2018

THE CONSUMPTION AND SALES PATTERN OF UGLY APPLES IN SOUTH KOREA

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Digital Object Identifier: https://doi.org/10.13023/etd.2018.437

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THE CONSUMPTION AND SALES PATTERN OF UGLY APPLES IN SOUTH KOREA

THESIS

A thesis submitted in partial fulfillment of the
requirements for the degree of
Master of Science in the College of Agriculture,
Food and Environment
at the University of Kentucky

By

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Lexington, Kentucky

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2018

ABSTRACT OF THESIS

THE CONSUMPTION AND SALES PATTERN OF UGLY APPLES IN SOUTH KOREA

Approximately half of all wasted food is fruits and vegetables. One major cause of food waste is abnormal aesthetics; even if it is just as delicious as its normal counterpart. Food with a non-standard appearance (hereafter called ugly food) can be expelled by the markets. To reduce such waste, ugly food campaigns, which were developed in Europe and spread throughout the world, advocate for the consumption of ugly food. To study the problem of ugly food waste, this thesis examines ugly apples, since apples are the most common, representative, and readily accessible fruit. The objective of this thesis is to suggest marketing strategies and actions to facilitate the consumption and sales of ugly apples that can be expanded to other ugly fruits and vegetables. The data used for analysis are obtained from the Rural Development Administration in Korea. The findings of the thesis indicate that younger people and lower-income households are more likely to purchase ugly apples from online markets, non-stores such as food trucks and traditional markets compared with mega-scale discount stores. When advertising ugly apples, food quality should be emphasized rather than price.

Keywords: food quality, food waste, mega-scale discount store, ugly food campaign

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November 30, 2018

THE CONSUMPTION AND SALES PATTERN OF UGLY APPLES IN SOUTH KOREA

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There are persons who wait and pray that my study will end safely.

Dedicated to my wife, Jinwook Shin, son, Seojin, and mother, Jungja Lim

ACKNOWLEDGMENTS

I would like to thank my all class professors for their guidance during the University of Kentucky. None of the knowledge I've obtained would be possible without their passion and inspiration. Most of all, I appreciate my research advisor, Dr. Yuqing Zheng, since my thesis would be impossible without his valuable insights and enthusiasm. Special thanks to my advisory committee members, Dr. Michael Reed and Dr. Leigh Maynard, for their advice and support.

I would also like to thank other members of the University of Kentucky community including Ph. D. GwanSeon Kim, Alamri Yosef A, Almojel Suliman A, Lijiao Hu, Mahla Zare, Wei Zhang and the other instructors in the Department of Agricultural Economics. Learning from them provided me with pleasure and opportunity to step up for my knowledge.

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CHAPTER 1 – INTRODUCTION

1.1. Context

Food waste is a phenomenon that occurs in all food supply chains. Previous literature on food waste in the United States (Jones, 2004; Muth, 2011), Europe (Usva et al., 2009; WRAP, 2008; Knudsen, 2009; Sundt, 2010), Canada (Gooch, Felfel, & Marenick, 2010) shows that most food waste occurs during the consumption phase in developed countries. The primary reason for waste is consumer behaviors, such as inadequate food purchasing plans, consumer habits, and adherence to the best-before date. (Calvo-Porral et al., 2017; Newsome et al., 2014).

Numerous articles estimated the amount of food that is discarded in food supply chains and at the consumer level (Bräutigam et al., 2014; Buzby & Hyman, 2012; Quested et al., 2011). However, not all estimates reflect accurate statistics. For example, estimates of such food waste in the United States are based only on the amount that is consumed by retailers and consumers (Buzby et al., 2014), and thus a massive amount of food generated by producers is overlooked. It is estimated that about 30 percent of all produced food is wasted (Parfitt et al., 2010).

There are various causes of food waste. One significant cause is aesthetically abnormal appearance. Ugly food, defined as food with non-standard, suboptimal, or imperfect size, color or shape (Bunn, Feenstra, Lynch, & Sommer, 1990; Garfield, 2016) but with acceptable inherent quality or safety (Aschemann-Witzel et al., 2015; Göbel et al., 2015; Halloran et al., 2014), is often excluded from the production stage to the consumption stage even if it is as delicious as normal food.

Most produce that receives a low-grade[1] due to non-standard appearance is disposed of in compost piles, thrown into waste landfills, or plowed back into fields, and some is used as raw material for processed foods or livestock feed (Petruzzelli, 2015). It is discarded based on the presumption that both supply chains and consumers are unwilling to sell, purchase, and consume ugly food.

