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Hedonic Analysis of Retail Egg Prices Using Store Scanner Data: An Application to the Korean Egg Market

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Abstract

The objective of this study is to identify product characteristics that affect retail prices of fresh eggs. The study develops a hedonic price model to estimate implicit prices of product attributes of Korean fresh eggs. Then, the estimated shadow prices of attributes are used to identify a preference ranking of different levels of the same attribute and the relative importance of the attributes. The study uses store-level scanner data which include prices, sales quantities, and product attributes for all egg transactions for an entire one-year period. Unlike many earlier hedonic price models, the model developed in this study considers the potential effect of quantity sold in estimating implicit prices of attributes. Results suggest that sales quantity is one of important variables in hedonic price models, and therefore omitting the quantity variable could lead to a biased result, particularly when prices and sales vary widely across observations. Results also indicate that Korean consumers put a significantly high value on fertile, organic, free-range-feeding, and larger sized eggs, plus smaller package sizes. The findings could help both producers and retailers formulate better production and marketing strategies by focusing on these attributes.

Keywords: hedonic price, store scanner data, Korean egg market, attribute, marketing

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Today's consumers want an ever-widening variety of food products with various characteristics of nutrition, convenience, food safety, environment, and other traits. Following the trend in consumers' preferences, food markets have become highly differentiated and have turned gradually to smaller niche markets that tailor their products for more precisely defined market. With the changes in food markets, retailers and producers must understand consumer needs in each of the segmented markets. The knowledge of consumer needs in the niches can be used to achieve better market positions and reputations for retailers and producers (Kotler and Armstrong, 2004).

Consumer needs in the differentiated food markets can be analyzed with various research methods. However, the hedonic pricing method, devised by Court (1939) and later further developed by many studies such as Becker (1965), Lancaster (1966), Muth (1966), and Rosen (1974), is considered as one of the most appropriate methods. In the hedonic pricing method, hedonic prices are defined as implicit prices of attributes, which represent the price of each attribute decomposed from the price paid for a differentiated product. Econometrically, the implicit prices are estimated by regressing product prices on various product attributes. The estimated implicit prices provide useful information for consumer preferences on alternative levels of each attribute and on the relative importance across attributes for developing marketing strategies.

Several studies have applied the hedonic pricing model for various agricultural and food markets. A few examples include Brorsen, Grant, and Rister (1984) for rice, Espinosa and Goodwin (1991) for wheat, Tronstad, Huthoefer, and Monke (1992) for apples, Misra and Bondurant (2000) for cotton seeds, Huang and Lin (2007) for fresh tomatoes, Roheim, Gardiner and Asche (2007) for frozen processed sea food, and Martinez-Garmendia (2009) for carbonated soft drinks. Although many studies in the literature provide hedonic price analyses for various agricultural and food products, not many studies focus on the egg market with one exception (Karipidis et al., 2005). They apply the hedonic price model for the Greek egg market and show retail egg prices are affected by several product attributes including nutritional and production-related attributes. Although their study provides some insights on consumer behavior in egg markets, the findings of their study could have limited implications because the study relies only on 175 data points obtained from shelves of selected retail stores.

The present study applies the hedonic model for the Korean egg market to identify product characteristics that affect retail prices of fresh eggs. More specifically, first a hedonic price model for the Korean fresh egg market is developed to estimate implicit prices of product attributes of fresh eggs. Then, the estimated shadow prices of eggs are used to identify a preference ranking of different levels of the same attribute and the relative importance among attributes. Unlike Karipidis et al. (2005), this study uses store-level scanner data which include prices, sales quantities, and product attributes for all egg transactions for an entire one year period. The electronically scanned store data are expected to provide more detailed and accurate information on consumer behavior in egg retail markets than market-level or surveyed data. Unlike many earlier hedonic price models, the model developed in this study considers the potential effect of quantity sold in estimating implicit prices of attributes. Typically, hedonic price models do not include quantity variable in the model assuming inelastic supply. The use of

the hedonic model has focused on inelastic supply goods that usually make a single transaction. Such markets include automobile, machinery, real estate, and highly perishable and expensive goods like tuna. However, prices and sales quantities vary considerably by transaction by transaction in the egg market. When price is lower, people tend to buy more eggs and vice versa. Therefore, including the sales volume variable in the model is imperative to estimate implicit prices of egg attributes particularly when store scanner data are used for the estimation.

