Costly Choices: Does the U.S. Retail Market Reward Coffee Origin Labeling?

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Selected Paper prepared for presentation at the 2016 Agricultural and Applied Economics Association Annual Meeting, Boston, Massachusetts, July 31 to August 2.

May 25, 2016

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1 Introduction

Single origin supply chains and single origin labeling have received considerable attention from coffee producers, expo government, retailers and consumers. Coffee producers and their organizations believe that development of single origin supply chains might provide a more direct link to the higher prices in coffee consuming nations. Columbia's National Federation of Coffee Growers began its longstanding campaign for 100% Columbian coffee in 1958.

In the 1990s, the International Coffee Organization (ICO) launched a "single origin" coffee as part of a gourmet coffee project [ICO 2000]. The sought to define and implement supply chains for specialty coffee, coffees distinguished from commodity coffees by their high quality. The goal was to reduce the gap between high and rising specialty coffees prices in the developed world and low and falling coffee prices in producing countries (ICO, 2000).

The ICO successes and the continuing rise in prices for specialty coffees encouraged development agencies, producers and larger retailers to invest considerable capital and time in experiments to define, secure and legally sanction single origin coffees with trademarks and geographical indications protection (Quinones et al 2015; Hughes 2009; Watson 2016). Specialty coffee retailers wager are steadfast in the view that consumers will pay more for increased diversity in single origin coffees (Kusek 2014).

Empirical evidence on the value added by single origin supply chains and labeling remains limited. The most well established evidence is derived from internet specialty auctions at a midpoint in the coffee supply chain (Donnet et al. 2008; Donnet et al 2010; Teuber 2010; Wilson and Wilson 2014). The auction bidders in these mid-supply chain auctions, however, represent a tiny slice of wholesalers, roasters and gourmet retailers. The 2012 Brazilian Cup of Excellent auction involved only 634 bags of coffee and auction revenue of $369 thousand compared to U.S. imports of 22 million bags and specialty coffee market retail sales of $10 to $12 billion (SCAA 2012).

Internet specialty wholesale auctions may give misleading signals as to consumer values, especially those associated with single origins as distinct from flavor and pre-auction cup rankings. Wholesale auction participants may want a specific origin not to sell as a retail,

single origin coffee, but to create a distinctive blend. The origin source may disappear in an proprietary blend. Wholesaler buyers also seek a coffee not for its specific flavors or origin but for its winning cupping rating in a pre-auction. Retailers may seek highly ranked coffees to signal the prestige and high quality of their retail outlets by stocking a coffee that placed first, second or third in a Cup of Excellence (Teuber, 2010). Finally, internet auctions are not held simultaneously for all countries, but each country-level auction is run sequentially over the global harvest season. The seasonality of country-level auctions makes it difficult to distinguish the value of single origin effects from seasonality in coffee prices.

This present paper presents estimated single origin value added premiums based on retail prices for specialty coffees offered in the U.S. market from 1997 to 2014. The data include retail price, the quantity sold in a retail package and label descriptions that identify 28 different origins. Label descriptions also include information on cultural practices such as natural and organic production, market channels such as Fair Trade and whether the wholesale source was a specialty auction. In addition, data for each coffee contains a score for roast type and a cup rating determined by professional tasters. The overall data set permits and evaluation how coffee origin affects market values, as well as how different coffee supply chain segments affect value, including the coffee producer, market channel and roaster.

The valued added estimates for 28 coffee origins show both the potential benefits and the potential risks of supply chain investments in origin labeling. Origins with long-standing reputations for high-quality coffee have positive market premiums that are large, statistically different from zero and reasonably stable over time. The largest of these positive and stable values are for smaller growing areas such as Panama, Jamaican and Hawaii that are also widely recognized by consumers.

Eight other origins have positive value added premiums that are stable or increasing when estimated with other coffee attributes or in the most recent time period. But there are also risks of with origin labeling. Two origins are associated with negative values that are statistically different from zero, making it almost certain that origin labeling for these sources reduce revenue. Five of the 28 origins have no measurable market benefit–their value added premiums are not statistically different from zero. A final ten origins have positive

premiums that are statistically different from zero, but their value added appears to be declining over time.

