).[4]

[4] I thank one reviewer who suggested the “Linda” problem as another example for representativeness.

In the coffee example, I assert that buyers focus on the rank particularly first, second and third place, what I call the "Olympic heuristic" and that quality is only secondary information. And like the Olympic medal stand, gold medal winners (first place coffees) stand higher (receive the higher price) than the others regardless of the difference in the score. The gold medal goes to the swimmer who touches the wall 0.01 or 10 seconds faster. Similarly, the first place rank goes to the lot that achieves the highest quality score. As a result these first place coffees receive a substantial price premium over the other coffees in the market. The representative heuristic suggests that rank could drive the price not the quality score. However, once rank is acknowledged by the buyer she uses the quality score to make the final price. In other words, the effect of rank on price is moderated by the quality score.

Furthermore, a framing heuristic may influence the actions of the buyers in the market. In the data, evidence point to the idea that the context of the market matters. For example, coffees of a similar rank and quality score, holding other factors constant, have different prices depending on the overall quality of the market. That is a Brazilian 92 in a market where the average quality score is 88 gets a different price than a similar coffee with the average score for the market is 86. In particular, the modeling indicates differential effects of the squared mean deviation of the quality score based on rank. A similar contextual issue is the number of coffees in the auction. Previous research has not taken into consideration features of the auctions such as number of bids and non-winning bids, common in the literature on auctions. However, these data are not available. In this data set, I am able to determine the number of coffees in the auction, which influences the competitiveness of the market.

5 The Hedonic Method

An extensive literature uses the hedonic price model to explain a wide variety of markets as begun by Rosen (1974). Applications include housing (Hite & et al., 2001; Smith & Huang, 1995), wages (Hwang, Mortensen, & Reed, 1998), and agricultural commodities (Bowman & Ethridge, 1992; Buccola & Iizuka, 1997; Chang, Lusk, & Norwood, 2010). The basic structure of the hedonic model suggests that qualities of a product influence the price. Drawing explicitly from (Bishop & Timmins, 2011) based on (Epple, 1987), the quadratic hedonic price function is

$$(1.1)\quad P(Z_i;\beta_i) = \beta_o + \beta_1 Z_i + \frac{\beta_2}{2} Z_i^2 + \epsilon_i,$$

where $i = 1, \ldots, N$ indexes coffees, $P(Z_i; \beta_i)$ is the price of coffee i, and $Z_i$measures the level of the coffee attributes. The implicit or *hedonic* price is defined as

$$(1.2) \quad P'(Z_i; \beta_i) \equiv \frac{\partial P}{\partial Z_i} = \beta_1 + \beta_2 Z_i.$$

Within this framework, one can isolate the effects of specific characteristics or features of a product on its price. For the current model, the hedonic model permits an investigation of the coffee quality, rank, lot size, and other features that influence the price (Wilson & Wilson, 2014).

6 Data

The data come from the Association for Coffee Excellence. The data set includes information on the final price of each auction for each coffee, excluding shipping costs, average quality score, farm data (including growing conditions, processing methods, name of grower, etc.), and buyer data. The data are from auctions in Brazil, Bolivia, Colombia, Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua from 2004 to 2010. All prices are in 2011 prices based on the Producer Price Index. The summary statistics are of the core data are in Table 1. Similar data are used in Donnet et al. (2008), Teuber and Herrmann (2012), and Wilson and Wilson (2014).

7 Model

Figure 1 suggests a breakdown in the relationship between quality score and price for the coffees by rank. The graphs are limited so a basic OLS regression of the hedonic model is run by rank to see the effect of quality controlling for country of origin, year, and lot size (number of bags sold). The simple hedonic model is as follows:

$$(1) \quad \ln(P_i) = \beta_0 + \beta_1 Quality_i + \sum_j \beta_j Reputation_{ij} + \sum_k \beta_k Correction_{ik} + \varepsilon_i$$

where $Quality_i$is the quality score. I scale the quality score to range 1-17 rather than 84-100 to aid efficient estimation. $Reputation_{ij}$ includes lot size and country of origin. $Correction_{ik}$ includes dummies for years 2005-2010. These variables reflect the key determinants of coffee prices. This model is parsimonious to permit estimation of the relatively small sample sizes of up to 42 observations. The estimates are available upon request.

The results confirm the graphs: Only first and fourth place coffees have a statistically significant coefficient of quality score on the price. The marginal increase in price for a one unit increase in the quality score is 8.9% for first place and 11% for fourth place coffees. These results are similar to those of Donnet et al. (2008) (7.7%) and Teuber and Herrmann (2012) (6.9%).

The control variable for lot size, which is suggestive of quantity supplied, (Teuber & Herrmann, 2012) is statistically significant and negative. As the lot size is in natural logs, the estimates are similar to price flexibilities. The price flexibilities are -0.67 (first place), -0.58 (second place), and -0.41 (fourth place). Therefore, the price elasticity are at least -1.49 (first place), -1.72 (second place) and -2.44 (fourth place) (Tomek & Robinson, 2003; Wilson & Wilson, 2014). Interestingly, these results suggest that the coffees become more elastic with rank, which is suggestive of greater substitutability of lower ranked coffees.

The control variables for the year are mostly statistically significant, positive and progressively larger. Despite the global recession, the deflated coffee price increased over time. The effects of time are strongest for first place coffees. For example, the marginal effect[5] increases from 41.62% (in 2007), to 176.82% (2009) and to 247.48% (2010) for first place coffees. The marginal benefit of each year is more gradual for second and fourth place coffees. This result suggests that some of the increase in price over time despite quality score is due to inflationary pressures within markets. These results are similar to the findings in previously published work that suggests a greater appreciation and understanding of the CofE award and auction (Donnet et al., 2008; Teuber & Herrmann, 2012; Wilson & Wilson, 2014). However, since the time dummies are not significant for all ranks for each year, all of the price changes leading to the preference inversions cannot be ascribed to inflationary pressures. In sum, the simple models suggest that quality and price are not strongly related for some coffees (namely, second and third place coffees), though some years and the number of bags have a significant effect on price by rank.

One possible explanation for breakdown in the statistical relationship of quality and price could be limited variation in the quality score by rank. First place coffees have the highest mean and the widest spread in quality scores. For each subsequent rank, the mean and the spread of quality scores fall. Since the fourth place coffees have the lowest spread in the quality score, but they also have a statistically significant effect on price. Therefore, the breakdown in the statistical relationship may not be from low variation in the quality score. These results suggest a

[5] Since the dependent variable is logged, the percentage impact of dummy variable i is calculated as $e^{\beta_i - 0.5*var(\beta_i)} - 1$, multiplied by 100% (Kennedy, 1981)

more complex relationship of quality to price than the previous literature has recognized. These preliminary findings suggest that the quality score and price reversal are possible if the quality score has a limited or no effect on the price of coffee for certain quality coffees or if the quality score has to be analyzed in light of the rank.

