AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
<http://ageconsearch.umn.edu>
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Implicit Values of Functional Attributes of Fluid Milk Products

Donghyun Moon¹ and Sanghyo Kim²

***Selected Paper prepared for presentation at the 2021 Agricultural & Applied Economics socation
Annual Meeting, Austin, TX, August 1 – August 3***

Copyright 2021 by Donghyun Moon and Sanghyu Kim. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

¹ Corresponding author (email: dhmoon0326@krei.re.kr). PhD. researcher at the Korea Rural Economic Institute.

² Senior research fellow at the Korea Rural Economic Institute (email: skim@krei.re.kr).

Implicit Values of Functional Attributes of Fluid Milk Products

– Hedonic Analysis of Korean Fluid Milk Market³

Donghyun Moon⁴ and Sanghyo Kim⁵

Abstract

Competition in the Korean milk market is being intensified with the emergence of a variety of product-differentiated milk. The purpose of this study is to measure implicit values of functional attributes of fluid milk products in Korea, which is a representative factor in product differentiation. Hedonic price analysis and milk purchase data by households were employed for this study. Our findings suggest that Korean consumers have a high value for their lactose-free property (25.2% price premium) over conventional milk. This reflects the fact that many Korean adults have lactose intolerance and the lactose-free properties can help digest milk without negative symptoms. In addition, the estimated price premiums for calcium-fortified attributes were positive but a little higher over the base case at 2.4% level. In the case of vitamin fortification, it was found to have a negative value (-34.6%).

JEL codes: Q11, Q13

Keywords: Milk Price, Functional Attribute, Milk Attribute, Implicit Price, Hedonic model

³ This article was partially funded by 2020 Research Service for Food Consumption, Department of Agriculture, Food, and Rural Affairs.

⁴ Corresponding author (email: dhmoon0326@krei.re.kr). PhD. researcher at the Korea Rural Economic Institute.

⁵ Senior research fellow at the Korea Rural Economic Institute.

1. Background

1.1. The Korean Fluid Milk market

The size of the Korean domestic milk market is estimated to be about 3,118 billion won (KRW) as of 2020 (aT FIS Trend Pick. 2021.01). It is found the fluid milk market has stagnated since 2016. There are two main factors: The first factor is the drop in the birth rate. The other is the rise in milk substitute drinks. The former describes that the fall of the birth rate brought about the decline in the amount of fluid milk that children drink via the decrease in the number of children (aT FIS News Letter: Milk. 2020.01.)⁶ The number of newborns in Korea has considerably dropped from 484.6 in 2012 to 302.7 in 2019 (Statistics KOREA e-index). The latter is that fluid milk demand went down as milk substitute drinks increase. Milk substitute drinks are water extracts of plant material (Oduro, Saalia, and Adjei 2021). Some people consume milk substitute drinks, instead of cow milk. Examples of milk substitute drinks include soy milk, almond milk, Oat milk, coconut milk, rice milk, and coffee drink. These are also known as plant-based milk alternatives and look like cow milk in appearance.

Figure 1 illustrates the total fluid milk consumption in Korea. The fluid milk total consumption exceeded 1 million tons for the first time in 1987 and showed an increasing trend for 10 years until 1997.⁷ This incline trend is due to the increase in income level. The temporary decline in milk consumption in late 1999 was the impact of a decline in income by the Asian financial crisis. The total fluid milk consumption was 1.828 million tons (1.380 of white milk and 0.448 of processed milk) in 2003 when is the highest fluid milk consumption. After that,

⁶ The decline in the birth rate does not only affect the fluid milk market but also causes a decrease in the consumption of many other products.

⁷ According to Baik and Lee (2020) and Jeong, Cho, and Park (2003), in 1988 and 1999, there was a significant structural change in Korean milk demand.

the consumption of the fluid milk is slightly decreased and stagnated between 1.6 and 1.7 million tons levels. Total fluid milk consumption in 2020 was reported at 1.647 million tons.

Figure 2 shows per capita fluid milk consumption that is the total milk consumption divided by the population in each year. Despite the change in the population, fluid milk consumption per capita shows a very similar trend to total fluid milk consumption. The annual milk consumption per capita was 31.1 kg (28.9 of white milk and 2.2 of processed milk) in 1988, exceeding 30 kg, and showed a tendency to increase to 37.1 kg (31.5 of white milk and 5.6 of processed milk) in 1997. Like total milk consumption, milk consumption per capita in 1998-99 also temporarily fell sharply but recovered in the 2000s. Since then, it seems to have decreased slightly, and milk consumption per capita in 2020 reached 31.8 kg.

1.2. Imperfect Competition - Product Differentiation

The Korean milk market has traditionally been dominated by four producers (Seoul milk, Namyang milk, Maeil milk, and Binggrae), while the remaining producers occupy a small portion of the market. In particular, the top player (Seoul Milk) and the big three players (Namyang milk, Maeil milk, and Binggrae) have established an imperfect competition industry structure (Ahn 2006). According to Song et al. (2005), the market share of the Seoul milk in the fluid milk industry was about 38.9% in 2003. The respective figures for the Maeil milk, the Binggrae, and the Namyang milk were 14.5%, 12.9%, and 11.9% in the same year. These four producers account for 78.2% of the milk industry. While there have been fluctuations in the market share of the fluid milk industry among producers, the four major producers had maintained a market share of more than 75%.

However, it showed 73.4% market share (30.8% for Seoul milk, 13.5% for Maeil milk, 14.9% for Namyang, and 14.2% for Binggrae) for the first time in 2019, falling below 75%, and it was 65.7% (29.1% for Seoul milk, 17.6% for Maeil milk, 10.2% for Namyang, and 8.8%

for Binggrae) in 2020, showing less than 70% (aTFIS Trend Pick. 2021.01). This has been evaluated to be due to the increased consumption of functional milk and flavored milk. Unnevehr et al (2010) pointed out that price and income have less influence on food choices than past and that the quality or characteristics of food are more important. As shown by Baik and Lee (2002) and Shin and Jeong Ahn (2003), the characteristics of (conventional) fluid milk demand in Korea, which are inelastic to changes in price and income, can be also seen as supporting Unnevehr et al (2010)'s argument. This implies in the milk market, differentiation of products (for example, introducing functional characteristics and flavors) may appeal to consumers more than price competition. It is in this context that differentiated milk products, rather than conventional white milk, are gaining popularity in the market. As a result, each manufacturer's milk market share is changing.

According to the milk consumption structure in 2003, 76.6% of the total milk consumption was sold as white milk, and 23.4% was as processed milk, indicating that the milk consumption in Korea is concentrated in white milk. (Song et al., 2005). The white milk consists of 59.7% for general white milk and 16.9% for functional white milk. On the other hand, the processed milk comprises banana-flavored milk (6.4%), chocolate-flavored milk (1.8%), strawberry-flavored milk (4.2%), and others (7.5%). The fluid milk industry has been moving to one of the highly differentiated food markets as its functional properties attract attention from consumers and drinking milk substitutes are continuously developed. Milk characteristics lead to product differentiation. Examples include organic, low-fat, and fat-free (skim), functional attributes (lactose-free, calcium-fortified, and vitamin-fortified), processes (sterilized and pasteurized), packaging, bundling, volumes, and flavors. In particular, the functional properties of milk received a lot of attention from the market in the mid-1990s when calcium-fortified milk and vitamin-fortified milk were released and in the mid-2000s when

lactose-free milk was released.⁸ The market share of white milk in 2018 (68.2%) was decreased by about 8.4% from 2003, while the share of flavored milk increased to 31.8% (aTFIS News Letter: Milk. 2020.01.).⁹ Despite the decrease in the white milk consumption, the functional white milk consumption inclines (Woo et al., 2019).