The food purchase habits and dietary patterns of Korean egg consumers are rapidly changing from relatively homogeneous to highly differentiated products. Consumers recognize a variety of benefits from making healthy choices that reach beyond basic nutrition. Today's shoppers think eating healthy foods have emotional, physical, and even cosmetic benefits. To meet the changes in consumer demand, Korean egg producers have begun to produce organic, free-range, fertile, and nutrient-enhanced specialty eggs, and retailers have actively promoted these eggs in the market. Therefore, the present study on implicit prices of such attributes evaluated at the retail level will be very helpful to enhance production and marketing strategies of Korean egg producers and retailers.

Review of Previous Studies

In classical microeconomic consumer theory, consumer choice is based on the maximization of a utility function that specifies the quantities consumed subject to a financial constraint. A major point of criticism is that the neo-classical theory of consumer demand does not take the intrinsic properties of goods into consideration and therefore can't deal with problems like the introduction of new commodities and quality variations. One way to address this limitation is to adopt the hedonic hypothesis that goods do not by themselves provide utility to the consumer, but instead are valued for their utility-bearing attributes.

A few studies such as Becker (1965), Lancaster (1966), and Muth (1966), break away from the traditional approach and derive consumer utility not directly from goods but from properties or characteristics of goods. Such an extension makes it possible to study heterogeneous goods like housing, automobiles, and other complex goods within the framework of the classical consumer theory. While still considering utility-bearing characteristics, Rosen (1974) extends the previous studies by focusing on properties of market equilibrium. Rosen's framework is based on the notion that "goods do not possess final consumption attributes but rather are purchased as inputs into self-production functions for ultimate characteristics (Rosen 1974)."

In Rosen's framework, the attributes are represented by a vector of coordinates $v = (v_1, v_2, \dots, v_n)$, where v_i measures the amount of the ith characteristic contained in each good. A price $P(v) = P(v_1, v_2, \dots, v_n)$ is defined at each point on the plane and guides both consumer and producer choices regarding packages of characteristics bought and sold. The function $P(v)$ is identical with the set of hedonic prices and is determined by some market clearing conditions. As usual, market clearing prices, $P(v)$, fundamentally are determined by the distributions of consumer tastes and producer costs. Firms try to maximize profits by changing the product quantity and attributes. Equilibrium can be described by the intersection of supply and demand functions. From this equilibrium, we can understand how sellers determine the value of the

products they offer and how consumers value the products they buy. In the long-run equilibrium, a hedonic function represents the minimum price at which attributes can be supplied and the maximum price at which they will be purchased.

Empirical work for Rosen's hedonic price model requires a two-step procedure. The first step is to regress observed differentiated products' prices, *P*, on those product's characteristics, *v*, using the best fitting functional form. Next, using the regression results, one can compute a set of implicit marginal prices, $(\frac{\partial P(v)}{\partial v_i}) * \bar{p}$, for each buyer and seller, evaluated at the amounts of characteristics actually bought and sold, where $\overline{P}$ is the mean price.

The hedonic price approach has been applied for various food and agricultural products. Brorsen, Grant, and Rister (1984) studied the price structure in the rice market in the United States and developed a framework to analyze quality differentials for rough rice prices observed in bid/acceptance markets and the probability of whether or not producers will accept bids based on those differentials. Espinosa and Goodwin (1991) considered a hedonic price model for alternative quality characteristics of wheat. The results indicate that standard grading characteristics as well as alternative end-use quality characteristics influence wheat prices. Stanley and Tschirhart (1991) estimated implicit prices of breakfast cereal characteristics. The cereal market was chosen because consumers can gather information easily about cereal characteristics either through experience, advertising or package labeling. Tronstad, Huthoefer, and Monke (1992) focused on product attributes of apples for U.S. consumers. Results suggest that size, storage method, grade, and seasonality are the most important influences on the price of apples. Harris (1997) employed hedonic analysis to demonstrate that consumers value taste more than nutrition when they purchase frankfurters. Huang and Lin (2007) analyzed household purchases of fresh tomatoes and determined the magnitude of the price premium paid for the organic tomatoes by estimating a hedonic price model. Roheim, Gardiner and Asche (2007) also conducted a hedonic analysis for the frozen processed seafood market in the United Kingdom.
Although many of the hedonic analysis approaches have been conducted on agricultural products, the hedonic analysis model has rarely been applied to eggs. One exception is research conducted for the Greek egg industry (Karipidis et al., 2005). Karipidis et al. (2005) estimated the effects of product attributes, production methods, distribution and product image on retail egg prices. A few other studies in the literature focused on egg market although they did not use the hedonic method (Kinnucan and Nelson, 1993; Ness and Gerhardy, 1994; Fearne and Lavelle, 1996; Schmit and Kaiser, 1998; Gilbert, 2000; Kuney and Zeidler, 2001).

