

Short communication. The influence of size, variety, destination port and month of sale in the export price of Chilean apples: a hedonic approach

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Abstract

This study aims at determining the marginal prices of agronomic and marketing variables for Chilean export apples. The agronomic variables are variety and size, and the marketing variables destination port and month of sale. The database corresponds to the 2002-03 and 2003-04 seasons and was obtained directly from the export bulletins of an important Chilean fruit export company. A hedonic price linear function was estimated in terms of the variables mentioned. A generalized linear model was employed and parameters were estimated via the maximum-likelihood method. Results showed that the most influential variable on the final price of apples is destination port, followed by variety, month of sale and size. Using as reference Saudi Arabian ports, Taiwan should be preferred while Rotterdam, other European ports, Philadelphia and other American ports and Latin America are worst choices than Saudi Arabia. With respect to 'Red Chief', the reference variety, 'Fuji' and 'Gala' have positive marginal prices whereas 'Granny Smith' showed a null marginal price. Sales in March or April show negative and null marginal prices respectively, suggesting that the best choice is May. The cost of cold storage, however, can offset the advantage of a late sale. Finally the study shows that size has little significance on final price and that 28 additional points in the size index are required to justify the cost of thinning.

Additional key words: hedonic price function, marginal price.

Resumen

Nota corta. La influencia del calibre, variedad, puerto de destino y mes de venta en el precio de exportación de la manzana chilena: un enfoque hedónico

Este estudio busca estimar el precio marginal de algunas variables agronómicas y de mercado, en manzanas de exportación chilenas. Las variables agronómicas son variedad y calibre, y las de mercado, puerto de destino y mes de exportación. La base de datos corresponde a las temporadas 2002-03 y 2003-04 y se obtuvo de los boletines de exportación de una importante exportadora de fruta chilena. Se estimó una función lineal de precios hedónicos, en términos de las variables mencionadas. Se empleó un modelo lineal generalizado con estimadores de máxima verosimilitud. Los resultados mostraron que el puerto de destino es la variable más influyente en el precio final, seguido de la variedad, mes de venta y calibre. Tomando como referencia los puertos de Arabia Saudita, Taiwán es la mejor elección en tanto que Róterdam, otros puertos europeos, Filadelfia y otros puertos norteamericanos y los puertos latinoamericanos, muestran precios marginales negativos y, consecuentemente, son peores elecciones que los puertos árabes. En relación a 'Red Chief', la variedad de referencia, 'Fuji' y 'Gala' muestran precios marginales positivos en tanto que 'Granny Smith' tiene un precio marginal nulo. Una venta en marzo o en abril muestra precios marginales negativo y nulo respectivamente, sugiriendo que el mejor mes es mayo. No obstante, la ventaja de una venta tardía puede anularse por el costo del almacenaje en frío. Finalmente el estudio muestra que el calibre es poco significativo en el precio y que se requieren ganancias marginales de 28 puntos de calibre para justificar el costo del raleo.

Palabras clave adicionales: función hedónica de precios, precio marginal.

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Apples (*Malus sylvestris* var. *domestica* Mill.) are the second most important tree fruit crop, after table grapes, in Chilean fresh fruit trade. Thus, of the 900 million dollars that Chile exported in fresh fruit during 2005, 333 millions (37%) were supplied by apples. Although Chile reaches many continents, approximately 40% of total exports are sold in Europe, 26% in South America, 15% in North America and the remainder in Africa and Asia. To maintain a prominent position in the trade market, the Chilean apple industry has been updating technologically its orchards, especially in what refers to cultivars. Although 'Granny Smith' and the 'Delicious' varieties are still important in the Chilean annual supply to world markets, 'Gala' has gradually gained significance, becoming as the most important variety exported in 2001 and accounting for 37% of the total annual apple exports in 2005 (ODEPA-MA, 2006).

In economic theory, consumer demand is normally derived from a utility function, a theoretical construct that defines preferences over the array of commodities placed at the consumer's disposal. These preferences are based on the ordinal utility (i.e. satisfaction) obtained from the quality attributes of each commodity, as perceived by an ordinary consumer. Thus, it can be hypothesized that prices are the value that consumers attach to the bundle of quality attributes of each commodity, given certain budget restrictions and limited commodity supplies. The determination of market values based on commodity attributes can be carried out through the estimation of a «hedonic price function». A hedonic price function relates the price of a commodity to its various attributes or characteristics. The theoretical foundations of hedonic price functions were provided by Rosen (1974), who posited that competitive markets define implicit prices for the embodied commodity attributes, and that consumers evaluate these attributes when making a purchase decision.