At a time when the milk market size is stagnating, each manufacturer is competing by launching a variety of differentiated products. Analyzing the milk market, where competition is being intensified to increase its market share, is expected to provide useful information to industry and policy-makers. In particular, although functional milk became popular that shoppers can easily look for it on the shelves of stores, few economics studies have analyzed these milk properties. After 2000, several studies analyzed the Korean milk market in agricultural and food economics fields. These can be separated into three main topics, including demand estimation (ex. Baik and Lee 2002; Jeong, Cho, and Park 2003; Shin and Jeong 2003), price analysis (ex. Ahn and Lee 2005; Jeong, Jeong, and Sim 2015; Song and Choi 2016), and market power investigation (ex. Ahn 2005, Ahn 2006). On the other hand, little research focuses on the characteristics of fluid milk products in the Korean market.

In this perspective, this study attempts to measure implicit prices of attributes of fluid milk products using recent scanner data (Korean panel households' milk purchases), which is expected to contribute to a better understanding of price premium for milk attributes. In particular, our research focus on functional attributes of milk that is a representative factor in product differentiation. For example, the milk industry will be able to compare the marginal

⁸ About 75% of the global population suffers from lactose intolerance, which has some typical symptoms such as abdominal pains, diarrhea, flatulence, and bloating (Yoon 2009; Jellema et al. 2010). In particular, because of the fact that Asian, Native Americans, and African Americans have a high rate of lactose intolerance (Jellema et al. 2010), lactose-free milk has been much attention from consumers in South Korea.

⁹ Especially, banana- and chocolate-flavored milk consumption were increased to 10.6% and 8.8%, respectively.

cost of production of their products with the implicit price of milk attribute presented in this paper. Besides, policymakers are expected to be able to refer to consumer assessment of milk properties based on revealed preference data on fluid milk purchase. This could help establish relevant dairy policies for the milk market with oversupply.

This paper is organized as follows. In the next section, we illustrate the Nielsen Korea's Consumer Panel Service (CPS) data that we use. In the third section, we describe the methodological framework, the hedonic model approach, in this study. The next section discusses our empirical application strategy. Our estimation results are reported with discussions in section 5. Finally, section 6 summarizes our main results and gives a discussion for future research.

2. Data

The Nielsen Korea's Consumer Panel Service (CPS) data was employed to estimate the hedonic price function of fluid milk attributes in our analysis.¹⁰ The CPS data enable us to see consumers bought what products, when they purchased a certain item, and how much they paid for a certain item from the point of view of consumers. The CPS data has tracked household panels' purchases by scanning barcodes of chosen products and reporting the facts and characteristics of the products. The Consumer Panel consists of more than 2,500 households and is required to scan barcodes (Universal Product Code, UPCs) of each item they had got across retail channels. It seems to be similar to the Nielsen U.S. HomeScan.

¹⁰ The CPS data used in this paper is the very latest household unit purchase information. This data, which we received exclusively from Nielsen Korea, is collected by Nielsen Korea, but has not yet managed data sets for analysis and research. The authors would like to note that this CPS data has been processed by our agreement with Nielsen.

Given fact that many previous hedonic papers used transaction data at the store-level, this directly gives a unique opportunity to measure the implicit price of functional qualities based on household panels' purchase records. To our best knowledge, especially, this is the first empirical analysis using the Nielsen Korea's CPS data.¹¹ The consumer panels' milk purchase records from January to December 2020 were collected and used for our analysis. Our analysis is based on 56,791 observations obtained from 2,924 households in the most recent CPS data.

2.1. Demographics of household panels

Some members of the Nielsen Korea's CPS are often replaced by others when the response rate is low or for other reasons. Therefore, some members belong to the panel throughout the year, while some others were members from January to April, but are left out from May and other new members are introduced from May.

In addition, Nielsen Korea regularly updates demographic information about consumer panel members. This allows two or three demographic information for a certain panel identification number. For instance, consider an individual male consumer who has 2.5 million KRW of monthly income in January 2020. If his salary increases to 3.0 mil KRW in June and got married in July, then there are three different demographic properties for him. despite the data collected from 2,924 households, it is described as if the information was obtained from 5,191 households. Table 1 illustrates the demographics of consumer panel households. For the region, 53.6% of household panel residents in Seoul metropolitan area (Seoul, Incheon, and Gyeonggi-do), which are slightly higher, compared to the percentage of households by region

¹¹ The CPS data employed in this study was provided from the Nielsen Korea for 2020 Research Service for Food Consumption.

from Population Census of Statistics Korea. The regional portions of households in other metropolitans (4.6% for Daejeon, 5.0% for Daegu, 3.6% for Gwangju, and 7.7% for Pusan) area are also a little greater than the Population Census. The number of household panels living in Gangwon-do was the lowest at 2.4%. There are no panel households in Jeju-do.

For household income, 21.87% and 20.9% of household panels earned a monthly income of 3-4 million and 2-3 million KRW, respectively. Subsequently, the proportions of households in the high-income range of 4-5 and 5-6 million KRW were 18.0% and 13.2%, respectively, and 10.2% of households belonged to the low-income range of 1-2 million KRW. As for the number of household members, the ratio of single-person households was 11.1%, and two-person households accounted for the highest number of 34.1%. The figures for three-person households and four-person households were 25.5% and 21.8%, respectively.

2.2. Milk Attributes

This article focuses on milk products with a volume smaller than 3,000ml. We do not only consider functional attributes such as lactose-free, calcium- and vitamin-fortified, but do also account for other characteristics including manufacturers, organic, fat-contents (low-fat and fat-free), sterilization methods (sterilized and pasteurized), flavored (banana, chocolate, strawberry, coffee, milk tea and other), and packages (plastic bottle, tetra pack, can, foil bag, and carton).

Table 2 describes the attributes of fluid milk products used for this hedonic price analysis. In our Nielsen CPS's fluid milk purchase data, milk manufacturers were divided into seven groups, including Dongwon, Store Brand, and Other brands as well as big four milk producers (Seoul, Maeil, Namyang, and Binggrae). The proportion of organic milk is only 1.25% of 56,791 purchase records, which implies consumers' revealed choice of organic milk

products is still low. For functional attributes, calcium- and vitamin-fortified milk has the proportion of 4.65% and 0.96%, respectively. 2.48% of fluid milk chosen by consumers has a Lactose-free attribute. Sterilized or Pasteurized milk purchases account for less than 1.8%, suggesting that consumers usually purchase milk produced by conventional pasteurization. For milk flavors, white milk is the most popular (85.3%) as expected but it is notable that the portion of banana-flavored milk is quite high at 4.4%. 14.9% of the milk sold was low-fat milk. For Packages, For the milk packaging material, the proportion of Carton was 63.03%, followed by the plastic bottle (22.0%) and tetra pack (13.6%). And most milk bundles were single or double products.

3. Hedonic Price Method

3.1. Background of Hedonic Price Approach

In this study, the hedonic price method developed by Rosen (1974) was employed to measure the implicit values of functional attributes in fluid milk products. The hedonic price regression is widely used to estimate the willingness-to-pay for attribute qualities of differentiated products or estimate the marginal cost of producing.

