Running Head: KONA COFFEE ELASTICITY

Kona Coffee Elasticity

Zondre C. Watson

Economics 6000

Hawaii Pacific University

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Table of Contents

I. Introduction……………………………………………………………………………..3

II. Literature Review………………………………………………………………………5

 A. Statistical Analysis………...………………………………………...…………5

 B. Regression…………..………………………………………………………….6

 C. Elasticity………………………………………………………………………..7

 D. Hawaii Coffee Market…………..……………………………………………...8

III. Methodology…………………………………………………………………………..8

IV. Analysis & Results..…………………………………………………………………..9

V. Conclusions & Recommendations….………………………………………………...11

VI. References……………………………………………………………………………14

Kona Coffee Elasticity

Introduction

Coffee was originally planted in the state of Hawaii in 1818. It was planted in the Manoa Valley on the island of Oahu. And, in 1828 cuttings from those plants were taken to Hawaii, commonly referred to as the big island. The cuttings were planted in Kailua-Kona in what has come to be known as the Kona coffee belt. Throughout the 1800’s economic conditions became tough for coffee farmers in Hawaii and, sugar became highly prevalent. So, many coffee farmers switched to sugar. In the late 1800’s the only coffee farmers left were in Kona. And, at that time a new strain of Guatemalan Arabica was brought to the region.

This strain was very popular and has become what is now known as Kona coffee. However, in 1899, there was a world coffee market crash. Then in the first few years of 1900 there was drought in Hawaii, which led to an abysmal market for the Kona coffee farmers. So, the large commercial coffee producers began to parcel out their land and lease it to the immigrant farmers, who had worked the land. This began the transition to what still holds today, small family farms of approximately 3 to 5 acres (Hawaiian Paradise Trading Co. Ltd, 2004). In 2007, Hawaii was still the only state growing coffee commercially.

In 2004, The Hawaii Department of Agriculture (HDOA) published a paper on the outlook for the Hawaii coffee market. The paper contained some data going back to 1946. However, the most complete data covered the period between 1989 and 2003. Then in January of 2007, The U.S. Department of Agriculture (USDA), in conjunction with the HDOA, released additional statistics. Combining information from these two reports offers complete data between 1989 and 2006. However, during the 2006 season, there were unusual drought conditions, which caused a 40% reduction in coffee output for the year. Therefore, this paper focused on the years 1989 through 2005. In 2006, there were 790 coffee farms in the state including Oahu, Maui, Molokai, Kauai and Hawaii. The island of Hawaii had 745 farms, which sold 3.5 million pounds of coffee. However, in 2005, 5.8 million pounds had been sold (Morita).

In 2003, 95% of the coffee exported directly out of the state of Hawaii was shipped to Japan. However, this only amounted to 337,000 pounds or 4% of the state’s coffee production and 10% of the production in Kona. It is a little difficult to gauge the exact amount going to the country, because no records are kept of exactly how much is sold locally, blended with other coffees or sent to the mainland then out of the country (Southichack, 2004).

According to the market report, the two major factors, which affected the demand for Kona coffee, were consumer perception and income or economic conditions (Southichack). This paper adds to the Department of Agriculture’s report by quantifying the impact that these factors had. Additional variables were also analyzed including Kona coffee price, Japan retail coffee price, U.S. retail coffee price, Japan gross domestic product (GDP), the number of Japanese visitors to Hawaii, the number of visitors from the mainland, the total number of visitors, the pounds of coffee produced per acre, the level of disposable income in Japan, the amount of coffee produced on Oahu, Kauai and Maui (HKM), and HKM coffee price to determine what affect, if any, these variable had on the quantity demanded.

Personal income was used to determine the income elasticity. The coffee prices were used to determine the cross price elasticity. The GDP and disposable income level were used to determine what impact changes in the Japanese economy had, since it was the main importer of Hawaiian coffee. The coffee has also been sold locally to tourists, in hotels and restaurants, so the number of visitors was used to see if it had an impact. And, the production level was used to see if the farming efficiency elasticity could be quantified. The p-value of each factor was used to determine the factor’s significance. The confidence level was set at 95%, so the p-value must be .05 or less to be considered significant. And, the F-statistic and r² value was used to determine how well the model fit.

