Coffee Differentiation: Demand Analysis at Retail Level in the US Market

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Abstract

Scanned data was used to estimate US coffee demand using an AIDS model. The estimated elasticities have the expected signs and magnitude. Differentiated coffees are complements for regular and unclassified while regular and unclassified coffees are substitutes. These results could be useful in designing marketing strategies by coffee suppliers.

Introduction

Coffee production is regionally concentrated while coffee demand is extended worldwide. In the largest consuming markets, the U.S., Germany, France, and Japan, which together consume half of world exports, coffee is barely produced. Brazil, Vietnam, and Colombia are the world's largest producers and exporters.

The caffeinated agricultural commodity is one of the most valuable primary products traded in world markets. Sometimes it has been second only to oil exports as a source of foreign exchange for developing countries (ICO 2009). Its cultivation, processing, trading, transportation, and marketing provide employment for millions of people worldwide. Coffee is crucial to the economies and politics of many developing countries; for many of the world's Least Developed Countries, exports of coffee account for a substantial part of their foreign exchange earnings, in some cases over 80%. Coffee is a traded commodity on major futures and commodity exchanges, most importantly in London and New York. The coffee price crisis associated with world supply

increases, and declining per capita consumption severely affected the economy of producer countries. New strategies are required to boost coffee world prices. Producing countries are implementing coffee differentiation strategies to increase their profits and welfare. Coffee roasters and associated companies in the consuming countries also are implementing product differentiation strategies to enhance consumption and profits.

Differentiation in Agricultural Products

Producing countries and coffee roasters are pursuing new marketing strategies that involve market segmentation and product differentiation. When homogeneous commodities are transformed into differentiated goods, unique, heterogeneous products are offered to consumers. The differentiated goods are best described as close but imperfect substitutes. They perform the same basic functions but have differences in attributes such as type, style, quality, reputation, appearance, and location that tend to distinguish them from each other. In the coffee case, the major differentiation process has been development in association with type, quality, reputation, and denomination of origin.

The transition from commodity to a differentiated product changes the market structure from a perfect to a monopolistic competition model. Product differentiation leading to differences in prices and market shares are explained by theories of monopolistic competition (Chamberlin, 1934) and "love for variety" (Dixit and Stieglitz, 1977). These theories suggest that if a firm produces a product that is distinct from others of the same type and if consumers are better off with added varieties, market power takes place allowing the firm to set the price that will determine its market share (Rakotoarisoa et al, 2003).

The transformation of commodities into differentiated products is also occurring in the meat, dairy, cacao and other agricultural markets. The new trend on market structure organization due to heterogeneous supply and demand for differentiated products brings about questions that need to be studied: Do differentiated products exhibit different demand patters and elasticities than the undifferentiated ones? In the coffee case: Do regular (undifferentiated) coffee and differentiated coffees behave as different products? Do all differentiated coffee groups behave similarly? Do they exhibit different demand patters and elasticities? These questions have been difficult to answer for the US market because previous coffee demand studies have focused on regular coffee undifferentiated by country of origin, flavor, blend, roast, and/or social and environmental causes.

Recent studies estimated the demand for non-alcoholic beverages taking into account the interrelation among several beverages and do not focus on coffee. Alviola, Capps Jr. and Wu (2010), Dharmasena and Capps Jr. (2009), and Pofahl, Capps, Jr., and Clauson (2005) have conducted demand system analysis of non-alcoholic beverages estimating the regular coffee demand parameters using panel data of household purchases. Other demand studies of nonalcoholic beverage included coffee and tea combined (Zheng and Kaiser (2008), and Yen et al (2004).

Several demand studies related to coffee differentiated products have focused on the estimation of residual demand elasticities, showing the role of the firms' costs as a source of product differentiation (Rakotoarisoa et al. 2003), US demand for mild coffees from Colombia, Mexico,

and Brazil using imports as consumption (Houston, Santillan, and Marlowe, 2003) and demand of regular and soluble coffees (Huang et al. 1986).

The objective of this study is to estimate the demand parameters at retail level of regular and differentiated coffee for the US market. A unique data set was developed to classify the differentiated coffee in five major groups. The differentiated coffees were grouped into the following types: country of origin, cause related (organics, fair trade, and rainforest), flavored, blends, and roasts types.

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Methods and Procedures

The data source used for the research is a weekly coffee sales scanned data at retail level in the US from 2001 to 2006. It was provided by Information Resources Inc. (IRI) Research and Developing Academic Data Set. The data source contains information for US metropolitan areas in a time period of 313 weeks.