Kinnucan and Nelson (1993) analyzed the effects of increased vertical control on the egg industry performance as measured by the farm price spread. Ness and Gerhardy (1994) studied quality and freshness attributes of eggs using conjoint analysis. The study focused on establishing the link between consumer preferences for alternative products and products that can be offered by producers and retailers. Fearne and Lavelle (1996) demonstrated the importance of effective marketing communication and the potential for adding value to the basic egg. They found that there was a polarization of egg consumers, with free-range egg consumers at one extreme, largely influenced by bird welfare, and battery egg consumers at the other, for whom functional properties and value for money were the major factors determining egg purchasing behavior. Schmit and Kaiser (1998) estimated a model of the domestic demand for eggs in

United States. Empirical results indicate that most of the observed change in egg demand could be explained by dietary cholesterol concerns. They also find that advertising efforts over the past several years have resulted in net benefits to egg producers largely when considering inelastic supply responses. Gilbert (2000) examined consumer interests in functional nutrition for disease prevention and health enhancement. He finds that increased egg consumption is being driven by consumer interest in health benefits that reach beyond dietary avoidance strategies to positive nutrition strategies. Kuney and Zeidler (2001) attempted to measure the quality of eggs offered to consumers in large supermarkets in various regions of the United States.

The Model

As discussed in the previous section, the Rosen's hedonic pricing model describes an equilibrium price determined simultaneously by both sides of the market in terms of the amount of product attributes supplied by producers and demanded by consumers. Therefore, the empirical framework requires an estimation of both demand and supply equations simultaneously. However, many researchers have used a single equation approach arguing that product attributes supplied by producers tend to be highly inelastic (Wilson, 1984; McConnell and Strand, 2000; Kristofferson and Rickertsen, 2007). In this case, empirical hedonic price models requires only market clearing prices rather than both demand and supply schedules. Following most previous studies, a single hedonic price equation that represents market quilibrium conditions at some point of time is estimated in this study.

A few hedonic pricing models for consumer packaged goods in the literature have used grocery store data collected with scanners or by hand. One limitation of such data is that price is set by supplier without any buyer involvement at least in the short run. A supplier could sell the same SKU (stock keeping unit) at two different prices in two separate but otherwise identical stores with identical consumer bases. Therefore, when everything else is the same, one would expect that the stores with the lower price would sell more SKU units than the stores with the higher price. Given the volatility in prices and sales across weeks and stores in consumer packaged goods, not including quantity sold in the hedonic model would not capture the dynamics in the store and would get in the way of measuring the hedonic prices of the attributes composing the SKU. Martinez-Garmendia (2009) developed a hedonic price model that includes quantity sold as one of independent variables and showed that hedonic pricing method without quantity would lead to a biased estimation of consumer preference. Since this study uses scanner data collected from packaged egg trades in Korea, quantity sold is included as one of independent variables.

For estimating a hedonic egg price model, a functional form needs to be determined. A double-log functional form is chosen for analysis because its coefficients can be easily interpreted as price flexibilities, and the double-log form has been successfully used in similar previous studies (Carroll, Anderson, Martinez-Garmendia, 2001; Martinez-Garmendia, 2009). Then, a double log functional form of hedonic egg price for product *i* at time *t* is represented as:

$$(1)\quad lnPrice_{it} = \beta_0 + \beta_1 lnQuantity_{it} + \beta_2 Fertile_{it} + \beta_3 Nutrition_{it} + \beta_4(Fertile_{it} * Nutrition) + \beta_5 Organic_{it} + \beta_6 Antibioticfree_{it} + \beta_7 Freerange_{it} + \beta_8(Antibioticfree * Freerange_{it}) + \beta_9 Giftpackage_{it} + \beta_{10} Ecopackage_{it} + \beta_{11} Certified_{it} + \sum_{j=2}^{4} \gamma_j Size_{ijt} + \sum_{k=2}^{6} \delta_k Pkgsize_{ikt} + \sum_{l=2}^{4} \omega_l Season_{ilt} + \sum_{m=2}^{5} \theta_m Branch_{imt} + \varepsilon_{it},$$