Origins with long-standing reputations for high-quality coffee have positive market premiums that are large, statistically different from zero and reasonably stable over time. The largest of these positive and stable values are for smaller growing areas such as Panama, Jamaican and Hawaii that are also widely recognized by consumers. The stability of large premiums over time suggests that the natural and regulatory constraints in these smaller growing areas prevent producers from bringing additional acres into production with subsequent declines in origin-specific prices. Besides smaller growing regions, 7 other origins that appear to be positive, statistically different from zero and increasing over time.

2 Method

Lancaster [1966] and Rosen [1974] develop a theory of markets for attributed goods. Unlike homogenous commodities, a given quantity of an attributed good embodies a package of attributes that are costly to produce and valued by consumed. Lancaster and Rosen show that at a hedonic market equilibrium there is a price function, f, that describes the equilibrium relationship between market price, p, of a unit of a good, x, and the atttributes, a_I, $i \in (1, ..., I)$, that are valued by consumers and costly to produce. The equilibrium relationship is

$$p = f(a_1, ..., a_i, ..., a_I) \tag{1}$$

Marginal value added premiums are derived from equation (1) by differentiating f with respect to attribute a_i,

$$\frac{\partial p}{\partial a_i} = \frac{\partial f(a_1, ..., a_i, ..., a_I)}{\partial a_i} \tag{2}$$

Value added, $\frac{\partial p}{\partial a_i}$, may be positive or negative depending upon whether consumers see an attribute as desirable or detrimental. Positive value added is referred to as a premium. Negative value added is called a discount. Finally, value added may be zero if consumers are unaware of an attribute or are indifferent to it presence in a good.

The international specialty coffee market fits the hedonic model quite well. The market

is reasonably competitive in the sense of having many suppliers and consumers. Entry into the market is widely accessible even for small producers and intermediaries. Within the model, origins are one set of market attributes. Origins can be distinguished from other coffee attributes by denoting with the j^th origin as θ_j, $j \in (1, ..., J)$ where J is the total number of origins. A typical hedonic market market lets f be a semi-logarithmic function.

We first model coffee retail price as if consumers are indifferent to non-origin coffee attributes. Using the semi-logarithmic function, *Model 1* is the first empirical model of coffee price:

$$ln(p) = \beta_0 + \sum_{j=1}^{J} \hat{\beta}_{\theta_j} \theta_j + \eta \tag{3}$$

where p is the price of a coffee, β_0 is a constant, $\hat{\beta}_{\theta_j}$ is the coefficient of the j^{th} origin and η is a random stochastic term. By differentiation, the coefficient $\hat{\beta}_{\theta_j}$ is the value added of the j^{th} origin, the percentage change in coffee price for coffee from the j^{th} origin.

Model 1 treats coffee prices as if they are only influenced by coffee origins. The value added coefficients, $\hat{\beta}_{\theta_j}$, measures the average value added of coffee origin, but also the valued added all the other factors that might be correlated with coffee origin. For instance, if Indonesian coffees are often associated with dark roasts while Costa Rican coffees are associated with lighter roasts. *Model 1* doesn't control for the net valued added of coffee origin. It does not allow one to separate out of the effect of roast type on retail coffee prices, so the effect of roast type gets absorbed into the origin coefficients. The origin coefficients end up measuring the value added by origin, but also the value added of all the other effects that are correlated with origin.

The value added effects of non-origin attributes are separated from the value added of origin by explicitly including the non-origin attributes in the pricing model [Teuber, 2010a,b; Wilson and Wilson, 2014; Wilson et al 2012]. *Model 2* includes other coffee attributes that may be important to consumer choice and prices. *Model 2* is:

$$ln(p) = \beta_0 + \sum_{j=1}^{J} \beta_{\theta_j} \theta_j + \sum_{k=1}^{K} \beta_{A_k} A_k + \sum_{n=1}^{N} \beta_{M_n} M_n + \beta_{AS} AS + \beta_{CR} CR + \eta \tag{4}$$

where β_{A_k} are the marginal value added coefficients for K agricultural production attributes,

β_{M_n}, are the marginal value added coefficients for N market channel attributes, β_{AS} are the value added coefficient for a roaster processing score and β_{CR} is the value added coefficient of a profession cup rating. Each of the coefficients in *Model 2* give value added a percentage change in coffee price for a one unit change in a given variable. When the variable is a dummy variable, the value added coefficient gives the percentage change in price for the presence of that information on a coffee label, whether the information is an origin or a production practice.