7.1 *Replication of Wilson and Wilson (2014)*

In the earlier models, I assessed quality and controled for country of origin, year and lot size. However, this model fails to assess the complexity of the price determinants. Following Wilson and Wilson (2014), I estimate a model that is based on Donnet et al. (2008) and influenced by Teuber and Herrmann (2012):

$$\ln(P_i) = \beta_0 + \beta_1 Quality_i + \beta_2 Quality_i^2 + \sum_j \beta_j Reputation_{ij} + \sum_k \beta_k Correction_{ik} + \sum_m \beta_m Buyer\ Location_{im} + \varepsilon_i \quad (2)$$

where the $Reputation_{ij}$ now also includes altitude, growing area, rank, varietal and dummy variables for Organic and Rainforest Alliance certifications. $Buyer\ Location_{im}$ represents dummy variables reflecting the location (or type) of the buyer (Asia, North America, Europe, Nordic countries, other markets and buyer cooperatives). The $Correction_{ik}$ variables include the country of origin and time fixed effects. Unlike Wilson and Wilson (2014), I include a better presentation of the participating markets. Colombia in the early years had two auctions in two years. I include the fixed effect of each unique auction. I also include the number of coffees in the auction.

The results of the Base Model (see Table 1) are similar to Wilson and Wilson (2014). As found in Wilson and Wilson (2014), I estimate the model as a truncated maximum likelihood model because the Cup of Excellence only permits coffees that attain a score of 84 or higher to participate in the auction. Thus, the truncation effectively puts a floor on the price because the quality score is truncated from below. A Wald rejects the null hypothesis that the variables are jointly equal to zero. Wilson and Wilson (2014) initially added the quadratic term to allow the quality score to have diminishing returns; however, the quadratic term, given the relevant range of the score, indicates that the price rises as the quality score rises, but reaches a maximum and then falls. This result is surprising and suggests that a different functional form may be more appropriate.

Most of the reputation variables are statistically significant and are consistent with the idea that improvements in these variables, such as higher altitudes and higher rank will increase the price. As indicated earlier, the rank has a substantial effect on the price relative to the quality. The estimated coefficient for first place coffees is 0.8679 (the marginal effect or implicit price is 107.995%), while the estimated coefficient for second place is less than half this value at 0.3239 (marginal effect is 22.018%). As Wilson and Wilson (2014) note and as seen Table 1 the difference in quality score of first to second place coffees is on average 1.9 points, but the marginal effect can be five times greater. The strength of this result is suggestive of the representativeness hypothesis. Additional testing will further support this hypothesis.

Similar to Teuber and Herrmann (2012), the log of the number of bags (the lot size) is negative suggesting that smaller lots earn a higher price. Stated differently a smaller supply raises the price. Following the assumption that the lot size represents the supply, the price flexibility is -0.54. Therefore the price elasticity is at least -1.85 (Tomek & Robinson, 2003; Wilson & Wilson, 2014). The country of origin dummy variables are all statistically significant and negative suggesting that relative to Brazil, the reference country, coffees from these other sources have lower prices. Unlike wine, varieties such as Catuaí, Caturra or Pacamara do have not a statistically different effect on price, but mixed varieties have a lower price while other varieties, unique varieties, have a statistically higher price. The time dummies indicated that the deflated coffee price rises throughout the study period. Finally, the buyer dummy variables indicate buyers of Asian and other markets pay lower prices than the coffees bought by North American buyers. Nordic buyers, however, pay a higher price than North American buyers.

7.2 *A Cubic Quality Score*

In the previous section I build on the model from Wilson and Wilson (2014). To advance the analysis, I consider the effects of adding a cubic term and squared mean deviation of quality. The cubic term potentially may rectify the unexpected result of the maximum quality score. I hypothesized that the relevant range of the quality score given the cubic specification will be increasing at a decreasing rate, consistent with an assumption of diminishing marginal returns for increased quality. Therefore, the marginal benefit of an additional unit of quality, over the relevant range, will be positive and decreasing, not inclusive of the increasing range of the U-shaped marginal curve (excluding local minima or saddle points).

The cubic terms are statistically significant and the reputation, certification and control variables are similar to the previous model (see Table 2, Model 1). The rest of the estimates are similar to the cubic model, and the cubic specification has a lower AIC than the quadratic specification. The cubic term provides a marginal effect that is positive over the relevant range of the quality score, which is more consistent with expectations as compared to the quadratic model[6]. For example the marginal effect an additional unit of quality around the mean score of 87 (or 4 given the rescaling) is 14.22% which is similar to the marginal effect for the quadratic model (14.52%). In the quadratic model, we observe a "maximum quality score". A surprising result is that the effect of a one unit increase in the score and the price begins to fall after a quality score of 94.3, which would suggest a global maximum quality score. However the cubic quality score over the relevant range does not have an optimum, though prices around the quality score of 91.1 the marginal effect begin to rise. Over the relevant range, no local minimum exists as the marginal value is never zero. Therefore, mid-range quality scores generate a smaller marginal benefit than lower and higher quality scores. To illustrate this point, figure 2 shows the predicted price (in logs) for the adjusted quality score. The vertical, dashed line represents the beginning relevant adjusted quality score while the vertical, solid line represents the end of the relevant adjusted quality score. Overall we, see that first placed coffees by quality score receive a higher price. This result is statistically different over rank for a *p*-value less than 0.05.

7.3 Number of Coffees

As this is an auction, features of the auction may have an influence on the realized prices. For this data set as in the previous papers, I have access to only one auction variable, the number of coffees sold in the market. I hypothesize that the number of coffees present in the auction will have a negative effect on the price of coffee. The CoE auction is timed, and all coffees in a market are offered simultaneously. Thus, additional coffees add to the cognitive load of the bidders. Model 2a augments the cubic model with the number of coffees. The result shows that more coffees in the auction generate lower prices.

Furthermore, additional coffees will encourage bidders to focus (or tunnel as suggested by Mullainathan and Shafir (2013)) on a few coffees, namely the top ranked coffees. Thus, I hypothesize that by rank additional coffees will increase the price of higher ranked coffees but

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[6] The derivative of the $\ln(P_i)$ with respect to quality without buyer country specification is $\frac{\partial \ln(P_i)}{\partial Quality_i} * \frac{1}{P_i} = \beta_1 + 2 * \beta_2 * Quality_{ijt} + 3 * \beta_3 (Quality_{ijt})^2$.

lower the price of lower ranked coffees. To identify this relationship, I include the quadratic of the number of coffees in the auction interacted with the rank. The results show that as the number of coffees increases, first place coffee prices increase. However, the same does not hold for the lower ranked coffees (see Figure 3). This result begins to explain the price-quality inversions discussed earlier.

7.4 *Quality Score Squared Mean Deviation (SMD)*

In a second refiguring of the original model, I include the squared mean deviation of quality.