Size, form and the presence of visual attributes have an influence on the purchasing decision of consumers. Price premia or discounts are significant for fruit size, bruising, bitter pit, decay, misshapen apples and internal breakdown. On the contrary, commonly cited defects such as insect damage and apple scab have little or no significance on price (Harper and Greene, 1993). Consumers prefer a diameter of 7.5 cm, equivalent to a 110 to 120 size¹, and can tolerate the presence of

lenticel breakdown or of stem-end russet to the limit of 1 mm or 55% of the diameter of the fruit, respectively (Hampson and Quamme, 2000). To some extent, producers can increase the size of their fruit via chemical and/or manual thinning, a common practice in industrial orchards (García, 1991; Gil, 1992). Of course, the marginal price gained by size should be compared with the additional cost incurred in thinning (chemicals, machinery, labour) plus the value of the yield sacrificed, to assess the commercial convenience of carrying out this practice.

Besides size, other characteristics that influence wholesale price are cultivar and grade, as Carew and Smith (2004) have shown. These researchers analysed sales data and cultivar characteristics from three large wholesalers that purchase fruit in British Columbia, Canada, and found that a significant price premia (Can\$2.25 to 5.25 per box) were paid for specialty cultivars such as 'Gala', 'Fuji' and 'Braeburn', compared to traditional varieties as 'McIntosh', 'Red Delicious' and 'Spartan'. Smaller premia were paid for large fruit (Can\$1.73 per box) and small fruit received a discount (Can\$2.00 per box). Apples graded Extra Fancy and BC Extra Fancy received a premium of Can\$1.50 per box, over apples graded as Canada Fancy. Finally, apples kept in controlled atmosphere storage received a premium of Can\$0.96 to 1.89 per box, in the months of January through June.

Although strictly speaking the port of destination and month of sale are strategic decisions taken by producers rather than intrinsic attributes of the fruit, consumer tastes vary with the different locations and seasons and hence, they bear an influence on price. Carew (2000) concluded that, besides grade, cultivar, storage and size, the marketing season explains a significant proportion of the variation in apple prices.

This research aims at determining a hedonic price function for Chilean apples in the U.S market and the marginal prices of size, variety and destination port for Chilean apples.

The data were obtained directly from the export bulletins of a reputed Chilean fruit company (Rucaray S.A) and correspond to the seasons 2003 and 2004. Each bulletin corresponds to a business deal between the company and an importer overseas and, consequently, can be considered the valuation that a specific market

¹ In apple trade, size is measured by the quantity of fruit that fit in a 20-kg cardboard box. Thus, size 110 means that a 20-kg box can contain 110 apples. Obviously as the apple diameter increases the size index decreases, so an index of 100 represents a greater size than 110, and so on.

does of the quality of a particular shipment of apples. A total of 7,693 bulletins were obtained from the company but after screening for outliers, a final database of 7,502 observations were analysed. Each bulletin included the following variables:

— Free-on-Board (FOB) price, in US dollars per kilogram. By definition, this is the price paid to exporters for a merchandise at the port of origin, i.e. apples *ex* Valparaíso or San Antonio, Chile, in this case. Note that because all prices are quoted at the port of origin, the different markets are comparable regardless of the distance between Chile and the port of destination.

— Size, measured as the number of apples that fit in a 20-kg cardboard box.

— Variety: Observations included ‘Red Chief’, ‘Fuji’, ‘Royal Gala’ and ‘Granny Smith’.

— Month of sale: these are March, April and May, i.e. the months when apple exports from Chile occur.

— Port of destination: The following ports and group of ports were distinguished: Rotterdam, «Other in Europe» (Las Palmas, La Coruña, Vigo, Dover, Marseille, Genova, Naples, Pireo), Philadelphia, «Other in North America» (Los Angeles, New York), «Latin America» (Manzanillo, Mexico, Guayaquil, Buenaventura, Salvador de Bahia, San Pedro, Rio de Janeiro), «Taiwan» (Kaohsiung, Keelung), «Arabia» (Jeddah, Dammam, Sherja).

Price and size are continuous variables while variety, month of sale and port are binary («dummy») variables.

Following the general hedonic functions model, it was assumed that the price of the i -th kilogram of apples, P_i , is a function of the value attached by the consumer to its attributes Z_{ij} ($j = 1 \dots m$). Thus,

$$P_i = f(Z_{i1}, Z_{i2}, \dots, Z_{ij}, \dots, Z_{im})$$

It is also assumed that the market is in equilibrium, that is, that all consumers have made their utility-maximising choices, given their budget constraints and knowledge of the prices and characteristics of alternative goods. Moreover, all firms have made their profit-maximising decisions taking into account their production costs, and that the resulting prices and quantities have been set at market-clearing levels.

