HEDONIC ANALYSIS OF RETAIL EGG PRICES USING STORE SCANNER DATA - AN EMPIRICAL STUDY ON THE KOREAN NATIONAL AGRICULTURAL COOPERATIVE FEDERATION HYPERMARKETS -

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CHAPTER I

INTRODUCTION

Changes in Food Market

Today's consumer wants nutrition, convenience, and an ever-widening variety of food products. So, food markets are being split into smaller niches and gradually transformed into highly differentiated product markets. Changes in food demand have splintered the food market, challenging the food system to tailor its products for more precisely defined market niches (Barkema and Drabenstott, 1995). Since the mid-1990s, Korean food market also has been changing from a mass market to many niche markets due to rapid economic growth and rising levels of affluence. As these market trends change, it is becoming more important that retailers provide information to producers about what consumers want. Using this information, producers can develop new products to fulfill the consumers' wants, and retailers can increase the market share. Through niche marketing, a firm achieves a strong market position because of its greater knowledge of consumer needs in the niches it serves and the special reputation it acquires (Kotler and Armstrong, 1994).

Consumers recognize a variety of benefits from making healthy choices that reach beyond basic nutrition. Eating healthy foods has emotional (self-esteem), physical (feel good) and cosmetic (look good) benefits for shoppers today. Although many shoppers

started cutting back on egg consumption in the 1980s due to cholesterol concerns, eggs are considered a healthy food by most consumers as long as they are eaten in moderation. As consumers continue to look for ways to improve their eating habits, eggs are being eaten more often. The increase in egg consumption is being driven by consumer interest in health benefits that reach beyond dietary avoidance strategies to positive nutrition strategies (Gilbert, 2000).

The food habits and dietary patterns of consumers are changing, and they are increasingly demanding food products that possess certain attributes relating to how the food is produced or processed (Huang and Lin, 2006). As mainstream markets for organic food have expanded in the last decade, with natural food supermarkets increasing in size and number and conventional supermarkets adding organic sections, consumer direct markets have also expanded and broadened product offerings (Oberholtzer, Greene, and Lopez, 2006). As stated earlier, during the 1980s Eggs were maligned due to misguided concerns over cholesterol. This led to numerous attempts to reduce the cholesterol content of the egg.

After more than 30 years of research, a meta-analysis led Dr. Wanda Howell, spokesperson for the University of Arizona researchers, to report that, “for most healthy people, the cholesterol they eat does not raise their blood pressure.” After this finding, efforts shifted towards improving the egg’s nutritional quality. Some poultry producers have been trying to improve the quality of eggs by improving the quality of the feed (Hunter, 2000).

The egg industry has been taking significant steps to improve the control of production either through contracting or vertical integration. These improved controls

were motivated by the emergence of new specialized large-scale production technologies that placed a premium on quality control and the efficient use of information. Contracts and vertical coordination provide an efficient means of organizing markets by reducing transaction costs (Martinez, 2002).

Discount stores in Korea have expanded rapidly since E-mart, a subsidiary of Shinsegae Department Store, was established in November 1993. Since the introduction of the first discount store, the total annual sales of discount stores has increased sharply from 0.8 trillion won (1 billion dollars) in 1995 to 28.8 trillion won (27.5 billion dollars) in 2005. In other words, total sales of discount stores have expanded about 36 times in 11 years. The number of stores has also increased sharply to reach 300 in 2005. The major discount store format in Korea is the hypermarket/supercenter that sells food items as well as general merchandise. A supercenter/hypermarket is a superstore which combines a supermarket and a department store. The result is a very large retail facility that sells food items as well as general merchandise. In theory, hypermarkets allow customers to satisfy all their routine weekly shopping needs in one trip. The average hypermarket/super center size is about 10,000 m^2 (107,639 ft^2), carrying 25,000-30,000 items. Major hypermarket/supercenter operators are E-mart, Homeplus, Lotte Mart.

The National Agricultural Cooperatives Federation (NACF)[1] of Korea also aggressively participates in the discount store business by operating Hanaro Club, which is a discount store emphasizing sales of food products produced domestically. In Korean discount stores, food items play an important role in increasing the frequency of trips to the stores and general sales. In these stores, food items account for 58.6% of total sales.

Fresh food and processed food account for 26.4% and 27.3% of total sales, respectively (Stiegert and Kim, 2009).

Recently, the private brand (PB) goods of the Korean hypermarkets are increasing and acting as a threat to the manufacturing industry. Private brand (PB) is a brand owned not by a manufacturer or producer but by a retailer or supplier who gets its goods made by a contract manufacturer under its own label. The number of PB goods sold by major Korean hypermarkets such as E-mart, Lotte and Home Plus, is around 3,000 items on average, and their annual sales are increasing. The PB goods of retail stores are very common in developed countries and accounts for around 30% of retail stores' total sales, as we can see from examples such as Wal Mart, Tesco, etc. The market share of PB goods in hypermarkets is increasing because the Korean domestic hypermarket industry is becoming more competitive and each company is seeking methods to increase profits through product differentiation and cost reduction. As consumers' demand for fresh and low price agricultural products is increasing, direct transactions among the hypermarkets and the place of origin are also increasing. (Park, Lee and Ahn, 2008)

Importance

This study identifies characteristics/attributes that are important to consumers when purchasing eggs in the retail hypermarket. The features of special brand eggs are growing more and more diverse and it is hard to draw a clear distinction between these and ordinary (no-brand) eggs. Hedonic price modeling provides a way to analyze these features by decomposing the price paid for a heterogeneous good into separate components related to the product characteristics/attributes. Hedonic models can provide

a preference ranking for different levels of attributes, and they can be used to estimate values of the differences between levels of one attribute and another. These values allow retailers to identify specific characteristics that consumers perceive as important, and retailers can improve their sales and market share using this information. In addition, by giving this information to producers, producers can improve their production process and will be able to earn a higher return.

As stated earlier, it is becoming more important that retailers provide information to producers about what consumers want. Empirical analyses of premiums and discounts associated with the attributes of commodities are increasingly common. However the hedonic price model has been less frequently applied to the marketing field. Moreover, little research has been done in the Korean egg market. To my best knowledge, this is the first attempt to estimate values of egg attributes in the Korean egg market using the hedonic pricing technique. According to the recent report of the Nonghyup Economic Research Institute (NHERI) in 2008, Korean livestock farmers have suffered from increasing farm business expenses such as soaring animal feed and oil prices. The situation for egg farmers was nearly as dismal as their expenses have jumped by 22 percent annually since 2006 (Kim et al., 2008). One way to overcome this situation may be to increase marketing bill through niche and other value added marketing strategies. Findings from this study can help provide useful information for developing the marketing strategies.

Objectives

The purpose of this research is to identify egg attributes that affect egg prices and to estimate values of each attribute in the Korean egg market.