Model 2 allows the estimation of the value added by origins net of the other variables variables that add value to specialty coffee. In addition, estimates of *Model 2* provide insight into the relative value of other specialty coffee attributes that are under the control of supply chain participants. To the extent that these other attributes add or detract value added, supply chain participants can manage these other attributes to optimize their contribution to retail specialty coffee value and prices.

3 Data

The data are detailed retail price and coffee attribute data for U.S. coffees from 1997 to 2014 published by Coffee Review (CR). CR is an online buying guide for coffees sold by local, national and international retailers. Since 1997, CR has become the most widely read coffee review. CR's data include full attribute information and expert cupping evaluations for almost 4,000 coffees sold across the globe. The data include 1,350 complete observations for the U.S. market. These data were narrowed 1,258 observations to exclude single serve packages and focus on coffees routinely sold in 12 to 16 ounce packages.

Coffee prices per pound were calculated and adjusted to the 2014 price level using the current series Consumer Price Index for all urban consumers (BLS 2016). Origin dummies formulated origins for all single origin coffees as indicated by coffee label descriptions. The label descriptions were also used to formulated dummy variables for agricultural production practices and market channels. The roaster score and cup rating were derived from the CR reviews.

Table 1 reports descriptive statistics for the coffee review data. The first group of

variables are coffee prices. Price is mean price per pound at the 2014 price level for all the specialty coffees in the data. Price at baseline is the mean price for 189 coffee observations where all dummy variables were equal to zero. For the latter coffees, origin as well as agricultural production choices and market channel are unstated in the label.

Table 1 lists the 28 origin dummy variables derived from the coffee labels. Specialty coffees are uniformly derived *arabica* green coffee beans, so only *arabica* exports are included in the origins. The origins include the top 5 coffee global *arabica* producers tracked by the USDA Foreign Agricultural Service (FAS) but also include 3 origins not listed in FAS statistical reports–Thailand, Timor and Zambia (FAS 2016).

Market channel dummy variables include Auction and Fair Trade. Auction identifies a coffee label that states was procured through a Cup of Excellence auction or similar online specialty coffee auction. Fair Trade means the label carries the Fair Trade Certification.

Agricultural production choices stated in labels and measured with dummy variables are Peaberry bean type, Natural, USDA Organic and Estate produced coffee. Peaberry is coffee from seed pods that contain only one coffee bean rather than the usual two beans per pod. Natural is a label statement that it is natural coffee or is naturally made or produced coffee. Estate coffee is coffee derived from production at a single coffee farm.

The Agtron Score variable measure the depth of roast–whether the roast is dark, light or somewhere in between. The Agtron Score is produced by measuring the reflected light from roasted coffee using an spectrometer manufactured by Agtron, Inc. Agtron, Inc., produces these spectrometers especially for the coffee industry. An Agtron score is a number between 1 and 100. Less reflected light means the beans are darker in color, so the Agtron score is smaller the darker the bean.

Food science research indicates that the most flavorful roasts for *arabica* coffee are in the range of Agtron scores of 45 to 55 (Chung 2013). The mean Agtron Score of 51 with a standard deviation of 7.8 implies that at least 30% of the coffees in the data are outside the optimal roasting range. The mean data alone suggest that there is substantial room for improvement roast quality control by specialty coffee supply chains.

The last variable is the Cup Rating of professional coffee reviewers. Cupping procedures follow strict guidance of the Specialty Coffee Association of America. Cuppers first rate the

each coffee on dimensions such as aroma, body, flavor, acidity and aftertaste. The coffee is then given an aggregate rating from 1 to 100. Only coffees with a rating equal to or greater than 80 qualify as specialty coffee (SCAA 2015). The mean Cup Rating is 91.6, just over the midpoint for specialty coffee.

