HEDONIC PRICE OF FREE-RANGE EGGS IN COSTA RICA

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Abstract: *Eggs are a highly consumed animal product in Costa Rica. It is grown in different production systems and differentiation attributes, although there is little information about consumption and consumer preferences for grazing production. This study aimed to determine the effect of free-range on the price per kilogram of eggs paid by the consumer in Costa Rica. The results show a positive effect of 19.77% on price of eggs produced in free-range systems, but preference for other attributes such as nutritional fortification, egg size and brand names were also determined. Incorporating free-range technologies to replace caged poultry production can contribute to animal welfare and balance with nature, and producers can opt for differentiated prices in local markets.*

Keywords: Animal welfare, consumer preferences, cage-free

(JEL code: C5, E3, Q12, Q57)

INTRODUCTION

Eggs are a highly consumed animal product in Costa Rica, responding to consumer preferences for foods with high protein content, easy digestion, reasonable prices, and great versatility in culinary preparations. In Costa Rica, between 200 and 230 units of chicken eggs are consumed annually per person (Cardoza, 2016), which makes it the most recognized type of egg, surpassing others such as quail and duck eggs.

In Costa Rica, there are three distinct different laying hen production systems: battery-cages system, barn-system and free-range system. Pastured production refers to the laying hens being free-range, on the ground covered with pasture and forage, where they circulate and feed on seeds, minerals, insects, and plants cultivated for this purpose, although concentrated feed is also supplemented. Contrary to the confinement system, where hens remain in cages and are fed concentrates (Cruz-Bermúdez et al., 2021; Vargas et al., 2018).

Egg production farms must comply with the good poultry production practices required by Servicio Nacional de Salud Animal (SENASA), regardless of system type or technology adopted. These good practices are based on the guidelines on safety criteria recommended by the Codex Alimentarius of the Oficina Internacional de Epizootias[1] (OIE).

Currently, in Costa Rica there are no official statistics on farms dedicated exclusively to pastured hens, nor data on the quantity of eggs traded in markets with this differentiation scheme. However, it is common to find pastured eggs in retail stores as part of the available supply.

Consumers recognize this purchase option under the perception of an animal-friendly production, exalting the animal welfare, the nutritional value free of contaminants and the conservation process more friendly to the body and the environment (Campbell et al., 2017; Coy, 2017). The advantage for

[1] World Organization for Animal Health

producers consists of offering a better quality, safe and differentiated product with higher added value, which is generally traded in the market at higher prices than eggs obtained in conventional or confinement systems (Coy, 2017).

Battery-cages system is becoming a highly debated topic in different spheres including animal welfare advocates, researchers, producers, and consumers, who also value aspects of economic, environmental, human health and food safety sustainability (Molnár & Szollosi, 2020).

There are several studies focused on the production of organic, pastured, cage-free, fortified eggs, among others (Cruz-Bermúdez et al., 2021; Gómez, 2018; Marelli et al., 2021; Rentería, 2018; Rizzi & Chiericato, 2005). These studies demonstrate a worldwide trend for organic production, which guarantees a captive demand on differentiated products in population segments that are constantly growing (Álvarez & Rojas, 2013).

Evidence clearly supports the notion that birds' wellbeing is higher in cage-free systems than in a typical cage system. Therefore, there is a clear link between production systems and animal welfare (Vukina & Nestic, 2020). Free-range is a form of cage-free production that promotes animal welfare and therefore generates a positive contribution to the environment.

In a study conducted in Sonora, Mexico, an Exploratory Factor Analysis (EFA) and a cluster analysis were applied to segment consumers according to their attitudes, values, and environmental beliefs in the purchase decision of organic products (Salgado, 2019). The results indicate that young and mostly educated people are more sensitive to the consumption of differentiated and environmentally friendly products (Salgado, 2019). Studies such as these contribute to provide recommendations to market players to design marketing strategies and include environmental education through public institutions to improve people's awareness.

Also in Mexico, a study was carried out to measure the trend in per capita egg consumption using a second-order, linear, non-homogeneous and moving average difference equation model, considering a study period from 1980 to 2013 (Mendoza et al., 2016). These results indicate that egg consumption in Mexican households has already reached its consumption limit, so future demand will only grow according to the rate of population growth. However, eggs with differentiation represent an opportunity for small and medium-sized producers, and for consumers they represent a healthy food according to specific needs (Mendoza et al., 2016).