3) $$\ln(P_i) = \beta_0 + \beta_1 Quality_i + \beta_2 Quality_i^2 + \beta_3 Quality_i^3 + \beta_4 SMD_i + \sum_j \beta_j Reputation_{ij} + \sum_k \beta_k Correction_{ik} + \sum_m \beta_m Buyer\ Location_{im} + \varepsilon_i$$

The inclusion of the squared mean deviation (SMD) will allow buyers to adjust the purchase price based on a measure of the spread of quality in the market. This new variable is the quality score of each coffee less the mean of quality for that particular market in a specific year (i.e. $SMD_{ijt} = \left(Quality_{ijt} - \overline{Quality}_{jt}\right)^2$) for the i^{th} coffee sold in the j^{th} market in the t^{th} year. I hypothesize that a larger spread, e.g. larger SMD, will lead to higher coffee prices $\beta_4 > 0$, for those coffees where $Quality_{ijt} > \overline{Quality}_{jt}$, otherwise the effect is negative. The larger spread is suggestive of greater diffusion of coffee scores available in the market. Therefore, bidders will tend to bid up the price of high quality coffees to avoid the lower quality coffees. This mechanism is based on marginal effect of quality on price. The marginal effect of quality on price in a model with the SMD is

4) $$\frac{\partial \ln(P_{ijt})}{\partial Quality_{ijt}} * \frac{1}{P_{ijt}} = \beta_1 + 2 * \beta_2 * Quality_{ijt} + 3 * \beta_2 \left(Quality_{ijt}\right)^2 + 2\beta_3\left(Quality_{ijt} - \overline{Quality}_{jt}\right)$$

For coffees with a quality score above the mean quality, an additional unit of quality with a $\beta_3 > 0$ will add to the marginal effect assuming a positive marginal effect of the base cubic specification $\left(\text{i.e. } \beta_1 + 2 * \beta_2 * Quality_{ijt} + 3 * \beta_2 \left(Quality_{ijt}\right)^2 > 0\right)$. On the other hand, increases in quality for coffees below the mean quality score of the market will lead to a smaller marginal effect. Again assuming similar estimates of the base cubic specification, the marginal effect will remain positive, $\left(\text{e.g. } \left|\beta_1 + 2 * \beta_2 * Quality_{ijt} + 3 * \beta_2\left(Quality_{ijt}\right)^2\right| > \left|2\beta_3\left(Quality_{ijt} - \overline{Quality}_{jt}\right)\right|\right)$, but if $Quality_{ijt} < \overline{Quality}_{jt}$ the increase in quality generates a smaller benefit for an additional unit of coffee quality as compared to higher quality coffees (Those coffees with quality above the mean quality score).

As seen in Table 3, Model 4a and 4b, the squared mean deviation of quality for each market is statistically significant and positive. In this framework, I show that as the SQM increases and in the price of coffees increase. However the interactive term suggests that this effect is different by rank, namely a negative result for third place coffees, with larger effects of SQM on the first and fourth place coffees relative to second and fifth place coffees.

7.4.1 Representativeness

Based on the cubic model, we can begin to consider the heuristic of representativeness. The core agreement of representativeness is that bidders are using the information of rank to influence their bids so that prices are not always consistent with standardized quality. Therefore, a necessary condition for representativeness is the coefficient on rank is positive. In that case, a sufficient condition for representativeness is that rank is the only statistically significant reputational or quality variable. However, if the rank and the quality are both statistically significant then, representativeness holds if the marginal effect of rank is larger than the marginal effect of quality. The models presented in this paper and in previous work have provided evidence of the sufficient condition holding.

However, this conceptualization of representativeness assumes that no interactions between rank and quality occur. If the interactions of rank and quality on price are independent—that is the interactions are not statistically significant—then representativeness may still hold if the marginal effect of rank remains larger than that of quality. However, if the rank and quality interactions are statistically significant and positive, even for one rank, suggesting that higher quality leads to higher prices by rank, then representativeness is rejected. On the other hand negative interactions of quality and rank suggest that higher quality coffees by rank generate lower prices, which supports the representativeness hypothesis.

To test for representativeness, I estimate the following model:

$$\ln(P_i) = \beta_0 + \beta_1 Quality_i + \beta_2 Quality_i^2 + \beta_3 Quality_i^3 +$$

5)

$$\sum_{k=4}^{7} \beta_k Rank_{i,k-3} + \sum_{k=8}^{19} \beta_k Rank_{i,k-7} * (Quality_i + Quality_i^2 + Quality_i^3)$$
$$+ \sum_j \beta_j Reputation_{ij} + \sum_k \beta_k Correction_{ik}$$
$$+ \sum_m \beta_m Buyer\ Location_{im} + \varepsilon_i$$

In this specification, the ranks, which were incorporated into $Reputation_{ij}$ in Model 2, are presented separately and interacted with the quality score. If representativeness holds then, the interactions will have no or a negative effect on price($\beta_i \leq 0\ \forall\ i = 8,9,10, \dots ,19$), assuming a larger marginal effect of rank over quality$\left(\frac{\partial \ln(P_{ijt})}{\partial Rank_{i,k-3}} * \frac{1}{P_{ijt}} > \frac{\partial \ln(P_{ijt})}{\partial Quality_{ijt}} * \frac{1}{P_{ijt}}\right)$. However for negative interactions, a lower quality score, but a higher rank, will lead to higher prices than higher quality and a lower rank. For the sake of brevity, I have omitted these results, which are available upon request. The results indicate that the interactions are statistically significant, at least for second place coffees. However, the predicted margins show that quality score has a differential effect on the price by rank, furthering the argument for representativeness.

7.4.2 Framing

The representativeness argument has statistical support, but another heuristic may influence the behavior of bidders in the CoE auctions, that is framing. I present framing as the contextual aspects of the market nudging bidders to treat coffees in certain markets differently. If framing holds then the spread, as measured by the squared mean deviation (SMD) of the quality score, will have a significant effect on the price. Earlier results suggest that this does hold. As in the case of representativeness, the interaction may further this insight. Thus, the wider spread in quality scores may have differential effects depending on the rank of the coffee. For example, higher ranked coffees may benefit from a greater spread in quality, because buyers will bid up the prices of these better coffees to avoid the lower quality coffees.

I estimated the model with SMD similar to Equation 3

6)

$$\ln(P_i) = \beta_0 + \beta_1 Quality_i + \beta_2 Quality_i^2 + \beta_3 Quality_i^3 +$$
$$\sum_{k=4}^{7} \beta_k Rank_{i,k-3} + \beta_8 SMD_i + \sum_{k=9}^{12} \beta_k Rank_{i,k-7} * SMD_i +$$
$$\sum_j \beta_j Reputation_{ij} + \sum_k \beta_k Correction_{ik} + \sum_m \beta_m Buyer\ Location_{im} + \varepsilon_i$$

As hypothesized, I find evidence of framing Table 3 Model 3b. Like the earlier model, including the SMD with the interactions generates a statistically significant positive SMD effect on the price of coffees regardless of rank. As suggested earlier, buyers bid up the prices of coffees as the quality scores increases relative to the mean quality in the market. The context of greater spread of the quality affects the price. In this light we can see additional evidence of the invesion of preference can occur as the bidders may be influenced by a framing heuristic.

Furthermore, rank and SMD interactions are statistically significant but negative for second and third place coffees. The marginal effects at the mean however are not statisticly significant at the means, expect for fifth place coffees (coefficient=0.0004645 and *p*-value=0.011). On average for lower ranked coffees, as the quality spread increases for those coffees above the mean quality score, the price increases, and for coffees below the mean the price falls. The problem with margins at the means is the mean quality as well as the squared mean quality deviation varies by rank with higher qualities and SMD for higher ranked coffees. Also for the top four ranked coffees, the quality score is above the mean. Thus, I consider the marginal effects on predicted values for specific ranges of the SMD. As the SMD increases, the model predicts (see Figure 4) that first place coffees will see a rise in prices that is much faster than the other coffees and is higher over similar quality ranges. In short, for the same quality score, first place coffees receive a price premium, and experience a greater price increase for an increase in quality. Second, fourth and fifth places also experience price increases for increases in the SMD, but the price increase in second place coffees is very small. Third place coffees are hurt by the increase, thought the loss is small. This result adds nuance to the earlier hypothesis. With the interaction terms, we see that for third place coffees a greater spread (SMD) in quality lowers the price, but for the others, especially first place coffees as the SMD increases, the price increases. Since the SMD is a function of the quality and the mean quality of the market, the SMD adjusts with changes in either (or both) of these two factors.