The key underlying assumption of the hedonic price method is that a good consists of various characteristics or qualities. That is, a good is a combination of characteristics or qualities (DeHaan and Diewert 2013). However, each character cannot be sold independently in a market. For an example of fluid milk, it is not a challenge for consumers to look for organic milk but an organic attribute cannot be purchased apart from milk products. As such, the price of a good can closely relate to the characteristics of the good, and the price of the good can be calculated by adding up the hedonic value of each property. Because of the nature of the

hedonic price approach that focuses on attributes of market goods, it has been widely applied to the differentiated product market.

The hedonic model assumes that consumers' utility comes from the qualities (or characteristics) of a product so that the equilibrium price of differentiated products is equivalent to the sum of the implicit value of each quality it has (Costanigro and McCluskey 2011). The equilibrium price is derived from the consumers' utility maximization problem and the sellers' profit maximization problem. A consumers' utility is maximized when the bidding functions are exactly tangent to the hedonic function in all the dimensions of attributes. In similar, a seller's profit is optimized when the seller's offer functions meet the hedonic price function. This suggests that the buyer's marginal bid and the seller's marginal offer are exactly matched (Costanigro and McCluskey 2011). If the market is in equilibrium, the marginal price can be explained as a lower bound measure of willingness to pay for consumers who buy a product with that attribute, whereas an upper bound measure of willingness to pay for consumers who do not purchase the same product (Hussein and Fraser 2018; Griffith and Nesheim 2013).

The implicit values of attributes of a certain good are induced by a combination of consumer demand and product supply (Schulz, Schroeder, and White 2012). In this study, the price of fluid milk, P , is described by a hedonic price function, $P = P(z)$, where z is a vector of milk characteristics so that $z = (z_1, z_2, z_2, \dots, z_K)$ (Costanigro, McCluskey and Mittelhammer 2007). A vector of the implicit marginal value is simply obtained by differentiating $P(z)$ with respect to its i^{th} attribute z_i .

$$P(z_i) = \frac{\partial P(z)}{\partial z_i}$$

3.2. Applications of Hedonic Price Model to Milk and Dairy Markets

Several studies estimated a hedonic function of milk attributes in the field of agricultural and food economics. The main characteristics of fluid milk include organic claim/certifications (Smith, Huang and Lin 2009; Kiesel and Villas-Boas 2007; Griffith and Nesheim 2013; Loke, Xu and Leung 2015), Ultra-High-Temperature (UHT)-treated (Bimbo et al. 2016), plant-based produced (Yang and Dharmasena 2021), and locally produced (Loke et al. 2015).

Smith et al. (2009) estimated a hedonic function using the Nielson Homescan data, focusing on the organic attribute of the U.S. fluid milk. Smith et al. (2009) found a significant price premium of \$1.23 to \$1.86 on a half-gallon milk basis for the organic attribute in milk products. Kiesel and Villas-Boas (2007) utilized the Nielson Homescan data for assessing consumer valuation of the National Organic Program (NOP) in the U.S. Kiesel and Villas-Boas (2007) supports that the USDA organic seal increases the probability of purchasing organic milk. Yang & Dharmasena (2021) employed a hedonic metric augmented Barten's synthetical model to estimate the demand system for conventional milk and plant-based milk. The results of Yang and Dharmasena (2021) presents that three plant milk types (such as soy milk, rice milk, and almond milk) had inelastic demand for price changes. Soy milk, rice milk, and almond milk were complementary and four types of conventional milk were strong substitutes within the group. In addition, Loke, Xu, and Leung (2015) measured price premiums for organic, local, and other attributes of fluid milk products in Hawaii using scanner data. The estimated price premiums result that 24.6% for organic, 17.4% local

Recent European studies have applied the hedonic model to the UK and Italian milk markets. For example, Griffith and Nesheim (2013) estimated lower and upper bounds on willingness to pay for organic attributes in food products by using the 2004 Kantar Worldpanel for the U.K and hedonic price estimation. It reports that the median lower bound of WTP for organic characteristic is 0.2% of expenditure and the median upper bound is 31.5%. For Italy milk market, Bimbo et al. (2016) estimated the contributions of different attributes to Ultra-

High-Temperature (UHT)-treated milk prices in Italy, considering two market segments. The finding indicates that n-3 fatty acids, fiber, and vitamins have positive values in the hedonic analysis.

The hedonic analysis is widely used not only in the fluid milk market but also in livestock and other dairy industry to analyze attribute values and price premiums. Examples include cheese attributes (Ahn, Yoon, and Ji 2018), beef attributes (Lee and Choi 2000; Rho, Lee, and Lee 2015; (Parcell and Schroeder 2007; Schulz et al. 2012; Mitchell, Peel and Brorsen 2018; Hussein and Fraser 2018) and characteristics of eggs (Chang, Lusk and Norwood 2010; Kim and Chung 2011)¹².

Our study used big revealed preference data for measuring implicit prices of functional attributes in fluid milk products, whereas retail- or store-level data were used in many hedonic studies. This is expected to contribute to enrich hedonic analysis literature in food economics by analyzing the data from consumers rather than aggregated retailer sales. We used very recent milk purchase data, which provides information on consumer preferences for functional milk attributes to the milk industry and policy-makers.

4. Empirical Specification

In spite of a large number of hedonic price regressions, there is little guidance to determine appropriate functional form (Schulz et al. 2012). The linear or the semi-log functional forms are often used, and the log-log model is also one of the commonly used for hedonic price function estimation. Given the fact that the explanatory variables of interest used in this

¹² Ahn, Yoon, and Ji (2018) analyzed consumers' WTPs for attributes of cheese products using hedonic price model. Lee and Choi (2000) employed hedonic price method for evaluate beef qualities. Chang, Lusk, and Nordwood (2010) used a retail scanner data to analyze price premium for cage-free, organic, and Omega-3 eggs. Kim and Chung (2011) applied hedonic method to the Korean egg market.

analysis are dummy variables for attributes, the log-log model is judged to be inappropriate. A box-cox specification test was conducted to decide the model specification.

By adopting flexibility to functional formulation, a Box-Cox transformation is a useful tool that can bring about a richer model that contains the linear and semi-log models. We use a classical box-cox transformation approach that converts only the dependent variable for simplicity. Thus, the box-cox model is specified as below:

$$P_{ijt}^{(\theta)} = \beta_0 + \sum_k \beta_k Z_{kj} + \sum_n \beta_n X_{nit} + \gamma_p + \psi_t + \delta_r + \varepsilon_{ijt}$$

where P_{ijt} is the unit price (KRW/mL) paid by household i for milk product j at time t , which is transformed as into $P_{ijt}^{(\theta)} = \frac{P_{ijt}^\theta - 1}{\theta}$. And Z_k is an indicator for observable attribute k of milk product j , β_k are parameters to be estimated for Z_k , X_{nit} is a socio-economic characteristic (SEC) variable of household i , β_n are parameters to be estimated for X_{nit} , and ε_{ijt} is a stochastic error term. γ_p , ψ_t , and δ_r indicate promotion type, time (month), and regional fixed-effects of product j on price for control, respectively (p = promotion type, t = month, and r = region). The price a customer paid for the fluid milk product may vary depending on whether there is a promotion or the type of promotion. Promotions can be conducted by the retail store itself or by the milk manufacturer. In some cases, additional milk may be provided. If you buy 1.8 liters of milk, you will occasionally encounter a store event that gives you a bonus of 200 ml of milk as a gift. In other cases, there may be price discounts. For example, the price of one liter of milk is usually 2,700 KRW, but it is sometimes sold for 2,500 KRW at a discount. We consider promotion fixed-effects to control the impact of these promotions on milk price. Sales promotions were categorized into five different types (no-promotion, price discount, additional milk volume, gift, and other), and no-promotion is the base case. Milk consumption is known to have a seasonality that is consumed more in the

summer (Shin and Jeong 2003; Jeong, Cho, and Park. 2003), which indicates that milk prices can also vary depending on the season. Therefore, in this study, a time-fixed effect was added to the model to control seasonality. The household purchase record consists of 52 weeks, but if 52-week variables are contained, the degree of freedom in our model increases significantly. As such, we use month for the time fixed-effect, and January is the base. Fluid milk prices vary slightly depending on the region. Since the residential area is included in the households' demographic information that is divided into 12 regions, it is controlled for regional fixed-effect.