The perception that pasture-based production is sustainable and animal-friendly was analyzed by Banaszewska et al. (2020), in whose study they also included the environmental and human benefits, in addition to the improvement in egg quality. These authors compared the eggs quality from organic and conventional farms, and the sodium (Na) and potassium (K) content, using a mean difference analysis. The findings of this research indicate a slightly better quality of eggs produced under organic farming compared to eggs in confinement; in addition to a higher Na and K content in albumen, yolk, and whole egg (Banaszewska et al., 2020).

The findings of Banaszewska et al. (2020) agree with Filipiak-Florkiewicz et al. (2017), who compared the quality of certified organic, nutraceutical (enriched in n-3 fatty acids) and conventional (cage-rearing system) farm eggs through a one-way analysis of variance (ANOVA), finding high levels of protein, potassium, and copper (Cu) content in the yolk of organic eggs; in addition to higher protein content in albumin.

Another research addressed a discrete choice approach to measure consumer preferences for eggs with differentiating attributes (Zakowska-Biemans & Tekień, 2017). The study revealed a strong preference for non-caged systems, even over organic and environmental production, with consumer education having a significant positive effect on willingness to consume (Zakowska-Biemans & Tekień, 2017).

Product-differentiation questions can be examined through various methods, but the hedonic pricing approach, introduced by Rosen (1974), is recognized as one of the most appropriate. In this context, consumers make their purchases based on consumption preferences, then some attributes affect the price of the products, which are understood as the value that consumers attribute to the characteristics that differentiate the goods from other similar ones, limited by their budget and the available supply (Troncoso & Aguirre, 2006a).

To evaluate the value of the attributes to be paid by consumers, the hedonic price function is the way which relates the prices of a given good to its most visible and relevant attributes or characteristics (Rosen, 1974; Troncoso & Aguirre, 2006a).

Hedonic prices are based on the fact that the characteristics of a good are not homogeneous and it is assumed that its value can be broken down from its attributes, then it refers to an intrinsic value that is not normally taken into account in the price. market value (Jansson & Axel, 2000; Rosen, 1974).

The hedonic price function can be obtained Ordinary Least Squares (OLS) method and commonly uses dummy variables to isolate the qualitative attributes of the good. This method has been widely used with approaches to environmental analysis, real estate valuation, the agri-food sector and the like, by authors such as Aragón et al. (2018), Das et al. (2017), Gracia & Pérez (2004), Méndez et al. (2021), Ogwang & Wang (2003), Vukina & Nestic (2020), and Paniagua et al. (2021).

Other methodologies applied have been logistic regression models. Bejaei et al. (2015) analyzed attributes to predict the likelihood that a consumer would purchase a specific type of egg, including regular (white and brown), cage-free, free-range, pastured, organic, and nutrient-enhanced eggs. The results suggest a higher probability of purchase for non-caged eggs compared to the others (Bejaei et al., 2015). Authors such as Oviedo Álvarez (2016) and Cárdenas & Celeita (2015) analyzed the differentiation through additions of selenium, Omega 3, and other fortifying components, finding economic and commercial viability, since consumers accept the added value in a good way.

Due to the limited information available in Costa Rica, it is important to generate information bases that favor decision making by producers and consumers. Therefore, in this research, econometric methods were applied to determine the effect of the free-range attribute on the price per kilogram paid by the egg consumer in Costa Rica.

MATERIALS AND METHODS

This is a quantitative research based on econometric procedures to model the price paid by consumers of chicken eggs in Costa Rica through the application of multiple linear regression techniques. Table 1 describes the variables used, with the unit price (PRICE) and number of eggs per package (UNITS) as quantitative variables, which can be log transformed. The remaining variables are qualitative, specifically binary, to capture the effect of presence or absence of the expected attributes.