CHAPTER II

CONCEPTUAL FRAMEWORK AND PREVIOUS RESEARCH

In classical microeconomic consumer theory, consumer choice is based on maximization of a utility function specifying 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 hence can't deal with problems like the introduction of new commodities and quality variations. A way out of some of the problems is to adopt the hedonic hypothesis that goods do not by itself provide utility to the consumer, but instead are valued for their utility-bearing attributes.

Lancaster (1966) developed an alternative theory of consumer demand suggesting that it is the properties or characteristics of goods from which utility is derived. Such an extension made it possible to study heterogeneous goods like housing, automobiles, and other complex goods within the framework of the classical theory of the consumer. Like Lancaster, Rosen (1974) focused on characteristics, but had less to say about their utility-bearing nature and more about how suppliers and consumers interact within a framework of bid and offers for characteristics. Ladd and Zober (1977) revised Lancaster's model, relaxing three of the most criticized assumptions of his model. For product-differentiation questions, the hedonic pricing approach, introduced by Rosen (1974), is recognized as one of the most appropriate.

A New Approach to Consumer Theory

The main objective of consumer theory is to determine the impact on observable demands for commodities under alternative assumptions on the objectives and on the behavioral rules of the consumer, and on the constraints which he faces when making a decision. The traditional approach to consumer behavior is to assume that the consumer has well-defined preferences over all of the alternative bundles and that the consumer attempts to select the most preferred bundle from among those bundles that are available. (Barten and Bohm,1982).

Consumer demand can also be expressed as a function of tastes/preferences for the intrinsic properties. Market researchers, advertisers, and manufacturers believe that knowledge of the intrinsic properties of goods is relevant to the way consumers will react toward them. All intrinsic properties of particular goods have been omitted from the traditional theory, which does not account for intrinsic value that goods have, but states that goods are the direct objects of utility.

Lancaster (1966) developed a new approach to consumer theory. This approach's chief technical novelty lies in breaking away from the traditional approach that goods are the direct objects of utility and, instead, supposing that it is the properties or characteristics of the goods from which utility is derived. The essence of the new approach can be summarized as follows: (Lancaster, 1966)

1. The good does not give utility to the consumer; it possesses characteristics, and these characteristics give rise to utility
2. In general, a good will possess more than one characteristic, and many characteristics will be shared by more than one good.

3. Goods in combination may possess characteristics different from those pertaining to the goods separately.

Lancaster's model was a model of the demand for characteristics. In the model, consumers obtain positive utility from the characteristics contained in goods. This model looks at product heterogeneity coming from products having different kinds of characteristics. Lancaster's work has tremendously influenced modern hedonic analysis.

The Hedonic Pricing Approach

The hedonic pricing model is a model of product differentiation based on the hedonic hypothesis that goods are valued for their utility-bearing attributes or characteristics. A contribution to the theory of consumer behavior and properties of market equilibrium has been made by Rosen (1974). Rosen(1974) developed the Hedonic pricing model as a problem in the economics of spatial equilibrium in which the entire set of implicit prices guides both consumer and producer locational decisions in characteristics space. Hedonic prices are the implicit prices of attributes and are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them. Econometrically, implicit prices are estimated by the first step regression analysis (product price regressed on characteristics) in the construction of hedonic price indexes.

According to Rosen (1974), the hedonic model is based on the assumption that products consist of a set of attributes. The attributes are represented by a vector of coordinates $Z = (Z_1, Z_2, \dots, Z_n)$, where Z_i measures the amount of the *i*th characteristic contained in each good. A price $P(Z) = P(Z_1, Z_2, \dots, Z_n)$ is defined at each point on the

plane and guides both consumer and producer choices regarding packages of characteristics bought and sold. The function $P(Z)$ is identical with the set of hedonic prices and is determined by some market clearing conditions. As usual, market clearing prices, $P(Z)$, 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 product they offer and how consumers value the product they buy. In the long-run equilibrium, a hedonic function represents the minimum price at which attributes can be supplied and the maximum at which they will be purchased.

Following Rosen (1974), a hedonic model can be written as:

(1) $$P(Z) = f(Z_1 , Z_2 , \dots , Z_n).$$

Then, Corresponding utility function can be defined as:

(2) $$\mathrm{U}(\mathrm{Z}_1 , \mathrm{Z}_2 , \dots , \mathrm{Z}_\mathrm{n}, \mathrm{X}),$$

where X represents all other goods consumed. Maximization of utility subject to a budget constraint requires choosing X and Z. Then we have the first-order conditions choosing each component of the vector Z as:

(3) $$\frac{\partial \mathrm{P}}{\partial \mathrm{Z}_\mathrm{i}} = \mathrm{P}_\mathrm{i} = \frac{\mathrm{U}_{\mathrm{Z}_\mathrm{i}}}{\mathrm{U}_\mathrm{X}},$$

where i = 1,…,n.

Utility maximization is achieved by purchasing a product offering the desired combination of characteristics given consumer's budget constraint. Consumers and producers interact in the market to establish the market price for a given set of quality attributes, Z. The market price for a good in the market is a composite of the implicit prices of attributes.

Estimation requires a two-step procedure. First, estimate $P(Z)$ by the usual hedonic method. Next, compute a set of implicit marginal prices, $\partial \mathrm{P(Z)} / \partial \mathrm{Z_i} = \widehat{p_i}(\mathrm{Z})$ for each buyer and seller, evaluated at the amounts of characteristics actually bought and sold. The first step is to regress observed differentiated products' prices, *P*, on all of their characteristics, Z, using the best fitting functional form. This econometrically duplicates the information acquired by agents in the market, on the basis of which they make their decisions. So, this is the most commonly used, where the hedonic price function is estimated with the differing price and characteristic information for the commodity. Through this we can get implicit prices of varying characteristics that reveal details on the underlying preferences for the characteristics. Most empirical applications focus on the marginal implicit price estimation of the attributes of the product (Hudson, 2007).

For empirical models, most economists have applied the Lancaster model to agricultural products and developed hedonic price approaches to estimate implicit values of product characteristics (Ladd and Suvannunt 1976; Ladd and Martin 1976). Three assumptions of the Lancaster model have been criticized: (1) every characteristic has nonnegative marginal utility; (2) utility is independent of the distribution of characteristics among products; and (3) linear consumption technology. Ladd and Zober

(1977) introduced a model that is similar to Lancaster's model of consumer demand, but that does not use the most criticized assumptions of this model. Ladd and Zober's utility function is a composite function of services, in which services depend on the characteristics of goods. Their model provides an estimate of the implicit price of product characteristics. More specifically, Ladd and Zober (1977) introduced the idea that goods with different characteristics provide consumers with services such as taste, convenience, and nutrition. The various characteristics contained in these products contribute to these services. Because utility depends on the quantities of consumption services, Ladd and Zober (1977) express the consumer's utility function as a function of the amounts of various services obtained or consumed.