Consumers' selection of normal food in developed countries is compatible with classical economics; there is no special reason to select ugly food as it is seen as an inferior product and there is an abundance of normal products. Contrary to the reasonable decision making, the ugly food campaign which intends to facilitate the consumption of ugly food ironically started in developed European countries with abundant normal food resource, spreading throughout the world.

To resolve the problem of food waste, supply chains, consumers, and policymakers have created non-profit organizations; changed laws; as well as promoted the ugly food campaign (Aschemann-Witzel et al., 2016; Fuchs & Glaab, 2011; Halloran et al., 2014; Quested et al., 2013; Sieber & Pérez Domínguez, 2011). These efforts have produced opportunities for farmers, retailers and consumers to reduce food waste. Selling ugly food provides more choices for consumers, as it is cheaper than normal produce, and just as delicious, and provides suppliers with additional profit. Furthermore, reducing food waste has a positive impact on the environment (Nellemann, 2009); wasted food

[1] Agricultural produce is graded by the United States Department of Agriculture (USDA), regardless of whether they could be eaten before being distributed to the market. Concrete standards for the grade are appearance, shape, size, and texture. If an agricultural product is classified as low-grade, it is not harvested or sold.

pollutes water, causes odor, emits greenhouse gases, and contributes to climate change (Quested et al., 2013).

Since the sales and consumption of ugly food has a positive effect on business and the environment, concrete plans and actions need to be designed to advocate for ugly food and change consumers' perceptions and behaviors. As the choice to consume the ugly food might be perceived as an environmentally friendly action, pro-environmental commitment can have a positive impact on consumers' preferences for ugly food. Knowledge of the issues associated with food-waste can also lead consumers to change their behaviors and preferences (Porpino et al, 2015; T. Quested, Marsh, Stunell, & Parry, 2013; de Hooge et al., 2017).

Consuming ugly food and reducing food waste due to environmental concerns may create a positive externality in demand. A positive externality is the consequence of economic activities on independent third parties. In this case, it arises from the consumption of ugly food, for which there is no suitable compensation, and may lead to market failure when the social marginal costs (SMCs) and social marginal benefits (SMBs) are not taken into account (LAZĂR, 2018). Figure 1.1 illustrates that more ugly food should be consumed since the SMB is higher than the SMC at the equilibrium of quantity Q_0 (Gans et al., 2011). If only Q_0 is consumed, the positive externality incurs an opportunity cost represented by welfare loss, ΔABC. To handle market failure due to positive externalities, a subsidy policy can be implemented to reduce the price paid by consumers.

For example, the European Union (EU) offered environmental grants to the Portuguese project to reduce ugly food waste rejected in 2015. The government can also provide information about the positive external benefits of ugly food to encourage them to be aware of and consume more such produce. Thus, an externality allows the government to intervene in the market to support the consumption of ugly food.

However, retailers, not consumers or the government, need to take the lead in aggressive sales of ugly food. In the supply chains, retailers are regarded as a major cause of food waste, since they have the right to reject ugly food (Gustafsson, Cederberg, Sonesson, & Emanuelsson, 2013). Extensive rejection by retailers is still a common practice, as they presume that customers will not purchase food with an abnormal color or shape (Stuart, 2009). To encourage consumers to buy ugly food, retailers often lower prices compared to normal food (Aschemann-Witzel, de Hooge, Amani, Bech-Larsen, & Oostindjer, 2015). This can be a successful strategy if discounts critically contribute to the consumption and sales of ugly food. However, sellers face practical limitations to the extent to which they can increase the sales of ugly food. Consumers may consciously or unconsciously perceive low prices and abnormal appearance as indicators of low quality. Thus, stores selling these foods can project a negative image to consumers. Low-priced food can also affect consumers' expectations of normal food, leading to decreases in the price of standard food and retailers' profitability (Aschemann-Witzel, Jensen, Jensen, & Kulikovskaja, 2017).

1.2. Objectives and research questions

To address the problem of wasted ugly food, especially fruits and vegetables, this thesis examines ugly apples. Apples are the most common, representative, and readily accessible fruit. In the past, ugly apples could not be purchased in markets due to their abnormal appearance. Recently, however, retailers have introduced products associated with ugly apples and promoted ethical consumption[2] for environmental and health benefits. Figure 1.2 shows some examples of ugly apples in online markets in South Korea.