The marginal effect of a change in the mean quality provides evidence in support of the framing heuristic. The marginal effect can be written as

8) $$\frac{\partial \ln(P_{ijt})}{\partial \overline{Quality}_{jt}} * \frac{1}{P_{ijt}} = -2\beta_3(Quality_{ijt} - \overline{Quality}_{jt}) - 2\beta_n(Quality_{ijt} - \overline{Quality}_{jt})$$

$\forall n = 9, 10, 11, 12$

The marginal effects of a change in the mean quality score on the price is negative for first and thrid place coffees $\left(-2(\beta_8)\left(Quality_{ijt} - \overline{Quality}_{jt}\right) < 0\right)$ as $\beta_n = 0 \; \forall \; n = 9{,}12$. The same is true for second place coffees $\left(-2(\beta_8 + \beta_{10})\left(Quality_{ijt} - \overline{Quality}_{jt}\right) > 0\right)$ as $(\beta_8 + \beta_{10}) > 0$ and positive for third place coffees $\left(-2(\beta_8 + \beta_{11})\left(Quality_{ijt} - \overline{Quality}_{jt}\right) < 0\right)$ as $(\beta_8 + \beta_{11}) < 0$. For the top four ranked coffees $-2\beta_n\left(Quality_{ijt} - \overline{Quality}_{jt}\right) > 0 \; \forall \; n = 9, 10, 11{,}12$, since $\left(Quality_{ijt} - \overline{Quality}_{jt}\right) > 0$. The striking result is that for every unit decrease in the mean quality raises the price of first, second, and third place coffee and lowers the price of third place coffee. As the mean quality decreases, the SMD increases, thus the benefit to ranked coffees (see figure 3). In short, if the mean quality of the market falls then buyers pay a higher price for first, second, and fourth place coffees and a lower price for third place coffees. For lower ranked coffees that are below the mean quality they gain from the decrease in mean quality. Thus, in markets where the mean quality decreases, the price of top ranked coffees increases regardless of the quality scores of those coffees, increasing the likelihood of preference inversions. The findings here support the framing heuristic.

7.4.2.1 Framing Redux

Consideration of the quality effect of SMD has more to do with representativeness than framing. Earlier, I considered the marginal effects of changing quality in the model with SMD without the interaction term. However, with the interaction we get a different marginal for second and third place coffees:

8) $$\frac{\partial \ln\left(P_{ijt}\right)}{\partial Quality_{ijt}} * \frac{1}{P_{ijt}} = \beta_1 + 2 * \beta_2 * Quality_{ijt} + 3 * \beta_2\left(Quality_{ijt}\right)^2 + 2\beta_3\left(Quality_{ijt} - \overline{Quality}_{jt}\right) + 2\beta_n\left(Quality_{ijt} - \overline{Quality}_{jt}\right) \quad \forall n = 9{,}11$$

The coefficients on the interaction terms for second place coffees is negative, but smaller than the coefficient on SMD $[(\beta_3 + \beta_n) > 0]$ and larger for third place coffees and larger than the coefficient on SMD $[(\beta_3 + \beta_n) < 0]$. As a result for each additional unit of quality, assuming the same starting quality and mean quality, the marginal effects are positive (negative) but lower for second and third place coffees relative to other coffees. The other ranked coffees, especially first place coffees, have marginal effects that are larger because the interaction terms are not statistically significant., adding more to the hypothesis of representativeness.

8 Discussion[7]

While this paper provides evidence of behavioral effects on price and quality, some limitations exist. As this market is an auction, ideally, I would like to model more carefully the auction aspects of the market. I was able to include the number of coffees in the auction, but I do not know anything about non-winning bids and the number of bidders, which can influence the realized price. Transportation costs could influence the price that bidders from different countries are willing to pay. Future analysis could consider these issues.

The CoE auction is only one source of coffees for many buyers. Thus, some buyers may participate in the auction for specific coffees from specific countries, and these buyers may not consider the quality over time and space. Buyers are looking for a portfolio of coffees and may pay beyond the quality to obtain a unique coffee from a specific grower. These factors could contribute to the price/quality inversions that promoted this analysis.

9 Conclusion

Increases in quality should increase the price of the good. However, the data from the Cup of Excellence provides evidence that for lower quality coffees, buyers are willing to pay a higher price if the rank of the coffee is higher. The preference invesions observed in the data may be explained by two heuristics from behavioral economics namely: representativeness and framing. From representativeness, we see a tendency to pay higher prices based on the rank of a product. This heuristic makes sense within a single market; however, across countries and years, we see higher ranked coffees that have lower quality scores than coffees with higher quality scores and lower rank receiving higher prices than these fomer coffees. And still these higher-ranked, mostly first place, coffees receive a higher price than what the quality would imply. The statistical analysis indicates that the bidders are willing to pay higher prices for lower quality, first place coffees, then higher quality second (or third) place coffees. Both suggest that rank plays a role in coffee prices that lead to perverse valuation of the coffees.

The framing heuristic suggests that market context shapes how bidders value individual coffees. The models provide evidence that as the spread in quality increases some bidders

[7] Several of the comments come from seminar participants at Cornell University and the University of Georgia. I appreciate the conversations with colleagues at both institutions for improving the paper. Addition insights have come from presenting an earlier version of this and work with Adam Wilson at the Specialty Coffee Association of America 2015.

evaluate the coffees differently. The bidders are concerned not only with the quality of the coffee that they purchase; they are also considering the qualities of the other coffees. Similar to the representative heuristic, relative quality matters to the valuation of the individual coffees. The influence of relative quality suggests the buyers are focused only on the market at hand. They are not looking across markets over time. The actions of bidders suggest that top quality today in this market is worthy of the price premium regardless of the quality of coffees beyond that market. I suggest that quality should dominate regardless of time and space. Related to framing the number of coffees has an influence on the price, as more competitive or more distracting markets may lead to lower prices, especially for coffees with lower ranks.

An important extension of this work is the consideration of the welfare consequences of the heuristics of the bidders. Are buyers either paying too much for first place coffees or are they discounting the prices of lower ranked coffees? Or worse, are bidders doing both? From the perspective of the coffee growers does the price and quality disconnect discourages growers from generating or at least bringing to market the very best quality? These questions can be answered by experimental economics. In experimental settings, one could replicate the market and evaluate the welfare implications of this auction mechanism versus others that disrupt the suggested heuristics. As suggested from this body of work, buyers in the Cup of Excellence auction may evaluate coffee prices more in line with quality if representativeness and framing are better managed.