Literature Review

*Statistical Analysis*

Studies in almost every field, including business, economics and finance, use statistics to draw conclusions regarding the various factors involved.

Statistics is the science of collecting, organizing, analyzing and interpreting data (Larson & Farber, 2003, p. 3). Inferential statistics is the branch that involves using a sample to draw conclusions about a population. A basic tool in the study of inferential statistics is probability (Larson & Farber, p. 7). And, statistical probability is based on observations obtained from probability experiments. The statistical probability of an event is the relative frequency of an event.

P (E) = frequency of event/ Total frequency (Larson & Farber, p. 113)

In other words, statistics gathers data about a sample, measures the probability of a particular event, and uses mathematical analysis to determine the likelihood that the observed sample is representative of the population as a whole. And, the law of large numbers says that the more often the observed sample is repeated, or the larger the number of observation, the closer the sample will come to the theoretical probability (Larson & Farber).

The only way to know exactly what happens in a population is to observe the entire population. So, when a sample is used there is always a possibility of making an error. Statisticians use hypothesis testing to determine the probability of making an error. When testing a hypothesis there are two possible errors that can be made. A hypothesis can be rejected when it is true or a hypothesis may not be rejected even though it’s false. One way of making a decision on a hypothesis is to determine the probability of making one of these errors. This is determined using a p-value (Larson & Farber). This paper used the decision rule - if the p-value is less than the confidence level then rejects the null hypothesis. The null hypothesis was that the factors being analyzed were not significant.

*Regression*

“The primary goal of regression is to predict or explain one variable (the dependant variable) using one or more known variables (the independent variables)” (Seiler, 2004, p 128). Regression works by drawing a line between predicted variables and finding the best fit by reducing the variation between the predicted line and the observations. Figure 1 shows an example of a linear regression line. It is easy to see that the line doesn’t actually touch all of the observed values. So it’s necessary to determine how well the line fits the model.

Figure Source: Wikipedia

One measure of goodness of fit is called r squared. “The coefficient of determination r² is the ratio of the explained variation to the total variation” (Larson & Farber, p. 469). In other words, with an r² of .88, 88% of the variation can be explained by the variables that form the regression line. And, 12% comes from variables that aren’t present. Another measure uses an F-test, which compares the variances of two populations (Larson & Farber). According to Dr. Seiler this is the most important number and measures the overall models significance (P 134).

*Elasticity*

According to Dr. Laney, “Economists often consider demand functions to have a multiplicative exponential form. Thus if you take the natural logarithms of all the data you intend to regress, then perform the regression, the coefficients can be interpreted directly as elasticities” (Demand presentation). It’s important to be able to measure elasticity, because it shows how a variable changes with a small change in another variable. Business executives can use this information to determine if a business will be affected by a change in some variable and if so by how much. Elasticity can be calculated for any variable that can be quantified.

The study conducted for this paper measured the elasticity of the variables outlined in the introduction and listed in the appendix section. And, the results are shown in the analysis section. However, the two main elasticity measures are income and cross price elasticity. Income elasticity measures how quantity demanded of a product changes with changes in income. And, cross price elasticity measures how quantity demanded changes with changes in the price of other products.

Farnham (2005) defined two types of goods, when measuring income elasticity – a normal good and an inferior good. A normal good is one that has a positive elasticity; if income increases quantity of the good demanded increases. An inferior good, however, moves in the opposite direction. Within the normal good category there are also two types of goods. A necessity is a good with elasticity between 0 and 1. And, the elasticity of a luxury good is greater than 1. Quantity demanded for a luxury good increase more than 1% for a 1% increase in income

When measuring cross price elasticity there are also two types of goods – substitutes and compliments. A substitute good has positive cross price elasticity. This means that if the price increases for good X, the quantity demanded of good X will decrease, but the quantity for good Y will increase. The opposite is true for complimentary goods. They have negative cross price elasticity. The goods would generally be used together, such as cream and coffee. If the price for coffee goes up, quantity demanded of coffee will go down and so will quantity demanded of cream.