where *Price* is price per egg; *Quantity* is sales volume (the number of eggs sold); *Fertile* represents fertile eggs; *Nutrition* represents nutritionally enhanced eggs produced with extra feed supplements; *Organic* denotes eggs produced using only organic feeds[1]. *Antibioticfree* denotes eggs produced without feeding antibiotics; *Freerang*e denotes eggs produced from free range farms; *Giftpackage* denotes eggs packed in gift packages; *Ecopackage* denotes eggs packaged with environmental friendly packages; and *Certified* represents eggs labeled with NACF certification logo[2]. Two interaction terms (*Fertile* Nutrition and Antibioticfree* Freerange*) are considered in the model to account for interaction effects between major attributes. Because cross-tabulation results show other interaction terms are either mutually exclusive (*Organic* and *Antibioticfree*) or identical with a single attribute (the interaction term between *Organic* and *Freerange* is identical with *Organic*, and the term between *Giftpackage* and *Ecopackage* is identical with *Giftpackage*), these terms are not included in equation (1). Four dummy variables are included in the model: *Size* represents egg size; *Pkgsize* is the package size; *Season* represents the seasonality of egg sales; *Branch* represents five different store branches located in Seoul and its surrounding cities and should account for store-specific promotion and marketing strategies; and the last term ε represents stochastic errors for equation (1).

In most cases, eggs produced for human consumption are unfertilized because laying hens are kept without a rooster. Scientifically, fertile eggs (*Fertile*) are known to be no more nutritious than non-fertile eggs. However, many consumers in Korea believe fertile eggs are a delicacy and are nutritious. Therefore, a higher price is charged for fertile eggs in the market. Nutritionally enhanced eggs (*Nutrition*) are produced by feeding supplements of medicinal herbs, particularly ginseng, and high protein. Consumers tend to prefer nutritionally enhanced (*Nutrition)*, organic

[1] Organic certification and labeling programs for agricultural products follow regulations set by the the National Agricultural Products Quality Management Service (NAQS), which is the official certification body designated by the Korean government. Organic and antibiotics free products are separately certified by NAQS in Korea. Organic livestock certification is granted only to the livestock products produced with organic feeds following the NAQS guidelines. Antibiotic-free certification is granted to the livestock products produced without using antibiotics. However, no government certification system is available for other specialty eggs such as fertile, free range, and nutritionally enhanced eggs.

[2] Korean agricultural cooperatives have approximately 2.4 million member farmers, 1,187 member cooperatives, and one cooperative federation called the National Agricultural Cooperative Federation (NACF).The NACF provides various services to member farmers and cooperatives, which include farm credits, feeds and seeds, fertilizers, farm machineries, and other items. The NACF is also a major player in marketing farm products in Korea. For example, the NACF had a 48 percent market share in selling farm products in 2007 (Kim, Ahn, and Sohn, 2008). Agricultural products with the NACF logo are produced by member farmers and are considered as high quality products.

(*Organic*), antibiotic free (*Antibioticfree*), and free range feeding (*Freerange*) eggs over eggs produced with traditional feed and production systems. Unlike typical egg containers/packages, gift packages (*Giftpackage)* are specially designed packages with gift wraps. Traditionally, agricultural products such as meat, fruits, and eggs have been used as gifts for special occasions in Korea. Environmentally friendly packages (*Ecopackage*) are made from mostly paper clay that can be easily decomposed after disposal while other containers generally use plastic materials. Certified eggs (*Certified)* have the NACF certification logo on packages. Food safety is also an important issue when consumers purchase agricultural and food products in Korea. The NACF certification label could increase consumer trust of products. Four dummy variables are constructed to represent egg size: $Size_1$ (44 gram to 51 gram), $Size_2$ (52 gram to 59 gram), $Size_3$ (60 gram to 67 gram), and $Size_4$ (over 68 gram). Six different package sizes are included in the data. They are $Pkgsize_1$ with 6 eggs, $Pkgsize_2$ with 10 eggs, $Pkgsize_3$ with 15 eggs, $Pkgsize_4$ with 20 eggs, $Pkgsize_5$ with 30 eggs, and $Pkgsize_6$ with 60 eggs. As specified in equation (1), we omit one variable for each of the dummy variable categories such as *Size*, *Pkgsize*, *Season*, and *Branch* to avoid the perfect collinearity problem.

