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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The Economics of Quality in the Specialty Coffee Industry:

Insights from the Cup of Excellence Auction Programs

Abstract

This study investigates the Cup of Excellence coffee auctions and explains with behavioral economics observed intransitives in choice sets. Buyers are selecting lower quality coffees and paying higher prices for these coffees because they receive a higher rank. The estimates suggest that the representativeness and the framing heuristics explain the price premium for higher ranked coffees.

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Introduction

Coffee tastes good. Specialty coffees taste really good. Though definitions vary, specialty coffees include a wide array of premium quality coffees which are commonly single origin and sold in coffee shops. Coffees with this designation are often evaluated for quality based on a series of taste tests (cuppings), and a quality score is given for these coffees. Thus, quality should play a major role in the valuation of these coffees. Specialty coffees provide an interesting market for evaluating the effects of quality on price and provide a forum to understand better behavioral aspects of quality on price.

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, et al., 2008, Teuber and Herrmann, 2012, Wilson and Wilson, forthcoming). 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, buyers in the CoE auctions show a reversal 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 reversal 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 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 reversals in coffee acutions are explained by behavioral economics.

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) 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, forthcoming) [1].

The auctions are eBay-style with ascending bids. Bidders in the auction are roasters and importers for well-established specialty coffee companies mostly from Europe, Japan, North America and Nordic Countries. Bidder information is hidden during the auctions. The Associate of Coffee Excellence (ACE) provides bidders a full complement of information of each lot

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

including farm/cooperative name, growing altitude, processing methods, average quality score, cupping notes, and rank. Potential buying firms may purchase small samples to cup before bidding.

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 and Wilson, forthcoming).

Previous Analysis of the CoE Auction

Donnet, et al. (2008), Teuber and Herrmann (2012), and Wilson and Wilson (forthcoming) 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) 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 (forthcoming) 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.

Preference Reversals

To establish the observed preference reversal, let us consider the evolution of price and quality over time. Table 1 provides summary statistics of price, quality and other coffee metrics over the time period 2004-2010. Table 2 contains the country of origin, rank, score and price of the top three coffees sold in 2008, 2009 and 2010. 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, note that the first place Brazilian coffee score 93.91 and earned a price of $25.05 in 2011 USD. The number one Columbian 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 in Table 1 reflects a reversal in preferences. This violation of transitivity suggests that bidders are making an error which behavioral economics may explain. Similar reversals appear throughout the table and the data set. According to Suzy Spindler, Executive Director, of the Alliance for Coffee Excellence, no reversal has taken place. In reality, she argues that a 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. While this contextualization may hold for the administrators and buyers of this auction, this idea is incongruous with the standardized, internationally accepted quality score based on the sensory aspects of the coffee. Furthermore, Wilson and Wilson (forthcoming), among others, find 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 2010 dollars for those years were $19.33, $24.63 and 29.41. The intransitivity continues for the second and third place coffees, and reversals are also inconsistent with inflationary pressures or a general trend in coffee prices. Again, this result suggests a reversal 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 1suggests 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 in the third place coffees.

Heuristics

One explanation of the reversal, suggested by Kahneman (2011), reflecting the work that he Amos Tversky conducted, is that of representativeness. One interpretation 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, these fields are generally smaller than the humanities, education, social science, etc. Thus, respondents depend on the stereotype not the base rate to rank computer science above the humanities.

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. Referring back to Table 1, the representative heuristic suggests that rank should 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. While it makes sense to pay a higher price for coffees that rank higher, it seems inconsistent to pay more for a coffee that has a lower quality score regardless of the rank.

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. Again, the effect of rank on the price is modulated by, in this case, the average quality score.

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 and et al., 2001; Smith and Huang, 1995), wages (Hwang et al., 1998), and agricultural commodities (Bowman and Ethridge, 1992; Buccola and Iizuka, 1997; Chang et al., 2010). The basic structure of the hedonic model suggests that qualities of a product influence the price. Drawing explicitly from (Bishop and 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 $i = 1, \dots, N$ 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 and Wilson, forthcoming).

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 (forthcoming).

Model

The earlier graphical presentations of data suggest a breakdown in the relationship between quality score and price for the coffees by rank. The graphical presentations 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). See Table 3. The simple hedonic model is as follows:

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

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 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 and 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 and Robinson, 2003; Wilson and Wilson, forthcoming). 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[2] 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 and Herrmann, 2012; Wilson and Wilson, forthcoming). However, since the time dummies are not significant for all ranks for each year, all of the price changes leading to the preference reversals cannot be ascribed to inflationary pressures. In sum,

[2] 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, Peter E 1981. Estimation with Correctly Interpreted Dummy Variables in Semilogarithmic Equations. American Economic Review 71.

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. Figure 2 shows the box-whisker plots of 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 graphs and estimation results suggest a 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.

