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.

JEL Codes: Q13, D44, C24

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

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 excellent 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 suggest 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 as statistically significant effect on the price. 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).

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 assessment is standardized and rigorous as the juries are highly trained professionals who cup based on the same set of predetermined criteria. Those coffees without defect and which obtain an average quality score of 84 or above out of 100 in the final round receive the prestigious Cup of Excellence Award. Based on their quality score, the award-winning coffees are ranked and entered into an online auction (Spindler, 2012, Wilson and Wilson, forthcoming).

Donnet, et al. (2008), Teuber and Herrmann (2012), 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 have a high quality score in absolute terms.” While these authors recognize this interesting result 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 suing heuristics of representativeness and framing to make purchasing decisions. To begin this investigation, consider Table 1. This table 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 the 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 Brazillian and the top El Salvadorian coffees. If so, the purchasing pattern in Table 1 reflects a refesal in preferences. This violation of transitivity suggests that buyers (or at least 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.

The intransitivity can be seen over time for the same market. Consider the case of El Salvador. The quality score for first place coffees was 92.67 in 2008, 91.68 in 2009 and 91.05 in 2010; however, the coffee prices 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, paying more for lower quality coffees than higher quality.

These results call into question the effect of quality on price. As the previous papers provide evidence that quality affects quality 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? 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, and the relationship is negative in the third place coffees. The graphical presentation is limited so a basic regression is run by rank to see the effect of quality holding country of origin, year, and lot size (number of bags sold) constant see Table 3. Confirming the results of the graphs, only first and fourth place coffees have a statistically significant relationship between quality score and price.

One possible breakdown in the statistical relationship 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 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 that the previous literature has failed to address. 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.

One explanation of the reversal, suggested by Kahneman (2011), reflecting the work that he did with Amos Tversky, 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 the buyers focus on the rank particularly first, second and third place, what I call the “Olympic heuristic” and that quality is only secondary information. 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 make 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 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 higher price than a similar coffee with the average score for the market is 86. In particular, the modeling indicates differential effects of mean 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 (Smith and Huang, 1995, Hite and et al., 2001), 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 $i = 1, \ldots, N$ 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.

Data

The data for this model are the same as Wilson and Wilson (forthcoming). The data set includes information on the final price of each auction for each coffee, excluding shipping costs, the quality score, farm data (including growing conditions, processing methods, name of grower, etc.), and buyer data. All prices are in 2011 prices based on the Producer Price Index. The summary statistics are of the core data are in Table 2.

Model

The hedonic model provides a framework to understand how quality affects price. In the preliminary model, we assessed quality and controls such as 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):

(1) $\ln(P_i)$

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

where the $Reputation_{ij}$ now include altitude, growing area, and dummy variables for Organic and Rainforest Alliance certifications. I scale the quality score to range 1-17 rather than 84-100 to aid efficient estimation.

Replication of Wilson and Wilson (forthcoming)

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 puts a floor on the price. 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[1] 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 1 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; however, additional testing will further support for 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. 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, variety such as Catuaí, Caturra or Pacamara have not 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.

[1] 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, P. E., 1981. Estimation with Correctly Interpreted Dummy Variables in Semilogarithmic Equations *Am. Econ. Rev.* **71**.

New Models and Results

In the previous section I replicate the model from in Wilson and Wilson (forthcoming). To advance the analysis, I consider the effects of adding a cubic term and squared difference of quality and its mean for the market. The cubic term potentially may rectify the unexpected result of the maximum quality score. The squared difference of quality and its mean is considered to see if the buyers adjust their willingness to pay based on a measure of the spread of quality in the market.

The cubic terms are statistically significant and the reputation, certification and control variables are similar to the previous model (see Table 4, Model 2). 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. However, the marginal benefit of additional quality falls and rises suggesting a U-shape to the marginal function. Therefore, mid-range quality scores generate a smaller marginal benefit than lower and higher quality scores.