Data

Data used in this study include purchases of all eggs from five large NACF supercenters located in Seoul and surrounding areas in Korea for the 2009 whole year. Egg prices and sales data of retail supercenters were collected from the data server of the Information Technology Center of NACF for each transaction of product code. Prices were measured in Korean Won (KRW) per egg, and sales quantities were measured by the number of eggs. Corresponding egg attributes for each product code were obtained from labels of egg packages on the shelves of each supercenter. The store scanner data included 2,590,525 transactions for the year 2009, which were aggregated daily for each product code and each store. The data set includes a total of 65,182 observations for 122 products.

Table 1 lists descriptive statistics for variables used in the hedonic price model. The mean of price per egg (*Price*) is 249.21 KRW (approximately $0.20 applying an exchange rate, $1 = 1,246 KRW), and a wide range of price is observed: 92.7 to 617.1 KRW ($0.07 to $0.50). Fertile (*Fertile*) and nutritionally enhanced (*Nutrition*) eggs are 30% and 22% of total observations, respectively. Organic (*Organic*), antibiotics free (*Antibioticfree*), and free range (*Freerang*e) eggs are 2%, 75%, and 23%, respectively[3]. In terms of packaging, 22% and 86% of eggs use gift packaging (*Giftpackage*) and environmentally friendly packaging (*Ecopackage*), respectively, and 8% of eggs are certified and labeled with the NACF logo (*Certified*). Among all egg size groups, $Size_3$ is the most popular size in the data set. Out of six package sizes, $Pkgsize_2$, $Pkgsize_3$, *and* $Pkgsize_5$ are the most common package sizes. Our data shows egg sales are almost evenly distributed across seasons, and $Branch_5$ has the highest sales among five branches throughout the year.

[3] These attributes are not mutually exclusive. Approximately 20% of eggs have both antibiotic free and free range attributes. No organic, antibiotics free, or free range eggs account for only 22% in the dataset. Korean consumers, particularly those living in Seoul area, show strong preference for food safety- and animal-friendly eggs.

Table 1. Descriptive Statistics of Data Used for Hedonic Price Model Estimation

Variable	Mean	Description
Rice	249.21	Price per egg (KRW)
Quantity	829.64	Number of eggs sold daily by product code and store
Fertile	0.30	1 for fertile egg; 0 otherwise
Nutrition	0.22	1 for nutritionally enhanced egg; 0 otherwise
Fertile Nutrition*	0.08	1 for fertile and nutritionally enhanced egg; 0 otherwise
Organic	0.02	1 for organic egg; 0 otherwise
Antibioticfree	0.75	1 for antibiotics free egg; 0 otherwise
Freerange	0.23	1 for free range egg; 0 otherwise
Antibioticfree Freerange*	0.19	1 for antibiotics free and free range egg; 0 otherwise
Giftpackage	0.22	1 for gift package; 0 otherwise
Ecopackage	0.86	1 for environmentally friendly package; 0 otherwise
Certified	0.08	1 for certified eggs; 0 otherwise
$Size_1$	0.03	1 for 44g to 51g per egg; 0 otherwise
$Size_2$	0.27	1 for 52g to 59g per egg; 0 otherwise
$Size_3$	0.49	1 for 60g to 67g per egg; 0 otherwise
$Size_4$	0.21	1 for over 68g per egg; 0 otherwise
$Pkgsize_1$	0.01	1 for package with 6 eggs; 0 otherwise
$Pkgsize_2$	0.29	1 for package with 10 eggs; 0 otherwise
$Pkgsize_3$	0.35	1 for package with 15 eggs; 0 otherwise
$Pkgsize_4$	0.02	1 for package with 20 eggs; 0 otherwise
$Pkgsize_5$	0.32	1 for package with 30 eggs; 0 otherwise
$Pkgsize_6$	0.01	1 for package with 60 eggs; 0 otherwise
$Season_1$	0.23	1 for January to March; 0 otherwise
$Season_2$	0.24	1 for April to June; 0 otherwise
$Season_3$	0.26	1 for July to September; 0 otherwise
$Season_4$	0.27	1 for October to December; 0 otherwise
$Branch_1$	0.16	1 for Branch1; 0 otherwise
$Branch_2$	0.20	1 for Branch2; 0 otherwise
$Branch_3$	0.18	1 for Branch3; 0 otherwise
$Branch_4$	0.22	1 for Branch4; 0 otherwise
$Branch_5$	0.24	1 for Branch5; 0 otherwise
Number of obs.	65,182	