Replication of Wilson and Wilson (forthcoming)

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

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

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 results of Wilson and Wilson (forthcoming) are in Table 4, Column 1. As found in Wilson and Wilson (forthcoming), 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 becaue the quality score is truncated from below. The truncated maximum likelihood estimations produce normal residuals—Kolgomorov-Smirnov tests fail to reject a normal distribution at 95% confidence for the truncated models. The results show that quality and quality squared have a positive effect on coffee prices. A F-test rejects the null hypothesis that the variables are jointly equal to zero. Wilson and Wilson (forthcoming) 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. Obtaining first place carries the highest premium at 144.23% more than coffees not ranked in the top four. By contrast, obtaining second place only carries a premium of 37.02%. For third place coffees the premium is 25.78%. As Wilson and Wilson (forthcoming) note and as seen Table 2 the difference in quality score is on average 1.9 points, but the price premium can be over 100%. 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 and Robinson, 2003; Wilson and Wilson, forthcoming). 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.

A Cubic Quality Score

In the previous section I replicated the model from Wilson and Wilson (forthcoming). 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 4, column 2). The rest of the estimates are similar to the cubic model, but 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[3]. For example the marginal effect an additional unit of quality around the mean score of 87 (or 4 given the rescaling) is 15.11% which is similar to the marginal effect for the quadratic model (15.72%). In the quadratic model, we observe a "maximum quality score". For example, in the range of 90.00 to 90.99 an additional unit of quality in the quadratic model will raise the price between 6.46 to 8.76% for an additional increase in the quality score, but for the cubic model the change is 5.29% to 6.31%. A surprising result is that the effect of a one unit increase in the score turns negative after a quality score of 93.78, 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 91 the prices do fall, though no local minimum exists as the marginal is never zero. See figure 3. Therefore, mid-range quality scores generate a smaller marginal benefit than lower and higher quality scores. On the surface, this result is also odd; however, when rank is taken into consideration, this conflict is resolved.

Quality Score Squared Mean Deviation (SMD)

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

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

(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 for 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 $\beta_4 > 0$. The larger spread is suggestive of more low scoring coffees 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, $\Big(\text{e.g. } \left|\beta_1 + 2 * \beta_2 * Quality_{ijt} + 3 * \beta_2 \left(Quality_{ijt}\right)^2\right| >$

$\left|2\beta_3\left(Quality_{ijt} - \overline{Quality}_{jt}\right)\right|\big)$, but it generates a smaller benefit for an additional unit of coffee quality as compared to higher quality coffees.

As seen in Table 4, Column 3, the squared mean deviation of quality for each market is not statistically significant, though the other variables are still significant and the expected sign. In this framework, the model does not indicate that buyers are considering the effects of the spread of quality in the market in their pricing.

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 on 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 suggests that no interactions between rank and quality occur. If the interactions of rank and quality on price are independent, then representative still holds if the marginal effect of rank remains larger than that of quality. However, if the rank and quality interactions are positive, suggesting that higher quality leads to higher prices by rank, then representativeness is weakened and may support the rejection of representativeness if the marginal effect of quality dominates rank. On the other hand negative interactions of quality and rank suggest that higher quality coffees by rank generate lower prices.

To test for representativeness, I estimated the following model:

(5) $$\ln(P_i) = \beta_0 + \beta_1 Quality_i + \beta_2 Quality_i^2 + \beta_3 Quality_i^3 + \beta_4 First_i + \beta_5 Second_i + \beta_6 Third_i + \beta_7 Fourth_i + \beta_8 First_i * Quality_i + \beta_9 Second_i * Quality_i + \beta_{10} Third_i * Quality_i + \beta_{11} Fourth_i * Quality_i + \sum_j \beta_j Reputation_{ij} + \sum_k \beta_k Correction_{ik} + \sum_m \beta_m Buyer\ Location_{im} + \varepsilon_i$$

In this specification, the ranks, which were incorporated into $Reputation_{ij}$ in Model 3, are presented separately and interacted with the quality score. If representativeness holds then, the interactions will have no effect on price, assuming a larger marginal effect of rank over quality. However for negative interactions, a lower quality score but a higher rank will lead to higher prices than higher quality and a lower rank.

The estimated model in Table 5 Column 1 provides evidence in support of representativeness. The interaction terms of rank and quality are statistically significant and negative. To aid interpretation of this result consider Figure 4. I used the relevant range of variables to predict the price for the ranks Brazilian coffees in 2004 bought by North Americans given the average of the other variables (Note that all subsequent predictions are based on the same assumptions). As the figure illustrates, when the quality score is 91, the first place coffee would receive a price of \$17.10, while the second place coffee would receive \$8.94, the third \$7.68 and forth \$7.20. However, for a second place coffee to attain a quality score of 93 and in another market the first place coffee receives 91, the higher quality second place coffee would only receive \$10.12. The result suggests that buyers are following a heuristic that says that the first place rank provides most of the relevant information.

An interesting side note is that price of first place coffees, over the relevant quality range, increase at an increasing rate while the price of third place coffees fall throughout the range, so much so that fourth place coffees receive a higher price for qualities over 91.3. However it should be understood that the fourth place does not have statistically significant rank nor quality-rank interaction terms. Thus lower ranked coffees will follow the same pattern as fourth place coffees, but the relevant quality score range will be lower. The negative relationship between quality and price for third place coffees is supported by the Figure 2. The statistical result also supports representativeness, but in a different light. Bidders may approach third place coffees as good coffees that are simply not good enough to be first or second. Thus, these coffees are discounted as the quality rises to the level of first and second place coffees. In sum, bidders appreciate quality but rank dominates the valuation of coffees to the point that the lower quality, higher ranked coffees earn a higher price than lower ranked higher quality coffees. Furthermore, quality has a negative effect on price for third place coffees because bidders perceive that the rank is too low for such high quality coffee. Again representativeness may hold the key to the reversal of preferences.

