Food Market Value Analysis: Product quality improvement, Product Origin Protection and Timing decisions in Apple Market

Philippos I. Karipidis[*], and Konstantinos Galanopoulos[**]

Abstract

In an effective quality enhancement programme of fruit production and marketing, total quality firms must include consideration of those attributes that are important to customers. In this study the hedonic model is adopted, in order to examine the effects of product quality, region of origin and time of product availability on the price structure determination in the apple market in Greece. Results suggest increased marginal shadow values (customers' interest) for physical product quality and for product origin – particularly in the case of Volos region. There is no evidence that out-of-season time is an important factor determining product prices. Further, it is also shown that it is possible to use the hedonic analysis for the estimation of shadow value for some sales quality characteristics other than the physical ones.

Keywords: *hedonic model, apple quality, product origin, timing, price structure, total quality*

Introduction

Ever since Rosen's (1974) hedonic prices theory was formulated as a problem in the economics of spatial equilibrium, and buyer and seller choices were analysed, numerous studies have estimated implicit prices for physical and intrinsic characteristics of agricultural inputs, products and foods. Depending on the particular good or market, the estimated implicit prices may provide useful insights about customer preferences, market value, structure of the market, and how customers gather and react to information describing the good.

In the total quality concept, the customer-defined value of a product or service is a bundle of characteristics including more than the physical or intrinsic ones (Goetsch and Davis, 1997). It is actually, the sum of a customer's perceptions of several factors such as product quality, services provided, personnel, image, etc.

In the fruit market, these characteristics can be defined as attributes of total quality fruit and vegetable marketing firms, some of which attempt to receive an ISO 9004 certification (Goetsch and Davis, 1997, p. 165; Anonymous, 1996). In the wholesalers' and retailers' market, such important attributes may be the place of product origin and the season of production or distribution. The place of origin may reflect a combination of factors that are not included in the official scheme of standardisation (taste, aroma, packaging, uncertainty, local image, etc), but they are the outcome of a multiyear inter-

[**] Assistant Professor in the Department of Farm Management, School of Agriculture, Technological Educational Institute of Thessaloniki (TEI) and lecturer in Cooperative School of Thessaloniki, Panhellenic Confederation of Agricultural Cooperatives in Greece. Tel.: 03031 474055; fax: 03031 998828; e-mail: kekpasth@otenet.gr

[**] Research Associate in the Department of Marketing, Agricultural Policy and Cooperatives, Aristotle University of Thessaloniki, Greece.

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action between local physical conditions, human resources and local knowledge and investment.

In addition to consumer preferences for time convenience, the time of production and distribution reflects the seasonality of physical conditions, the fluctuation of the costs of production and distribution, and of the product features (excluding those in the official quality scheme and the region of origin variable).

In this paper, the hedonic model and the retailer's production function is applied in order to estimate implicit prices not only of product quality but of firm sales as well (product quality, product origin, and time of production and distribution) in a major apple market in Greece, namely Central Macedonia. Apples were chosen on the basis of the following criteria: They are an important food consumed throughout the year, they are sorted according to an official EC Regulation (Reg. 920/89), and customers can gather information about product quality and origin easily, both from package labelling as well as from sellers.

The results provide helpful insights about sellers' pricing policies, customers' preferences, and the premiums they are willing to pay for product quality, product origin and the time of product availability. These factors are of particular importance for marketers' and farmers' investment and pricing policies, as well as for legal aspects, such as the protection of product origin according to 2081/92 EU Regulation allowing producers of regional speciality foods to patent the use of their products names (Tregear et all, 1998). The greater understanding of the apple market value is also useful for investment, industry extension, and regulation policy decisions.

The succeeding sections are organised as follows. Firstly, the hedonic framework and the apple retailing firm production function are described and the firm quality variables are defined, subsequently the obtained results are presented, and finally some concluding remarks and policy implications are reported in the last section.

Estimation model

The hedonic approach provides the proper ground to analyse customers' preference structure and the market value of products (Rosen, 1974; Ratchford, 1990; Uri and Hyberg, 1995). According to the hedonic framework, the price of a heterogeneous good or service represents the valuation of the characteristics that are bundled in it, where each characteristic is valued by its implicit price.