Empirical Results

The estimation of equation (1) raises three econometric issues: endogeneity, autocorrelation, and heteroscedasticity. First, the endogeneity needs to be checked because equation (1) includes a quantity variable that could be endogenous and therefore could be correlated with the stochastic error terms. A simple endogeneity test suggested by Hausman (1978) finds the evidence of endogeneity of the quantity variable. Secondly, since the data used in this data include a panel nature with time series (daily) and cross sectional observations, both autocorrelation and heteroscedasticity tests were conducted. The autocorrelation test indicates that there no autocorrelation problem exists in the model. However, the hypothesis for homoskedasticity of error terms is rejected based on a Lagrange multiplier test. To address the endogeneity and heteroskedasticity problems, we use the generalized method of moments (GMM) procedure with two unique instrumental variables: egg size and daily number of transactions. [4] The identification of the instrumental variables has been tested following Hansen (1982), and the test result indicates that over-identifying restrictions are valid in the model.

Table 2 shows estimates of coefficients, corresponding standard errors, and marginal implicit prices. Marginal implicit prices are calculated by multiplying the average price to the partial derivative of price with respect to each product attribute. As shown in Table 2, all variables are statistically significant at the 1% level. R^2 indicates that the change in egg prices in the Korean market is well represented by the change in the set of independent variables of equation (1).
As expected, sales quantity is negatively related to price. A 1% increase in egg quantity results in a 0.05% decrease in egg price. The statistical significance of *LnQuantity* shows the existence of volume effect in determining egg price. Fertile, organic, and free-range eggs show relatively high implicit prices. Marginal implicit prices of these eggs are \$0.06, \$0.11, and \$0.03 per egg, respectively. The estimated implicit prices show a strong potential for developing niche markets for fertile, organic, and free-range eggs.

Although gift packaging and environmental-friendly packaging positively influences the price, packaging methods do not seem to have a large impact on egg prices. However, certification shows a relatively high value over eggs with no NACF certification. The NACF certification label is well recognized and highly valued in Korea because consumers believe that NACF products are supplied mostly by their cooperative members and are carefully inspected before certified and labeled.

As expected, egg prices are found to increase with egg size. The larger the egg size, the higher the price at retail stores. Differentials of marginal implicit prices between the smallest size and $Size_2$, $Size_3$, and $Size_4$ are \$0.04, \$0.05, and \$0.05 per egg, respectively. Package size is also an important price determining factor in Table 2. The price differentials between the smallest package size and $Pkgsize_2$, $Pkgsize_3$, $Pkgsize_4$, $Pkgsize_5$, *and* $Pkgsize_6$ are \$0.10, \$0.10, \$0.09, \$0.14, and \$0.15, respectively. Results suggest that both per egg and package sizes are two major factors of determining egg values for fresh egg shoppers in the retail market. The shoppers show a strong preference for larger eggs and smaller packages, probably for their convenience. Egg prices also show seasonal variation. Prices in $Season_1$, January to March, tend to be higher than prices for the rest of the year. Egg prices differ across branches, which reflect different pricing and promotion schemes across branches.