The Rural Development Administration (2017) indicated that the number of normal apples and pears purchased per household has gradually decreased from 2014, while the purchase of ugly fruits has been increasing. Figure 1.3 illustrates the annual expenditure on ugly apples and pears per household. On average, 5.1 times more ugly fruits were purchased per household in 2016 than in 2012; the annual expenditure on ugly apples and pears per household increased from 108 KRW[3] in 2012 to 556 KRW in 2016. In addition, the proportion of households that purchased ugly fruits increased from 0.9 percent in 2012 to 4.6 percent in 2016. The annual expenditure on only ugly apples increased by 109 percent from 40 KRW in 2012 to 476 KRW in 2016, and the proportion of households that purchased ugly apples increased from 0.5 percent in 2012 to 3.8 percent in 2016.

The primary purpose of this paper is to suggest a marketing strategy to increase the consumption and sales of ugly apples and then extend this strategy to increase the

[2] The concept of ethical consumption generally refers to the consumption considering the consequences for other people, society, and the environment. For example, it means some people actively purchase the products that do not harm people, animals, or the environment.

[3] KRW means Korean won

consumption of other imperfect fruits and vegetables. To do so, this thesis first identifies how socio-demographics, including family size, gender, job, age, income, education, and place of residence, impact the consumption of ugly apples in Korea. It also examines which markets, including stores and non-stores such as the Internet, food trucks, and traditional markets, have a higher market share of ugly apples. The results can help farmers and retailers create appropriate marketing strategies and plans. Further, the thesis determines which features of ugly apples should be emphasized to promote them and influence consumers' behavior. Through selling ugly apples, retailers can make additional profits and the government can achieve the policy goal of reducing food waste. We propose the following hypotheses.

Hypothesis 1: Younger people, those with lower incomes, and homemakers consume more ugly apples than older people, those with higher incomes, and breadwinners.

In recent years, the consumption of ugly food has increased in South Korea. According to a survey conducted by the Nong-Hyup Economic Research Institute (2014), three-fourths of respondents aged 19 and older had a positive perception of ugly agricultural products. In addition, de Hooge et al. (2017) indicated that younger consumers were more open to buying and consuming ugly produce. Younger people tend to support the consumption of ugly food by purchasing ugly food and introducing it to family and friends through online social networks. They are more likely to purchase ugly fruits than older generations since they are cheaper, because they are considered to be inferior to normal fruits, but are still delicious. People with lower incomes are also more likely than those with higher incomes to purchase ugly fruits; Aschemann-Witzel et al.

(2017) indicated that consumers who were more likely to search for price discounts typically had lower incomes. Furthermore, a single-income family is generally more affected by the price elasticity of demand than a dual-income family, and male or female homemakers are more likely to purchase ugly apples than breadwinners since the former tend to spare expenses.

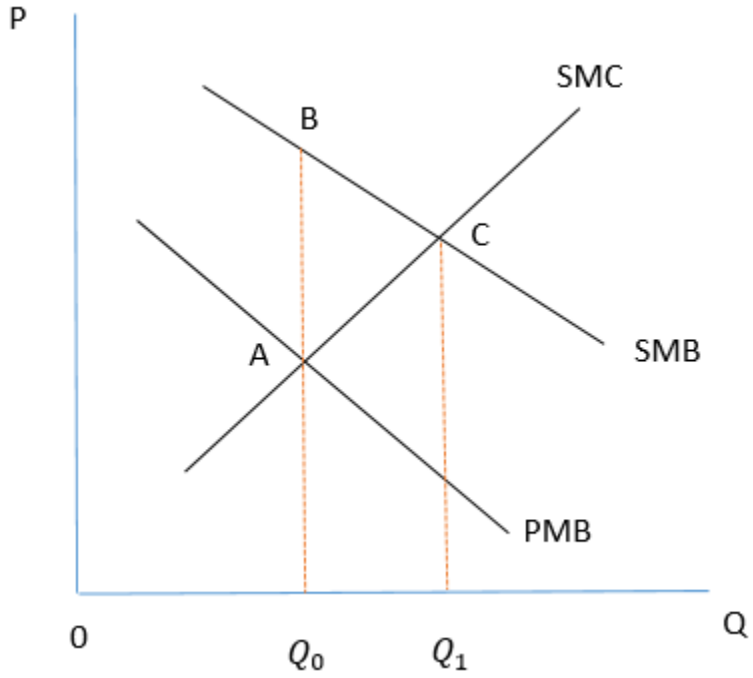
Hypothesis 2: The mega-scale discount store will sell more ugly apples than any other markets.