Framing

The representativeness argument has statistical support, but another heuristic may influence the behavior of bidders in the Cup of Excellence 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 not hold. As in the case of representativeness, the interaction may provide clearer insights. Thus, the wider spread may have differential effects depending on the rank of the coffee. For example, higher ranked coffees should 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) $$\ln(P_i) = \beta_0 + \beta_1 Quality_i + \beta_2 Quality_i^2 + \beta_3 Quality_i^3 + \beta_4 First_i + \beta_5 Second_i + \beta_6 Third_i + \beta_7 Fourth_i + \beta_8 SMD + \beta_9 First_i * SMD_i + \beta_{10} Second_i * SMD_i + \beta_{11} Third_i * SMD_i + \beta_{12} Fourth_i * SMD_i + \sum_j \beta_j Reputation_{ij} + \sum_k \beta_k Correction_{ik} + \sum_m \beta_m Buyer\ Location_{im} + \varepsilon_i$$

As hypothesized, I find evidence of framing Table 5 Column 5. Unlike the earlier model, including the SMD has a statistically significant positive effect on the price of coffees regardless of rank. As suggested earlier, buyers bid up the prices of coffees as the coffees have quality scores that are greater distances from the mean. The context of greater spread of the quality affects the price. In this light we can see how reversals 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 first and third place coffees. Thus, we see that the marginal effect of greater spread is negative though small for first $(2SMD_i(\beta_8 + \beta_9) < 0)$ and third place $(2SMD_i(\beta_8 + \beta_{11}) < 0)$coffees, but the marginal effect $(2\beta_8 2SMD_i > 0)$is positive for the other ranked coffees. The negative effect runs counters to the earlier hypothesis. As the SMD increases, the model predicts (see Figure 5) that second and fourth place coffees will see a rise in prices while the first and third place coffee prices fall. This result adds nuance to the earlier hypothesis. With the interaction terms, now we see that for certain ranks a greater spread in quality lowers the price. Since the SMD is a function of the quality and the mean quality of the market, the SMD may move because of either of these two factors. Earlier, we considered the marginal effects of changing quality in the model with

SMD. The marginal effects are the same as before for all coffees except first and third place coffees, which are lower because of the negative component from the interaction term $\left(2\beta_k\left(Quality_{ijt} - \overline{Quality}_{jt}\right) < 0 \ k = 9, 11\right)$. For a first place coffee that has a high quality relative to its mean, the model predicts a lower price relative to similar coffees closer to the mean quality score of the market. However, exceptionally high quality coffees, which are far from the mean quality score of the market, will still earn high prices because of the cubic term. Again, we can see that the framing heuristic can explain preference reversals. Another interpretation, given the definition of SMD, is that the spread could change because the mean quality score for the market changes.

The marginal effects of a change in the mean quality score on the price are positive for first $(-2SMD_i(\beta_8 + \beta_9) > 0)$ and third $(-2SMD_i(\beta_8 + \beta_{11}) > 0)$place coffees and negative $(-2\beta_8 SMD_i < 0)$for the other coffees. The marginal effects are in Figure 6. The striking result is that for every unit increase in the mean quality raises the price of the first and third place coffees. The opposite holds for second and fourth place coffees. In short, if the mean quality of the market increases then buyers pay a higher price for first and third place coffees. Thus in markets where the mean quality increases, the price of first place coffees should increase regardless of the quality scores of those coffees, increasing the likelihood of preference reversals. The findings here support framing heuristic and the representative heuristic.

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 reversals 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 with in a market; however, across countries and years, we see highly ranked coffees that have lower quality scores than higher quality coffees of lower rank receiving higher prices than these other coffees. And still these higher-ranked, mostly first place, coffees receive a higher price than what the quality would predict. The statistical analysis indicates that the bidders are willing to pay higher prices for lower ranked first place coffees. Additionally, third place coffees receive a price discount if the quality rises too high. 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 may shape how bidders value individual coffees. The modeling provides evidence that as the spread in quality increases some bidders 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 spread.