Although hedonic methods have been used extensively on different studies, only the ones focusing on agricultural products and food markets are presented here. Brorsen *et al* (1984) studied the price structure in the U.S. primary rice market. Veeman (1987) and Larue (1991) used hedonic method to analyse product heterogeneity in the world cereal market. Bowman and Ethridge (1992) analysed the supply and demand for cotton fibber characteristics in the U.S. market. Lenz *et al* (1994) studied end-product heterogeneity in the cheese market and – subsequently - in milk components. Ladd and Suvanunt (1976) defined the price structure and product quality characteristics on several food markets and Stanley and Tschirhart (1991) on breakfast cereals. Golan and Shalit (1993) estimated the price of wine quality and subsequently the contribution of each grape characteristic on grape quality. Parker and Zilberman (1993) also used the hedonic method on the fresh peach market. They tested a farm-retail marketing margin model using producer and retail prices of peaches in which, time during season and peach quality characteristics were the variables.

A hedonic function expresses the price of a good or service as a function of the quantities of characteristics in it (Rosen, 1974). Thus, an apple sales hedonic function may be expressed as

$$R = R(\mathbf{Z_i}; \mathbf{Y}), \tag{1}$$

where R represents the apple prices; $\mathbf{Z_i}$ is a vector of characteristics or quality variables; and **Y** is exogenous demand shift variable, representing buyers' characteristics.

According to Rosen (1974), three key assumptions must be satisfied. The first requires that products are differentiable into market-oriented attributes. Considering that the apple market includes many producers, wholesalers and retailers supplying various combinations of characteristics (product quality, product origin, time of production or distribution), this assumption is tenable.

The second assumption requires that products cannot be divided or rearranged into a different bundle without additional costs. Given that any different mix of product quality, region of origin, and time of production, results in different offerings (sales) costs, this assumption is also applicable.

Finally, the third assumption requires that the product can be described by a large number of product bundles, in such a manner that choice among various combinations of characteristics is continuous. Bearing in mind that customers decide to purchase different product qualities, from different places at different seasons in order to meet their total needs, the choice among various combinations (sales packages-offerings) is indeed continuous.

Differences in producers' and wholesalers' technology and inputs (e.g. production and distribution management, local or individual knowledge, product preservation expenses, local or individual efforts for improvement) act as supply shifters across "sales packages". As the hedonic assumptions apply to apples sales (suppliers), we consider a typical competitive[1] retailing firm, purchasing apples from wholesalers. Let the retailer's production function for output x (retailing sales) be represented as $F_x(Z_i)$. The first-order conditions assuming profit maximisation (Ladd and Martin, 1976) give an implicit price for input v (apples), R_v, as follows:

$$R_v = P_x \sum_{i=1}^{m} (\partial F_x/\partial Z_{ix})(\partial Z_{ix}/\partial Z_{vx}), \tag{2}$$

where R_v is the price of input v, P_x is the price of output x (apple retailing sales), m is the number of characteristics of the input, $(\partial Z_{ix}/\partial Z_{vx})$ is the marginal yield of the ith characteristic in the production of x from input v, and $P_x(\partial F_x/\partial Z_{ix})$ is the value of the marginal product of characteristic i used in the production of x (the implicit price of the ith characteristic). Equation (2) indicates that the price of each input is equal to the sum of the implicit prices of the characteristics possessed by the input multiplied by the marginal yield associated with each of those characteristics. Hence, it is possible to predict the expected effect of quality variables on apple prices by using the retailing firm's production function.

Equation (2) can be further simplified considering the typical retailer and assuming that only one product is produced (apple sales). In addition, it may also be assumed that he covers his operational needs purchasing several product qualities, origins and seasons so that $(\partial Z_{ix}/\partial Z_{vx})=B_v$ and $P_x(\partial F_x/\partial Z_{ix})=Z_{iv}$ are constant. In other words, it is assumed that each additional unit of input v contributes the same amount of the quality characteristic to the production function and that the implicit price for this characteristic is constant (Ladd & Martin, 1976). Hence, (2) may be rewritten as:

$$R_v = \sum_{i=1}^{m} B_i Z_{iv}, \tag{3}$$

where B_i is the marginal value of characteristic i and Z_{iv} is the quantity of characteristic i contained in each unit of input v (e.g. daily sales) that goes into the production function of x.

Data Description and Estimation Method

In order for the above model to be estimated, three different sets of variables have to be defined, each one representing the quality, regional and seasonal effects.