Using Scanner Data and the Inclusion of Quantity Sold

In the literature, most hedonic pricing models for consumer packaged goods have used grocery store data collected with scanners or manually. A limitation of such data is that preferences are not measured at the individual consumer level but at the aggregate buyer level. These aggregate data typically contain information only on how many consumers chose each brand in each period without the knowledge of the choices of each individual consumer (Musalem et al., 2009). Therefore, findings from aggregate data set are limited to an aggregate set of buyers at participating stores rather than representative consumers in the market. The second, the data typically include quantity discounts. For the first challenge, researchers should note that results from studies of using such data represent behaviors of aggregate buyers rather than individual consumers. The second challenge

may be eliminated by including quantity sold as one of independent variables (Martinez-Garmendia, 2009).

Martinez-Garmendia (2009) consider including quantity sold in the hedonic model. 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. With everything else being the same, one would expect to see 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, stores in consumer packaged goods, not including volume 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) showed that hedonic pricing method without quantity would underestimate the true consumer degree of preference for brand B. In Figure 1, the inverse demand curves for two products, brand A and B, but otherwise identical in quality, are plotted. Brand A is priced by the supplier at P_A resulting in market sales Q_A, while brand B is priced at P_B ,with market sales Q_B. One can say that $P_B - P_A$ is the premium consumers place on brand B. However, in reality, $P_B - P_A$ is only the relative supplier premium. The true consumer premium should be $P'_B - P_A$ for the same quantity sales, which represents the additional amount consumers would pay for brand B over brand A.

Literature Review

Early research conducted by Waugh (1928) recognized the need to differentiate among important attributes of quality when he examined the effect of stalk color and stalk size

on the market price for asparagus. Waugh employed quality characteristic models to analyze the importance of a wide range of quality features embodied in a bundled product. Since Waugh's research, hedonic price modeling has developed to provide applications measuring implicit value of key product attributes of heterogeneous goods revealed to consumers, based on the theory laid by Lancaster (1966), Rosen (1974) and Ladd and Zober (1977).

Afterwards, numerous studies have estimated implicit prices for physical and intrinsic characteristics of products. The merit of the hedonic price model is that it can decompose the price paid for a heterogeneous good into separate components related to the product characteristics. The Hedonic price model promotes the analysis of the price structure of a commodity in its specific attributes by the estimation of product-attribute shadow prices. Hedonic prices are defined as the implicit prices of attributes and are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them (Rosen 1974). Through the estimation of product-attribute shadow prices, helpful information can be extracted for an effectual product-differentiation marketing strategy.

A basic premise of the hedonic price approach is that it requires market clearing conditions (Rosen 1974). Therefore, most of its application has been focused on the field of economics for inelastic supply goods and perishable markets where supply for goods is highly inelastic. It is generally argued that the hedonic pricing approach is suitable for substantially varied food products. But even in products with less variation, such as raw food products, the hedonic price approach has been successfully applied.

The hedonic price approach has been applied by agricultural economists to study various agricultural products and foods. Brorsen, Grant, and Rister (1984) studied the price structure in the rice market in the United States. They 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 hedonic price models for alternative quality characteristics of wheat. The results indicate that standard grading characteristics as well as alternative end-use quality characteristics influence the prices. Futhermore, the results indicate that the alternative sets of characteristics exhibit quality information that is, to some degree, independent of one another. Tronstad, Huthoefer, and Monke (1992) estimated an integrated hedonic price model for the U.S. apple industry. Results suggest that size, storage method, grade, and seasonality are the most important influences on the price of apples. Huang and Lin (2006) analyzed household purchase of fresh tomatoes and determined the magnitude of the price premium paid for the organic tomatoes by estimating a hedonic price model.

Although many of the hedonic analysis approaches have been conducted on agricultural products, the hedonic analysis model has rarely been applied to eggs. The only study found by this research was conducted in Greece (Karipidis et al., 2005). They researched the effects of product attributes, production methods, distribution and product image on retail egg prices in Greek egg market. Nowadays, the main trend of the fresh egg market is the transformation of eggs from a relatively homogeneous to a highly differentiated product. Several researchers analyzed the egg market but most of the earlier studies did not focus on measuring the retail price structure. Kinnucan and Nelson

(1993) determined 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, a statistical method for the analysis of consumer attribute trade-offs. The focus of that research was the link between consumer preferences for alternative product concepts and products that can be offered by producers and retailers.

Fearne and Lavelle (1996) studied the importance of effective marketing communication and the potential for adding value to the basic egg. They found that there is a polarization of egg consumers, with free-range consumers at one extreme, largely influenced by bird welfare, and battery consumers at the other, for whom functional properties and value for money are 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 indicated that most of the observed change in egg demand could be explained by dietatry cholesterol concerns. They also found 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 found 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.

Moreover, hedonic analysis approaches have seen limited application in the marketing field. There are a few exceptions. Stanley and Tschirhart (1991) applied the hedonic technique to estimate implicit prices of breakfast cereal characteristics. They chose cereals because consumers can gather information easily about cereal characteristics either through experience, advertising or package labeling. Harris (1997) employed hedonic analysis to demonstrate that consumers value taste more than nutrition when they purchase frankfurters. Roheim, Gardiner and Asche (2007) conducted a hedonic analysis of the frozen processed seafood market in the United Kingdom.

All these studies are about the consumer packaged goods and have used grocery store data collected with scanners or manually. In these works, the challenges of proposing an extension of the traditional approach to account for sales quantity are not tried. Martinez-Garmendia's study (2009) is the first trial this research has found in the literature.

CHAPTER III

EMPIRICAL ANALYSIS

To motivate the empirical work, Stanley and Tschirhart (1991) extended Rosen's (1974) utility function by assuming consumers derive utility from services, *S*, the characteristics of the products, and a composite good X. Then, a utility function can be written as:

(4) $$U(S_1 , \ S_2 , \dots , S_m, X).$$

Let $Z_i = (Z_1, Z_2, \dots, Z_n)$ be the vector of characteristics/attributes and let $S_h = (Z_1, Z_2, \dots, Z_n)$ be service h ,h = 1,…,m. According to Stanley and Tschirhart (1991), consumers gain utility from the services (S) of the characteristics of the product they buy. A characteristic can enter positively into one service and negatively into another. In other words, a product attribute may have a positive or negative effect on consumer utility. Incorporating the attributes into the hedonic function, it is possible to predict and to estimate a simple equation in which the price per egg depends on the summation of the marginal yields of characteristics/attributes multiplied by their respective marginal implicit prices.

The individual products are called marginal money values and the sum of these values equal the product price. Standard utility maximization shows that the marginal implicit price of a characteristic measures the value of an additional unit of the

characteristic relative to an additional dollar's worth of other goods. In equilibrium, the marginal implicit prices represent the joint envelope of the consumer's value functions and the firm's offer functions.