Table 1. Research variables details

Variable	Details
PRICE	Natural logarithm of price in local currency per kg (colones[2])
UNITS	Natural logarithm of number of eggs per package
HIGHSIZE	Dummy variable that takes the value of 1 if eggs are labeled under a high size distinction and 0 otherwise
FREEGRAZING	Dummy variable that takes the value of 1 if eggs come from free-range system and 0 otherwise

[2] Exchange rate = 650 Costa Rican colones / 1 US$

ENRICHED	Dummy variable that takes the value of 1 if eggs are nutritionally enrichment and 0 otherwise
B1	Brand 1
B2	Brand 2
B3	Brand 3

We used the three main commercial egg brands present in the supermarkets visited; the other competitors are very small, and their brands are not representative.

Data were collected through visits to supermarkets during September, October, and November 2021. A total 403 observations were collected, providing information about price and product attributes. This study focused on supermarkets in urban areas in the capital city of Costa Rica, San José province.

Inflation rate during this period was very close to zero, so observed prices behave as real prices for practical purposes.

The model proposed in this research is formalized by the following equation and corresponds to a semilogarithmic model:

$$lnP_i = \delta + \alpha FG_i + \sum_{k=1}^{K} \theta_k Z_{ik} + \sum_{m=1}^{M} \gamma_m T_{im} + u_i \quad (1)$$

Where, FG is the attribute of coming from free grazing or not for each *i*-th observation; Z are other attributes of importance that influence the price of the product up to the *k*-th attribute present in the *i*-th observation; T trademark of the i-th observation for the *m*-th outstanding brands in the market.

RESULTS AND DISCUSSION

For the data sample used, an average package of 17 eggs sells for an average price of US$3.27. The price fluctuates over a range of US$ 2.23 to US$ 4.14, with the upper limit being the price reflecting the product with the highest distinguishing attributes. Table 1 shows the descriptive statistics for quantitative variables.

Table 2. Summary statistics for quantitative variables (n = 403)

Statistic	UNITS	PRICE (¢)[3]	PRICE US$
Mean	17.27	2125.60	3.27
Median	15	2152.30	3.31
Min.	6	1450.30	2.23
Max.	30	2693.80	4.14
Std. Dev.	7.2537	260.82	0.40
C.V.	0.42	0.12	0.1227
Skewness	0.59244	-0.44719	-0.44719
Ex. kurtosis	-0.2851	-0.03719	-0.03719

[3] Local currency of Costa Rica is "colon" (¢)

Regarding the qualitative variables, the free-range attribute was present in 13.4% of the observations analyzed, but the attribute with the highest presence was the enriched egg since it was present in 19.45% of the observations. For variables measuring the effect of trademarks on price, Brand 2 had the highest presence, while competitor brand 3 had the lowest presence. Table 2 shows the frequency distribution for binary variables.

Table 3. Frequency distribution for qualitative variables (n = 403)

Variable	No	Yes
HIGHSIZE	90.57%	9.43%
FREE-RANGE	86.60%	13.40%
ENRICHED	81.39%	18.61%
B1	80.15%	19.45%
B2	66.50%	33.50%
B3	93.30%	6.70%

To model the price of eggs in Costa Rica based on the attributes described above, the multiple regression method was applied with the weighted least squares (WLS) technique to correct for heteroscedasticity in the residuals and table 4 shows the respective results.

Regression coefficients have signs consistent with economic theory. Likewise, the regression coefficients presented statistical stability according to Harvey-Collier test, while the residuals are free of heteroscedasticity (p-value = 0.0853) and present normality (p-value = 0.1682) at 8% and 16% statistical significance according to Breusch-Pagan and Jarque-Bera tests, respectively.

Table 4. Weighted-Least Squares (WLS) results

Parameter	Coefficient	Std. Error	t-ratio	p-value	
UNITS	-0.1546	0.0084	-18.4300	<0.0001	***
HIGHSIZE	0.1144	0.0128	8.9610	<0.0001	***
FREE-RANGE	0.1977	0.0082	24.1200	<0.0001	***
ENRICHED	0.1039	0.0144	7.2250	<0.0001	***
B1	0.0559	0.0103	5.4460	<0.0001	***
B2	-0.0153	0.0081	-1.8900	0.0596	*
B3	0.1357	0.0159	8.5110	<0.0001	***
const	8.0177	0.0258	310.8000	<0.0001	***