By using the Box-Cox specification test, we determined that the semi-log model is appropriate for our hedonic analysis. The Box-Cox specification test reported that the null hypothesis of (1) $\theta = 0$ is rejected. In addition, the null hypothesis of (2) $\theta = +1$ and (3) $\theta = -1$ were rejected. However, the estimate of θ is close to 0 ($\hat{\theta}=0.037$) rather than close to +1 or -1. That provides greater support for a semi-log model and it is chosen as our final model. There is no difference between the linear and semi-log model except taking the log of the dependent variable (unit price). Hence, our final model¹³ is specified in semi-log functional form as follow:

$$\ln(P_{ijt}) = \beta_0 + \sum_k \beta_k Z_{kj} + \sum_n \beta_n X_{nit} + \gamma_p + \psi_t + \delta_r + \varepsilon_{ijt}$$

5. Results

This article measures consumers' implicit values for functional attributes of fluid milk products using the hedonic price model and the Nielsen Korea's CPS data. Heteroskedasticity issue is

¹³ The semi-log model, here, indicates that the log of price paid by households is specified as a linear combination of a set of attributes.

often concerned in hedonic regression literature. Breusch-Pagan test and White test were conducted for heteroskedasticity. Test statistics (868.62 of BP test and 26,897.63 of White test) rejected the null hypothesis of homoskedasticity at 1% statistically significant level. To address heteroskedasticity, White's robust-standard errors were used.

The hedonic price regression results are reported in Table 3, presenting the five different estimation results. The difference between the four models is in the FE for control, and there is no difference in the remaining attribute variables of interest in this study. Each model 1 to 3 uses only one fixed effect to control other factors. Model 1 uses only the promotional fixed-effect, and model 2 contains only the time fixed-effect. Model 3 uses only the regional fixed-effect. Conversely, model 4 includes promotion-, time-, and region-fixed effects at the same time for control. In addition, we add the socio-economic characteristics (SEC) of households in model 5. One of the advantages of using household-level data is to for us to use household information. We try to reflect the nature of CPS data. Household income and the number of households are of interest in the model 5.

Estimation results show that there were slight differences in the values of the estimated coefficients depending on the model. We found that the best model fit is shown in the model 5 which includes promotions, time, regional fixed-effects, and the SECs. The model 5 estimation result is preferred in terms of R-squared, log-likelihood, Akaike Information Criterion (AIC), and Bayesian Information Criterion (BIC). Note that despite this, it is not very different from the model 4. We continue to illustrate the hedonic function estimation results for the functional properties of fluid milk, focusing on the model 5.

The coefficient estimate for organic certification was 0.698, which was relatively high among the various milk properties. This implies that in the Korean fluid milk market, the average price of organic milk is 101.22% ($= 100 \times \exp(0.699) - 1$) higher than the

conventional milk.¹⁴ The estimated price premium of each milk attribute is presented in Table 4. The estimated marginal contribution of organic milk to the log of the price of Koreans may be high because organic milk accounts for only 1.25% of our data. But it seems reasonable. This is because 750 ML organic milk products are sold at the price level of 5,000 KRW (the price level from 500 to 600 KRW per ML) in the retail market places, which is the double price of conventional milk products.

Among the attributes of milk producers, the coefficient estimate of Namyang milk is the highest at 0.109, followed by Maeil milk (0.073), and Seoul milk (0.051). It shows that fluid milk products manufactured by these three traditional milk producers are valued higher than other brands. On the contrary, Store brands (-0.344), Binggrae (-0.040), and Dongwon (-0.073) have negative values of coefficient estimates, indicating that consumers are likely to give less value for the fluid milk products by these manufacturers over the base case (other manufacturers).

Let's look at the hedonic price estimates for functional properties, which are of the main concern of this study. The estimated coefficients for calcium- and vitamin-fortified properties in fluid milk are 0.023 and -0.425, respectively. These figures give rise to the respective price premiums of 2.37% and -34.61. It is noticeable that the property of calcium-enhanced has a different sign from the vitamin-enhanced milk. In the data sample, i.e., of the milk products purchased by the CPS panel households, the proportion of calcium-fortified milk was 4.65% whereas that of vitamin-fortified milk was 0.96%, This means that consumers rarely buy vitamin-fortified milk.

In addition, another functional characteristic of particular interest in this paper is lactose-free. The estimated coefficient of lactose-free property is estimated to 0.227. The price

¹⁴ This study follows the calculation of price premium by Chang et al. (2010)'

premium of the lactose-free attribute is estimated to 25.48% ($= 100 \times \exp(0.227) - 1$). For instance, if the price of fluid milk with the volume of 1,000ml is 2,700 KRW, the price of lactose-free milk could be 3,380 KRW (the price premium of lactose-free milk could be about 680) KRW. Milk products with the lactose-free property were found to be 2.48% of our observations. It is almost double the portion of organic milk (1.25%). Given the fact that the lactose-free fluid milk products are sold at around the price of 3,000 KRW for 900 ML in the retail market. This price premium does make sense for the Korean fluid milk market.

Milk flavors are not the main concern of this paper, but briefly, all the marginal contributions of the flavor attribute to the log value of the price are estimated to be positive values and have a relatively huge magnitude than other attribute groups. It shows a better preference than the conventional non-flavored attribute milk products. For milk sterilization methods, milk properties processed by special approaches (sterilized and Pasteurized) over the conventional milk sterilization methods are relatively positive contribute to consumers' hedonic price. It is noticeable that the coefficient estimate of sterilized milk is quite high at 0.546. it leads to a price premium of 72.8%. It is understood that consumers give a lot of value to the characteristic that sterile milk can be stored for a long time. As for package materials, all package attributes (Tetra pack, Can, Foil bag, Plastic bottle) are positively correlated to the milk price base. On the other hand, bundle and low-fat attributes in fluid milk products are negative contributors. The marginal contribution of zero-fat contents was estimated as 0.022, which was not statistically significant from zero at 5% level. All other attributes are significantly different from zero at 0.1% level.

The last column of Table 3 also shows the relationship between the SECs of households and milk price paid. Estimated coefficients for income and number of household members were significantly estimated at the level of 0.1%, but the magnitudes were small (0.000036 for income and -0.011 for the number of household members). It suggests that even high-income

households don't buy particularly expensive milk products, and even households with many members are less likely to look for particularly cheaper milk.