Data

Data used in this study were collected through two steps. Firstly, data of attributes were obtained from labels of egg packages from the shelves of the five large supercenters (N.A.C.F Hanaro Club) in Korea, located in Seoul and its surrounding area in 2009. Secondly, data of product price were collected from the data server of the N.A.C.F Information Technology center. This study uses a full year of daily store scanner data which include 2,590,525 transactions for eggs. These transactions were aggregated daily for each product code. Product prices obtained from the retail markets were measured in Korean won per package. The package price was divided by the number of eggs per package to get Korean won per egg. A total of 65,182 observations were gathered from the five large supercenters that are located in Seoul and its surrounding area. Demographic characteristics of Seoul and its surrounding area are assumed the same as those for the metropolitan area. Chang-dong branch is located in Northern Seoul while Yang-jae branch is located in Southern Seoul. Goyang branch is in Northern Gyeonggi (capital area) , and Seongnam branch and Suwon branch are in Southern Gyeonggi (capital area). Figure 2 shows locations of each branch store.

Attributes

As stated earlier, today's consumers are looking for nutrition, convenience, health, and food safety when they purchase food. Health and food safety are especially important factors to most Korean consumers. Recently, the demand for organic food has been increasing. Today's busy consumers also value time-saving convenience, and image of products.

Egg attributes can be grouped into four attribute classifications: nutrition, convenience, health and food safety, and product image. These attributes are selected on the basis of the former research (Fearne and Lavelle, 1996; Karipidis et al, 2005) and adjusted to the Korean fresh egg market. Attributes associated with nutrition are derived from natural product quality (egg size and the status of fertility) and production conditions (nutrition enhancement). Attributes related to convenience are provided by the package size. Attributes related to health and food safety include organic feeding, use of antibiotic-free feed, free range feeding, and quality control. Attributes related to product image are provided by the package design, private brand (PB), and production contract. The image of the product is related to consumer's psychological needs. For example, a unique package design is related to premium image, while PB and production contract are related to fresh and low price.

Table 1 summarizes consumers' expected utility from attributes of each group and their expected impacts on egg price. It is arguable whether consumers can effectively evaluate all natural attributes of eggs. But many attributes in consumer package goods can easily be assessed visually because most producers advertise special characteristics of the product by labeling[3].

It is believed that larger egg size gives more utility to most consumers. So, it is expected to have a higher shadow price ($\partial P/\partial Z_1 > 0$) than smaller egg size. In an effort to meet consumers' demand for specialty eggs, Korean egg producers have begun marketing fertile, nutrition enhancement, organic, and free-range eggs. Due to a higher production cost, specialty eggs are more expensive than generic shell eggs. Although it is not proved by science, Korean consumers tend to believe that fertile eggs have more nutrition than normal eggs. Therefore, it is expected to have a higher shadow price ($\partial P/\partial Z_2 > 0$) than normal eggs in the Korean egg market.

As stated earlier, the increase in egg consumption is being driven by consumer interest in health benefits that reach beyond dietary avoidance strategies to positive nutrition strategies (Gilbert, 2000). As these market trends changed, producer's efforts shifted towards improving the egg's nutritional quality. Some poultry producers have been trying to improve the quality of eggs by improving the quality of the feed (Hunter, 2000). Korean poultry producers have been also trying to improve the quality of eggs by feeding ginseng, medicinal herbs, crickets, etc. Thus, nutrition enrichment is expected to have a higher shadow price ($\partial P/\partial Z_3 > 0$) than normal eggs.

According to a report from the Korean Animal Welfare Association (KAWA), Korean livestock farmers used 0.91 kilograms of antibiotics for every ton of livestock in 2002 compared to 0.14 kilograms in U.S. Unfortunately, in 2008, some eggs and chickens that were advertised as antibiotic free by major Korean grocery stores were found to contain an antibiotic substance, enrofloxacin. Korea is one of the most health-conscious countries in the world. "What to eat and what not to eat" is a common interest in everyday Korean life (The Korea Times, 2010). Egg production using organic feed and

not using antibiotics are expected to improve the quality of product and minimize the risk of health. Therefore, labeling of organic feed and antibiotic-free is expected to have a positive effect on product price ($\partial P/\partial Z_4 > 0$, $\partial P/\partial Z_5 > 0$). There was almost unanimous agreement by consumers that battery-egg production was cruel because bird welfare is clearly an emotive topic which can raise strong feelings in consumers. Although, the importance of welfare issues with regard to consumer purchasing decisions is dwarfed by functional factors (Fearne and Lavelle, 1996), the labeling of free range feeding is expected to have a positive effect on product price ($\partial P/\partial Z_6 > 0$). Larger package size is inconvenient to handle and cheaper than smaller size because of economies of scale. In the same product, the larger quantity package is expected to have a lower the price per item. So, a larger package is expected to have a negative shadow price ($\partial P/\partial Z_7 < 0$).

The variety of egg packaging today is a result of changes in consumer awareness of alternative farming methods and growing understanding of the contribution of healthy eating to a longer lifespan. The priority with egg sales must be to introduce attractive, high quality egg carton designs in new colors. The introduction of these cartons will make it possible for the egg trade to distinguish between different products (Orth, 2004). In the past decades, there has been growing public concern with regard to environmental care. So, unique package design and environmental-friendly packaging gives a premium image to consumers. As a result, the package appearance is expected to have a positive effect on product price ($\partial P/\partial Z_8 > 0$, $\partial P/\partial Z_9 > 0$). Because most of the consumers are concerned about the product quality and want to check on the quality labels on products, producers usually advertise their own quality control system or international

system like HACCP[2] to minimize consumers' concern. Therefore, the labeling of quality control is expected to have a positive effect on product price ($\partial P/\partial Z_{10} > 0$). Kinnucan and Nelson (1993) and Martinez (2002) indicate that contracting should reduce egg marketing/transaction costs. As stated earlier, PB goods in the hypermarkets have been increasing because the Korean domestic hypermarket industry is highly competitive and therefore each company is seeking methods to increase profits through product differentiation and cost reduction. Hence, the labeling of contract and private brand are expected to have a negative effect on product price ($\partial P/\partial Z_{11} < 0,\ \partial P/\partial Z_{12} < 0$).