4 Estimation

The value added coefficients in *Models 1* and *2* were estimated using ordinary least squares (OLS). The stochastic terms in *Models 1* and *2* are likely to be correlated across retail coffee observations. Stochastic correlations may arise between at a number of different levels, but the most salient one may be at the level of individual retailers. Any particular retailer has geographical presence, an online presence, an advertising strategy and a regular clientele. None of the latter variables are measured by explicit variables in *Models 1* and *2*, so their effect enters into the stochastic terms and least to stochastic cross-correlations.

Panel data models and clustered robust errors are two ways to control for stochastic cross-correlations. Panel data models give consistent estimates when observations are correlated by a single additive error term and the remaining stochastic effects are independent. In the CR data, the uneven panels are the coffees offered by a particular retailer and one would assume the remaining stochastic error was independent across and within panels. However, retailers may have some coffees that are more prominent in their marketing strategies and others that are less prominent. Featured coffees may vary over time. The result of these alternate retailers marketing strategies may introduce either serial correlation or heteroskedasticity into the remaining, non-panel errors. In the latter case, the variance-covariance matrix in panel data models is biased and OLS with a clustered-robust control variance-covariance matrix is a better estimation strategy (Cameron and Trevedi 2005). Accordingly, both *Models 1* and *2* are estimated using the latter approach with clusters at the retailer level.

5 Results

Table 2 lists estimates for *Model 1* and *Model 2*. Model 1 is estimated on the full data set with all 1,258 observations from 1997 to 2014. Model 2a are the estimates for Model 2 using the full data set, all observations from 1997 to 2013. Model 2b is estimated on a subset of the data including only the observations for 2012 to 2014. Comparison of the estimates for *Model 2a* and *Model 2b* lends gives insight into how the value added coefficients may be trending in time as specialty coffees become more established in the market and more familiar to both supply chain participants and consumers. Origin value added coefficients are grouped to facilitate comparisons.

The valued added estimates for 28 coffee origins show both the potential benefits and risks. The estimates first underscore the risk of estimating origin value added premiums without controlling for other coffee attributes. Excluding Tanzania which has a zero coefficient in *Model 1*, the value added coefficients are on average 15% smaller when estimating jointly with other attributes in *Model 2* than when estimated with the origin-only *Model 1*. The origin values for Colombia, Brazil, Ethiopia and Rwanda drop by 50% or more from *Model 1* to *Model 2*. There is some good news. The origin value added goes from -20% in *Model 1* to positive 12% in *Model 2*

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Eight other origins have positive value added premiums that are stable or increasing when estimated with other coffee attributes or in the most recent time period. But there are also risks of with origin labeling. Two origins are associated with negative values that are statistically different from zero, making it almost certain that origin labeling for these sources reduce revenue. Five of the 28 origins have no measurable market benefit–their value added premiums are not statistically different from zero. A final ten origins have positive premiums that are statistically different from zero, but their value added appears to be declining over time.

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The risks and costs of origin labeling are apparent for 17 of the 28 estimates. Ten of these 17 estimates are positive in the full sample and 9 are statistically different from zero. However, these premiums are substantially smaller in the most recent subsample period from 2012 to 2014. Four of the 10 origin values are not statistically different from zero in the 2012-2014 period.

The situation is worse for 7 other origins. Five of these 7 origin values are not statistically different from zero. Two of the 7 are negative, meaning that costly labeling actually reduces the prices for these coffee origins. Not surprisingly, the latter two origins are not present in the coffees sampled for 2012 to 2014.

The hedonic equation estimates suggest other strategies other than origin labeling may add significant value to retail consumers and the specialty coffee supply chains. The estimates show that coffee prices also vary systematically with roast as represented by Agtron Score and Cup Rating. In *Model 2a*, a 5 unit increase in cup rating increases coffee price by an amount larger than 19 of the 27 coffee origins. Coffee producers and others who are considering origin labeling may find it more advantageous to invest in research on roasting and improved flavors than in origin labeling.

Figure 1 presents estimated coefficients as the percentage change in price for given changes in coffee attributes. The orange bars represent the value added coefficients from *Model 2a*. The green bars represent the *Model 2b* coefficient estimates. The height of the blue line represents the percentage change in price that might be expected from a 5 unit change in Cup Rating. In Figure 1, it's easy to see that a 5 unit change in Cup Rating results in a greater percentage price increase than origin labeling for 19 of the 28 origin.