The squared mean deviation of quality from its mean 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

If representativeness holds then, the rank will hold most of the value of the price. Furthermore, statistically significant interactions of the quality score with rank indicate that for the same quality score higher rank leads to higher prices. More importantly, 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 model 4 provides evidence in support of representativeness. The interaction terms of rank and quality are statistically significant and negative. To add in interpretation of this result consider Figure 3. I used the relevant range of variables to predict the price for the ranks Brazilian coffees in 2004 bought by North Americans. 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 first place coffees over the quality range increase at an increasing rate while third place coffees fall throughout the range, so much so that fourth place coffees receive a higher price for qualities over 91.4.

Framing

The context of the market may make significant impacts on the market. If framing holds then the spread of the quality score from the mean (squared) will have a significant effect on the price. However, the wider spread will have differential effects depending on the rank of the coffee. For example higher ranked coffees should benefit from great spread, because buyers will bid up the prices of these better coffees to avoid the lower quality coffees. In order to see this effect, I interacted the squared quality score to its mean with the rank.

As hypothesized, I find evidence of framing Table 4 Model 5. As the spread increases, the model predicts (see Figure 4) that second and fourth place coffees will see a rise in price while the first and third place coffee prices fall. One challenge with interpretation given the definition of the variable is that the spread could increase because the individual coffee quality score increased relative to the mean or the mean fell relative to the coffee quality.

To resolve this issue, I calculate the marginal effect of a change in the mean on the price. The marginal are in Figure 5. The striking result is that for every unit increase in the mean quality rises first and third place coffees receive an increase in price. The opposite holds for second and fourth place coffees. In short if the quality of the market increases then buyers pay a higher price for first place coffees. This result further supports the representative heuristic.

Conclusion

The series of estimations suggest that the surprising result of higher quality may not earn the higher price is supported by representativeness and framing. Further work will determine the welfare results of these heuristics on producers

Table 1. 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 2. Summary Statistics

Variable	Obs.	Mean	Std Dev	Min	Max
Auction Price (2011 US$/pound)	1039	5.993	4.733	1.200	80.220
ICO Composite Price (2011 US$)	1039	1.323	0.324	0.805	2.300
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 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

	Model 1 **Wilson and Wilson (2014) Replication** Equation (3.1) MLE	**Model 2** **Cubic Relationship** Equation (3.1) MLE	**Model 3** **Score Mean Deviation Squared** Equation (3.2) MLE
Sensory Variables			
Quality Score	0.250***	0.402***	0.433***
	(0.0238)	(0.00.0682)	(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. New model results

	Model 4 Cubic Relationship with Rank and Score Interaction	Model 5 Score Mean Deviation Squared with Rank and Score Mean Deviation Interaction
	Equation (3.1)	Equation (3.1)
	MLE	MLE
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-		-0.0181**

Mean Squared		
		(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. Box Whisker Plots of Coffee Quality Scores 2004-2010