Initially ordinary least squares (OLS) were employed for estimation, using the following model specifications: linear, log-linear, quadratic. All the models tested showed non-normality of residuals, breaking thus the basic assumption of OLS and yielding biased parameters. To overcome this difficulty, a truncated normal distribution of residuals was assumed and a generalized

linear model was adopted (Mc Cullagh and Nelder, 1989; Greene, 1999). Estimation was carried out by the maximum-likelihood method. Because the three specifications yielded similar maximum-likelihood parameters, the linear model was adopted for simplicity. In summary, the following price function was estimated:

$$P = \beta_0 + \sum_j \beta_j Z_j + \sum_w \beta_w Z_w \quad [1]$$

where P is FOB price and Z_j and Z_w represent the j -th continuous variable and the w -th dummy variable respectively.

To avoid collinearity between the dummy variables (the so-called «dummy variable trap»), reference variables were omitted in the dummy variables. These are: ‘Red Chief’ for cultivars, Arabia for ports and May for month of sale. Hence, results should be interpreted as departures, in dollar terms, from the price a kilogram of Red Chief apples would obtain in an Arabian port during the month of May.

The marginal prices were estimated as the derivative of the hedonic price function [1]. Thus, the marginal prices of the Z_j and Z_w variables are β_j and β_w , respectively.

Table 1 provides summary statistics of the data collected in this study. The most important varieties included in the sample are ‘Royal Gala’ and ‘Granny Smith’, although ‘Red Chief’ and ‘Fuji’ are also present, in small proportions. Most of the trade was destined to Rotterdam and other European ports, with Philadelphia and other North American ports ranking in a significant but second place. A small percentage of the shipments were destined to Latin America, Arabia and Taiwan. Sales start in March, which concentrates 43% of the total, and continue in a descending fashion throughout April and May. In general terms, the trade pattern showed by the data coincides with the general trends of the Chilean trade of apples, as described by Troncoso and Yuri (2004). Table 1 also shows that the data represents an extensive range of FOB prices (from US\$ 0.16 to 2.15, per kilogram) and sizes (from 36 to 150 apples per box).

Table 2 provides data for ‘Red Chief’ apples sold in May, the reference variety used in this study. On average, a ‘Red Chief’ apple sold during the month of May had a size 130 and was priced at US\$ 0.37 per kilogram.

Table 3 presents the maximum-likelihood estimates for the linear price hedonic function of Chilean apples in the international market. The log likelihood function yields a likelihood ratio test in the rejection area at the

Table 1. Data summary statistics

	Number of export bulletins	%
<i>a) Apple varieties</i>		
'Royal Gala'	3,455	46
'Granny Smith'	3,807	51
'Red Chief'	45	1
'Fuji'	195	3
Total	7,502	100
<i>b) Ports</i>		
Rotterdam	3,364	45
Other in Europe	1,307	17
Philadelphia	1,855	25
Other in North America	153	2
Latin America	590	8
Arabia	77	1
Taiwan	156	2
Total	7,502	100
<i>c) Month of sale</i>		
March	3,225	43
April	2,637	35
May	1,640	22
Total	7,502	100
	Price (US\$ kg ⁻¹)	Size (apples/box)
<i>d) Price and size</i>		
Average	0.58	95
Maximum	2.15	150
Minimum	0.16	36

Data collected at Rucaray, S. A.

1% probability level², supporting the conclusion that some or all the parameters of the price function are statistically different from zero. On closer examination, the β /SE ratios show that, with the exception of the estimates for 'Granny Smith' and «sale in April», all coefficients are significant at a 1% probability level. As stated earlier, because the function is linear, the coefficients are direct estimates of the marginal prices of each variable or attribute. The analysis concentrates now on these prices.

The first observation is that the destination port has the most significant marginal price, followed by cul-

Table 2. Price and size of 'Red Chief' apples sold in May

	Price (US\$ kg ⁻¹)	Size (apples/box)
Average	0.37	130
Minimum	0.34	110
Maximum	0.41	150

Data collected from the export bulletins of Rucaray, S. A.

tivar, month of sale and size. Thus, the marginal prices of the destination ports range from –US\$ 0.41 to 0.28, for cultivars from US\$ 0.14 to 0.27 and for month of sale from –US\$ 0.02 to 0.005, all of them FOB per kilogram sold. In the case of size, recalling that the index is inversely related to size, a 10-points increase in size (e.g passing from size 130 to size 120) brings about an increase in price of US\$ 0.007 per kilogram, a very insignificant result compared to the previous values. Hence, an important result of this research is that strategic decisions such as destination market and/or cultivar are far more influential on the final price of apples than the month of sale and/or agronomic practices (e.g thinning) carried out to increase fruit size.