*Hawaii Coffee Market*

The HDOA did a market outlook report in 2004 on the Hawaii coffee industry (Southichack). The report looked at the price history and growth trends for the Hawaii coffee market. And, it also looked at which countries were importing Hawaiian coffee to determine what export opportunities existed. The report was limited because the industry doesn’t keep detailed records on how the coffee is sold. No records were kept on how much coffee was sold locally, how much was sold on the mainland, how much coffee was blended with foreign coffees, where the coffee went after it was sent to the U.S. mainland and what retail prices were charged for the different types of coffee. However, the HDOA did conclude that the two main factors affecting demand were income and consumer perception. And, it concluded that the best growth opportunities were exporting coffee to Asia. Yet, the report didn’t attempt quantify the affects of income and it didn’t attempt to quantify how changes in the Asian country’s economies would affect demand for Hawaiian coffees. This paper adds to the analysis by quantifying these affects. And, the conclusions were brought current by adding data through 2005.

Methodology

The data used for this paper were the amount of Hawaiian coffee sold in Kona and on the other islands consolidated as Honolulu, Kauai and Maui (HKM) between 1989 and 2005. This data was taken from the Hawaii coffee industry market outlook report, which can be found on the HDOA website (Southichack) and supplemented by the Hawaii Coffee report from the USDA (Morita). The retail prices of coffee in the U.S. and Japan were also used, which was downloaded from the International Coffee Organization’s (ICO) website (2007). The prices of coffee in Japan were used, because as was pointed out in the introduction, 95% of the coffee exported directly from Hawaii went to Japan. Therefore, data on changes in economic conditions and tourism from Japan were also used. Gross domestic product (GDP) and disposable income were used as economic indicators, which was downloaded from the website of Japan’s statistics bureau (Department of National Accounts, 2003 & 2005). And, the data on tourism was gathered from the Hawaii Department of Business Economic Development and Tourism (DBEDT, 2007). Since, Hawaiian coffee has been sold locally in hotels, restaurants and retail outlets; the total number of tourists and U.S. mainland tourists was also used. And finally, because changes in farm efficiency might affect the amount available for sale and therefore price, data on the number of pounds per acre each year was used, which was also taken from the HDOA report. A table with all of the data used for the analysis is shown in appendix A.

The first step in analyzing the data was to convert all of the numbers into their natural log equivalent. This was done in excel using the formula feature. Then a regression was performed using the data analysis add-in from the analysis tool pack. The confidence level was set to 95%. And, insignificant variables were removed until all of the variables present were significant. Since, there are almost as many variables as data points some variables were rotated in the analysis to see if there was any affect on the significance.

Analysis & Results

Several different periods were analyzed, because of changes that took place in the market. The first period used was 1991 through 2006, because 1991 was the first year that farms on other islands started producing coffee again. However, the first season that the HKM farms started selling a significant amount of coffee commercially was in 1996. So the second period analyzed was 1996 to 2006. Yet, when it was determined that HKM pricing was not significant, the final period analyzed, included all of the data from 1989 to 2005.

|  |  |
| --- | --- |
| Variable | P-Value |
| Intercept | 0.072436723 |
| US Income | 0.153056875 |
| Kona Price | 0.436887064 |
| US Retail | 0.126670967 |
| Japan Retail | 0.1168771 |
| Japan Income | 0.929386227 |
| Japan GDP | 0.758582418 |
| Japan Visitors | 0.298127994 |
| Mainland visitors | 0.294006275 |
| Total Visitors | 0.199941079 |

Table

Appendix B shows the initial regression for this period, and, Table 1 shows the p-values for that initial regression. None of the p-values were less than or equal to .05. So, one variable was removed at a time, starting with the least significant one, Japan Income. Once all of the variables, which were not significant, were removed, additional regressions were run adding in each variable, individually. This was done to be sure that the significance level was not affected by some of the other variables. The final regression is shown in Appendix C. The only significant variables were U.S. Income and Japan Retail Coffee Price. The p-value for U.S. Income was .00002, and, was approximately .017 for Japan Retail Coffee. These were both well below .05, which was the criteria used for this study.