Mean dependent var	185.0776	S.D. dependent var	59.0347
Sum squared residuals	912.1894	S.E. of regression	1.5216
R-squared	0.9999	Adjusted R-squared	0.9993
F (8, 394)	729 686.4000	P-value(F)	<0.0001
Log-likelihood	-736.4398	Akaike criterion	1 490.8800
Schwarz criterion	1 526.8700	Hannan-Quinn	1 505.1280

Breusch-Pagan test for heteroskedasticity -
Null hypothesis: heteroskedasticity not present
with p-value = P(Chi-square (9) > 16.744) = 0.0853
Jarque-Bera test, p-value 0.1682
CUSUM test for parameter stability -
Test statistic: Harvey-Collier t (393) = 1.3369

with p-value = P t (393) > 1.33688) = 0.1820
Mean Absolute Percentage Error 0.7507
Root Mean Squared Error 1.5045
Theil's U2 0.0198

*** The coefficient is statistically significant at a 1% error level, that is, the null hypothesis that this coefficient is equal to zero is rejected.
** The coefficient is statistically significant at a 5% error level, that is, the null hypothesis that this coefficient is equal to zero is rejected.
* The coefficient is statistically significant at a 10% error level, that is, the null hypothesis that this coefficient is equal to zero is rejected.

This research focused on measuring the effect of the free-range attribute on price paid by consumers and the results indicate that the presence of this attribute, which must be duly accredited, generates a willingness to pay an additional 19.77% over the price of conventional eggs. This finding is higher than other researchers like Vukina & Nestic (2020), whom using retail price data in Croatia, found that there is a 7.8% premium in the price of eggs produced cage-free. Given this, it is important to mention that the free-range attribute can be considered broader than "being cage-free", since it implies grazing areas and interaction of birds with nature, generating a higher degree of animal well-being. Cage-free is also of lesser scope because it may be that the birds are always raised enclosed in space, without a cage, but enclosed.

On the other hand, this value is low compared to other authors like Chang, Lusk , & Norwood (2010), whom find that in the U.S. market, the consumer pays 62.9% for free-range eggs over conventional ones.

Systems adopting "more natural" production measures and providing animal welfare, increase their profitability through improvements in market price (Cruz-Bermúdez et al., 2021). In addition, growing consumer empathy and willingness to pay for animal welfare-related attributes is imperative, not only in egg production but in other agricultural products such as dairy and meat (Zakowska-Biemans & Tekień, 2017).

These preferences also lead to a greater likelihood of purchase by those consumers who are informed and more educated. For this reason, market segmentation at the marketing level is critical to empower those consumers and consolidate more profitable market niches (Bejaei et al., 2015).

Meanwhile, Lusk (2019) concluded a higher level of consumption preference for organic eggs than pastured eggs, in contrast to Zakowska-Biemans & Tekień (2017). Furthermore, their results show that most consumers are not willing to pay significantly higher prices. Chang et al. (2010) also concluded that market shares of these products in the United States of America are very small and the willingness to pay is lower than estimated. In this sense, according to Mair (2021), pastured and organic eggs are traded in small and specialized niche markets, so we can speak of specialty and value-added products.

Consumption preference for a grazing egg is also related to a better taste. The consumer has the perception that no chemicals and hormones are added in the hens' feed that may be present in the egg (Peña et al., 2011). For Yenice et al. (2016), protein content in the egg whites of pastured eggs is higher than eggs produced in cages in conventional systems.

In contrast to Yenice et al. (2016), other researchers found that conventionally produced eggs have better attributes of aroma, consistency, yolk color, flavor, and texture (Terčič et al., 2012). Even that the microbiological and dioxin counts of eggs produced under the pasture system are higher than those found in conventional eggs (Chilur Omkarappa et al., 2019; Guier-Serrano et al., 2022; Molnár & Szollosi, 2020), a situation that could affect the price in the retail market.

Price paid by consumers also includes other statistically significant. For example, our results suggest that egg price per kg tends to decrease 15.45% for each additional unit within the same package. This change is measured through the regression coefficient of UNITS variable.

Larger egg size (more quantity, usually units, per package) provides more utility to consumers and is expected to have a higher shadow price than smaller egg size.