An important extension of this work is the consideration of the welfare consequences of the mistakes 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
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

Table 2. Rank, Quality Score and Deflated Price in 2008-2010

		2008		2009		2010	
Country	Rank	Score	Price	Score	Price	Score	Price
Brazil	1	93.65	10.19	91.08	25.48	93.91	25.05
	2	90.00	7.15	90.83	10.70	90.68	12.10
	3	89.95	10.19	89.42	7.47	90.45	11.20
Columbia	1	92.39	16.75	91.68	23.93	94.92	41.40
	2	91.61	9.92	90.63	14.93	93.10	15.81
	3	91.05	9.67	90.21	11.45	91.62	15.76
El Salvador	1	92.67	19.33	91.68	24.63	91.05	29.41
	2	90.88	9.18	89.86	9.19	90.48	18.43
	3	90.05	5.87	89.86	9.46	90.45	8.83
Nicaragua	1	92.25	15.74	94.14	34.68	94.14	37.44
	2	91.43	18.19	91.45	11.11	91.45	13.18
	3	90.28	10.64	91.31	7.43	91.31	7.93

Table 3. Estimates of Quality Score on Deflated Coffee Prices by Rank

	First Place	**Second Place**	**Third Place**	**Fourth Place**
Sensory Variables				
Quality Score	0.089**	0.063	-0.061	0.11**
	(0.044)	(0.052)	(0.068)	(0.053)
Reputation Variables				
Log (No. of Bags)	-0.67***	-0.58***	-0.12	-0.41**
	(0.28)	(0.19)	(0.15)	0.19
Bolivia	-0.037	0.093	0.027	0.27
	(0.24)	(0.23)	(0.21)	(0.20)
Costa Rica	0.040	-0.15		-0.090
	(0.40)	0.35		(0.29)
Columbia	0.045	-0.029	-0.026	0.10
	(0.22)	(0.23)	(0.18)	(0.19)
El Salvador	0.21	-0.069	-0.21	0.11
	(0.21)	(0.19)	(0.18)	(0.18)
Guatemala	0.58	0.25	0.077	0.60
	(0.24)	(0.23)	(0.22)	(0.20)
Honduras	-0.12	-0.049	-0.28	0.13
	(0.25)	(0.26)	(0.21)	(0.20)
Nicaragua	0.21	0.028	-0.32*	0.18
	(0.21)	(0.23)	(0.18)	(0.18)
Correction Variables				

2005	0.33	-0.13	-0.48**	0.24
	(0.11)	(0.17)	(0.21)	(0.15)
2006	-0.16	0.12	-0.12	0.23
	(0.22)	(0.20)	(0.21)	(0.15)
2007	0.37*	0.12	0.13	0.55***
	(0.21)	(0.19)	(0.19)	(0.14)
2008	0.31	0.28***	0.040	0.72***
	(0.21)	(0.18)	(0.20)	(0.15)
2009	1.052***	0.65***	0.066	0.75***
	(0.26)	(0.19)	(0.22)	(0.20)
2010	1.30***	0.95***	0.26	1.049***
	(0.33)	(0.22)	(0.27)	(0.28)
Constant	3.59***	3.31 ***	3.18***	1.90***
	(1.099)	(0.81)	(0.74)	(0.71)
N	42	38	40	39
AIC	48.42	0.748	40.38	19.90
Log likelihood	-7.21	-2.77	-4.19	7.052

Table 4. New model results

	Wilson and Wilson (2014) Replication	Cubic Relationship	Score Mean Deviation Squared
	(1)	(2)	(3)
Sensory Variables			
Quality Score	0.250***	0.402***	0.433***
	(0.0238)	(0.0682)	(0.0780)
Quality $Score^2$	-0.0116***	-0.0409***	-0.0450***
	(0.00233)	(0.00123)	(0.00133)
Quality $Score^3$		0.00159**	0.00163**
		(0.000651)	(0.000651)
Squared Quality-Mean			0.00345
			(0.00409)
Reputation Variables			
Altitude	0.0231***	0.0229***	0.0230***
	(0.00770)	(0.00772)	(0.00770)
Log (Growing Area)	0.0192	0.0190	0.0190
	(0.0121)	(0.0122)	(0.0121)
Log (No. of Bags)	-0.540***	-0.533***	-0.529***
	(0.0482)	(0.0482)	(0.0484)
First Place	0.896***	0.915***	0.917***
	(0.0780)	(0.0789)	(0.0788)
Second Place	0.317***	0.364***	0.367***

	(0.0643)	(0.0674)	(0.0674)
Third Place	0.231***	0.274***	0.276***
	(0.0576)	(0.0604)	(0.0604)
Fourth Place	0.149***	0.186***	0.187***
	(0.0557)	(0.0578)	(0.0578)
Bolivia	-0.243***	-0.231***	-0.232***
	(0.0872)	(0.0875)	(0.0873)
Colombia	-0.389***	-0.384***	-0.384***
	(0.0891)	(0.0892)	(0.0890)
Costa Rica	-0.536***	-0.530***	-0.544***
	(0.104)	(0.104)	(0.105)
El Salvador	-0.320***	-0.315***	-0.317***
	(0.0555)	(0.0556)	(0.0556)
Guatemala	-0.177**	-0.171**	-0.171**
	(0.0819)	(0.0820)	(0.0818)
Honduras	-0.508***	-0.506***	-0.507***
	(0.0660)	(0.0661)	(0.0660)
Nicaragua	-0.288***	-0.278***	-0.275***
	(0.0643)	(0.0644)	(0.0643)
Catuaí	0.169	0.145	0.146
	(0.206)	(0.206)	(0.206)
Caturra	0.0308	0.0280	0.0290
	(0.0459)	(0.0459)	(0.0458)