Based on IRI data source, a unique data set was developed to classify the differentiated coffee in five major groups. Information related to flavor, scent and description of each coffee product listed for the study period was used for the grouping process. The differentiated coffees were grouped into the fallowing types: country of origin, cause related (organics, fair trade and rain forest alliance), flavored, blends, and roasts types. The regular coffees were grouped fallowing the flavor/scent description of the IRI data set. Coffees which do not belong to the regular and differentiated categories were grouped on an unclassified category. The quantity data of the retail

sales was standardized in terms of pounds, the prices in terms of dollars per pound, and the expenditures in dollars.

To include the effect of seasonality in the studied period the data source was decomposed in winter, spring, summer, and fall seasons. The 313 weeks were classified accordingly with the season in place at that particular time of the year. Information from the Weather Business Bureau was accessed to determine the specific starting and ending date for each season.

Model

The almost ideal demand system (Full AIDS) model was selected to estimate the demand parameters at retail level of regular, differentiated, and unclassified coffee for the USA market. The AIDS model was developed by Deaton and Muelbauer (1980) and it was selected due to it several desirable properties. First, it is a flexible functional form but it has the added advantage of being compatible with aggregation over consumers, thus can be interpreted in terms of economic models of consumer behavior when estimated with aggregated (macroeconomics) or disaggregated (household survey) data. Second, the AIDS model provides an arbitrary first-order approximation to any demand system. Third, it is derived from a specific cost function and therefore corresponds with a well-defined preference structure. Fourth, homogeneity and symmetry restrictions depend only on the estimated parameters and are easily tested and/or imposed. Fifth, it aggregates perfectly across consumers without invoking parallel linear Engle's curves. Finally, it satisfies the axioms of choice exactly.

The seasonality adjustment was introduced to the Full AIDS model as a dummy variable that represents winter, spring, summer, and fall seasons. The model is used to evaluate the impact of cool, mild, and warm season on coffee consumption. It is assumed that spring and fall are mild seasons.

The specification of the Full AIDS model can be described as:

$$w_{it} = \alpha_i + \sum_j \gamma_{ij}^{*} \log p_{tj} + \beta_i \log\left(\frac{m}{P}\right) + \sum_{j=1}^{3} d_j S_{ijt} + e_{it}, \qquad (1)$$

where P is price index defined by

$$\log P = \alpha_0 + \sum_j \alpha_j \ln p_j + \frac{1}{2} \sum_i \sum_j \gamma_{ij}^{*} \ln p_i p_j \qquad (2)$$

and the parameters γ are defined by

$$\gamma_{ij} = \frac{1}{2}(\gamma_{ij}^{*} + \gamma_{ji}^{*}) = \gamma_{ji} \qquad (3)$$

where i= (1, 2, and 3) indexes of regular (1), differentiated (2) and unclassified (3) coffees in the system, t indexes the time in weeks (there are 313 weeks), p_{jt} is weekly average nominal price for each coffee considerate in the study, m is the total expenditures calculating using nominal prices p_{jt}, and the total quantity of each coffee consumed per week is q_{it}. The S_{ijt} is the seasonal dummy use to capture seasonality of the four seasons of the year. The disturbance term is represented by e_{it}. The weekly budget share of each coffee consumed is:

$$w_{it} = \frac{p_{it} q_{it}}{m} \qquad (4)$$

The model was estimated using SAS 9.2 statistical software. To estimate the Full AIDS Model the fallowing theoretical restrictions were imposed on the parameters:

(1) Adding-up Restriction requires, for all *i,*

$$\sum_i \alpha_i = 1, \sum_i \beta_i = 0, \sum_k \gamma_{ik} = 0 \tag{5}$$

(2) Homogeneity is satisfied if and only if, for all *i*,

$$\sum_k \gamma_{ik} * = 0 \tag{6}$$

(3) Symmetry is satisfied provided that

$$\gamma_{ik} = \gamma_{ki}, i \neq k \tag{7}$$

The Zellner's interactive seemingly unrelated regression (ITSUR) procedure was used to estimate the Full AIDS Model. The significance level used was a 10% (p-value 0.10).

The imposition of the adding up restrictions and the fact that the expenditure shares add to one resulted in the dropping of one budget share equation (unclassified coffees) to avoid the singularity error of the variance-covariance matrix. The parameters for unclassified coffee share equation were recovery using the adding up restriction.

The own price, cross price, and expenditure elasticities for the Full AIDS model were estimated employing the fallowing equations:

The expenditure elasticities for Full AIDS is as follows

$$\eta_i = \frac{\partial q_i}{\partial m} \cdot \frac{m}{q_i} \Rightarrow \eta_i = \frac{\beta_i}{w_i} + 1, \tag{8}$$

The uncompensated own-price elasticities for Full AIDS,

$$e_{ii} = \frac{\partial q_i}{\partial p_i} \cdot \frac{p_i}{q_i} \Rightarrow e_{ii} = \frac{\gamma_{ij}}{w_i} - \frac{\beta_i \alpha_j}{w_i} - \frac{\beta_i}{w_i} \sum_{k=1}^{9} \ln p_k - 1, \tag{9}$$