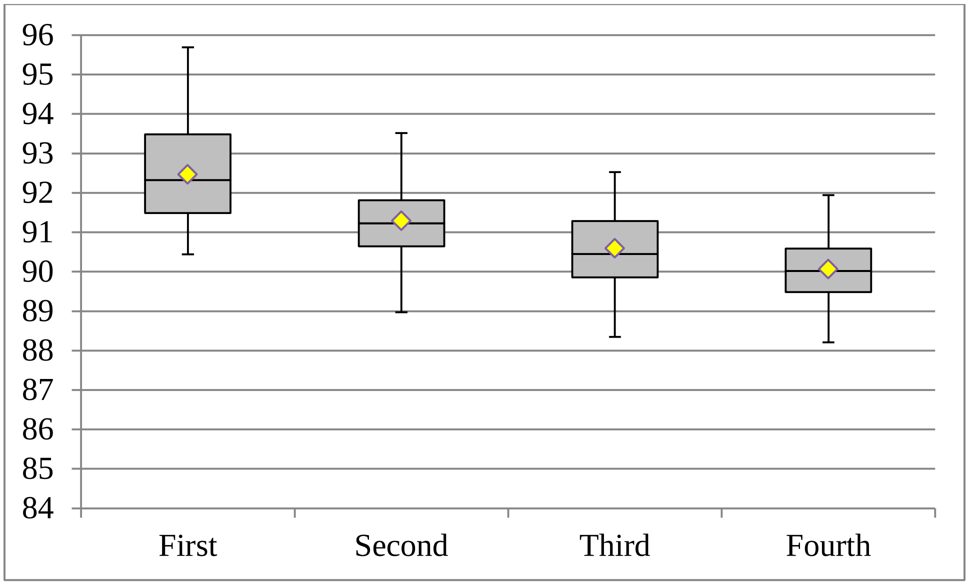
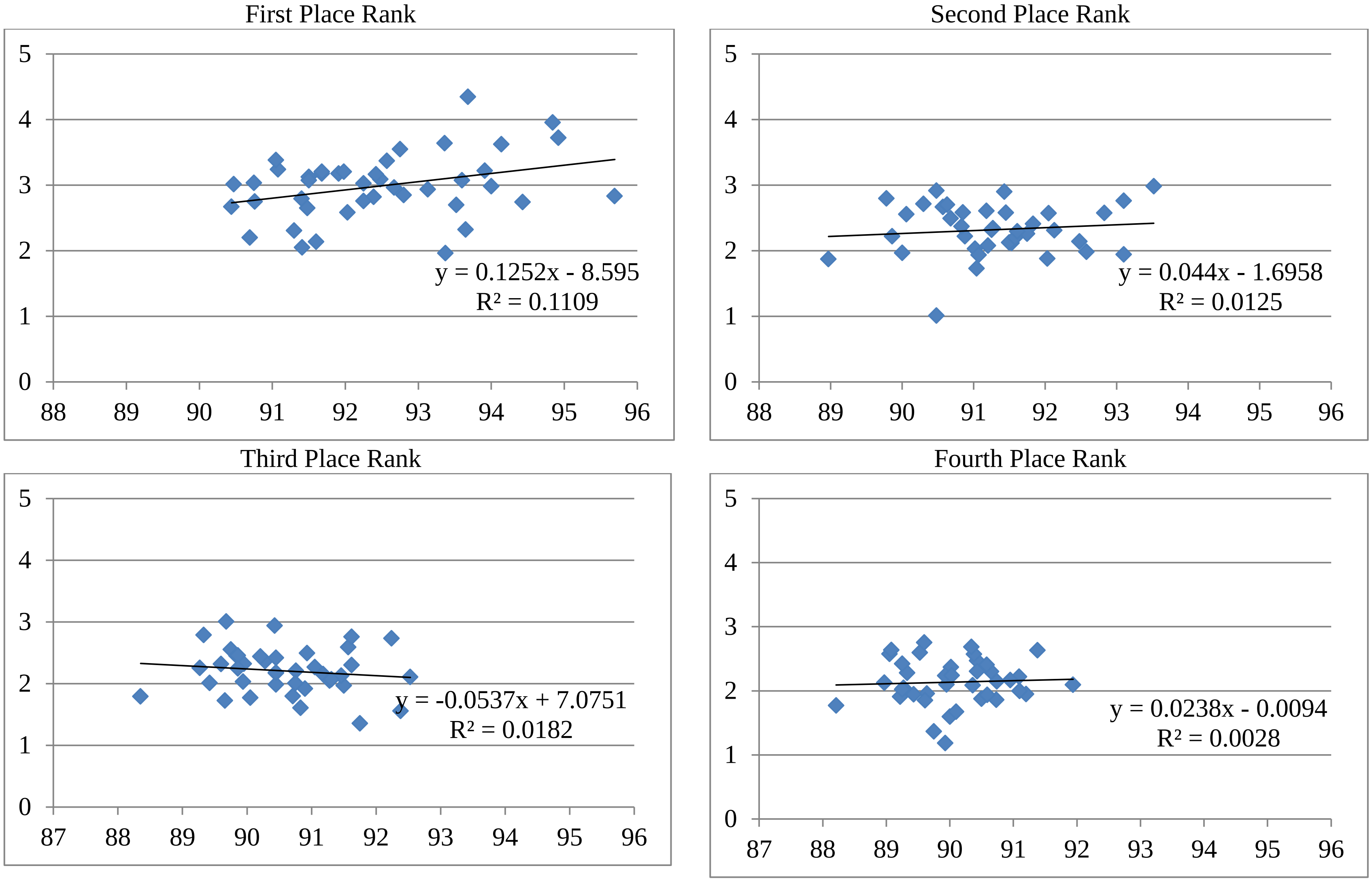