At this point the r² for the regression was .8378. This means that about 84% of the variation in the regression line could be explained by changes in these two variables. Therefore, the model was a good fit for this analysis. This was confirmed by the F-Statistic, which was 36.16, and was significant well beyond the .01 level.

The elasticity for each variable could now be interpreted directly from the coefficients. The income elasticity for Kona coffee was 4.59 and was positive. Therefore, a 1% increase in income resulted in a 4.6% increase in the quantity demand of Kona coffee. This result was expected, because the price of Kona coffee is well above that of typical grocery store coffee, it has a very limited supply, and it is perceived by many to be one of the top coffees in the world.

The cross price elasticity for retail coffee in Japan was .37 and was negative. Therefore, if the price of coffee in Japan went up by 1%, the demand for Kona coffee went down by .37%. It’s likely that Kona coffee was included in the retail prices for coffee in Japan. Or, Kona coffee was blended with many of the coffees in Japan for retail sales. Therefore, the prices and quantity demanded were inversely related just like they would have been for retail Kona coffee.

Conclusions and Recommendations

The income elasticity for Kona coffee was 4.59, which is ≥ 1. As was pointed out in the literature review section, under statistics, this meant it is a luxury good. Kona coffee producers can use this information in two ways. First, changes in the U.S. income level can be monitored to determine what the affect will be on total quantity demanded in the Kona coffee market. If economic conditions in the U.S. are improving then producers can anticipate increased demand. And specifically, for every 1% increase in income, there should be a 4.6% increase in the quantity demanded. This also means that the product should be targeted at higher income individuals and families. Marketers should use a differentiated strategy, positioning their product as a luxury item. Profits and prices should be at the higher end of the spectrum. And, marketing communications should be focused on more exclusive channels.

Since, the cross price elasticity of retail coffee in Japan was negative; it is a complimentary product to Kona coffee. In other words, they were used together. A couple of different conclusions can be drawn from this. First, enough coffee from Hawaii was sold in Japan that changes in prices in Japan affected the demand for Kona coffee. This means that the amount must have been greater than the 4% that the HDOA could trace directly to exports from the state. And, it also means that a significant portion of the coffee that went to the U.S. mainland was likely ultimately exported to Japan. Producers should monitor changes in coffee prices in Japan to anticipate changes in quantity demanded in the Kona coffee market. This factor also likely points to opportunities for producers to explore, since it seems that there was a market in Japan. It is interesting, however, that changes in income level and economic conditions in Japan did not have a significant impact on the quantity demanded. Further studies should be conducted to understand this better.

Some conclusions can also be drawn from the variables that weren’t significant. An interesting result was that coffee produced in other parts of the state didn’t have a significant impact on the quantity demanded for Kona coffee. Since, there wasn’t any significant cross price elasticity, positive or negative; these coffees were not in the same market. However, studies should be conducted, including retail prices for Kona coffee to be sure that this holds true.

It’s also interesting that none of the variables related to tourists coming to Hawaii had an impact on the quantity demanded. Several discussions are currently taking place regarding changing the labeling laws for Kona coffee. And, one of the issues to be determined is the impact these changes will have on the quantity demanded. The results of this study would seem to support the hypotheses that less Kona coffee has been sold locally as a Kona blend than some believe. And, it would seem suggest that tourists were not the main market for Kona coffee.

Further studies should be conducted to determine the price elasticity of Kona coffee in the entire market as well as for individual producers. These studies should also analyze the various markets for Kona coffee to determine the elasticity in each market. However, in order to conduct them data will be needed, which shows retail pricing, quantities sold in the various markets and quantities sold as Kona blend, which was not readily available for this study.