Concentrating the attention on destination ports, it is noticeable that only Taiwan has a positive marginal price, while Rotterdam, other European ports, Philadelphia, other ports of North America and Latin America, show negative signs. This means that only Taiwan should be preferred to Arabian ports and that the other traditional market places of Chilean apples are inferior choices. Adding the marginal price foregone and the negative premium attached to each choice, shipping to Latin America or to «other North American ports» instead of Taiwan imply a marginal opportunity loss of US\$0.75 and 0.72 per kilogram FOB, respectively. The other ports exhibit lower marginal opportunity losses, although still significant.

Cultivar choice is the second most important decision. The preferred varieties are 'Fuji' and 'Gala', with a marginal price of US\$0.27 and 0.14 per kilogram FOB, respectively. Since the estimate of 'Granny Smith' is statistically zero, the conclusion is that this variety adds no value with regard to 'Red Chief', the reference variety.

In regard to the choice of a month of sale, the results show a negative and a nil marginal price for March and

² The overall goodness-of-fit test applicable to maximum-likelihood estimates is the likelihood ratio test, which follows a chi-square distribution and can be estimated as $\chi^2_0 = 2 * (\log \text{likelihood function})$. The null hypothesis is that all the parameters equal zero. In this case $\chi^2_0 = 2 * 5,237.75 = 10,475.5$ which is far beyond $\chi^2_{.99} (12 \text{ d.f.}) = 26.2$, allowing the rejection of the null hypothesis.

Table 3. Maximum-likelihood estimates of the linear price hedonic function

Dependent variable	P			
Weighting variable	None			
Number of observations	7,502			
Log likelihood function	5,237.75			
Threshold values for the model:				
Lower = 0.0000 Upper = infinity				
Observations after truncation	7,502			
Disturbance SD	0.12			
Variable	Coefficient (marginal prices, US\$ kg ⁻¹)	SE	β/SE	P[Z > z]
Constant	0.946576	0.023734	39.88	0.0000
Size	-0.000732	0.000070	-10.51	0.0000
Royal Gala	0.141339	0.018203	7.77	0.0000
Granny Smith	-0.000823	0.018191	-0.04	0.9639
Fuji	0.269046	0.020975	12.83	0.0000
Rotterdam	-0.412770	0.013954	-29.58	0.0000
Other in Europe	-0.347729	0.014240	-24.42	0.0000
Philadelphia	-0.321622	0.014086	-22.83	0.0000
Other in North America	-0.434141	0.017212	-25.22	0.0000
Latin America	-0.465944	0.014783	-31.52	0.0000
Taiwan	0.285028	0.017860	15.96	0.0000
March	-0.022515	0.004564	-4.93	0.0000
April	0.005173	0.004495	1.15	0.2498

SD: standard deviation. SE: standard error.

April, implying that the best choice is May, the reference month. The marginal gain of selling in May instead of March is US\$0.02 per kilogram FOB, which should be compared to the cost of cold storage of two months. According to an expert opinion³ this cost is approximately US\$0.01 per kilogram-month, i.e. the marginal gain of selling in May is offset by its cost, eliminating the advantage. Hence, from a price convenience standpoint, the best choice is an early sale in March.

Finally, as indicated earlier, a gain of 10 additional size points commands a marginal price of US\$0.007 per kilogram FOB, a result of little significance. According to a preliminary estimate⁴, the cost of thinning varies in the proximity of US\$0.02 per kilogram, a number that is only justified if the size improvement exceeds 28 additional points. This means that thinning pays itself only if the size index can be brought from the

reference size of 130, to 102 or less, on average. Although this result can be achieved in practice, size remains a variable of less influence on the final price of apples than varieties and destination ports.

In conclusion, the two strategic decisions that influence final price of export apples are: (i) the choice of varieties and, (ii) once the orchard is established, the port of destination of the fruit. Size has little influence on the final price. This study shows that 'Fuji' and 'Gala' should be preferred to 'Granny Smith' and 'Red Chief', but this is a question that should be addressed periodically as market preferences may vary on time. And that at the current commercial conditions, Taiwan and Arabic ports are more interesting than Latin America, European and American ports, although it is wise to diversify the commercial contacts and hence, these less appealing sale points should also be served.

³ Ms. Claudia Moggia, agronomist specialised in postharvest methods, staff member of the «Centro de Pomáceas» (Pomme Centre), Universidad de Talca (Chile). Contact made on September 2006.

⁴ According to a survey conducted by the «Centro de Pomáceas» of Talca University on 10 industrial orchards of the Maule region of Chile (Yuri *et al.*, 2003), thinning costs about US\$ 780 per hectare, including labour and agrochemicals. Dividing this number by the yield reported in the survey (between 33 to 45 t ha⁻¹) the per-kilogram cost is estimated in the range between US\$ 0.017 and 0.024.

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