The uncompensated cross-price elasticities for Full AIDS,

$$e_{ij} = \frac{\partial q_i}{\partial p_j} \cdot \frac{p_j}{q_i} \Rightarrow e_{ij} = \frac{\gamma_{ij}}{w_i} - \frac{\beta_i \alpha_j}{w_i} - \frac{\beta_i}{w_i} \sum_{k=1}^{9} \ln p_k, i \neq j \tag{10}$$

The compensated own and cross price elasticities for Full AIDS,

$$e_{ij}^* = e_{ij} + \overline{w}_i \eta_i \tag{11}$$

Empirical Results and Discussion

This section presents and discusses the descriptive statistics of the variables, the estimated AIDS model parameters, and the expenditure and price statistics for regular, differentiated, and unclassified coffees. The summary of descriptive statistics in table 1 shows that the unclassified group presents the most expensive coffee ($5.23/lb.) following by the differentiated ($4.11/lb.) and regular ($3.10/lb.) groups. Unclassified coffee had also the widest range of price with a standard deviation of $0.76 per pound. The higher price of the unclassified group might be associated to the fact that coffees with one cup brewing system (pod) are included in this category. Usually the one cup brewing coffee is sold in a package that contains small quantities

with high price per unit. Further studies are needed to evaluate in more deeply this type of coffee that was introduced to the market during the studied period.

According to table 1, the differentiated coffee was the most consumed during the studied period fallowing by the regular and unclassified groups. The mean total quantity consumed of the differentiated group was 60.80% and 98.62% higher than regular and unclassified, respectively. The differentiated coffee had the highest budget share.

Parameters estimated by the AIDS model are reported in table 2. Out of six own and cross-price coefficients estimated five were statistical significant at 10% level. One of two intercepts coefficient (alphas) was statistically significant at 10% level. The expenditure coefficients (betas) and the coefficient associated with the dummy variable seasonality (d's) were not statistical significant at 10% level.

The expenditure, uncompensated, and compensated own and cross-price elasticities were calculated and presented in table 3 and 4. Calculated expenditure elasticities reveal that all coffee groups were normal goods while unclassified coffee is considered a luxury good (table 3). The unclassified good is the most elastic group followed by the regular and differentiated groups.

Uncompensated and compensated own and cross-price elasticities are presented in table 4. All uncompensated and compensated price elasticities have the theoretical expected negative sign. The uncompensated own-price elasticity for the unclassified coffee is -1.850. Own-price elasticities for differentiated and regular coffees were -0.946 and -0.901 respectively. The

uncompensated own-price elasticities were lower than the ones estimated by Dharmacena and Capps Jr. (2009) for coffee undifferentiated (-0.517) and Zheng and Kaiser (2008) for coffee undifferentiated and tea (-0.462).

Compensate cross-price elasticities reveal a complementary interaction between regular and differentiated coffees and a substitution relationship between regular and unclassified coffees (table 4). The differentiated coffee has a complementary interaction with both the regular and unclassified. Unclassified coffee is a substitute for regular coffee and a complement for differentiated coffee.

The results revealed that unclassified coffee has the highest price sensitivity compared with regular and differentiated coffees, implying that when its price increases consumers substitute it for regular coffee but may continue buying coffee from the differentiated group. The differentiated group includes coffees by origin of denomination, cause related (organic, rain forest, and fair trade) and different flavors, roasts and blends. The variety in the differentiated group appeals preferences of a wide group of consumers, which may explain its complementary interaction with the regular and the unclassified coffees.

We consider the performed demand analysis for US differentiated coffee at retail level as an initial exploratory study, and so, future analyses are recommended. Based on the study results, the following recommendations are made for future analysis: 1) to measure more accurately the demand of the differentiated group by performing a separate demand analysis for each one of the coffees that compose the group (different country origins, cause related, flavors, blends, and

roast), 2) to revise the unclassified group and estimate separately the demand for the coffee used on the one cup brewing system, and 3) to analyze and compare the demand of regular, differentiated, and unclassified coffees for different regions in the US.

Summary and Conclusions

The almost ideal demand system (AIDS) model was selected to estimate the demand parameters at retail level of regular and differentiated coffee for the US market. The data source used in the research was a weekly (313) coffee sales scanned data at retail level in the USA from 2001 to 2006. It was provided by Information Resources Inc. (IRI). Based on IRI data source a unique data set was developed to classify the coffee in three major groups: regular, differentiated, and unclassified. The differentiated coffees were grouped into the following types: country of origin, cause related (organics, fair trade and rainforest), flavored, blends, and roasted types. The regular coffees were group following the flavor/scent description of the IRI data set. Coffees which do not belong to the regular and/or differentiated groups were grouped on unclassified category.