Mixed	-0.134**	-0.128**	-0.127**
	(0.0525)	(0.0525)	(0.0524)
Other	0.0918**	0.0905**	0.0888**
	(0.0360)	(0.0360)	(0.0360)
Pacamara	0.536	0.529	0.511
	(0.349)	(0.350)	(0.350)
Typica	-0.0404	-0.0442	-0.0434
	(0.0624)	(0.0625)	(0.0624)
Certification			
Organic	0.0280	0.0191	0.0178
	(0.0676)	(0.0676)	(0.0675)
Rainforest Alliance	-0.0841	-0.0876	-0.08904
	(0.0853)	(0.0856)	(0.0856)
Correction Variables			
2005	0.0368	0.0377	0.0356
	(0.0532)	(0.0533)	(0.0533)
2006	0.169**	0.173***	0.171***
	(0.0539)	(0.0541)	(0.0541)
2007	0.316***	0.319***	0.319***
	(0.0550)	(0.0552)	(0.0550)
2008	0.409***	0.408***	0.407***
	(0.0516)	(0.0518)	(0.0518)
2009	0.746***	0.742***	0.736***

	(0.605)	(0.607)	(0.0610)
2010	1.0109***	1.000***	0.996***
	(0.0724)	(0.0728)	(0.0728)
Buyer Variables			
Asian Market	-0.120***	-0.122***	-0.123***
	(0.0283)	(0.0283)	(0.0283)
Nordic Market	0.0722*	0.0670*	0.0658*
	(0.0373)	(0.0374)	(0.0373)
European Market	0.0328	0.0325	0.0321
	(0.0414)	(0.0415)	(0.0414)
Other Market	-0.255**	-0.249**	-0.248
	(0.119)	(0.120)	(0.120)
Buyer Cooperation	0.0274	0.0303	-0.0300
	(0.0310)	(0.0310)	(0.0309)
Sigma	0.281***	0.282***	0.281***
	(0.00871)	(0.00881)	(0.00880)
Intercept	1.9754***	1.720***	1.650***
	0.188	0.213	(0.192)
N	1039	1039	1039
Log Likelihood	416.495	419.596	419.949
AIC	-758.990	-763.192	-761.898

Table 5. Interactions in the new model results

	Cubic Relationship with Rank and Score Interaction (4)	**Score Mean Deviation Squared with Rank and Score Mean Deviation Interaction (5)**
Sensory Variables		
Quality Score	0.426***	0.557***
	(0.0775)	(0.104)
Quality Score^2	-0.0533***	-0.0714***
	(0.0162)	(0.0196)
Quality Score^3	0.00295***	0.00327**
	(0.000111)	(0.000111)
Squared Quality-Mean		0.0112**
		(0.00547)
Reputation Variables		
Altitude	0.0229***	0.0221***
	(0.00764)	(0.00766)
Log (Growing Area)	0.0173	0.0177
	(0.0120)	(0.0120)
Log (No. of Bags)	-0.526***	-0.525***
	(0.0478)	(0.0480)
First Place	2.280***	1.120***
	(0.832)	(0.145)