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Appendix A

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|   | Qty | US Income | Kona Price | US Retail | Japan Retail | Japan Income | Japan GDP | Japan Visitors | Mainland visitors | Total Visitors | HKM Pricing |
| 1989 | 3.07 | $42,524.00 | $6.98 | $3.07 | 10.46 | $349,779.70 | ¥2,968,905,000 |  1,360,249  | 4,185,083 | 6,488,422 |   |
| 1990 | 2.46 | $41,963.00 | $6.00 | $2.97 | 10.26 | $378,030.10 | ¥3,039,705,000 |  1,492,786  | 4,154,645 | 6,723,531 |   |
| 1991 | 2.32 | $40,746.00 | $5.00 | $2.81 | 11.88 | $403,428.60 | ¥3,475,944,000 |  1,438,585  | 4,116,966 | 6,518,460 | $0.56 |
| 1992 | 1.79 | $40,422.00 | $4.70 | $2.58 | 12.62 | $401,888.30 | ¥3,793,827,000 |  1,705,860  | 3,647,764 | 6,473,669 | $0.75 |
| 1993 | 1.96 | $40,217.00 | $1.38 | $2.47 | 14.57 | $401,495.80 | ¥4,354,701,000 |  1,666,275  | 3,329,416 | 6,070,995 | $0.65 |
| 1994 | 2.10 | $40,677.00 | $2.00 | $3.40 | 14.69 | $407,261.90 | ¥4,794,194,000 |  1,819,332  | 3,510,435 | 6,364,674 | $0.63 |
| 1995 | 2.50 | $41,943.00 | $1.22 | $4.04 | 17.72 | $408,249.80 | ¥5,283,055,000 |  2,048,411  | 3,491,937 | 6,546,759 | $0.65 |
| 1996 | 2.30 | $42,544.00 | $9.90 | $3.43 | 15.24 | $422,003.00 | ¥4,688,258,000 |  2,146,883  | 3,588,663 | 6,723,141 | $1.85 |
| 1997 | 2.85 | $43,430.00 | $18.41 | $4.11 | 14.22 | $427,538.10 | ¥4,305,585,000 |  2,216,890  | 3,275,090 | 6,761,135 | $1.83 |
| 1998 | 3.50 | $45,003.00 | $12.75 | $3.77 | 13.52 | $416,768.60 | ¥3,933,249,000 |  2,004,354  | 3,327,400 | 6,595,790 | $1.43 |
| 1999 | 3.00 | $46,129.00 | $9.00 | $3.43 | 15.32 | $410,782.50 | ¥4,455,354,000 |  1,825,588  | 3,462,708 | 6,741,037 | $1.67 |
| 2000 | 3.80 | $46,058.00 | $4.88 | $3.45 | 12.92 | $416,108.40 | ¥4,649,637,000 |  1,817,643  | 3,726,012 | 6,948,595 | $1.60 |
| 2001 | 3.10 | $45,062.00 | $5.50 | $3.09 | 8.60 | $405,527.30 | ¥4,087,722,000 |  1,528,563  | 3,952,823 | 6,303,791 | $1.31 |
| 2002 | 4.10 | $44,546.00 | $4.44 | $2.92 | 8.13 | $399,454.00 | ¥3,904,827,000 |  1,483,121  | 3,822,845 | 6,389,058 | $2.14 |
| 2003 | 4.00 | $44,482.00 | $7.82 | $2.92 | 8.19 | $394,183.00 | ¥4,231,267,000 |  1,340,034  | 3,961,956 | 6,380,439 | $2.06 |
| 2004 | 3.20 | $44,389.00 | $6.60 | $2.85 | 8.75 | $400,157.00 | ¥4,584,865,000 |  1,482,085 | 4,573,379 | 6,912,094 | $2.08 |
| 2005 | 5.80 | $46,326  | $6.70 | $3.27 | 8.22 | $406,439.00 | ¥4,562,824,000 | 1,517,439 | 4,961,786 | 7,416,574 | $2.62 |