The results revealed that the unclassified group was the most expensive coffee ($5.22/lb.) following by the differentiated ($4.14/lb.) and regular ($3.09/lb.) groups. The higher price of the unclassified group might be associated to the fact that coffees with one cup brewing system (pod) are included in this group. Calculated expenditure elasticities showed that all coffee groups were normal goods, while the unclassified coffee should be considered a luxury good.

All uncompensated and compensated own-price elasticities have the theoretically expected negative sign. The uncompensated own-price elasticities were found as follows: unclassified; (-1.850), differentiated; (-0.946), and regular; (-0.901). Compensated cross-price elasticities reveal a complementary interaction between regular and differentiated coffees and a substitute relation between regular and unclassified coffees. The differentiated coffee has a complementary interaction with both regular and unclassified coffee. Unclassified coffee is a substitute for the regular one.

The performed study assumed an aggregated consumption at retail level. Considering this, the results suggest that household's members might have different preferences and, thus might purchase coffees that belong to the different groups. The variety in the differentiated group appeals preferences of a wide group of consumers, which may explain its complementary interaction with the regular and the unclassified coffees.

Future Work:

We consider the performed demand analysis for US differentiated coffee at retail level as an initial exploratory study, future analyses are recommended. Based on the study results the following recommendations are made for future analysis: 1) to measure more accurately the demand of the differentiated group by performing a separate demand analysis for each one of the coffees that compose the group (different country origins, cause related, flavors, blends, and roast), 2) to revise the unclassified groups and estimated separately the demand for the coffee use for the one cup brewing system, and 3) to analyze and compare the demand of regular, differentiated, and unclassified coffees for different regions in the US.

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Table 1. Descriptive Statistics for Each Coffee Group in the US by (n=313 weeks)

	Mean	Std. Deviation	Minimum	Maximum
Price ($/lb)				
Regular	3.10	0.30	2.30	3.84
Differentiated	4.11	0.51	3.21	5.30
Unclassified	5.29	0.76	3.05	7.99
Total Weekly Quantity (lb)				
Regular	208630.50	41391.65	143362.04	372003.52
Differentiated	532045.48	83893.86	398715.14	958284.62
Unclassified	7298.65	2452.10	4340.81	25392.34
Total Expenditure ($)				
Regular	638014.52	89198.68	482348.91	1014794.88
Differentiated	2169402.98	336434.45	1570905.17	3728647.00
Unclassified	37258.40	7029.16	27367.94	88203.63
Budget Shares				
Regular	0.230	0.026	0.160	0.290
Differentiated	0.760	0.030	0.700	0.820
Unclassified	0.010	0.003	0.0070	0.0310

Table 2. Parameter Estimates of AIDS Model for US Coffee[1]

Parameter	Estimate	Std Error	t Value	Pr>|t|
y_{11}	0.02249	0.0189	1.19	0.2338
y_{12}	**-0.03647**	0.0196	-1.86	0.0637
y_{13}	**0.013976**	0.0061	8.70	<.0001
y_{21}	**-0.03647**	0.0196	-1.86	0.0637
y_{22}	0.039155	0.0205	1.91	0.0573
y_{23}	-0.00269	0.0022	-1.22	0.2222
α_1	0.20885	0.1807	1.16	0.2488
α_2	**0.790255**	0.1877	4.21	<.0001
b_1	0.00112	0.0132	0.08	0.9325
b_2	-0.00257	0.0137	-0.19	0.8517
d_{11}	0.004526	0.00446	1.02	0.3104
d_{12}	0.006812	0.00472	1.44	0.1500
d_{13}	0.006488	0.00498	1.30	0.1997
d_{21}	-0.00422	0.00462	-0.91	0.361
d_{22}	-0.00629	0.00489	-1.29	0.1997
d_{23}	-0.0056	0.00516	-1.09	0.2762

[1] Coffee group: Regular (1), Differentiate (2), and Unclassified (3).
Note: all estimated coefficients in bold are significant at 10%

Table 3. Expenditure Elasticities for Coffee* Using Full-AIDS System

Group	Item	Elasticity
Regular	e1	1.005
Differentiated	e2	0.997
Unclassified	e3	1.109

*Coffee groups: Regular (1), Differentiated (2), and Unclassified (3).

Table 4. Uncompensated and Compensated Elasticities for Coffees* Using Full-AIDS System

	Item	Elasticity
Uncompensated	e11	-0.901
	e12	-0.165
	e13	0.062
	e21	-0.047
	e22	-0.946
	e23	-0.003
	e31	1.026
	e32	-0.285
	e33	-1.850
Compensated	e11	-0.675
	e12	0.599
	e23	0.075
	e21	0.177
	e22	-0.187
	e23	0.009
	e31	1.276
	e32	0.559
	e33	-1.83

*Coffee groups: Regular (1), Differentiated (2), Unclassified (3).