Figure 2. Scatter Plots of Deflated Logged Coffee Prices against Quality Score by Rank



Source: Author's Estimation

Figure 3. Predicted Coffee Prices from Model X over Relevant Ranges of Quality Scores

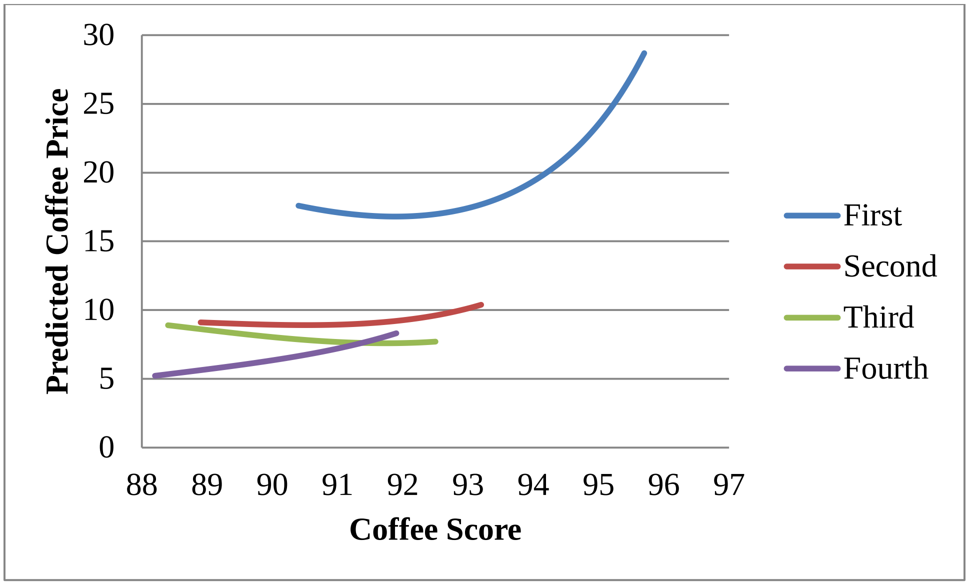


Figure 4. Predicted Coffee Price from Model Y over Relevant Ranges of Score Mean Difference Squared