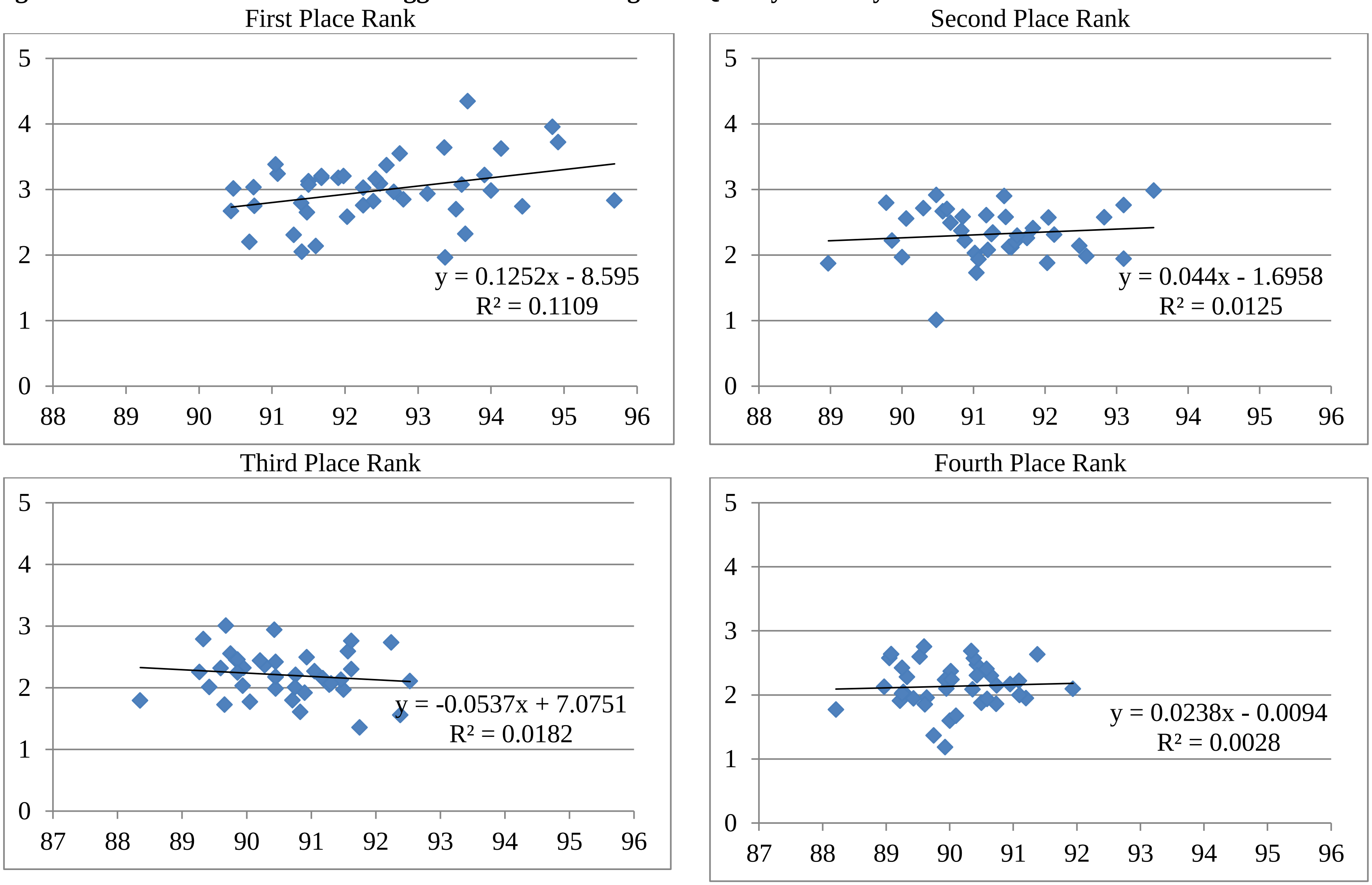
Second Place	1.257**	0.432***
	(0.561)	(0.119)
Third Place	1.496***	0.455***
	(0.466)	(0.103)
Fourth Place	0.581	0.252***
	(0.478)	(0.0962)
First Place*Quality	-0.179*	
	(0.104)	
Second Place*Quality	-0.126*	
	(0.0740)	
Third Place*Quality	-0.172***	
	(0.0645)	
Fourth Place*Quality	-0.0627	
	(0.0688)	
First Place*Quality-Mean Squared		-0.0160**
		(0.00812)
Second Place*Quality-Mean Squared		-0.0100
		(0.00739)
Third Place* Quality-Mean Squared		-0.0181**
		(0.00779)

Fourth Place* Quality-		
Mean Squared		-0.00973
		(0.00862)
Bolivia	-0.230***	-0.228***
	(0.0865)	(0.0867)
Colombia	-0.371***	-0.374***
	(0.0883)	(0.0884)
Costa Rica	-0.520***	-0.534***
	(0.102)	(0.104)
El Salvador	-0.318***	-0.312***
	(0.0550)	(0.0552)
Guatemala	-0.168**	-0.164**
	(0.0813)	(0.0813)
Honduras	-0.507***	-0.501***
	(0.0655)	(0.0655)
Nicaragua	-0.270***	-0.288***
	(0.0638)	(0.0640)
Catuaí	0.104	0.112
	(0.207)	(0.207)
Caturra	0.0222	0.0237
	(0.0455)	(0.0456)
Mixed	-0.124**	-0.127**
	(0.0520)	(0.0521)

Other	0.0912**	0.0917**
	(0.0357)	(0.0358)
Pacamara	0.521	0.486
	(0.345)	(0.346)
Typica	-0.0400	-0.0465
	(0.0618)	(0.0618)
Certification		
Organic	0.0230	0.0201
	(0.0669)	(0.0671)
Rainforest Alliance	-0.0969	-0.0954
	(0.0848)	(0.0850)
Correction Variables		
2005	0.0401	0.0279
	(0.0532)	(0.0530)
2006	0.183***	0.175***
	(0.0538)	(0.0538)
2007	0.331***	0.325***
	(0.0550)	(0.0548)
2008	0.417***	0.411***
	(0.0522)	(0.0517)
2009	0.742***	0.736***
	(0.603)	(0.0607)
2010	1.001***	1.000***

	(0.0721)	(0.0724)
Buyer Variables		
Asian Market	-0.124***	-0.122***
	(0.0281)	(0.0281)
Nordic Market	0.0626*	0.0608
	(0.0373)	(0.0373)
European Market	0.0343	0.0359
	(0.0410)	(0.0411)
Other Market	-0.248**	-0.244**
	(0.118)	(0.118)
Buyer Cooperation	0.0333	-0.0307
	(0.0307)	(0.0308)
Sigma	0.279***	0.280***
	(0.00871)	(0.00874)
Intercept	1.698***	1.468***
	0.216	(0.250)
N	1039	1039
Log Likelihood	423.240	423.0146
AIC	-762.479	-760.0292