Following Stanley and Tschirchard, (1991), and Lenz *et al* (1994) who have introduced some composite characteristics in the hedonic model, it is assumed that apple quality is a composite characteristic (appearance-shape-colour-skin defects-bruising-maturity-size) represented by one unique variable incorporating all these specifications.

According to the Common Quality Scheme for the application of European Standards for fruit and vegetables three different product categories (EXTRA, I, II) exist in Greece, based on quantitative limits. Given the way these categories are defined (EC Reg. 920/89), a higher category should be associated with a higher price ($\partial R/\partial Z_i>0$). Consequently, following Palmquist and Danielson (1989), a quality index was developed, taking the maximum value (3) for category EXTRA, and the lowest one (1) for category II.

As noted previously, the concern here is not only the product quality, but also product origin and time availability. Regarding product origin, it should be mentioned that wholesalers located at Thessaloniki are the main providers of the majority of retailing outlets in Central Macedonia. The product distributed by them originates from different regions all over Greece, while only few quantities are imported. Two important places of product origin (consumed at the local market) are the Volos region and the Naoussa (Rodochori) one.

Consequently, three dummy variables were introduced in the model representing product origin. They take unit value in the case the product originates from Volos, Rodochori or it is imported, and zero otherwise. If product origin is a desirable quality characteristic, it affects apple value and in that case, a positive buying interest exists, i.e. the marginal yield of this characteristic in the retailer's production is positive ($\partial R/\partial Z_i>0$).

The time-within-season of apple production and provision in Greece is between September and November. The inputs used and the total cost of production and distribution are minimised during this period, but as the season progresses the inputs and the costs increase. According to Rosen (1974), as cost increases (time out of season) the reservation supply price may also increase, causing a shift of market clearing implicit price function (hedonic) towards a higher level. It is possible to test this hypothesis incorporating in the hedonic model nine dummy variables representing the out of season months (December, January, February, March, April, May, June, July and August).

The data for the analysis were gathered from the public office of the Vegetable and Fruit Market Organisation located in Thessaloniki. More specifically, *Starking Delicious* apple retailer prices (daily weighted mean per each product category) and characteristic information (product quality categories, origins, season) were collected from the daily reports (each Tuesday and Wednesday). It should be emphasised that the data (number of observations) are not necessarily the same each day and can vary from one to seven). Since the period under study is January 1997 to January 1999, no attempt was considered necessary to correct for a changing price level.

Brown and Rosen (1983) have pointed out that the only way to identify the coefficients of the implicit price function is by imposing - possibly arbitrary - restrictions. Cropper *et al* (1988) recommended the linear and Box-Cox linear forms when a characteristic is replaced by a proxy. Given that in this study, characteristics are replaced by

proxies which in most cases take zero values, the linear model of apple price is adopted[2].

In the case that the disturbances of a linear regression are serially correlated, the coefficient estimates of ordinary least squares are inefficient, although still unbiased. The Durdin-Watson test was conducted to examine the autocorrelation hypothesis (Gujarati 1995). As this hypothesis could not be rejected, correction for serial correlation was made by using the first and second order autoregressive schemes[3].

Results and Discussion

Table 1 reports the estimated coefficients, the corresponding t-statistics and the elasticities for the characteristics evaluated at their means. These elasticities represent the marginal shadow values of the characteristics (mean value of the independent variable, multiplied by coefficient b, divided by the mean value of the dependent variable). Through these values it is possible to rank the quality characteristics according to their importance. The results reveal that 87% of apple wholesaler price is explained by the included variables. This determination coefficient is among the highest found in the relevant literature for hedonic price estimations. Naturally this is, to a certain extent, also due to the existence of four explanatory variables versus the two auto-regressive terms, however, R^2 was also quite high (85%) when the model was run without any auto-regressive terms.

Table 1. OLS estimates and elasticities for characteristics

Variable	Mean	Estimates	t statistics		Elasticities
Constant		67.428	2.323		
Product quality	1.6688	66.326	64.863	***	0.5566
Volos country	0.3931	26.927	20.280	***	0.0532
Rodochori country	0.0631	21.101	7.007	***	0.0067
Imported	0.0730	124.612	39.823	***	0.0458
R- squared	0.8710				
Adj. R-squared	0.8701				
F-statistic	1006.049				
n	903				

*** Significant at 0.01 level

In hedonic studies, one of the most consequential estimation problems is that collinearity among characteristics of a commodity, frequently resulted both in imprecise and implausible estimates of the prices of the characteristics as well as in estimates statistically insignificant with theoretically incorrect signs (Gujarati, 1995, p. 327). Preliminary analysis was undertaken to examine which variables are multicollinear, using a rather empirical approach proposed by Kmenta, based on the estimation of correlation coefficients (Lazarides, 1992, p. 146). The absence of any strong collinearity is ascertained by the low correlation coefficients (below 0.23).