Roasting and the sensory quality of specialty are strategics complements to origin labeling or, when addressed independently of origin, important substitutes to origin labeling.

6 Conclusions

Market premiums for original labeling are substantial for origins with long-standing reputations for high quality coffee. Growing area constraints or export quantity management may be important in the maintenance of positive origin premiums. Implicit prices do show positive and significant rewards to flavor characteristics, roast type and recent innovations in single-serve packaging. Market channels that identify high quality coffee add value to coffee sales. The U.S. retail market does not appear to offer positive premiums for Fair Trade, estate labeling or organic certification.

The results suggest strategies other than origin labeling may be advantageous either as an addition to origin labeling or to set a high quality foundation for origin labeling. Estimates show that prices are roaster choices and sensory qualities of the brewed coffee. The data show that roast type varies substantially, from very, very dark to very, very light– much more variation, apparently, then needed for optimal extraction of coffee flavors and sweetness. The value added estimates show that prices rise for coffee in the midrange of roasting and temperature. Producing regions may benefit from research that optimizes roast type or a given origin of green coffee. Similarly, coffee prices are also sensitive to cup ratings. A 5 unit increase in cup rating increases coffee price by an amount larger than 18 of the 28 coffee origins. At minimum, supply chains participants may work to define minimum and maximum guidelines for roast and brew by green coffee origin type. Coffee producers and others considering origin labeling may find roasting and brewing guidelines are a high-value added complement to origin labeling.

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Table 1. Descriptive Statistics

Variable	Description	Mean	Standard Deviation
Value:			
Price	$US per pound, 2014 price level	22.8	13.6
Price at baseline	$US per pound, 2014 price level	17.0	4.1
lnPrice	Natural logarithm of Price	3.0	.4
Origin:			
Jamaica	1 if Jamaica; 0 otherwise	.004	.06
Hawaii	1 if Hawaii; 0 otherwise	.03	.17
Panama	1 if Panama; 0 otherwise	.04	.20
Honduras	1 if Honduras; 0 otherwise	.03	.17
Costa Rica	1 if Costa Rica; 0 otherwise	.04	.20
El Salvador	1 if El Salvador; 0 otherwise	.05	.21
Guatemala	1 if Guatemala; 0 otherwise	.08	.28
Ecuador	1 if Ecuador; 0 otherwise	.01	.10
Bolivia	1 if Bolivia; 0 otherwise	.02	.13
Columbia	1 if Columbia; 0 otherwise	.07	.25
Uganda	1 if Uganda; 0 otherwise	.001	.03
Kenya	1 if Kenya; 0 otherwise	.11	.31
Ethiopia	1 if Ethiopia; 0 otherwise	.15	.36
Malawi	1 if Malawi; 0 otherwise	.001	.03
Philippines	1 if Philippines; 0 otherwise	.004	.06
Yemen	1 if Yemen; 0 otherwise	.003	.36
Haiti	1 if Haiti; 0 otherwise	.003	.06
Dominican Republic	1 if Dominican Republic; 0 otherwise	.006	.07
Timor	1 if Timor 0 otherwise	.002	.05
Peru	1 if Peru; 0 otherwise	.01	.11
Thailand	1 if Thailand; 0 otherwise	.003	.06
Mexico	1 if Mexico; 0 otherwise	.01	.10
Rwanda	1 if Rwanda; 0 otherwise	.02	.14
Brazil	1 if Brazil; 0 otherwise	.03	.18
Indonesia	1 if Indonesia; 0 otherwise	.08	.27
Tanzania	1 if Tanzania; 0 otherwise	.006	.07
Zambia	1 if Zambia; 0 otherwise	.002	.04
India	1 if India; 0 otherwise	.004	.07
Market Channel:			
Auction	1 if sold in COE or other auction; 0 otherwise	.02	.14
Fair Trade	1 if certified *Fair Trade*; 0 otherwise	.03	.17
Agricultural Production Choice:			
Peaberry	1 if peabody beans; 0 otherwise	.05	.21
Natural	1 if labeled *Natural*; 0 otherwise	.05	.22
Organic	1 if labeled *USDA Organic*; 0 otherwise	.11	.31
Estate	1 if labeled *Estate*; 0 otherwise	.09	.29
Roaster Processor:			
Agtron Score	Agtron roast score, dark to light, 0 to 100	51.0	7.8
Agtron Score at baseline	Agtron roast score, dark to light, 0 to 100	46.7	4.1
Sensory Rating:			
Cup Rating	Cup rating, 0 to 100	91.6	2.4
Cup Rating at baseline	Cup rating, 0 to 100	90.3	3.1