Regional Heterogeneity (Seoul Metropolitan Area vs. Others)

In addition, we try to investigate regional differences by subsample analysis. The subsample analysis is presented in Tables 5 and 6. Table 5 is for reporting hedonic regression estimates and Table 6 illustrates the price premium estimates. The estimates for organic properties were similarly estimated at 0.698 and 0.695 in the Seoul Metropolitan (simply “SM”) area and other areas (“non-SM”), respectively, and were statistically significant. As for manufacturers, it is thought that Seoul and Namyang Milk are more preferred in the SM area than in the non-SM area. In the case of the functional properties of fluid milk, calcium-fortified milk is preferred in other regions over the SM Area (0.017 in the SM, 0.033 in the non-SM), and vitamin milk is less preferred (-0.407 in the SM, -0.452 in non-SM). Table 6 shows regional differences in implicit prices for these attributes. The price premiums for the calcium-fortified attribute is 3.35% over conventional milk, which is higher than the SM area (1.72%). For the vitamin-fortified, price premiums are -33.44% and -36.36%, respectively, in the SM and non-SM. There is little difference in price premiums for lactose-free across the regions. The price premium in the SM market is estimated at 24.59% and that of non-SM is 23.61%. In addition to functional properties, regional differences in price premiums for pasteurized properties are remarkable. It is 23.26% in SM while 11.76% in others. This suggests that Seoul Metropolitan consumers place a higher value on pasteurized milk than those who live in other areas.

Our finding suggests that Korean milk consumers have a high value for lactose-free properties, which can be explained by the fact that there are many Korean adults with lactose intolerance and lactose-free milk products can help reduce negative symptoms from ingestion of lactose contained milk (Park et al. 2016).

6. Conclusion and Remarks

In this section, we conclude this paper by summarizing the main findings and suggesting implications for future research with the limitations of this study. This paper applied a hedonic price model to recent household purchase data to analyze how fluid milk prices vary with attributes. Given the circumstance that the milk market size is stagnated, each manufacturer is competing by launching a variety of differentiated products. Analyzing the milk market based on very recent data is expected to provide useful information to industry and policy-makers. For instance, the milk industry will be able to compare the marginal cost of production of their products with the implicit price of milk attribute presented in this paper. This may be useful for decision-making about the investment, production, or pricing strategy of differentiated products in the milk industry. Besides, policymakers are expected to be able to refer to consumer assessment of milk properties based on revealed preference data on fluid milk purchase. This could help establish appropriate dairy policies for the milk market. Our study used big revealed preference data for measuring implicit prices of functional attributes in fluid milk products, whereas retail- or store-level data were used in many hedonic studies. This may enrich hedonic analysis literature in food economics by analyzing the data from consumers rather than aggregated retailer sales.

Our estimation results suggest that Korean consumers do not place positive values on all functional characteristics of fluid milk products. Consumers give a high value for the lactose-free property (25.2% price premium) over the conventional milk. The estimated price premium for the calcium-fortified attribute was positive but a little higher over the base case at the level of 2.4%. In the case of vitamin-fortified characteristics, it has been found to have a negative value (-34.6% price premium). This reflects the fact that many Korean adults have

lactose intolerance and the lactose-free properties can help digest milk. The recent increase in consumers buying lactose-free milk to feed their pets (dogs or cats) could also be reflected. It is thought that the implicit price of vitamin properties is estimated to be a minus sign as they are consumed through other intake pathways such as fruit, juice, and health supplements other instead of milk.

It is reported that the consumption of sterilized milk is increasing recently (aT FIS Trend Pick. 2021.01). For milk sterilization methods, milk properties processed by special approaches (sterilized and Pasteurized) over the conventional methods are relatively positive contribute to consumers' hedonic price. It is remarkable that the coefficient estimate of sterilized milk is quite high at 0.546. it leads to the price premium of 72.8%. It may be explained by the circumstance that consumers give a lot of value to the characteristic that sterilized milk can be stored for longer.

We have tried to take into account preference heterogeneity using the latent class framework. However, no meaningful results could be drawn. When many attributes were considered in the latent class model, it was challenging to get converge well. Given the fact that the CPS data is at the household level, our study has limitations in that it did not reflect the characteristics of the household well. Thus, in future research, we hope that more useful information will be produced by reflecting the characteristics of consumers or households. This study focused on of functional characteristics of fluid milk. Given the increase in the consumption of milk substitute drinks (plant-based milk) and flavored milk, future research may investigate the substitute relationship between cow milk and plant-based milk. Analyzing by focusing on individual consumption of the flavored milk product, not the consumption at the household level, can derive interesting implications for the milk market. There are a wide variety of milk drinks in small sizes on the milk market.

References

- Ahn, B. 2005. "Effects of an increase in the raw milk price on the Korean infant formula industry". *Korean Journal of Agricultural Economics* 46(3): 99-118.
- Ahn, B. 2006. "Estimating the market power of fluid milk bottlers in Korea". *Journal of Rural Development* 29(2): 39-54.
- Ahn, B., and H. Lee. 2005. "Estimating of Milk Supply Response in Korea". *Korean Journal of Agricultural Economics* 46(2): 71-85.
- Ahn, M., S. Yoon, and I. Ji, 2018. "Analyzing consumer willingness to pay for the cheese characteristics with the hedonic price model". *Journal of Rural Development* 41(3):51-71.
Korea Rural Economic Institute.
- aT Food Information Statistics System (aT FIS). 2020. News Letter: Milk. 2020.01.
- aT Food Information Statistics System (aT FIS). 2021. Trend Pick: Milk. 2021.01.
- Baik, J., and Y. Lee. 2002. "Economic Analysis of Milk Demand and Consumption Information". *Korean Journal of Agricultural Management and Policy* 29(2): 316-333.
- Bimbo, F., A. Bonanno, X. Liu, and R. Viscecchia. 2016. "Hedonic analysis of the price of UHT-treated milk in Italy." *Journal of Dairy Science* 99(2):1095–1102.
- Chang, J.B., J.L. Lusk, and F.B. Norwood. 2010. "The price of happy hens: A hedonic analysis of retail egg prices." *Journal of Agricultural and Resource Economics* 35(3):406–423.
- Costanigro, M., and J.J. McCluskey. 2011. "Hedonic Price Analysis in Food Markets." In *The Oxford Handbook of the Economics of Food Consumption and Policy*. Oxford University Press, pp. 152–180.
- Costanigro, M., J.J. McCluskey, and R.C. Mittelhammer. 2007. "Segmenting the Wine Market Based on Price: Hedonic Regression when Different Prices mean Different Products." *Journal of Agricultural Economics* 58(3):454–466.

- DeHaan, J., and R. Diewert. 2013. "Hedonic Regression Methods." In et al OECD, ed. *Handbook on Residential Property Price Indices*. Eurostat, Luxembourg., pp. 49–64.
- Griffith, R., and L. Nesheim. 2013. "Hedonic methods for baskets of goods." *Economics Letters* 120(2):284–287.
- Hussein, M., and I. Fraser. 2018. "Hedonic Analysis of Consumers' Valuation of Country of Origin of Meat in the United Kingdom." *Journal of Agricultural Economics* 69(1):182–198.
- Jellema, P., F.G. Schellevis, D.A.W.M. van der Windt, C.M.F. Kneepkens, and H.E. van der Horst. 2010. "Lactose malabsorption and intolerance: a systematic review on the diagnostic value of gastrointestinal symptoms and self-reported milk intolerance." *QJM: An International Journal of Medicine* 103(8):555–572.
- Jeong, K., S. Jeong, and C. Sim. 2015. Imperfect Competition in Korean Milk Market.
- Jeong, K., S. Cho, and J., Park. 2003. Analysis of Milk Demand with the Structural Change. *Korean Journal of Agricultural Management and Policy* 30(1): 1-17.
- Korea Agro-Fisheries and Food Trade Corporation Food Information Statistics System (aTFIS). 2020. January. Food Market Newsletter: Milk Products.
- Kiesel, K., and S.B. Villas-Boas. 2007. "Got Organic Milk? Consumer Valuations of Milk Labels after the Implementation of the USDA Organic Seal." *Journal of Agricultural & Food Industrial Organization* 5(1):1152–1152.
- Kim, C., and C. Chung. 2011. "Hedonic Analysis of Retail Egg Prices Using Store Scanner Data: An Application to the Korean Egg Market." *Journal of Food Distribution Research* 42(3):14–27.
- Lee., K., and J., Choi. 2002. A Hedonic Price Analysis of Quality Characteristics of Korean Beef. *Korean Journal of Agricultural Management and Policy* 27: 28-42.