Table 2. GMM Estimation Results of the Hedonic Price Model

Variable	Estimate[a]	Standard Error	Marginal Implicit Prices in KRW [b]	Marginal Implicit Prices in US Dollar[c]
Intercept	5.8954	0.0118		
lnQuantity	-0.0507	0.0011		
Fertile	0.3290	0.0049	76.28	0.06
Nutrition	0.0590	0.0021	6.90	0.01
*Fertile*Nutrition*	-0.1043	0.0046		
Organic	0.5715	0.0030	142.42	0.11
Antibioticfree	0.0185	0.0018	10.17	0.01
Freerange	0.0979	0.0051	42.51	0.03
*Antibioticfree*Freerange*	0.0969	0.0028		
Giftpackage	0.0598	0.0013	14.90	0.01
Econpackage	0.0172	0.0020	4.29	0.00
Certified	0.0979	0.0033	24.40	0.02
$Size_2$	0.1891	0.0063	47.13	0.04
$Size_3$	0.2396	0.0061	59.71	0.05
$Size_4$	0.2595	0.0065	64.67	0.05
$Pkgsize_2$	-0.5124	0.0126	-127.70	-0.10
$Pkgsize_3$	-0.4778	0.0126	-119.07	-0.10
$Pkgsize_4$	-0.4306	0.0130	-107.31	-0.09
$Pkgsize_5$	-0.6864	0.0132	-171.06	-0.14
$Pkgsize_6$	-0.7375	0.0136	-183.79	-0.15
$Season_2$	-0.0076	0.0018	-1.90	0.00
$Season_3$	-0.0139	0.0019	-3.46	0.00
$Season_4$	-0.0507	0.0020	-12.63	-0.01
$Branch_2$	0.0552	0.0020	13.77	0.01
$Branch_3$	0.0711	0.0017	17.22	0.01
$Branch_4$	-0.0166	0.0017	-4.13	0.00
$Branch_5$	-0.0143	0.0020	-3.56	0.00
R^2	0.8844			
Number of obs.	65,182			

[a]All estimates are statistically significant at the 1% level.

[b]Marginal implicit prices in KRW are calculated as: $\frac{\partial P}{\partial v_i} * \bar{p}$, where v_i is the ith attribute in the model , and $\bar{P}$ is the mean price at 249.21 KRW($0.20).

[c]Exchange rate: $1 = 1,240 KRW.

Conclusion

Korean fresh eggs are increasingly differentiated following consumers' recent trends of dietary habits. Consumers tend to make healthy choices that reach beyond basic nutrition considering emotional, physical and even cosmetic benefits. To cope with recent changes in the Korean fresh egg market, farmers and retailers have actively marketed organic, free-range, fertile, and nutrient-enhanced specialty eggs. The objective of this study is to identify product characteristics that affect retail prices of fresh eggs in the Korean egg market. This study develops a hedonic price model to estimate implicit pries of product attributes of Korean fresh eggs. Then, the estimated shadow prices of attributes are used to identify a preference ranking of different levels of the same attribute and relative importance of attributes.

Results show that all coefficients from a double-log hedonic price model are statistically significant at the 1% level, which suggests all quality attributes considered in the model significantly affect retail price. The significance of quantity coefficient suggests an existence of the volume effect in the fresh egg retail markets in Korea, and therefore, ignoring quantity variable in hedonic price models could lead to a biased result particularly when prices and sales vary widely across observations. Major attributes affecting the retail price of eggs include the status of fertility, organic and free-range feeding, and egg and package sizes. Shoppers at the NACF retail outlets tend to pay $0.06, $0.11, $0.03 and $0.02 more each for fertile, organic, free-range-feeding, and store brand eggs, respectively. The shoppers also prefer bigger eggs to smaller eggs. For example, consumers paid $0.05 more for the biggest sized egg (over 68g) compared to the smallest egg (44g to 51g) when all other characteristics are held constant. In terms of package size, the shoppers prefer smaller package sizes while paying $0.15 more per egg for the smallest package size (6 eggs) compared to the largest package size (60 eggs). Results indicate that Korean consumers put significantly high value on fertile, organic, free-range-feeding, and larger sized eggs, plus smaller package sizes. These findings could help both producers and retailers formulate better production and marketing strategies by focusing on these attributes.

One caveat in interpreting findings in the present study is that our findings are based on the data collected from five NACF supercenters in Seoul and adjacent vicinities. Therefore, they may not reflect the overall behavior of Korean fresh egg consumers because the demographic distribution of shoppers in the data set may differ from general Korean fresh egg consumers.[5] However, many previous studies have surveyed shoppers of these supercenters and have used the data to analyze overall Korean consumer behavior (Park, Jung, and Kim, 2007 for pork; Roh, Han, and Chung, 2007 and Chung, Boyer, and Han, 2009 for beef). Another limitation of this study is that our empirical model does not include consumers' demographic characteristics. A better analysis can be conducted with a hedonic price model that is equipped with consumers' demographic information such as gender, education, age, income, occupation, and other traits. However, unlike home scanned data, most store scanned data, including data used in this study, do not have information on shoppers' demographic characteristics. Therefore, the hedonic price model estimated in this study is limited to focus on sales volume and product attributes.

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