In addition, as indicated by the computed F-statistic, the null hypothesis that all coefficients are simultaneously equal to zero is rejected. At the 10% confidence level, results indicate that four of thirteen estimates are statistically significant. Contrary to the theoretical constructs, the exclusion of all time out of season (December-August) variables was supported by their statistical insignificant individual coefficients.

Since heteroscedasticity may in some cases affect cross-sectional observations (Gujarati, 1995, p.380), the White's test for heteroscedasticity was performed on the model

and the null hypothesis of homoscedasticity was not rejected at 1% level (observations times R-squared=68.281<70.064).

Very often specification biases arise inadvertently, perhaps due to the inability to formulate the model as precisely as possible, either because the underlying theory is weak or because of the absence of appropriate data to test the model (Gujarati, 1995, p.459). Since a composite variable for product characteristics was used (physical quality) in the hedonic model, specification biases may arise. The Ransey's RESET test was performed and the null hypothesis that the model is misspecified was not accepted (F=21.664). The Jarque Bera test (Gujarati, 1995, p.143) was also conducted to test the normality hypothesis of the disturbance term and the normality assumption was not rejected (1% level).

Results (table 1) indicate that the product quality coefficient is significant (at 1% level) and positive as expected. The 0.5566 elasticity implies that a 10% improvement in product quality (10% enhancement of product category) results to a 5.57% increase in price paid by the customers (retailers). Hence, it is possible for farmers and marketers to account the net benefit of product quality improvement in order to increase their decision-making efficiency.

Regarding the product origin variables, coefficients for all three regions (Volos, Rodochori and imported) are found statistically significant (at 1% level) and positive. The elasticity for the Rodochori region (0.0067) is lower than the one for Volos (0.0532), implying that customers pay higher prices for Volos apples. The elasticity obtained for the import coefficient (0.0458) is higher than Rodochori but lower than Volos. Hence, it can be argued that consumers have high appreciation for Volos apples and are prepared to pay a premium over any other domestic or imported apple.

A 10% increase of the total sales of product originated from Volos, generates a 0.53% increase in the retailer prices of apples. Since higher prices are paid by customers for Volos apples in the market, individual, group-co-operative or regional policies aiming to protect the product's designation of origin would appear to be consistent with customer values and may also be profitable for farmers and distributors.

Since time-out-of-season individual coefficients are not statistically significant, the hypothesis that the out-of-season time of product availability for these months is an important determinant of apple price cannot be accepted. The reason that they are statistically insignificant and they do not influence the level of prices can be explained by the decreasing level of fresh apple quality during storage after harvesting, even when they are stored in proper conditions. Moreover, it implies that there is a substitution effect of other fruits supplied in the market during the time-out-of-season period. Nevertheless, it can be argued that seasonal effects are captured by the variable 'imported' to the extent that during the out of season months there is less domestic supply. Thus prices will be higher and at the same time imports will be larger, causing a positive correlation between imports and apple prices.

Concluding Remarks

The purpose of this study was to examine whether certain factors, such as product quality, place of product origin, and the time of availability -mostly out of season- affect product prices and subsequently the market value for apple distribution.

Results suggest that product quality is the major factor in the apple market purchasing decisions. They also support the notion that regionality is valued in the market - especially for Volos and Rodochori regions- suggesting that offering regional apples may subsequently be an appropriate mechanism for adding value to this product. This implies that it may be a profitable action for farmers, co-operatives or marketers to protect product origin, thereby generating a significant stimulus for the local economy too.

Given that there is no evidence that time of production can add value to the product, farmers and distributors are discouraged to increase production (genetic resources, fertilisation, pesticide application, etc.) and distribution expenditures (transportation costs, preservation expenses, etc.) in order to expand product availability during the out-of-season months. Based on the obtained results, it can be argued that it is in the best interest of apple producers to emphasise on increased product quality (as the quality parameter is found to be the most significant determinant factor) aiming however, not at the extended out-of-season period (when there is increased competition with imported apples and other domestically produced fruits), but rather at the apples' season period itself.