Statistics based on sample of 1,258 coffees sold by 266 retailers. The baseline sample is for 189 observations where all dummy variables are zero, representing coffee with unspecified origins

Table 2. Estimated Models and their Value Added Coefficients

Dependent:	Model 1		Model 2a		Model 2b	
lnPrice	1997-2014 Data		1997-2014 Data		2012-14 Data	
	Coefficient	t-Values	Coefficient	t-Values	Coefficients	t-Values
Origin: positive, increasing or constant value, model 2a to 2b						
Panama	0.92***	7.5	0.78***	7.0	0.96***	7.7
Hawaii	0.93***	10.4	0.84***	11.3	0.94***	9.4
Yemen	0.38	1.6	0.32	1.3	0.74***	31
Uganda	0.47***	21.1	0.54***	24.9	0.54***	15.7
Ecuador	0.30***	3.8	0.24***	3.6	0.29***	3.2
Dominican Republic	0.21	1.5	0.22	1.6	0.43***	7.6
Costa Rica	0.19***	5.4	0.14***	3.9	0.24***	5.2
Guatemala	0.18***	5.0	0.12***	3.4	0.18***	3.5
Columbia	0.20***	3.9	0.10**	2.4	0.16**	2.4
Thailand	0.05***	.2	0.10	.6	0.12*	1.9
Philippines	−0.2***	−9.0	0.12**	2.3	0.18**	2.0
Origin: value tending to decrease, model 2s to 2b						
Jamaica	1.01***	30.5	1.04***	19.2	0.92***	29.7
Kenya	0.34***	10.9	0.19***	7.2	0.17***	3.7
Honduras	0.29***	7.2	0.21***	5.9	0.16***	3.6
Bolivia	0.28***	4.1	0.18***	3.6	0.14**	2.3
Malawi	0.17***	7.6	0.11***	6.3	0.09***	4.3
Ethiopia	0.24***	7.4	0.12***	4.4	0.09**	2.3
El Salvador	0.22***	4.4	0.12***	2.6	0.06	1.6
Rwanda	0.20***	3.8	0.08*	1.9	0.06	1.0
Brazil	0.12***	3.3	0.05	1.6	0.05	1.3
Peru	0.11**	2.0	0.10*	1.8	0.00	−0.1
Origin: no statistical value						
Indonesia	0.09***	3.7	0.03	1.3	0.01	0.5
Timor	0.08	0.7	0.11	1.6	*na*	*na*
Haiti	0.21	1.3	0.26	1.5	0.10	0.6
Mexico	0.10	1.4	0.09	1.4	0.03	0.6
Tanzania	0.00	0.0	−0.04	−0.6	0.07	1.0
Origin: negative value						
Zambia	−0.14***	−3.5	−0.14***	−3.2	*na*	*na*
India	−0.17***	−2.2	−0.25***	−3.5	*na*	*na*
Culture						
Peaberry			0.02	0.7	−0.02	−0.5
Natural			0.01	0.1	0.03	0.5
Organic			−0.04*	−1.8	0.00	0.0
Finca			−0.09***	−2.9	−0.13	−2.1**
Market Channel						
Auction			0.32***	6.9	0.17	1.8*
Fair Trade			−0.09***	−3.9	−0.16	−3.7***
Roaster Processor						
Agtron Score			0.007***	5.6	0.006	3.3***
Sensory						
Cup Rating			0.043***	6.3	0.050	4.7***
Constant	2.80***	127.8	−1.01*	−1.8	−1.97**	−2.0
R^2	.37		.48		.59	
N	1,258		1,258		580	

Clustered robust variance-covariance matrix with 266 coffee retailer clusters for full 1997-2014 data. Significance levels for two-tailed tests with $p < .1$ indicated by *, $p < 0.05$ by ** and $p < 0.01$ by ***. An *np* indicates an origin is not present in the 2012-14 data.