- Loke, M.K., X. Xu, and P.S. Leung. 2015. "Estimating organic, local, and other price premiums in the Hawaii fluid milk market." *Journal of Dairy Science* 98(4):2824–2830.
- Mitchell, J.L., D.S. Peel, and B.W. Brorsen. 2018. "Price Determinant of Bred Cow." *Journal of Agricultural and Applied Economics* 50(1):64–80.
- Oduro, A.F., F.K. Saalia, and M.Y.B. Adjei. 2021. "Using Relative Preference mapping (RPM) to identify innovative flavours for 3-blend plant-based milk alternatives in different test locations." *Food Quality and Preference* 93:104271.
- Parcell, J., and T.C. Schroeder. 2007. "Hedonic Retail Beef and Pork Product Prices." *Journal of Agricultural and Applied Economics* 39(1):29–46.
- Park, S.H., Y.W. Chang, S.J. Kim, M.H. Lee, J.H. Nam, C.H. Oh, J.W. Kim, J.Y. Jang, J.O. Yang, J.A. Yoo, and J.Y. Chung. 2016. "Efficacy of Lactose-free Milk in Korean Adults with Lactose Intolerance." *The Korean journal of gastroenterology* 67(1):22–27.
- Rho, S., T. Lee, and S. Lee. 2015. Formulating Strategy to Strengthen Korean Beef Characteristic Values by Using Hedonic Price Model. *Korean Journal of Agricultural Management and Policy* 42(4): 733-762.
- Rosen, S. 1974. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *Journal of Political Economy* 82(1):34–55.
- Schulz, L.L., T.C. Schroeder, and K.L. White. 2012. "Value of Beef Steak Branding: Hedonic analysis of Retail Scanner Data." *Agricultural and Resource Economics Review* 41(2):260–273.
- Shin, S., and M. Jeong. 2003. *Analysis of Milk Demand with POS Data*. Research Report R462. Korea Rural Economic Institute.
- Smith, T.A., C.L. Huang, and B.-H. Lin. 2009. "Estimating organic premiums in the US fluid milk market." *Renewable Agriculture and Food Systems* 24(3):197–204. Available at: <https://www.cambridge.org/core>. [Accessed March 22, 2021].

- Song, J., and Y. Choi, 2018. "Estimating Consumer Damage in the Korean Milk Industry." *Journal of Women and Economics* 15(1): 49-63.
- Statistics KOREA e-index. Total Fertility Rate (TFR).
- Unnevehr, L., J.S. Eales, H. Jensen, J.L. Lusk, J. McCluskey, and J. Kinsey. 2010. "Food and consumer economics." *American Journal of Agricultural Economics* 92(2):506–521.
- Yang, S., S. Lim, and C. Lee. 2018. "Analysis of Characteristics of Rice Sales in Large Discount Store". *Journal of Rural Development* 32(5): 17-43.
- Yang, T., and S. Dharmasena. 2021. "U.S. Consumer Demand for Plant-Based Milk Alternative Beverages: Hedonic Metric Augmented Barten's Synthetic Model." *Foods* 10(2):265. Available at: <https://www.mdpi.com/2304-8158/10/2/265> [Accessed March 22, 2021].
- Yoon, S. 2009. "Review: Distribution, Lactose Malabsorption, and Alleviation Strategies of Lactose Intolerance." *Journal of Dairy Science and Biotechnology* 27(2):55–62.
- Woo, B., H. Lee, J. Kim, B. Han, and M. Kim. 2019. "Supply-Demand Trends and Outlook of Beef Cattle, Swine, and Milk Cow". *2019 Agricultural Outlook*. Korea Rural Economic Institute.

Figure 1. Total Fluid Milk Consumption

Source: Ministry of Agricultural, Food and Rural Affairs. The Production and Consumption Status for Milk and Dairy Products.

Figure 2. Per Capita Fluid Milk Consumption

Note: The per capita fluid milk consumption is computed by dividing the total milk consumption by the population.

Source: Korea Dairy Committee.

Table 1. Descriptive demographics of household panel

Demographics	Description	Frequency	Percent	Cumulative percent.
Region	Seoul	1,133	21.8	21.8
	Incheon	330	6.4	28.2
	Gyeonggi-Do	1,321	25.4	53.6
	Gangwon-Do	124	2.4	56.0
	Daejeon	237	4.6	60.6
	Chungcheongnam-do, Chungcheongbuk-do, Sejong	286	5.5	66.1
	Gwangju	186	3.6	69.7
	Jeollanam-do, Jeollabuk-do	313	6.0	75.7
	Daegu	261	5.0	80.7
	Kyungsangbuk-do	217	4.2	84.9
	Pusan	401	7.7	92.6
	Kyungsangnam-do, Ulsan	382	7.4	100.0
Income	Under 1 Mil KRW	119	2.3	2.3
	1 to 2 Million KRW	529	10.2	12.5
	2 to 3 Million KRW	1,085	20.9	33.4
	3 to 4 Million KRW	1,131	21.8	55.2
	4 to 5 Million KRW	932	18.0	73.1
	5 to 6 Million KRW	685	13.2	86.3
	6 to 7 Million KRW	301	5.8	92.1
	7 to 8 Million KRW	169	3.3	95.4
	8 to 9 Million KRW	110	2.1	97.5
	9 to 10 Million KRW	36	0.7	98.2
	10 Million KRW and greater	70	1.3	99.5
	-	24	0.5	100.0
Number of Household Members	1	574	11.1	11.1
	2	1,771	34.1	45.2
	3	1,325	25.5	70.7
	4	1,134	21.8	92.5
	5	302	5.8	98.4
	6	53	1.0	99.4
	7 and more	8	0.2	99.5
	-	24	0.5	100.0
Gender of Main Shopper	Male	267	5.1	5.1
	Female	4,900	94.4	99.5
	-	24	0.5	100.0
Occupation of Main Shopper	Farmer	11	0.2	0.2
	Engineer	56	1.1	1.3
	Civil servant	109	2.1	3.4
	Clerk	1,164	22.4	25.8
	Professional	235	4.5	30.3
	Service	196	3.8	34.1
	Self-owner	111	2.1	36.3
	Housewife	2,450	47.2	83.5
	Student	60	1.2	84.6
	Other	628	12.1	96.7
	Unemployed	147	2.8	99.5
	-	24	0.5	100.0
Education of Main Shopper	High School	1,858	35.8	35.8
	College Degree	3,309	63.7	99.5
	-	24	0.5	100.0
Total		5,191	100.0	100.0