Appendix B

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SUMMARY OUTPUT |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| *Regression Statistics* |  |  |  |  |  |  |  |
| Multiple R | 0.955702969 |  |  |  |  |  |  |  |
| R Square | 0.913368164 |  |  |  |  |  |  |  |
| Adjusted R Square | 0.801984376 |  |  |  |  |  |  |  |
| Standard Error | 0.135046154 |  |  |  |  |  |  |  |
| Observations | 17 |  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* |  |  |  |
| Regression | 9 | 1.345955908 | 0.149550656 | 8.200189402 | 0.005591114 |  |  |  |
| Residual | 7 | 0.127662246 | 0.018237464 |  |  |  |  |  |
| Total | 16 | 1.473618153 |   |   |   |  |  |  |
|  | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | -43.04186845 | 20.36732732 | -2.113280145 | 0.072436723 | -91.20294457 | 5.119207667 | -91.20294457 | 5.119208 |
| US Income | 2.529914573 | 1.578629686 | 1.602601671 | 0.153056875 | -1.202951466 | 6.262780612 | -1.202951466 | 6.262781 |
| Kona Price | -0.071784652 | 0.087072821 | -0.82442089 | 0.436887064 | -0.277679156 | 0.134109851 | -0.277679156 | 0.13411 |
| US Retail | 0.788266801 | 0.454822614 | 1.733130186 | 0.126670967 | -0.287217782 | 1.863751384 | -0.287217782 | 1.863751 |
| Japan Retail | -0.705706518 | 0.394636032 | -1.788246536 | 0.1168771 | -1.63887245 | 0.227459414 | -1.63887245 | 0.227459 |
| Japan Income | -0.150894846 | 1.642739874 | -0.091855593 | 0.929386227 | -4.03535739 | 3.733567699 | -4.03535739 | 3.733568 |
| Japan GDP | 0.156380567 | 0.489266644 | 0.319622376 | 0.758582418 | -1.000551204 | 1.313312338 | -1.000551204 | 1.313312 |
| Japan Visitors | -1.020440396 | 0.90797199 | -1.123867704 | 0.298127994 | -3.167452982 | 1.12657219 | -3.167452982 | 1.126572 |
| Mainland visitors | -1.458586344 | 1.285867566 | -1.134320813 | 0.294006275 | -4.499179974 | 1.582007287 | -4.499179974 | 1.582007 |
| Total Visitors | 3.388625523 | 2.394562861 | 1.41513325 | 0.199941079 | -2.273615889 | 9.050866934 | -2.273615889 | 9.050867 |

Appendix C

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SUMMARY OUTPUT |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| *Regression Statistics* |  |  |  |  |  |  |  |
| Multiple R | 0.915314276 |  |  |  |  |  |  |  |
| R Square | 0.837800224 |  |  |  |  |  |  |  |
| Adjusted R Square | 0.814628827 |  |  |  |  |  |  |  |
| Standard Error | 0.13066329 |  |  |  |  |  |  |  |
| Observations | 17 |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* |  |  |  |
| Regression | 2 | 1.234597619 | 0.617298809 | 36.15665634 | 2.9536E-06 |  |  |  |
| Residual | 14 | 0.239020535 | 0.017072895 |  |  |  |  |  |
| Total | 16 | 1.473618153 |   |   |   |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | -45.29893599 | 8.263948515 | -5.481512367 | 8.08614E-05 | -63.02334269 | -27.5745 | -63.0233 | -27.5745 |
| US Income | 4.590777345 | 0.732827928 | 6.264468327 | 2.07564E-05 | 3.019017765 | 6.162537 | 3.019018 | 6.162537 |
| Japan Retail | -0.37347409 | 0.137310467 | -2.719924414 | 0.016595943 | -0.66797575 | -0.07897 | -0.66798 | -0.07897 |