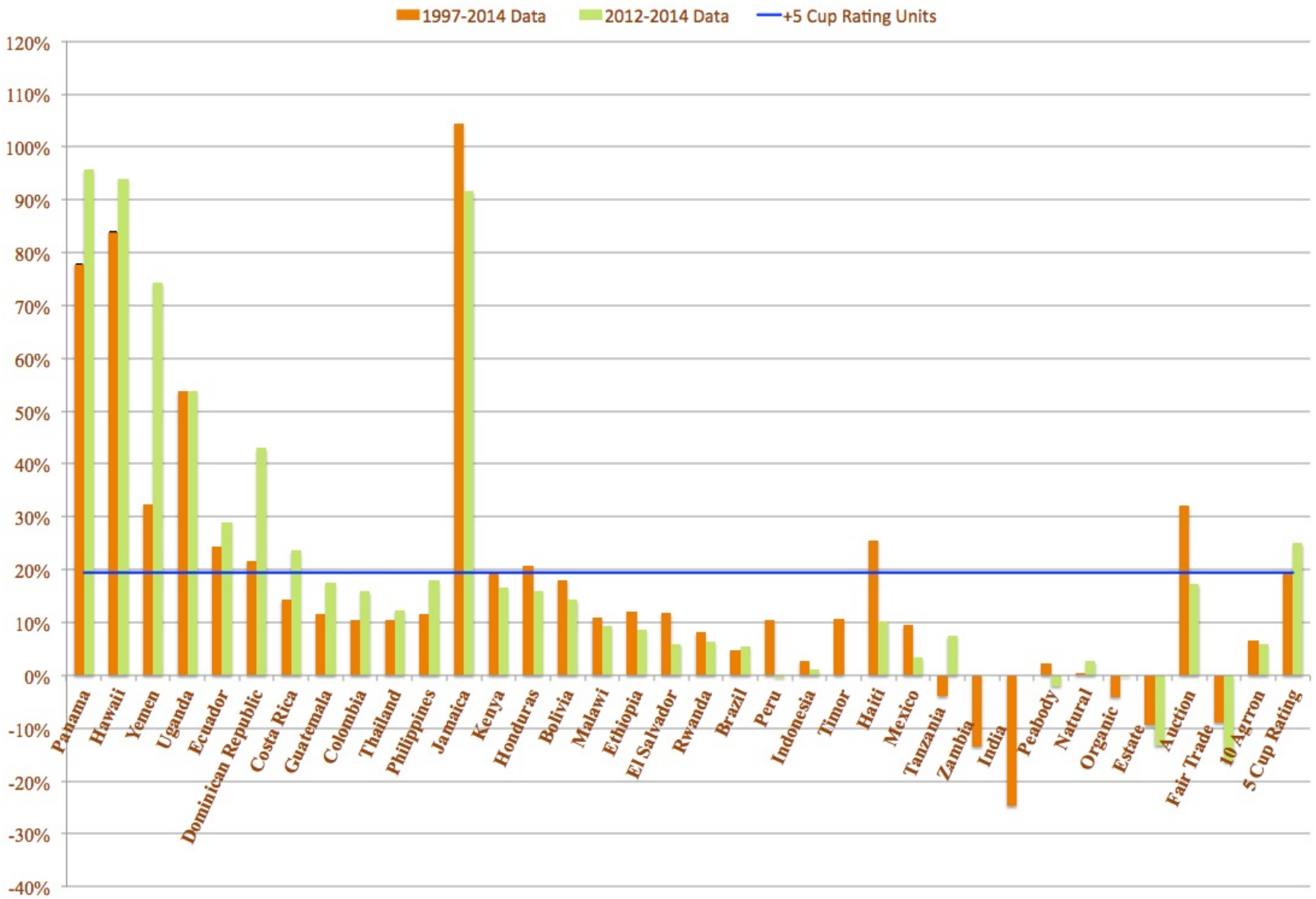

Figure 1: Agtron, Origin, Culture and Market Percentage Price Premiums, 95% Error Bars in Red