Estimated Hedonic Price Model

Before estimating the hedonic price model, a functional form needs to be determined for the model. Cropper et al. (1988) found that when variables are omitted or replaced by proxies, simpler forms such as linear, semi log, double log or Box-Cox approaches perform better than more complex ones. Because of the ease of interpretation of its coefficient as price flexibilities, a double log functional form was chosen for this study. Following Martinez-Garmendia (2009), we included quantity sold as an independent variable in our study. Then, a double log function form of hedonic price model for Korean egg market (located in Seoul and its surrounding area) is represented as :

$$(5)\quad \ln P_{it} = \alpha + \beta_1 \ln \text{Quantity}_{it} + \beta_2 \text{Fertility}_i + \beta_3 \text{Nutrition}_i + \beta_4 \text{Organic}_i + \beta_5 \text{Antibioticfree}_i + \beta_6 \text{Freerange}_i + \beta_7 \text{Uniquepackage}_i + \beta_8 \text{Ecopackage}_i + \beta_9 \text{Qualitycontrol}_i + \beta_{10} \text{Contract}_i + \beta_{11} \text{Privatebrand}_i + \sum_{j=2}^{4} \gamma_j \text{Size}_{ij} + \sum_{k=2}^{6} \delta_k \text{Pkgsize}_{ik} + \sum_{l=2}^{4} \varepsilon_l \text{Season}_{itl} + \sum_{m=2}^{5} \theta_m \text{Branch}_{im} + e_{it},$$

where subscripts i and t indicate product and time, respectively.

Table 2 lists all the variables used in our hedonic model and descriptive statistics for these variables. Total 65,182 daily observations were used to estimate the model. The mean of price per egg (P) is 249.21 KRW (0.20 USD) and price per egg (P) has a wide price range (92.7 - 617.1 KRW; 0.07 - 0.50 USD). 30% of the observations have fertile eggs (Fertility) attribute and 22% of the observations have nutrition enhancement attribute. 2% of the observations have organic feeding (Organic) attribute. 75% of the observations have antibiotics free feed (Antibioticfree) attribute and 23% of the observations have free range feeding (Freerange) attribute. 22% of the observations have uniquely designed package attribute and 86% of the observations have environmental friendly package (Ecopackage) attribute. 8% of the observations have private brand attribute. Egg size 3 (60 grams per egg; Size_3) is most common in egg size. Package size 2 (10 eggs; Pkgsize_2), package size 3 (15 eggs; Pkgsize_3), package size 5 (30 eggs; Pkgsize_5) are most common in package size. Data were almost evenly distributed across seasons. To avoid the perfect collinearity problem, one dummy variable was dropped for Size, Pkgsize, Season, and Branch as noted in equation (5).

CHAPTER IV

RESULTS

The hedonic model included 24 independent variables and was estimated with 65,182 observations. Sales volume (Quantity) is the quantity sold of the products in the number of eggs. Other independent variables included in the model were dummy variables. Variable of fertile eggs (Fertility) equaled to 1 when the eggs have fertility and 0 otherwise.

The next four variables (Nutrition, Organic, Antibioticfree, Freerange) equaled 1 when the product was produced under specific feeding conditions (medicinal herb feeding, organic feeding, antibiotic-free feeding, free-range feeding) and 0 otherwise. The variables Uniquepackage and Ecopackage take the value 1 in the case of specific package design and environmental friendly packaging, respectively and 0 in any other cases.

Variables Qualitycontrol and Contract were dropped to avoid perfect multicollinearity with Antibioticfree and Privatebrand , respectively. Privatebrand takes the value 1 when the marketing process was undertaken by the retailer, and the value of 0 in any other cases. Dummy variables $Size_1$ to $Size_4$ were used to model egg size. The egg sizes considered in the study include $Size_1$ (44grams), $Size_2$ (52grams), $Size_3$ (60grams) and $Size_4$ (68 grams).

Package size (number of eggs per pack) is represented by dummy variables Pkgsize_1 to Pkgsize_6 , for 6, 10, 15, 20, 30 and 60 eggs per pack, respectively. Seasonality variation was included using dummy variables Season_1 to Season_4. Branch locations were also included using five dummy variables, Branch_1 to Branch_5.

Table 3 shows results of the estimation. The hypothesis for homoskedasticity in error terms was rejected, and the maximum likelihood estimation procedure was used to correct for the heteroskedasticity. The significant effect of each of the independent variables on the price of egg was tested with a t-distribution. The null hypothesis that coefficient is zero is rejected for all independent variables at $\alpha = 0.01$. All variables are statistically significant but some variables did not show expected signs.

The result of the F-test (F = 26,136.3, significant at one percent) indicates that the change in egg price in the Korean egg market is well represented by the change in the set of independent variables of equation (5). The high value of the adjusted R-square (0.8962) indicates that a high percentage of retail egg-price variability is explained by this empirical model.

Sales quantity is negatively related with price. A 1% increase in egg quantity results in a 0.04% decrease in egg price. The results show the existence of volume discounts. The fertile eggs, organically produced eggs, and the eggs produced by a free-range feeding system show higher implicit prices than the others. Marginal implicit prices of fertile eggs, organically produced eggs, and the eggs produced by a free-range feeding system are \$0.06, \$0.09, and \$0.04 per egg, respectively. These findings indicate that Korean customers prefer eggs produced through natural feeding processes.

Although unique package design and environmental-friendly package positively influenced the price, packaging methods were shown not to have a large effect on the egg prices. Under normal circumstances, private brand products tend to be cheaper than products sold by national brand products. Therefore, customers usually expect a lower price on the private brand products. In the previous study about the Greek egg market (Karipidis et al., 2005), supermarket-controlled egg marketing reduced egg retail prices as a result of a retailer involvement in both wholesaling and distribution. However, results of this study show that the private brand attribute affects the price in a positive way.

As expected, the egg price is found to increase with the 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 \$0.05, \$0.06, and \$0.06 per egg, respectively. The results indicate that Korean consumers tend to prefer large eggs to small eggs. Results also show that package size is one of important price determining factors. Marginal implicit prices decreases with package size. Differentials of the prices between the smallest package size and $Pkgsize_2$, $Pkgsize_3$, $Pkgsize_4$, $Pkgsize_5$, and $Pkgsize_6$ are \$0.12, \$0.11, \$0.11, \$0.16, and \$0.17, respectively. The result indicates that Korean egg consumers tend to prefer small package (containing 6 eggs) for convenience. Korean egg prices also shows seasonal variation. Price in $Season_1$ tends to be higher than prices of the rest of the year. Egg price differs across branches, which reflects alternative pricing and promotion schemes across branches.

CHAPTER V

SUMMARY AND CONCLUSION

Because of rapid economic growth and rising levels of affluence, shift of consumer demand toward quality, variety, convenience, safety and health can be seen throughout Korea. To meet these increasingly varied needs, food retailers and producers are adding value and differentiating their products. As these market trends to change, it becomes more important for retailers to adopt closer coordination between producers and retailers in order to customize products to meet consumer demands.

Nowadays, the main trend of the fresh egg market is the transformation of eggs from a relatively homogeneous to a highly differentiated product. In an effort to meet consumer demand, egg producers have begun marketing organic, free-range, fertile, and nutrient-enhanced specialty eggs in Korea. Moreover, because of soaring animal feed and oil prices, Korean egg farmers have suffered from increasing farm expenses.