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



Source: Author's Estimation

Figure 2. Box Whisker Plots of Coffee Quality Scores 2004-2010

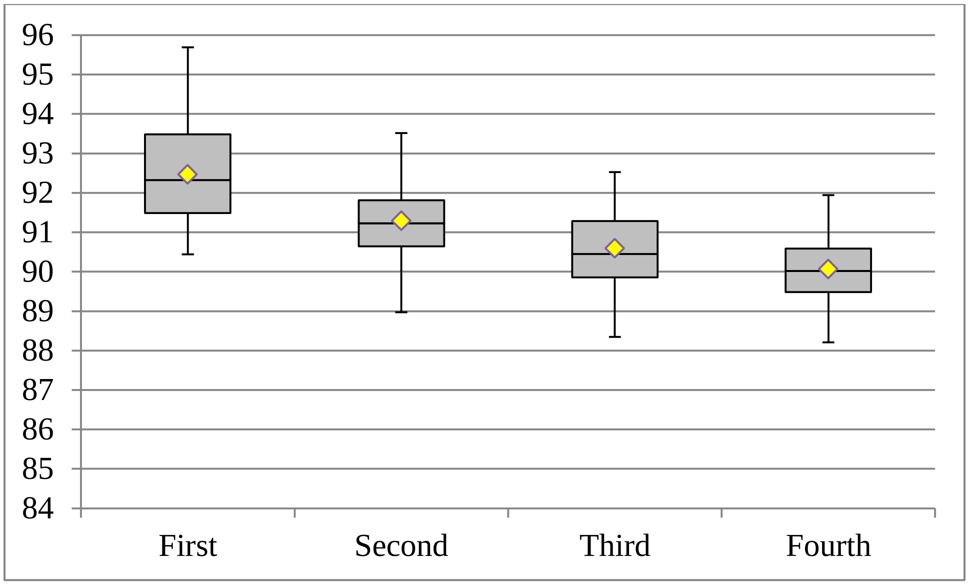


Figure 3. Predicted Price and Marginal Effects of a Quadratic vs. Cubic Specification of Quality

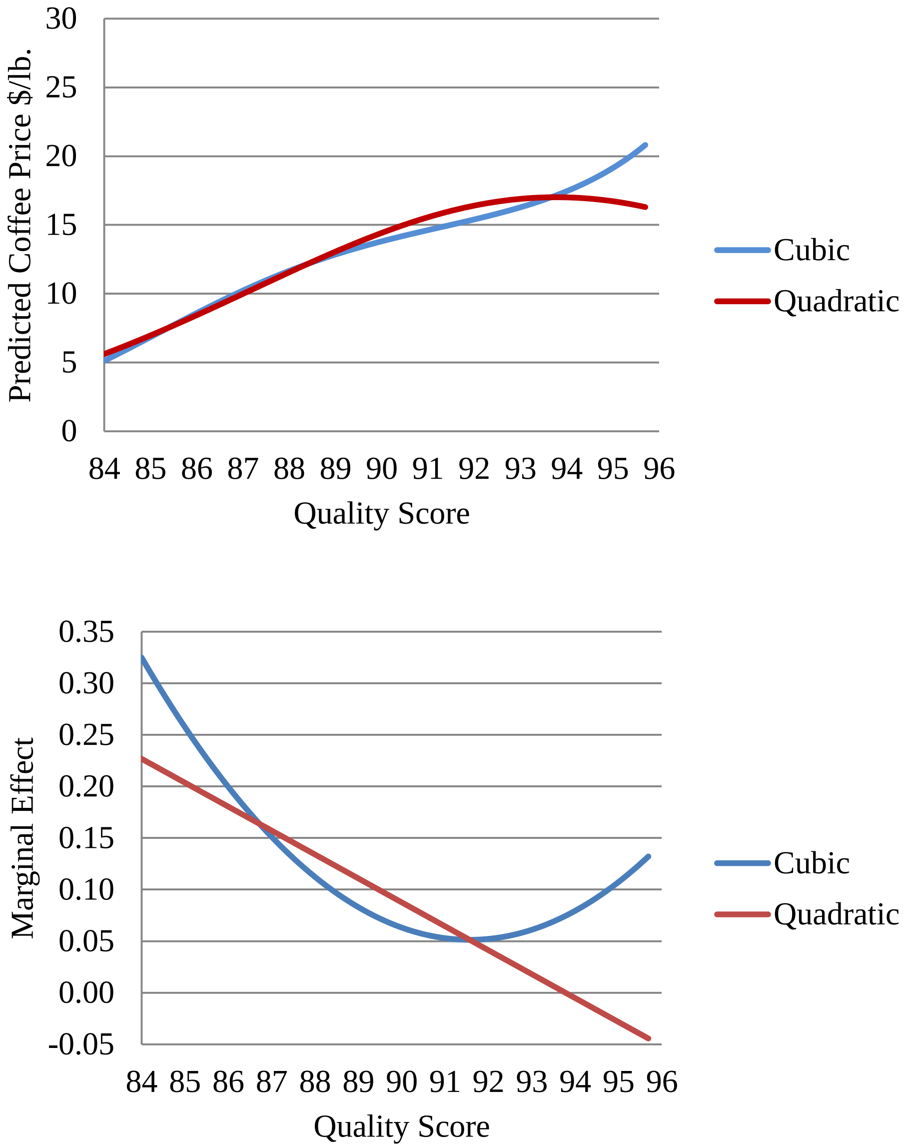


Figure 4. Predicted Coffee Prices from Model 4 over Relevant Ranges of Quality Scores