Table 1. Summary Statistics

Variable	Obs.	Mean	Std Dev	Min	Max
Auction Price (2011 US$/pound)	1039	5.993	4.733	1.200	80.220
Quality Score (0-100)	1039	86.997	2.413	84	95.690
Mean Quality Deviation	1039	0.0127	2.368	-3.856	7.899
Growing Altitude (Meters)	1039	1,470.595	234.342	600	2,2100
Growing Area (Hectares)	1039	73.631	187.164	0.570	2,500
Lot Size (70kg Bags)	1039	24.354	13.395	9	145
Brazil	1039	0.0857	0.280	0	1
Bolivia	1039	0.109	0.311	0	1
Colombia	1039	0.194	0.396	0	1
Costa Rica	1039	0.0241	0.153	0	1
El Salvador	1039	0.189	0.391	0	1
Guatemala	1039	0.0780	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	0.00289	0.054	0	1
Typica Variety	1039	0.071	0.257	0	1
Pacamara Variety	1039	0.000962	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	0.0346	0.183	0	1
Rainforest Alliance Certified	1039	0.0241	0.153	0	1
North American Market	1039	0.218	0.413	0	1
Nordic 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	0.0212	0.144	0	1
Buyer Cooperation	1039	0.170	0.376	0	1
Number of Coffees	1039	28.0116	5.800	13	41

Table 2. Truncated Regression Models of Log (Price) Base Model, Cubic Model, and Number of Coffees

	Base Model		Model 1		Model 2a		Model 2b	
	Coef. Std. Err.	*p*-value	Coef. Std. Err.	*p*-value	Coef. Std. Err.	*p*-value	Coef. Std. Err.	*p*-value
Quality Score	0.2244***	0	0.3446***	0	0.3666***	0	0.3661***	0
	0.0218		0.0613		0.0616		0.0604	
Quality Score^2	-0.0099***	0	-0.0331***	0.003	-0.0369***	0.001	-0.0377***	0.0006
	0.0022		0.0111		0.0112		0.011	
Quality Score^3			0.0013**	0.0323	0.0014**	0.0153	0.0015***	0.0082
			0.0006		0.0006		0.0006	
Altitude	0.0249***	0.0005	0.0249***	0.0006	0.0271***	0.0002	0.0283***	0.0001
	0.0072		0.0072		0.0073		0.0072	
Log (Growing Area)	0.0216*	0.053	0.0215*	0.0548	0.0249**	0.0259	0.0242**	0.0283
	0.0111		0.0112		0.0112		0.011	
Log (No. of Bags)	-0.0187***	0	-0.0185***	0	-0.0181***	0	-0.0176***	0
	0.0018		0.0018		0.0018		0.0017	
Rank								
First	0.8539***	0	0.8679***	0	0.8835***	0	2.2990***	0.0015
	0.0728		0.0735		0.0735		0.7246	
Second	0.2868***	0	0.3239***	0	0.3354***	0	1.5729**	0.0485
	0.0596		0.0624		0.0625		0.7974	
Third	0.2100***	0.0001	0.2449***	0	0.2533***	0	1.4989**	0.046
	0.0535		0.0561		0.0561		0.7511	
Fourth	0.1461***	0.0048	0.1762***	0.0011	0.1838***	0.0006	1.3304	0.1076
	0.0518		0.0538		0.0538		0.8268	
Country of Origin								
Bolivia	-0.2263***	0.0044	-0.2171***	0.0065	-0.1977**	0.0131	-0.1986**	0.0113

	0.0795		0.0798		0.0796		0.0784	
Colombia 1	-0.2989***	0.0003	-0.2959***	0.0003	-0.2732***	0.0008	-0.2637***	0.0011
	0.0817		0.082		0.0819		0.0806	
Colombia 2	-0.4798***	0	-0.4784***	0	-0.5164***	0	-0.5279***	0
	0.0927		0.093		0.0933		0.0923	
Costa Rica	-0.5501***	0	-0.5452***	0	-0.5356***	0	-0.5326***	0
	0.0943		0.0945		0.0942		0.0923	
El Salvador	-0.2779***	0	-0.2756***	0	-0.2484***	0	-0.2502***	0
	0.0512		0.0514		0.0517		0.0507	
Guatemala	-0.1771**	0.0176	-0.1731**	0.0207	-0.1572**	0.0354	-0.1422*	0.0522
	0.0746		0.0749		0.0747		0.0733	
Honduras	-0.4300***	0	-0.4309***	0	-0.3730***	0	-0.3719***	0
	0.0614		0.0616		0.0628		0.0617	
Nicaragua	-0.2824***	0	-0.2750***	0	-0.2746***	0	-0.2705***	0
	0.059		0.0592		0.059		0.058	
Varietals								
Caturra	0.0584	0.1667	0.0559	0.1871	0.0419	0.3232	0.0329	0.4327
	0.0422		0.0424		0.0424		0.0419	
Catuai	0.1008	0.5943	0.0839	0.6588	0.1456	0.4401	0.0907	0.6345
	0.1893		0.1899		0.1885		0.1907	
Mixed	-0.1463***	0.0025	-0.1412***	0.0036	-0.1292***	0.0078	-0.1238***	0.0096
	0.0484		0.0485		0.0485		0.0478	
Other	0.0808**	0.0145	0.0798**	0.0161	0.0707**	0.0332	0.0629*	0.0555
	0.0331		0.0332		0.0332		0.0329	
Pacamara	0.4539	0.1544	0.4501	0.1595	0.4468	0.1606	0.425	0.1737
	0.3188		0.3199		0.3185		0.3124	
Typica	-0.0960*	0.0994	-0.0979*	0.0934	-0.0837	0.1496	-0.0917	0.1071
	0.0583		0.0584		0.0581		0.0569	
Organic	0.0579	0.3476	0.0501	0.4179	0.0473	0.4424	0.034	0.5768

	0.0617		0.0618		0.0616		0.0609	
Rainforest Alliance	-0.047	0.5478	-0.0506	0.5187	-0.0402	0.6056	-0.0338	0.6594
	0.0782		0.0785		0.0779		0.0766	
Year								
2005	0.071	0.1461	0.0705	0.1507	0.1259**	0.0148	0.1419***	0.0061
	0.0488		0.0491		0.0517		0.0517	
2006	0.1457***	0.0031	0.1492***	0.0026	0.1138**	0.0236	0.1161**	0.0195
	0.0493		0.0496		0.0503		0.0497	
2007	0.2834***	0	0.2863***	0	0.2463***	0	0.2521***	0
	0.0504		0.0506		0.0518		0.0511	
2008	0.3845***	0	0.3834***	0	0.3481***	0	0.3540***	0
	0.0475		0.0477		0.0487		0.0481	
2009	0.7046***	0	0.7013***	0	0.6516***	0	0.6488***	0
	0.0552		0.0554		0.0564		0.0556	
2010	1.0029***	0	0.9944***	0	0.9346***	0	0.9238***	0
	0.0688		0.0692		0.0702		0.069	
Buyer Location								
Asian	-0.1239***	0	-0.1255***	0	-0.1285***	0	-0.1357***	0
	0.026		0.0261		0.026		0.0257	
Europe	0.0264	0.4862	0.0263	0.4898	0.0183	0.6314	0.0062	0.8688
	0.0379		0.038		0.0381		0.0377	
Nordic	0.0620*	0.0734	0.0586*	0.0919	0.0534	0.1241	0.0521	0.1285
	0.0346		0.0348		0.0347		0.0343	
Elsewhere	-0.2581**	0.0161	-0.2541**	0.0184	-0.2522**	0.0186	-0.2569**	0.0143
	0.1073		0.1078		0.1071		0.1048	
Buyer Coop	0.029	0.3093	0.0311	0.2758	0.0266	0.3516	0.0357	0.2102
	0.0285		0.0286		0.0286		0.0285	
Number of Coffees	-0.0127***	0	-0.0124***	0	0.0698***	0.0013	0.1043***	0.0001
	0.0024		0.0024		0.0217		0.0263	