To overcome this difficult situation, it is essential for egg farmers to increase the marketing margin through niche marketing and other value added strategies.

Applying hedonic price modeling can help Korean farmers accomplish this. The model provides applications measuring implicit value of key product attributes of heterogeneous goods revealed to consumers, based on the theory laid by Lancaster (1966), Rosen (1974) and Ladd and Zober (1977).

The hedonic pricing approach is recognized as one of the most appropriate methods for product differentiation questions. The merit of the hedonic price model is that it can decompose the price paid for a heterogeneous good into separate components related to the product characteristics. Therefore, many of the hedonic analysis approaches have been conducted for agricultural products: rice (Brorsen et al., 1984), wheat (Espinosa and Goodwin), apples (Tronstad et al., 1992), tomatoes (Huang and Lin, 2006), etc. However, the hedonic analysis model has rarely been applied to eggs in the literature. The only hedonic analysis conducted on eggs was Karipidis et al (2005). Moreover, hedonic analysis approaches have been applied rarely in the marketing field. A few exceptions are breakfast cereals (Stanley and Tschirhart, 1991), frankfurters (Harris, 1997), eggs (Karipidis et al., 2005), and frozen processed seafood (Roheim et al., 2007). All these studies have used grocery store data collected manually or with scanners. There are challenges of applying the hedonic pricing method to consumer packaged goods using scanner data. Martinez-Garmendia (2009) was the first attempt that proposes an extension of the traditional approach to account for sales quantity as a solution.

Research about the Greek egg market (Karipidis et al.2005) was conducted using 175 manually collected observations. Our study used a full year of daily store scanner data which included 65,182 observations. Our study is the first attempt to estimate a hedonic function for eggs in Korea. Our study also accounts for sales volume by including a quantity sold as an independent variable.

The objective of this study was to identify the product attributes that affect egg prices in Korean egg market, more specifically, the Korean N.A.C.F hypermarket. All quality attributes considered in this model significantly affected price. Findings suggest

that the retail price is influenced by specific natural attributes of eggs. The results show that major attributes positively affecting the retail price of eggs include the status of egg fertility, organic feeding, and free-range feeding. These findings indicate that Korean customers prefer eggs produced through natural feeding processes. The findings could help both producers and retailers formulate better production and marketing strategies focusing on attributes such as egg fertility, organic feeding, free-range feeding, egg size, and package size.

This study focused on estimating values of the product attributes that affect retail egg prices. The study did not provide information of profitability considering the production cost. Estimating profits of each attribute in egg production is beyond the scope of the current study.

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, etc. Findings from this type of analysis can be used for developing better marketing strategies.

FOOTNOTES

1. Korean agricultural cooperatives, known as an "NH, NongHyup" in Korean, consist of 2.4 million member farmers and about 1,187 member cooperatives and one apex federation, the NACF .

Established in 1961, the NACF aims to raise the living standards of farmers by enhancing their economic, social and cultural status and to ensure the balanced development of the national economy by increasing the competitiveness of Korean agriculture.

The NACF and its member cooperatives are major players in the marketing of farm products. In 2007,The NACF had a 48 percent share in Korea's rural agricultural marketing business and 8 percent share in the domestic retail market.

2. Hazzard Anlysis Critical Control Point (HACCP) was developed in the US and is based on seven principles aimed at identifying hazards in food production, controlling hazards at the critical control points in the process, and verifying whether the system is working properly.

3. The Korean government has developed an organic certification and labeling program that has had an additional positive effect of increasing consumer awareness about the heavy use of agricultural chemicals in Korea. The labeling requirements for agricultural products are set by the National Agricultural Products Quality Management Service (NAQS), which was designated as the official certification body by government.

Generally, organic feeding includes antibiotic free feeding, but in Korea, these two things are separately certified by NAQS. Organic livestock certification is only granted to the livestock products fed with organic feed and raised according to the guidelines. Antibiotic-free certification is granted to the livestock products fed without antibiotics. However, there is no governmental certification system for other specialty eggs such as fertile, free range, and nutritionally enhanced eggs.

Table 1. Product Attributes, Expected Consumer Utility, and Expected Influence on Egg Price.

Group	Attribute	Utility	Expected influence on price
Natural characteristics	Product Size (z_1)	Nutrition	Positive
	Fertile eggs (z_2)	Nutrition	Positive
Feeding methods	Nutrition Enrichment (z_3)	Nutrition	Positive
	Organic feeding (z_4)	Health / Food Safety	Positive
	Antibiotic-free(z_5)	Health / Food Safety	Positive
	Free range (z_6)	Health / Food Safety	Positive
Package	Package size (z_7)	Convenience	Negative
	Unique design package (z_8)	Image (Premium)	Positive
	Environmental-friendly package (z_9)	Image (Premium)	Positive
Quality control	Quality control (z_{10})	Health / Food Safety	Positive
Marketing	Contract (z_{11})	Image (Fresh & Low price)	Negative
	Private Brand (z_{12})	Image (Fresh & Low price)	Negative

Table 2. Descriptive Statistics of Data Used for Hedonic Price Model Estimation

Variable	Mean	Min	Max	Description
P	249.21	92.7	617.1	Price per egg (Krw)
Quantity	829.64	6	72,600	Number of Eggs sold
Fretility	0.30	0	1	Dummy for Fertile egg
Nutrition	0.22	0	1	Dummy for Nutrion enhancement
Organic	0.02	0	1	Dummy for Organic
Antibioticfree	0.75	0	1	Dummy for Antibiotic-free
Freerange	0.23	0	1	Dummy for Free range
Uniquepackage	0.22	0	1	Dummy for Uniquely designed package
Ecopackage	0.86	0	1	Dummy for Environmental-friendly package
Qualitycontrol	0.75	0	1	Dummy for Quality Control
Contract	0.08	0	1	Dummy for Contract
Privatebrand	0.08	0	1	Dummy for Priviate Brand
$Size_1$	0.03	0	1	Dummy for Egg size (44grams per egg)
$Size_2$	0.27	0	1	Dummy for Egg size (52grams per egg)
$Size_3$	0.49	0	1	Dummy for Egg size (60grams per egg)
$Size_4$	0.21	0	1	Dummy for Egg size (68grams per egg)
$Pkgsize_1$	0.01	0	1	Dummy for Package Size 1 (6eggs)
$Pkgsize_2$	0.29	0	1	Dummy for Package Size 2 (10eggs)
$Pkgsize_3$	0.35	0	1	Dummy for Package Size 3 (15eggs)
$Pkgsize_4$	0.02	0	1	Dummy for Package Size 4 (20eggs)
$Pkgsize_5$	0.32	0	1	Dummy for Package Size 5 (30eggs)
$Pkgsize_6$	0.01	0	1	Dummy for Package Size 6 (60eggs)
$Season_1$	0.23	0	1	Dummy for Seasonality 1 (Jan~Mar)
$Season_2$	0.24	0	1	Dummy for Seasonality 2 (Apr~Jun)
$Season_3$	0.26	0	1	Dummy for Seasonality 3 (Jul~Sep)
$Season_4$	0.27	0	1	Dummy for Seasonality 4 (Oct~Dec)
$Branch_1$	0.16	0	1	Dummy for Branch1 (Suwon)
$Branch_2$	0.20	0	1	Dummy for Branch2 (Goyang)
$Branch_3$	0.18	0	1	Dummy for Branch3 (Seongnam)
$Branch_4$	0.22	0	1	Dummy for Branch4 (Changdong)
$Branch_5$	0.24	0	1	Dummy for Branch5 (Yangjae)