Note: - indicate no information for that properties

Table 2. Attributes of Fluid Milk Products purchased by Consumer Panel

Attributes		Frequency	Percent (%)
Manufactures	1. Seoul	19,006	33.5
	2. Store Brand	6,403	11.3
	3. Namyang	5,852	10.3
	4. Dongwon	5,025	8.9
	5. Maeil	6,337	11.2
	6. Binggrae	5,258	9.3
	7. Other Brands	8,910	15.7
Organic	1. Organic	711	1.3
Functional Attributes	1. Calcium-fortified	2,642	4.7
	2. Vitamin-fortified	543	1.0
	3. Lactose-Free	1,407	2.5
Sterilization Methods	1. Sterilized	147	0.3
	2. Pasteurized	845	1.5
Flavors	1. White	48,447	85.3
	2. Milk Tea	227	3.4
	3. Coffee	1,607	2.6
	4. Strawberry	1,500	4.4
	5. Banana	2,514	1.4
	6. Chocolate	1,913	0.4
	7. Other Flavors	779	2.8
Fat Contents	1. Low-Fat	8,111	14.3
	2. Fat-Free	171	0.3
Packages	1. Tetra pack	7,713	13.6
	2. Can	10	0.0
	3. Foil Bag	760	1.3
	4. Plastic Bottle	12,515	22.0
	5. Carton	35,793	63.0
Bundles	1	33,622	59.2
	2	17,717	31.2
	3	2,738	4.8
	4	1,639	2.9
	6	165	0.3
	8	30	0.1
	9	39	0.1
	10	10	0.0
	12	176	0.3
	16	19	0.0
	24	636	1.1
Total		56,791	100.0

Table 3. Hedonic Price Model Regression results

Dependent Variable	ln(price)	Coefficients									
		(1)		(2)		(3)		(4)		(5)	
Organic	Organic	0.695	***	0.695	***	0.699	***	0.699	***	0.698	***
(Base: non-organic)		(0.013)		(0.013)		(0.013)		(0.013)		(0.013)	
Manufacturers	Seoul	0.050	***	0.050	***	0.051	***	0.051	***	0.050	***
(Base: Others)		(0.005)		(0.005)		(0.005)		(0.005)		(0.005)	
	Namyang	0.109	***	0.109	***	0.109	***	0.109	***	0.108	***
		(0.006)		(0.006)		(0.006)		(0.006)		(0.006)	
	Maeil	0.073	***	0.073	***	0.073	***	0.073	***	0.071	***
		(0.010)		(0.010)		(0.010)		(0.010)		(0.010)	
	Dongwon	-0.075	***	-0.075	***	-0.073	***	-0.073	***	-0.072	***
		(0.006)		(0.006)		(0.006)		(0.006)		(0.006)	
	Binggrae	-0.040	***	-0.040	***	-0.040	***	-0.040	***	-0.040	***
		(0.006)		(0.006)		(0.006)		(0.006)		(0.006)	
	Store brands	-0.346	***	-0.346	***	-0.344	***	-0.344	***	-0.344	***
		(0.007)		(0.007)		(0.007)		(0.007)		(0.007)	
Functionality	Calcium-	0.023	***	0.023	***	0.023	***	0.023	***	0.024	***
(Base: conventional		(0.006)		(0.006)		(0.006)		(0.006)		(0.006)	
(no functionality)	Vitamin-	-0.428	***	-0.428	***	-0.426	***	-0.425	***	-0.422	***
		(0.010)		(0.010)		(0.010)		(0.010)		(0.010)	
	Lactose-Free	0.224	***	0.224	***	0.228	***	0.227	***	0.225	***
		(0.008)		(0.008)		(0.008)		(0.008)		(0.008)	
Flavors	Banana	0.483	***	0.483	***	0.483	***	0.484	***	0.486	***
(Base: White milk		(0.009)		(0.009)		(0.009)		(0.009)		(0.009)	
(no flavored)	Chocolate	0.289	***	0.289	***	0.289	***	0.289	***	0.293	***
		(0.011)		(0.011)		(0.011)		(0.011)		(0.011)	
	Strawberry	0.343	***	0.342	***	0.344	***	0.343	***	0.344	***
		(0.014)		(0.014)		(0.014)		(0.014)		(0.014)	
	Coffee	0.127	***	0.126	***	0.131	***	0.131	***	0.128	***
		(0.017)		(0.017)		(0.017)		(0.017)		(0.017)	
	Milk tea	0.645	***	0.643	***	0.647	***	0.646	***	0.644	***
		(0.025)		(0.025)		(0.025)		(0.025)		(0.025)	
	Other flavors	0.427	***	0.427	***	0.427	***	0.428	***	0.429	***
		(0.015)		(0.015)		(0.015)		(0.015)		(0.015)	
Sterilization	Sterilized	0.548	***	0.547	***	0.547	***	0.546	***	0.546	***
Methods		(0.053)		(0.053)		(0.053)		(0.053)		(0.053)	
(Base: conventional)	Pasteurized	0.169	***	0.168	***	0.172	***	0.171	***	0.171	***
		(0.010)		(0.010)		(0.010)		(0.010)		(0.010)	
Fat Contents	Low-fat	-0.045	***	-0.045	***	-0.046	***	-0.046	***	-0.047	***
(Base: conventional)		(0.003)		(0.003)		(0.003)		(0.003)		(0.003)	
	Zero-fat	0.017		0.017		0.022		0.022		0.020	
		(0.033)		(0.033)		(0.033)		(0.033)		(0.033)	
Packages	Tetra pack	0.146	***	0.145	***	0.144	***	0.144	***	0.143	***
(Base: Carton)		(0.009)		(0.009)		(0.009)		(0.009)		(0.009)	
	Can	0.916	***	0.916	***	0.904	***	0.904	***	0.900	***
		(0.029)		(0.028)		(0.030)		(0.029)		(0.027)	
	Foil bag	0.376	***	0.376	***	0.373	***	0.373	***	0.376	***
		(0.017)		(0.017)		(0.017)		(0.017)		(0.017)	
	Plastic bottle	0.162	***	0.161	***	0.163	***	0.162	***	0.163	***
		(0.004)		(0.004)		(0.004)		(0.004)		(0.004)	

Bundle	Bundle	-0.033	***	-0.033	***	-0.033	***	-0.033	***	-0.033	***
(Base: 1)		(0.002)		(0.002)		(0.002)		(0.002)		(0.002)	
Fixed Effects	Promotion FE	YES		YES		YES		YES		YES	
	Month FE	No		YES		No		YES		YES	
	Regional FE	No		No		YES		YES		YES	
SEC	Income									0.000	***
										(0.000)	
	HH members									-0.011	***
										(0.001)	
Intercept	Constant	0.896	***	0.866	***	0.868	***	0.913	***	0.931	***
		(0.005)		(0.007)		(0.006)		(0.008)		(0.009)	
Num. of Samples	N	56,791		56,791		56,791		56,791		56,732	
	R-squared	0.4087		0.4090		0.4102		0.4105		0.4113	
	Log-likelihood	- 15,023.58		- 15,971.55		- 15,902.43		- 14,928.23		- 14,869.56	
	AIC	30,107.15		30,089.30		29,979.07		29,960.47		29,847.11	
	BIC	30,375.57		30,456.13		30,345.90		30,425.72		30,330.20	

Note: Single, double, and triple asterisks (*, **, ***) denote significance at the 5%, 1%, and 0.1% level, respectively. The Standard errors are presented in parentheses.