Number of Coffees^2					-0.0015***	0.0001	-0.0021***	0
					0.0004		0.0005	
Interactions								
First X Number of Coffees							-0.1244**	0.0199
							0.0535	
Second X Number of Coffees							-0.0968*	0.0957
							0.0581	
Third X Number of Coffees							-0.0853	0.1212
							0.055	
Fourth X Number of Coffees							-0.093	0.1211
							0.06	
First X Number of Coffees^2							0.0025***	0.009
							0.001	
Second X Number of Coffees^2							0.0018*	0.0845
							0.001	
Third X Number of Coffees^2							0.0014	0.1628
							0.001	
Fourth X Number of Coffees^2							0.0018*	0.0927
							0.0011	
Constant	1.1567***	0	0.9738***	0	-0.2077	0.5669	-0.6815	0.1101
	0.1467		0.1726		0.3627		0.4265	
Sigma	0.2640***	0	0.2646***	0	0.2638***	0	0.2602***	0
	0.0082		0.0082		0.0082		0.0081	
Log Likelihood	432.0858		434.4247		442.2299		450.7811	
Wald χ^2	2495.91	0	2466.56	0	2472.53	0	2527.02	0
AIC	-788.849		-802.46		-802.46		-786.172	
N	1039		1039		1039		1039	

* p<0.10, ** p<0.05, *** p<0.01

Table 3. Truncated Regression Models of Log (Price) Considering Quality and Quality Deviation

	Model 3a		Model 3b	
	Coef. Std. Err.	*p*-value	Coef. Std. Err.	*p*-value
Quality Score	0.4078*** 0.0685	0	0.4770*** 0.0954	0
Quality Score^2	-0.0417*** 0.0118	0.0004	-0.0566*** 0.0183	0.002
Quality Score^3	0.0013** 0.0006	0.0239	0.0022** 0.001	0.0279
Score Deviation Mean Quality^2	0.0105** 0.0051	0.0396	0.0184** 0.0072	0.0113
Altitude	0.0244*** 0.0072	0.0006	0.0246*** 0.0071	0.0006
Log (Growing Area)	0.0218** 0.0111	0.049	0.0208* 0.011	0.0591
Log (No. of Bags)	-0.0186*** 0.0018	0	-0.0185*** 0.0017	0
Rank				
First	0.8000*** 0.0799	0	0.9021*** 0.1668	0
Second	0.2868*** 0.0644	0	0.4660*** 0.1432	0.0011
Third	0.2238*** 0.0566	0.0001	0.4631*** 0.1259	0.0002
Fourth	0.1640*** 0.0537	0.0022	0.1562 0.1333	0.2413

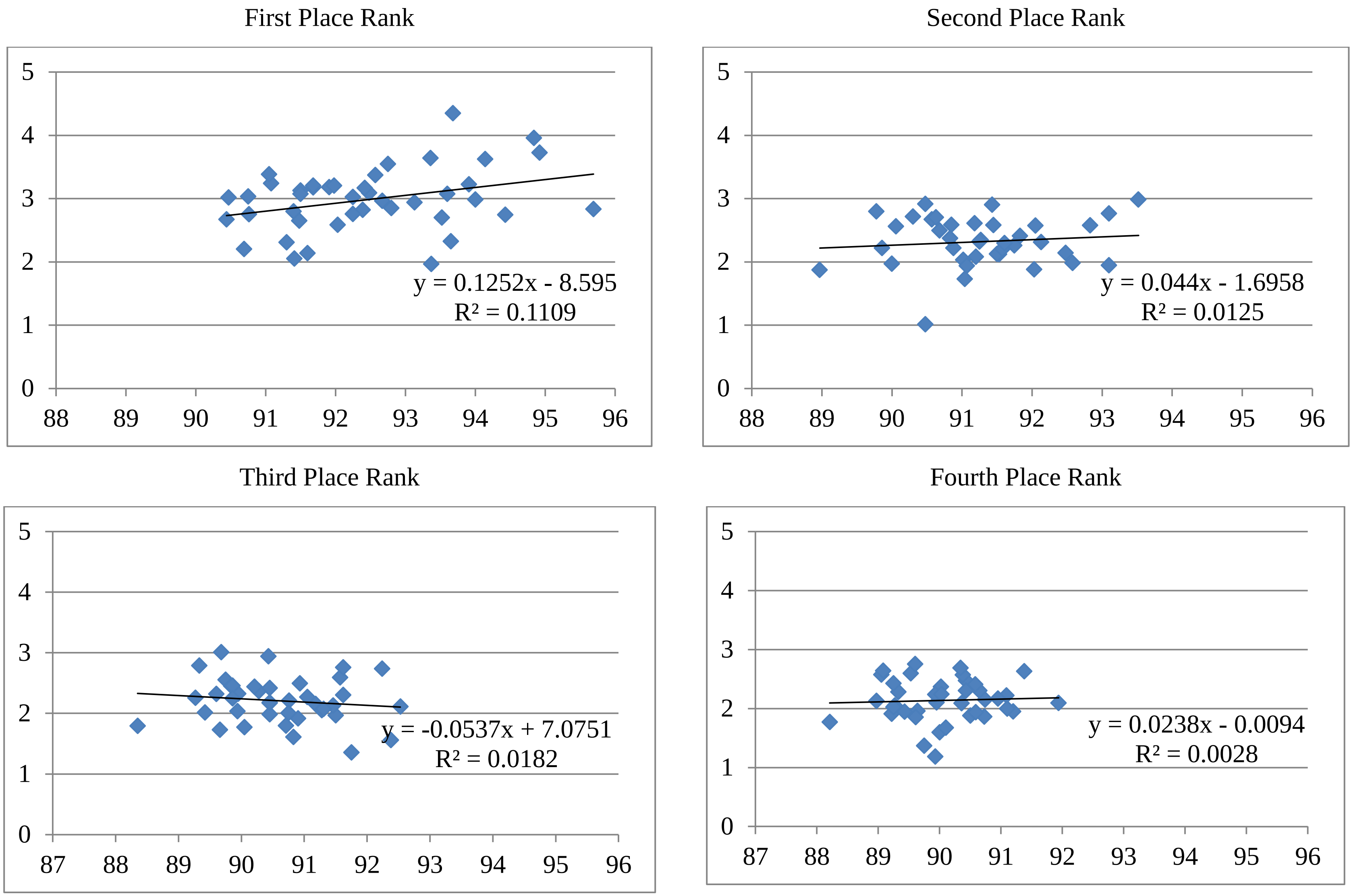
Country of Origin				
Bolivia	-0.2106***	0.0076	-0.2124***	0.0069
	0.0789		0.0786	
Colombia 1	-0.2833***	0.0005	-0.2786***	0.0006
	0.0812		0.0807	
Colombia 2	-0.4681***	0	-0.4607***	0
	0.0921		0.0915	
Costa Rica	-0.5334***	0	-0.5294***	0
	0.0934		0.0928	
El Salvador	-0.2700***	0	-0.2703***	0
	0.0508		0.0505	
Guatemala	-0.1742**	0.0188	-0.1750**	0.0179
	0.0741		0.0739	
Honduras	-0.4168***	0	-0.4195***	0
	0.0612		0.0611	
Nicaragua	-0.2694***	0	-0.2644***	0
	0.0586		0.0582	
Varietals				
Caturra	0.0509	0.2247	0.0495	0.2359
	0.042		0.0417	
Catuai	0.0888	0.6363	0.0616	0.7471
	0.1878		0.191	
Mixed	-0.1292***	0.0075	-0.1294***	0.0072
	0.0483		0.0482	
Other	0.0757**	0.0213	0.0786**	0.0166
	0.0329		0.0328	
Pacamara	0.4475	0.157	0.4518	0.1501
	0.3162		0.3139	
Typica	-0.0895	0.1205	-0.0882	0.1232