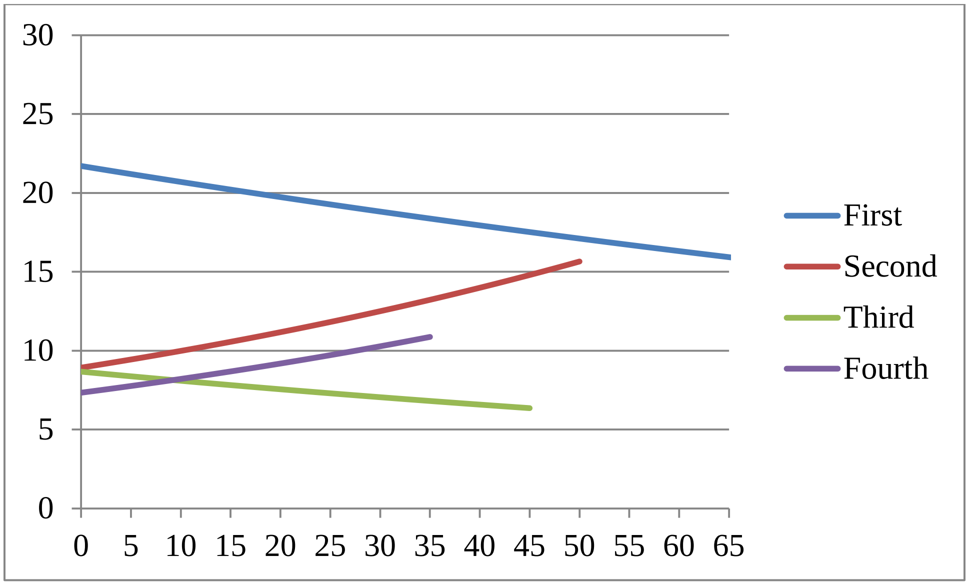
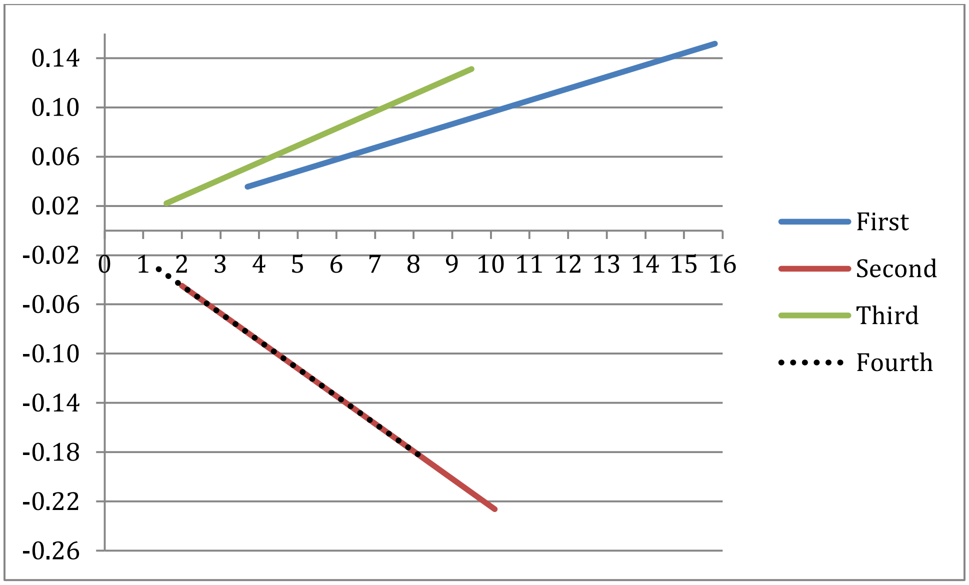


Figure 5. Marginal Change in Price of a One Unit Change in the Mean Quality Score by Rank



Appendix[1]

The Cup of Excellence Programs

The Cup of Excellence (CoE) programs are competitions designed to allow farmers the opportunity to test their best quality lots against those of other farmers from the same country. The Association for Coffee Excellence (ACE) hosts these programs each harvest season and entry is free to any farm or cooperative within the participating country. Lots submitted to CoE go through a rigorous elimination process where coffees are "cupped" by recognized national and international coffee graders and scored based on quality. Cupping refers to the process of roasting, grinding, brewing, and tasting coffees according to exact and standardized parameters to ensure consistent results. Submitted coffees must pass three rounds of elimination—any coffee discovered to have a defect in any round is dropped from the competition. Those coffees obtaining a quality score of 84 or above out of 100 in the final round are given the prestigious *Cup of Excellence Award*, and the award-winning coffees are then ranked according to score (i.e. the highest scoring coffee in a given program is awarded first place, the next highest quality score receives second place, etc.). The winning coffees are then entered into an online auction[2].

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

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[1] This appendix is text directly from Wilson, A. P., Wilson, N. L. W., forthcoming. The Economics of Quality in the Specialty Coffee Industry: Insights from the Cup of Excellence Auction Programs, *Agricultural Economics*.

[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"

predominantly funded by roaster/importer members, they are able to transmit the vast majority of auction prices directly to the producer (cf. Talbot, 1997).

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

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