Number of Observations: 65,182

Table 3. Estimation Results of the Hedonic Price Model

Variable	Parameter Estimate	Marginal Implicit Prices in Korean won (USD) [a]		Standard Error	t-statistic	p-value
Intercept	5.9047	N/A	(N/A)	0.0128	462.94	0.0001
lnQuantity	-0.0420	N/A	(N/A)	0.0005	-82.37	0.0001
Fertility	0.3160	78.75	(0.06)	0.0025	129.23	0.0001
Nutrition	0.0233	5.81	(0.00)	0.0013	17.84	0.0001
Organic	0.4678	116.58	(0.09)	0.0030	154.63	0.0001
Antibioticfree	0.0056	1.40	(0.00)	0.0013	4.47	0.0001
Freerange	0.1759	43.84	(0.04)	0.0024	72.01	0.0001
Uniquepackage	0.0538	13.41	(0.01)	0.0013	42.81	0.0001
Econpackage	0.0198	4.93	(0.00)	0.0015	13.44	0.0001
Privatebrand	0.0892	22.23	(0.02)	0.0020	45.15	0.0001
$Size_2$	0.2374	59.16	(0.05)	0.0038	62.03	0.0001
$Size_3$	0.2779	69.26	(0.06)	0.0039	70.86	0.0001
$Size_4$	0.3038	75.71	(0.06)	0.0040	76.47	0.0001
$Pkgsize_2$	-0.5854	-145.89	(-0.12)	0.0128	-45.85	0.0001
$Pkgsize_3$	-0.5642	-140.60	(-0.11)	0.0128	-44.14	0.0001
$Pkgsize_4$	-0.5230	-130.34	(-0.11)	0.0131	-39.80	0.0001
$Pkgsize_5$	-0.7818	-194.83	(-0.16)	0.0129	-60.65	0.0001
$Pkgsize_6$	-0.8457	-210.76	(-0.17)	0.0133	-63.64	0.0001
$Season_2$	-0.0032	-0.80	(0.00)	0.0012	-2.61	0.0090
$Season_3$	-0.0074	-1.84	(0.00)	0.0012	-6.11	0.0001
$Season_4$	-0.0458	-11.41	(-0.01)	0.0013	-36.27	0.0001
$Branch_2$	0.0369	9.20	(0.01)	0.0015	25.20	0.0001
$Branch_3$	0.0701	17.47	(0.01)	0.0015	46.35	0.0001
$Branch_4$	-0.0175	-4.36	(0.00)	0.0015	-12.02	0.0001
$Branch_5$	-0.0191	-4.76	(0.00)	0.0016	-12.33	0.0001