	0.0577		0.0572	
Organic	0.0491	0.4232	0.0477	0.436
	0.0613		0.0612	
Rainforest Alliance	-0.0481	0.5347	-0.0652	0.4027
	0.0774		0.0779	
Year				
2005	0.0674	0.1654	0.0713	0.1423
	0.0486		0.0486	
2006	0.1470***	0.0027	0.1551***	0.0015
	0.049		0.0489	
2007	0.2811***	0	0.2879***	0
	0.0501		0.0501	
2008	0.3787***	0	0.3853***	0
	0.0473		0.0477	
2009	0.6946***	0	0.6971***	0
	0.0549		0.0547	
2010	1.0002***	0	1.0010***	0
	0.0685		0.0681	
Buyer Location				
Asian	-0.1244***	0	-0.1252***	0
	0.0258		0.0257	
Europe	0.0213	0.5721	0.0202	0.589
	0.0377		0.0375	
Nordic	0.0612*	0.0757	0.0623*	0.0713
	0.0345		0.0345	
Elsewhere	-0.2552**	0.0164	-0.2538**	0.0161
	0.1064		0.1054	
Buyer Coop	0.0296	0.2953	0.034	0.2277
	0.0283		0.0282	

Number of Coffees	-0.0133***	0	-0.0126***	0
	0.0024		0.0024	
Interactions				
First X Score Deviation Mean Quality^2			-0.0113	0.2465
			0.0098	
Second X Score Deviation Mean Quality^2			-0.0157*	0.0959
			0.0094	
Third X Score Deviation Mean Quality^2			-0.0229**	0.0241
			0.0101	
Fourth X Score Deviation Mean Quality^2			-0.0029	0.8273
			0.0135	
Constant	0.8818***	0	0.7487***	0.0004
	0.177		0.2116	
Sigma	0.2625***	0	0.2611***	0
	0.0082		0.0081	
Log Likelihood	436.505		439.58	
Wald χ^2	2512.54	0	2550.88	0
AIC	-837.64		-837.607	
N	1039		1039	

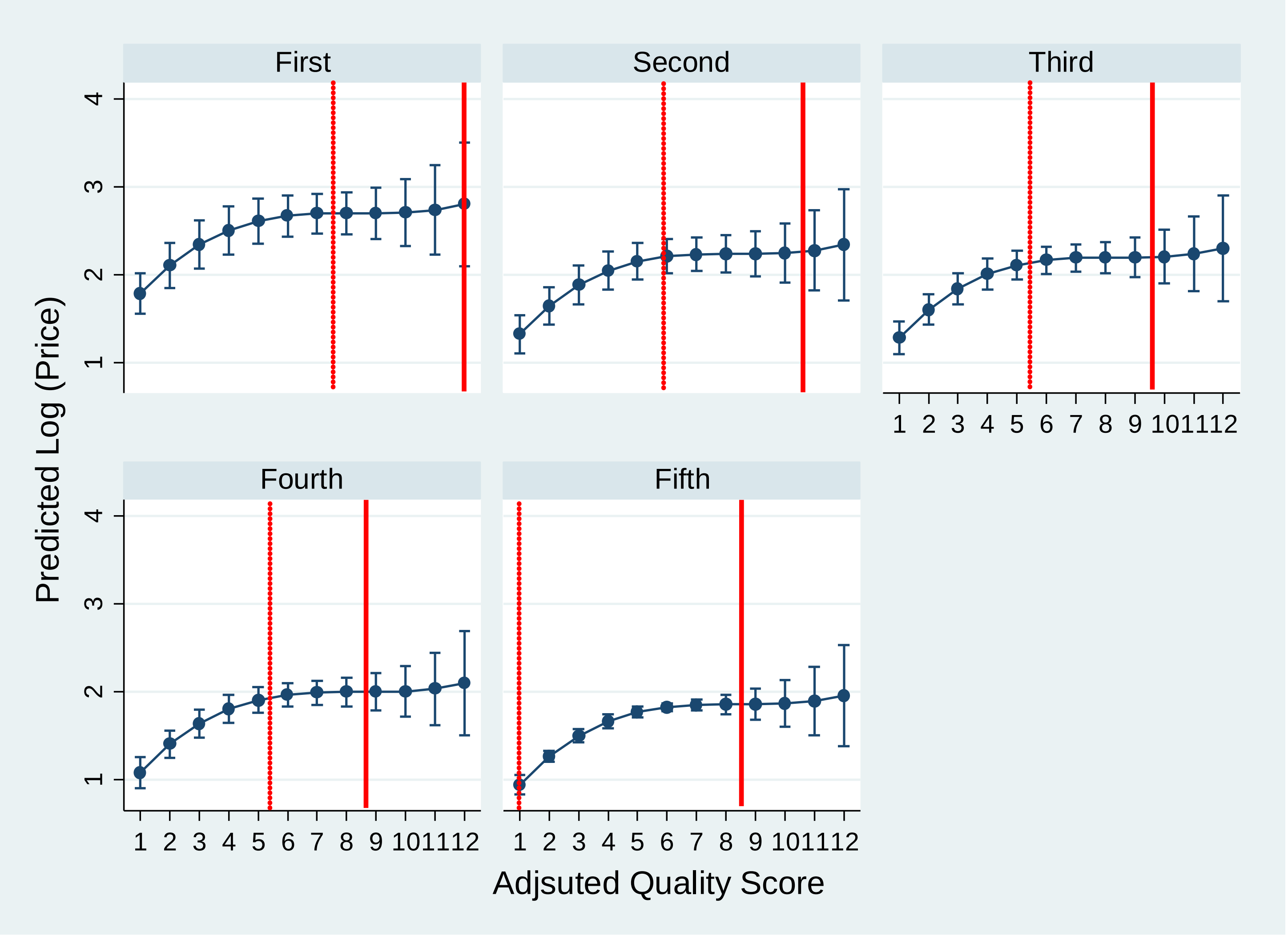
* p<0.10, ** p<0.05, *** p<0.01

Figure 1. Scatter Plots of Deflated Logged Coffee Prices against Quality Score by Rank



Source: Author's Estimation

Figure 2. Predicted Log of Coffee Prices from Model 4 over Relevant Ranges of Quality Scores



Note: The dashed line represents the beginning of the relevant quality score. The solid line is the end of the relevant range. The adjusted quality score ranges from 1 to 12, which ranges from 84 to 95 in the actual quality score.