Regarding HIGHSIZE variable, the merchant offers the product at an 11.44% higher price compared to presentations without this distinction. These results can be contrasted with Yenice et al. (2016), in the sense that the weight of eggs in cage system was the highest, followed by the grazing system and the home type system, being that consumers prefer to consume larger eggs due to the perception of higher cooking yield.

On the other hand, Chang, Lusk , & Norwood (2010), also found a positive effect on the price of an increase in egg size but using quality variable like small, medium, high, jumbo among others.

The results show that nutritional fortification of eggs is a condition positively valued by the consumer, since an additional 10.39% in price is recognized. Cárdenas & Celeita (2015) also demonstrated a moderate marketing potential for fortified eggs, mainly in the bakery, confectionery, and food service products market.

The results of this research are closer to those obtained by Karipidis et al (2005), who found that the market price for enriched eggs is 46% higher than those that are not.

Chang, Lusk , & Norwood (2010), using the omega 3 content in the egg as a measure of fortified egg, found that the consumer pays a premium of 49.3% over the non-fortified egg.

Competitor 2's trademark (variable B2) had a downward effect on price compared to other brands with a lower share. This effect may be due to the power it has to offer better prices given its scale economies for being a large producer. Competitor 1's brand (variable B1) differentiates itself with a positive effect of 5.58% on price, while competitor 3's brand (variable B3) differentiates itself with a positive effect of 13.56% on price. This is to be expected since this brand follows a strong differentiation strategy in local markets.

To exemplify the effect of regressors on egg prices, the price of a 15-unit pack was projected, since this is a traditional sales unit in the Costa Rican market. The first simulation was made for a product without any of the attributes described and marketed under the B2 brand. The second simulation consists of a product with the attributes HIGHSIZE, FREEGRAZING and ERICHED, marketed under the brand name B3, which has the highest prices in the market. Both projections are obtained from the regression equation developed below:

$$\begin{aligned} lnP_i = 8.0177 - 0.1546\, lnUNITS + 0.1144 HIGHSIZE + 0.1977 FREEGRAZING \\ + 0.1039 ENRICHED + 0.0559 B1 - 0.0153 B2 + 0.1357 B3 \end{aligned} \tag{2}$$

It should be noted that the regression equation presents variables in logarithmic form and to predict the price in monetary terms, the anti-logarithm should be applied when necessary. Table 5 shows the result of the price projection for the two types of products.

In this sense, a 15-unit pack produced in a conventional system, without any attributes and marketed under Brand 2, could have an average price of US$ 3.02. On the other hand, the average price of the same package with specialized attributes and marketed under Brand 3 is US$ 5.33. That is, its price increases about 76.30%. It should be noted that these predictions have a margin of forecasting error according to the homoscedastic variance of regression model (Gujarati & Porter, 2010).

Table 5. Egg price forecast in Costa Rica

Variable	Egg without attributes	Egg with attributes
LN Price	7.5837	8.1507
Local price (colones)	1 965.9590	3 465.9271
Price US$	3.0246	5.3322
Percent change		76.30%

CONCLUSIONS

The proposed econometric model was adequately adjusted to predict egg price Costa Rican local market, with quantitative and qualitative variables that reflect the effect of different attributes. In addition, the variable FREE-RANGE significantly measures the difference in price of an egg obtained in grazing and conventional systems.

The simulation of prices for two types of eggs (with and without differentiating attributes) reflects that the Costa Rican market recognizes a higher price for pastured eggs, in addition to effects due to commercial brands, the size of the egg and the fact that the product been enriched.

Markets are increasingly interested in offering differentiated products; however, the heterogeneity of information in several studies suggests that consumers tend to purchase eggs in the same proportion and at the same price, except when they are well informed about the benefits that the eggs provide. alternative production systems offer. In this way, consumers are free to decide whether they recognize a higher price due to differentiation that they would be willing to pay during the purchasing process.

It is recommended that local producers analyze the cost-benefit of incorporating free-range technologies to replace poultry production in cages and thus also contribute to better animal welfare and balance with nature, in addition to providing more information on the different production systems that allow consumers improve their purchasing criteria.

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