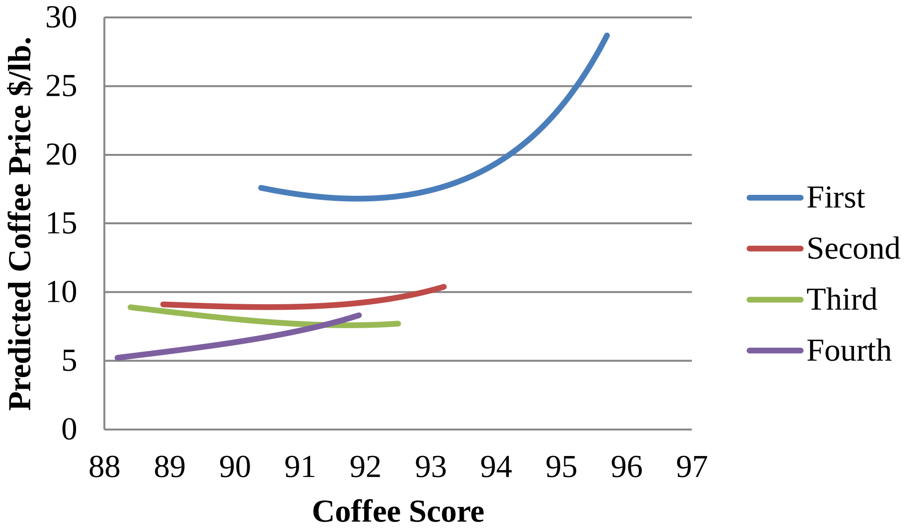


Figure 5. Predicted Coffee Price from Model 5 over Relevant Ranges of Squared Mean Deviation of the Quality Score

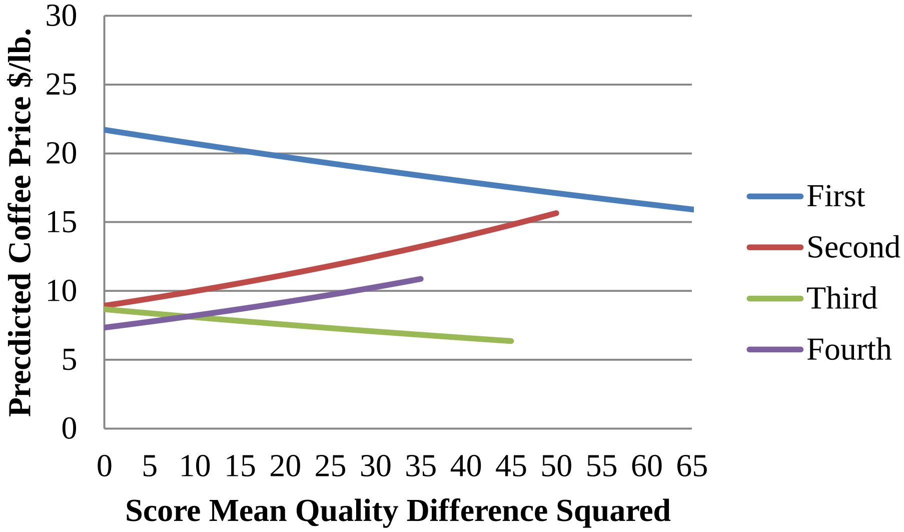
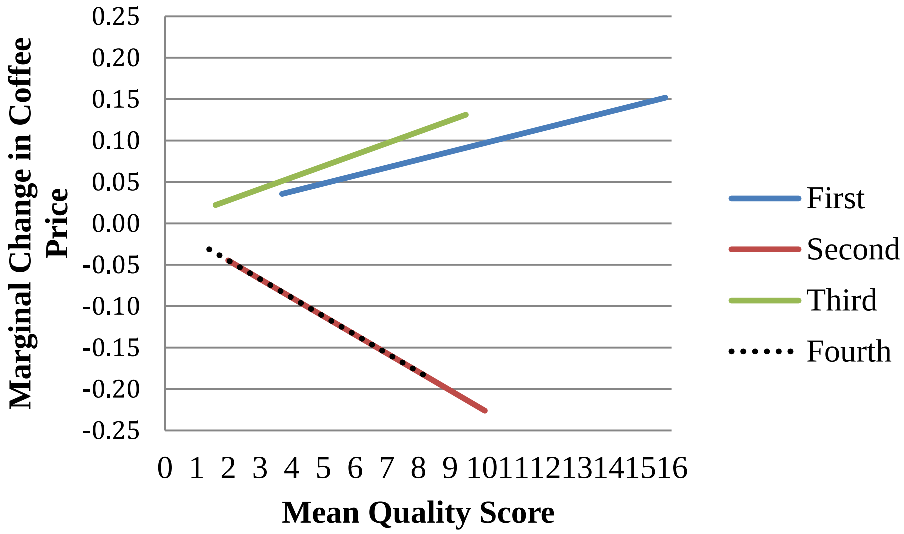


Figure 6. Marginal Change in Price of a One Unit Change in the Mean Quality Score by Rank



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