Figure 3. Predicted Log of Coffee Prices over the Number of Coffees in the Auction from Model 2b

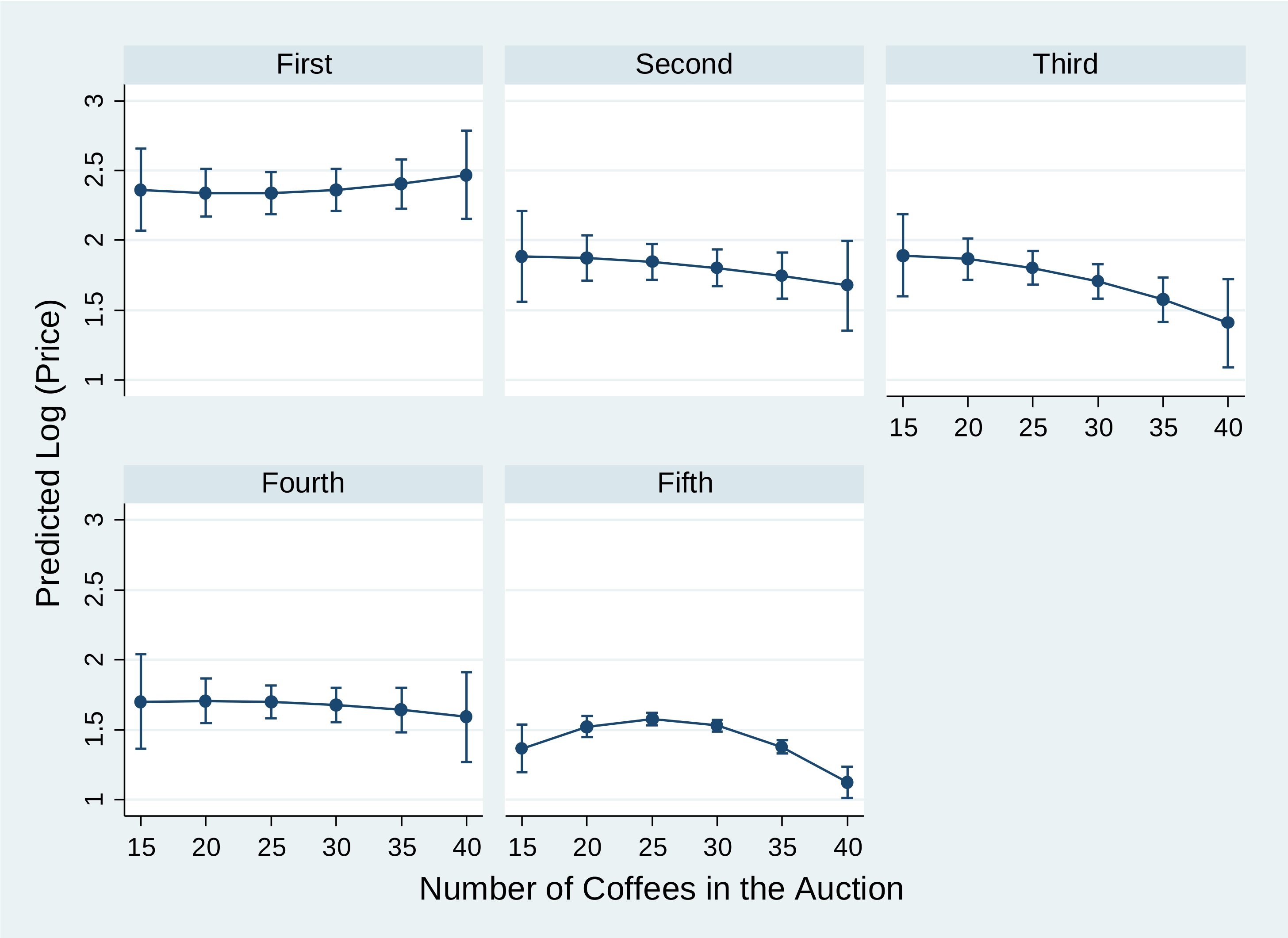
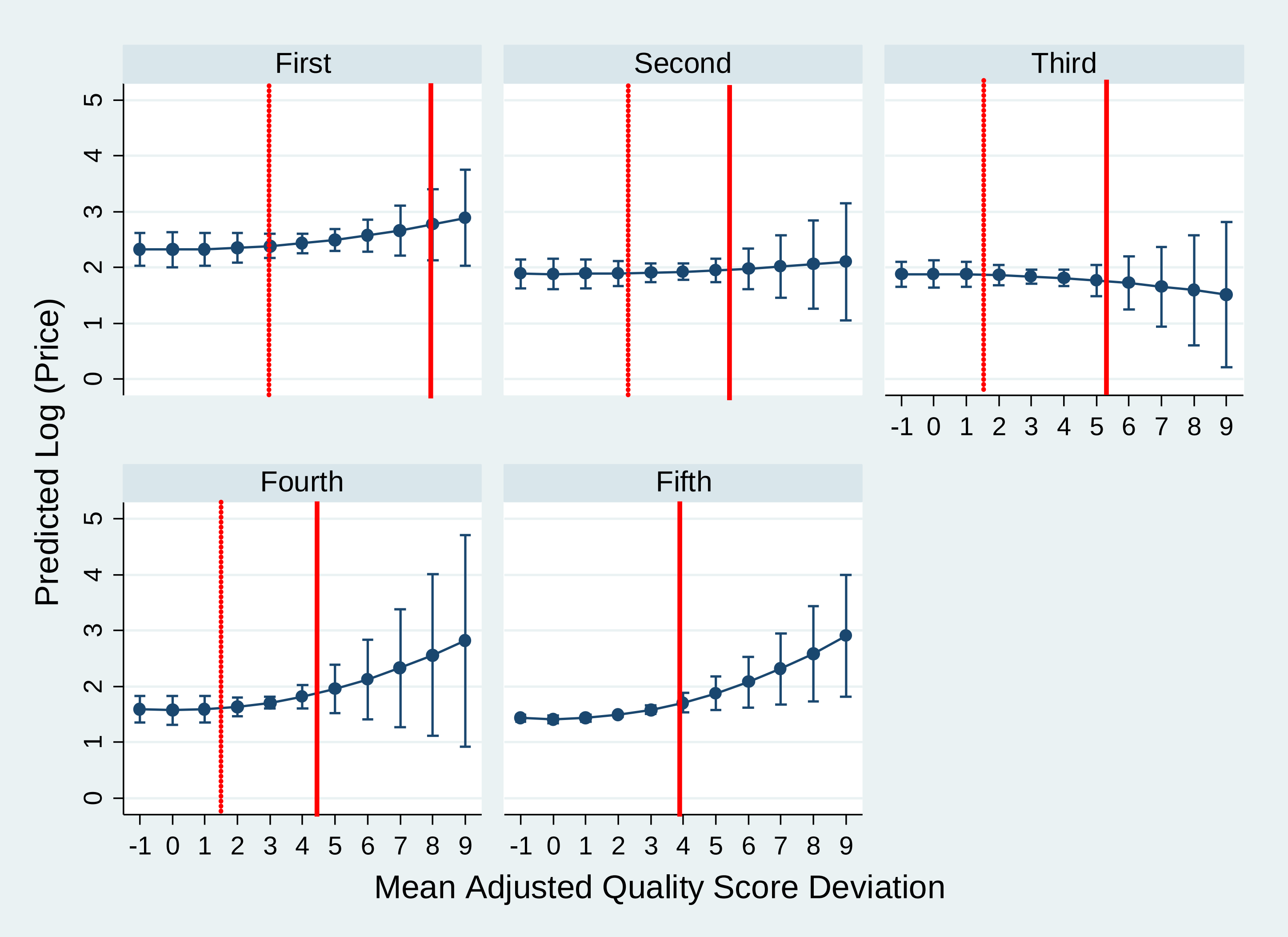


Figure 3. Predicted Coffee Price from Model 5 over Relevant Ranges of Squared Mean Deviation of the Quality Score



Note: The dashed line represents the beginning of the relevant mean quality score deviation. The solid line is the end of the relevant range. The mean adjusted quality score ranges from -3.85 to 8.

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