In conclusion, it is shown that objectively measured characteristics other than product features can explain relative prices in such a manner that they may define the customers' perceived value of the product. As it is possible to use hedonic analysis to estimate the shadow value of the marginal yield of origin and time in addition to product quality, the approach used in this paper suggests that the hedonic methodology is a tool useful also in the total quality management decision-making.

Notes

1 The large number of apple wholesalers and retailers present in the market (280 wholesalers in Thessaloniki country) suggests that the assumption of perfect competition is tenable.

2 Statistical analysis was made with the EViews software programme (1994 Quantitative Micro Software).

3 The values obtained for each scheme were 0.244 (t-stat=7,56) and 0.261(t-stat=7,99) respectively. The second order autoregressive model takes the form $u_t = n_1 u_{t-1} + n_2 u_{t-2} + a_t$, where n_1 and n_2 are the first and second order serial correlation coefficients. As the Durbin-Watson statistic for this model was d=2.56 the hypothesis for autocorellation was rejected.

References

Anonymous. 1996. Quality Management in the Fruit Trade, International Fruit World (2): 174-176.

Bowman, K. R., and E. Ethridge. (1992). Characteristics Supplies and Demands in a Hedonic Framework: U.S. Market for Cotton Fibber Attributes, American Journal of Agricultural Economics, 74(4): 991-1002.

Brorsen, W. B., W. R. Grant, and M. E. Rister. (1984). A Hedonic Price Model for Rugh Rice Bid/Acceptance Markets, American Journal of Agricultural Economics, 66: 156-163.

Brown J., and S. Rosen. (1982). On Estimation of Structural Hedonic Price Models, Econometrica, 50(3): 765- 768.

Cropper, M. L., L. B. Deck and McConnel. (1988). On the Choice of Functional Form for Hedonic Price Functions, The Review of Economics and Statistics, 70: 668-675.

Goetsch, L. D. S. B. Davis. 1997. Introduction to Total Quality, Prentice Hall.

Golan, A., and H. Shalit. (1993). Quality Differentials in Hedonic Grape Pricing, Journal of Agricultural Economics, 44(2): 311-321.

Gujarati, D. (1995). Basic Econometrics. McGraw-Hill.

Ladd, G. M., and M, B. Martin. (1976). Prices and Demand of Imput Characteristics, American Journal of Agricultural Economics, 58: 21-30.

Ladd, G. W., and V. Suvanunt. (1976). A Model of Consumer Goods Characteristics, American Journal of Agricultural Economics, 58: 504-510.

Lazarides, A. (1992). Econometrics II, School of Law and Economics, Aristotle University of Thessaloniki (in Greek).

Larue, B. (1991). Is Wheat a Homogenous Product? Canadian Journal of Agricultural Economics 39: 103-117.

Lenz, J. E., R. C. Mittelhammer, and Hongqi Shi. (1994). Retail-Level Hedonics and the Valuation of Milk Components, American Journal of Agricultural Economics, 76: 492-503.

Palmquist, R. B. and L. Danielson. (1989). A Hedonic Study of the Effects of Erosion Control and Drainage on Farmland Values, American Journal of Agricultural Economics, 71(1): 55-62.

Parker, D. D. and D. Zilberman. (1993). Hedonic Estimation of Quality Factors Affecting the Farm-Retail Margin, American Journal of Agricultural Economics, 75: 458-466.

Ratchford, B. T. (1990). Marketing Applications of the Economics of Product Variety, Marketing Science, 9(3): 207-211.

Rosen, S. (1974). Hedonic Prices and Implicit Markets, Journal of Political Economy, 82: 34-55.

Stanley, L. R., and J. Tschirhart. (1991). Hedonic Prices for a Nondurable Good: The Case of Breakfast Cereals, The Review of Economics and Statistics, 63: 537-541.

Tregear, A., S. Kuznesof, and A. Moxey. 1998. Policy Initiatives for Regional Foods: Some Insights from Consumer Research, Food Policy, 23(5): 383-394.

Uri, N. D. and B. Hyberg. (1995). The Market Value of Quality Characteristics for U.S. Wheat Exports, Oxford Agrarian Studies, 23(2): 133-153.

Veeman, M. M. (1987). Hedonic Price Functions for wheat in the World Market: Implications for Canadian Wheat Export Strategy, Canadian Journal of Agricultural Economics, 35: 535-552.