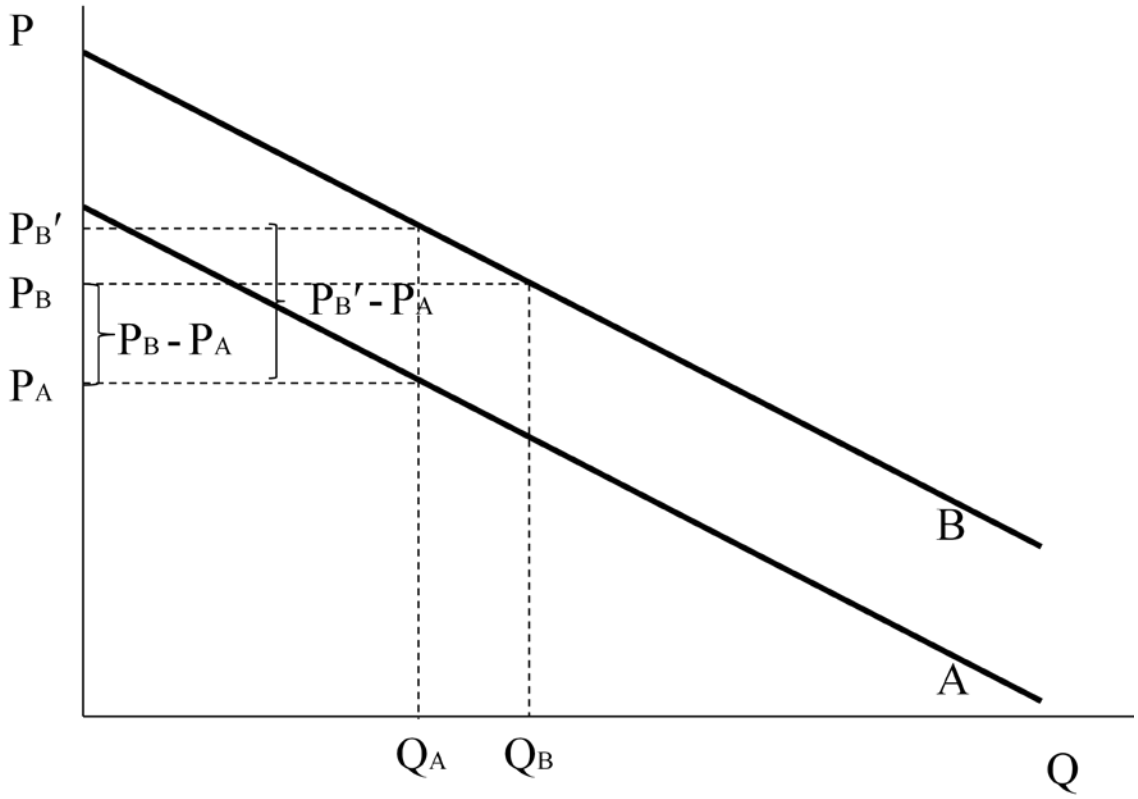
R-square = 0.8962

Dependent variable = log of price per egg

F-value = 23,136.3

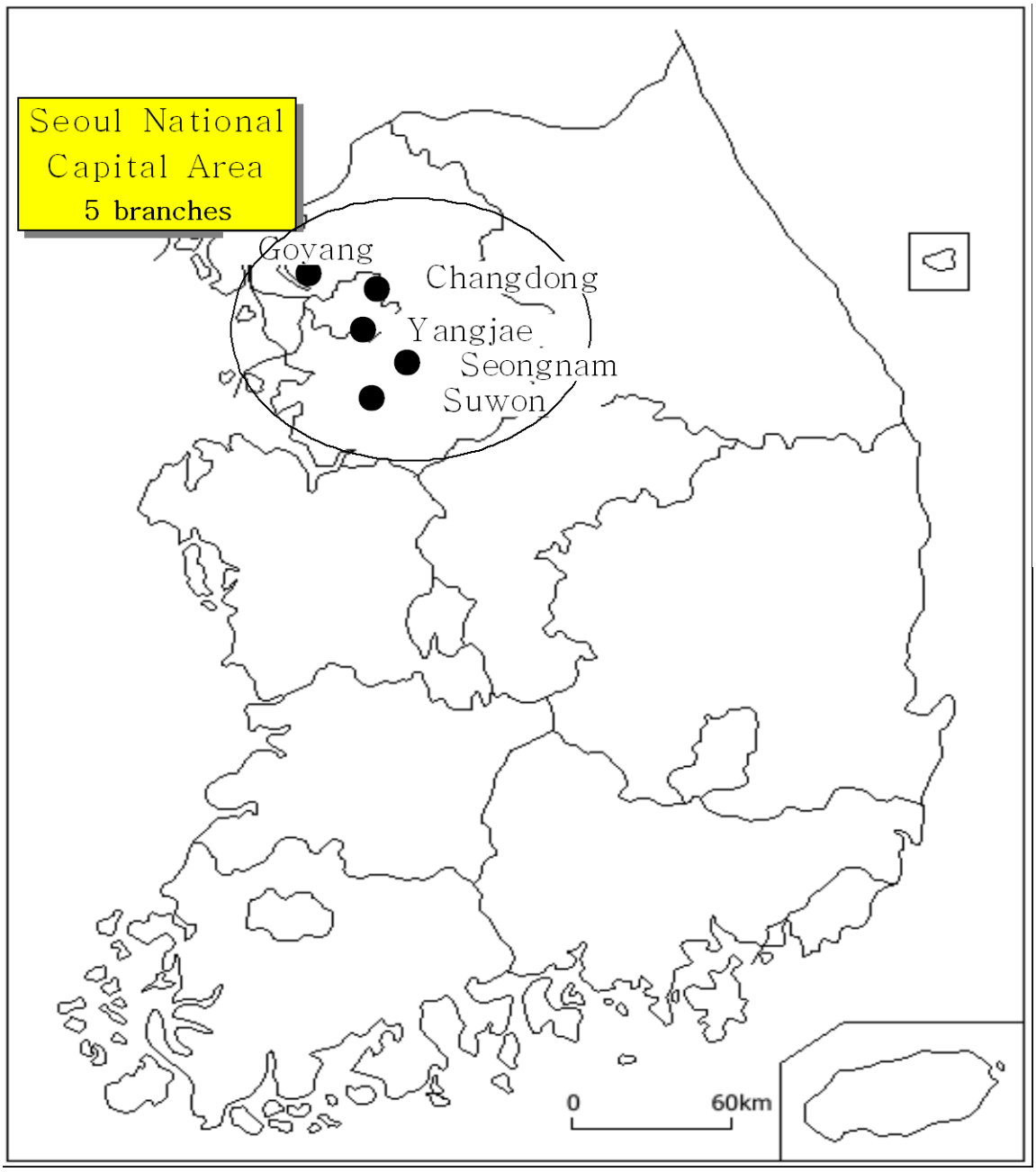
[a]Marginal implicit prices in Korean won are calculated as: $\frac{\partial P}{\partial z_i}=\beta_i \cdot \overline{P}$. Mean price ($\overline{P}$) is 249.21 KRW(0.20 USD). Exchange rate: 1USD = 1,240 KRW.

Figure 1. Graphical illustration of the importance of including quantity in the Hedonic Price Model



Source : Martinez-Garmendia, 2009

Figure 2. Information of the branch locations



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APPENDICES

Pictures of Egg Products

* These pictures present types of Korean egg products in the N.A.C.F hypermarket.
It is possible to identify some attributes of Korean egg products by looking at the picture.

Product Code	Picture
8801448104235	
8801448106055	
8802474800214	

Product Code	Picture
8802474880001	
8802474880414	
8804030030622	

Product Code	Picture
8804030030592	
8809105665099	
8809081460091	

Product Code	Picture
8805823900030	
8809135090014	
8802474880025	

Product Code	Picture
8809105665075	
8809105665419	
8809140199993	

Product Code	Picture
8802874199901	
8805215020629	
8805823900023	

Product Code	Picture
8809140193021	
8809140193014	
8809105665174	

Product Code	Picture
8809105665273	
8809105665105	
8809081460008	

Product Code	Picture
8809081460022	
8802474880117	
8802474880094	

Product Code	Picture
8802474880087	
8805215020605	
8808509000192	

Product Code	Picture
8809115850508	
8809135090021	
8809014000707	

Product Code	Picture
8809271627105	
8804896531226	
8809233550021	

Product Code	Picture
8809081460015	
8809227721116	
8809135090229	

Product Code	Picture
8809185287150	
8805198280454	
8809081460060	

Product Code	Picture
8807238001012	
8807778500112	
8804701700311	

Product Code	Picture
8809217620801	
8807778460355	
8807778500303	

Product Code	Picture
8807238001067	
8809227721161	
8809227721130	

Product Code	Picture
8807778500150	
8809105665051	
8808246009786	

Product Code	Picture
8808246009854	
8808246009793	
8808246009861	

Product Code	Picture
8809082100026	
8809082100040	
8809135090205	

Product Code	Picture
8809105665426	
8809105665112	
8804030100028	

Product Code	Picture
8809049220101	
8801448104242	

VITA

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Thesis: HEDONIC ANALYSIS OF RETAIL EGG PRICES USING STORE SCANNER DATA: AN EMPIRICAL STUDY ON THE KOREAN NATIONAL AGRICULTURAL COOPERATIVE FEDERATION HYPERMARKETS

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Scope and Method of Study: The purpose of this research is to identify egg attributes that affect egg prices and to estimate values of each attribute in the Korean egg market.

A hedonic price model is developed to estimate values of egg attributes, and the model is estimated using store scanner data. Attributes considered in this study include natural characteristics, feeding methods, packaging methods and marketing.

Findings and Conclusions: The results show that the status of egg fertility, organic feeding, and free-range feeding are main attributes that positively affect the retail price of eggs.

The findings indicate that Korean customers prefer eggs produced through natural feeding processes. The findings can be used to develop better marketing and production strategies for both retailers and producers.

On the basis of findings of the present study, various future studies regarding the micro-marketing and profitability analysis could be performed.

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