Table 4. Predicted Price Premiums of Milk Attributes

Attribute Group	Attribute	Price Premium (%)									
		(1)		(2)		(3)		(4)		(5)	
Organic (Base: non-organic)	Organic Seoul	100.38 5.13		100.39 5.15		101.20 5.22		101.22 5.24		100.87 5.15	
Manufacturers (Base: Others)	Namyang	11.50		11.48		11.52		11.50		11.39	
	Maeil	7.52		7.55		7.58		7.62		7.41	
	Dongwon	-7.19		-7.21		-7.01		-7.02		-6.96	
	Binggrae	-3.88		-3.92		-3.88		-3.91		-3.88	
	Store brands	-29.26		-29.28		-29.09		-29.10		-29.10	
Functionality (Base: conventional (no functionality))	Calcium-	2.31		2.32		2.37		2.37		2.40	
	Vitamin-	-34.85		-34.80		-34.66		-34.61		-34.41	
	Lactose-Free	25.17		25.08		25.56		25.48		25.22	
Flavors (Base: White milk (no flavored))	Banana	62.02		62.13		62.12		62.21		62.50	
	Chocolate	33.47		33.48		33.49		33.51		34.06	
	Strawberry	40.89		40.79		40.99		40.88		41.06	
	Coffee	13.52		13.45		14.03		13.97		13.69	
	Milk tea	90.57		90.31		91.03		90.76		90.49	
	Other flavors	53.26		53.29		53.33		53.36		53.50	
Sterilization Methods (Base: conventional)	Sterilized	72.92		72.78		72.73		72.60		72.62	
	Pasteurized	18.41		18.31		18.78		18.69		18.68	
Fat Contents (Base: conventional)	Low-fat	-4.44		-4.42		-4.47		-4.47		-4.55	
	Zero-fat	1.68		1.72		2.20		2.24		1.97	
Packages (Base: Carton)	Tetra pack	15.67		15.62		15.53		15.49		15.42	
	Can	149.98		150.01		146.84		146.90		145.86	
	Foil bag	45.61		45.67		45.20		45.26		45.61	
	Plastic bottle	17.54		17.50		17.67		17.64		17.70	
Bundle (Base: 1)	Bundle	-3.29		-3.29		-3.28		-3.28		-3.26	

Note: the price premium is calculated as $100 * [\exp(\text{coefficient estimate of the attribute of interest}) - 1]$.

Table 5. Hedonic Price Model Regression results (Seoul Metropolitan Area vs. Others)

Dependent Variable	ln(price)	Coefficients		Coefficients	
		Seoul Metropolitan		Other Regions	
Organic	Organic	0.698	***	0.695	***
(Base: non-organic)		(0.016)		(0.023)	
Manufacturers	Seoul	0.084	***	0.020	***
(Base: Others)		(0.007)		(0.006)	
	Namyang	0.152	***	0.070	***
		(0.009)		(0.008)	
	Maeil	0.131	***	0.010	
		(0.014)		(0.015)	
	Dongwon	-0.044	***	-0.103	***
		(0.008)		(0.008)	
	Binggrae	-0.028	***	-0.044	***
		(0.009)		(0.008)	
	Store brands	-0.319	***	-0.367	***
		(0.009)		(0.010)	
Functionality	Calcium-Fortified	0.017	***	0.033	***
(Base: conventional)		(0.008)		(0.009)	
no functionality)	Vitamin-Fortified	-0.407	***	-0.452	***
		(0.013)		(0.014)	
	Lactose-Free	0.220	***	0.212	***
		(0.012)		(0.012)	
Flavors	Banana	0.478	***	0.483	***
(Base: White milk		(0.014)		(0.013)	
(no flavored)	Chocolate	0.290	***	0.285	***
		(0.015)		(0.016)	
	Strawberry	0.309	***	0.370	***
		(0.021)		(0.019)	
	Coffee	0.095	***	0.195	***
		(0.019)		(0.038)	
	Milk tea	0.654	***	0.634	***
		(0.031)		(0.041)	
	Other flavors	0.384	***	0.479	***
		(0.020)		(0.022)	
Sterilization	Sterilized	0.555	***	0.530	***
Methods		(0.075)		(0.066)	
	Pasteurized	0.209	***	0.111	***
		(0.012)		(0.016)	
Fat Contents	Low-fat	-0.044	***	-0.047	***
		(0.005)		(0.004)	
	Zero-fat	0.024		-0.009	
		(0.047)		(0.023)	
Packages	Tetra pack	0.127	***	0.168	***
(Base: Carton)		(0.012)		(0.013)	
	Can	0.934	***	0.906	***
		(0.019)		(0.085)	
	Foil bag	0.409	***	0.301	***
		(0.019)		(0.039)	
	Plastic bottle	0.159	***	0.168	***
		(0.005)		(0.006)	
Bundle	Bundle	-0.034	***	-0.032	***
(Base: 1)		(0.003)		(0.003)	
Fixed Effects	Promotion FE	YES		YES	
	Month FE	YES		YES	
	Regional FE	YES		YES	
Intercept	Constant	0.865	***	0.930	***

		(0.011)		(0.010)	
Num. of Samples	N	30,729		26,062	
	R-squared	0.4293		0.3873	
	Log likelihood	- 8,495.26		- 6,336.74	
	AIC	17,072.52		12,755.49	
	BIC	17,414.17		13,090.38	

Note: Single, double, and triple asterisks (*, **, ***) denote significance at the 5%, 1%, and 0.1% level, respectively. The Standard errors are presented in parentheses.

Table 6. Predicted Price Premium Estimates (Seoul Metropolitan Area vs. Others)

Attribute Group	Attribute	Price Premium (%)			
		Seoul Metropolitan		Other Regions	
Organic	Organic	101.03		100.37	
(Base: non-organic)	Seoul	8.73		1.98	
Manufacturers	Namyang	16.42		7.23	
(Base: Others)	Maeil	14.01		0.97	
	Dongwon	-4.27		-9.77	
	Binggrae	-2.73		-4.31	
	Store brands	-27.32		-30.72	
Functionality	Calcium-Fortified	1.72		3.35	
(Base: conventional)	Vitamin-Fortified	-33.44		-36.36	
no functionality)	Lactose-Free	24.59		23.61	
Flavors	Banana	61.21		62.14	
(Base: White milk	Chocolate	33.62		33.04	
(no flavored)	Strawberry	36.16		44.81	
	Coffee	9.98		21.57	
	Milk tea	92.28		88.61	
	Other flavors	46.77		61.47	
Sterilization	Sterilized	74.21		69.83	
Methods	Pasteurized	23.26		11.76	
Fat Contents	Low-fat	-4.32		-4.62	
	Zero-fat	2.47		-0.86	
Packages	Tetra pack	13.49		18.28	
(Base: Carton)	Can	154.40		147.48	
	Foil bag	50.60		35.10	
	Plastic bottle	17.29		18.25	
Bundle	Bundle	-3.35		-3.18	
(Base: 1)					

Note: the price premium is calculated as $100 * [\exp(\text{coefficient estimate of the attribute of interest}) - 1]$.

Appendix

Table A1. Box-Cox regression results

Dependent Variable	Price	Coef.
	/theta	0.037
		(0.001)
Explanatory Variables	Notrans	Coef.
Organic	Organic	0.732
Brands	Seoul	0.051
	Namyang	0.112
	Maeil	0.075
	Dongwon	-0.076
	Binggrae	-0.041
	Store brands	-0.353
Functionality	Calcium-Fortified	0.025
	Vitamin-Fortified	-0.441
	Lactose-Free	0.236
Flavors	Banana	0.501
	Chocolate	0.301
	Strawberry	0.359
	Coffee	0.139
	Milk tea	0.677
	Other flavors	0.447
Sterilized	Sterilized	0.546
	Pasteurized	0.175
Fat Contents	Low-fat	-0.048
	Zero-fat	0.023
Packages	Tetra pack	0.153
	Can	0.956
	Foil bag	0.385
	Plastic bottle	0.170
Bundle	bundle	-0.033
Fixed Effects	Promotion FE	Yes
	Month FE	Yes
	Regional FE	Yes
Intercept	Constant	0.929
	/sigma	0.325