What consumers are willing to purchase is connected to what grocery stores are currently selling (Petruzzelli, 2015). Retailers and farmers have the opportunity to increase profits through the sales of ugly apples. In Korea, most of the ugly apples that are sold are blemished or bruised rather than misshapen. Due to the discrepancy between products and images on online markets, most consumers would search for ugly apples at store markets. For example, in Figure 1.2, the pictures of brands A, B, and C were uploaded by sellers, while the picture of brand D was uploaded by a consumer who purchased directly through the Internet; some ugly apples looked rotten unlike images on online markets. Purchasing ugly apples at store markets can reduce the risk of adverse selection. Of the store markets, consumers are most likely to purchase ugly apples from mega-scale discount stores, as they can apply more discounts to ugly apples through bulk purchases and mass sales.

Hypothesis 3: Price-conscious consumers purchase more ugly apples than non-price focused consumers.

As stated previously, ugly apples are just as delicious as other normal apples but are imperfect in terms of appearance. Theotokis et al. (2012) illustrated that consumers would not be motivated to purchase ugly food in markets without price discounts. Verghese et al. (2013) also indicated that consumers need to be incentivized to purchase ugly produce with price deductions. Therefore, retailers need to offer a range of price discounts to consumers to promote a positive response to ugly apples and encourage consumers to purchase them. In general, price-conscious consumers purchase ugly apples more often than non-price focused consumers since they are as delicious as normal produce and about 30 percent cheaper. When advertising ugly apples, retailers need to emphasize price rather than, for example, quality, food stability, and country of origin.

Figure 1.1 A positive externality in demand



PMB: Private Marginal Benefit

SMB: Social Marginal Benefit

SMC: Social Marginal Cost

Figure 1.2 Ugly apples on online sales in South Korea

[Brand A]

(Source: http://itempage3.auction.co.kr/DetailView.aspx?itemno=B449434115)

[Brand B]

(Source:https://www.coupang.com/vp/products/139446827?itemId=406906373&vendorItemId=3994651506&q=%EB%AA%BB%EB%82%9C%EC%9D%B4%EC%82%AC%EA%B3%BC&itemsCount=36&searchId=9162039dbf824e7c9d7825fcc8205690&rank=12)

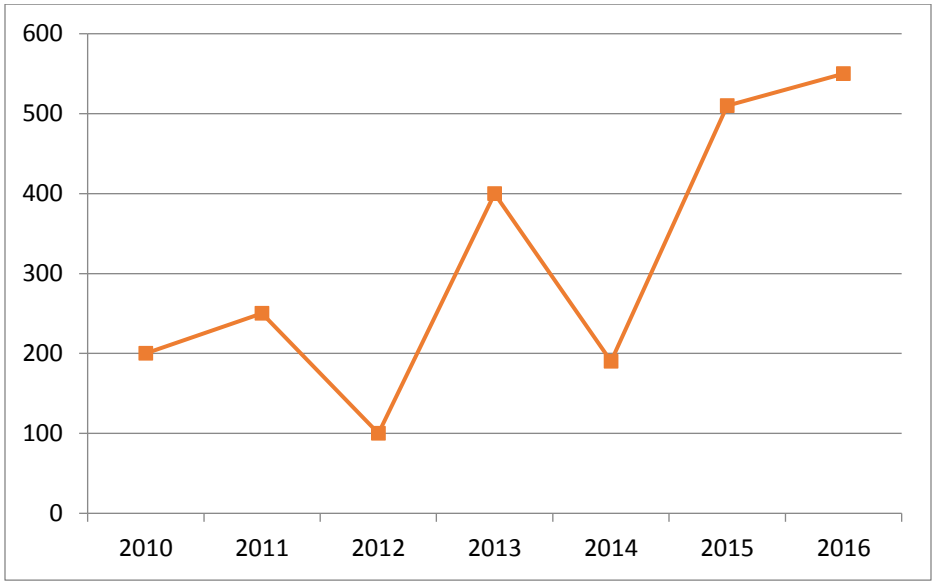
[Brand C]

(Sourch:http://www.ticketmonster.co.kr/deal/1560498442?opt_deal_srl=1563762782&keyword=%EC%82%AC%EA%B3%BC)

[Brand D]

(Source:https://www.coupang.com/vp/products/136159819?itemId=399161834&vendorItemId=3972534456&q=%EB%AA%BB%EB%82%9C%EC%9D%B4%EC%82%AC%EA%B3%BC&itemsCount=36&searchId=b6efd0f675ed4277b7702b85bcb9bf63&rank=2)

Figure 1.3 Annual expenditures for ugly apples and pears per household



Source: The Rural Development Administration (2017), (unit: won)

CHAPTER 2 – BACKGROUND AND LITERATURE REVIEW

2.1. Global food waste

Malnutrition and famine are serious global problems that threaten tens of millions of people, but a large amount of excess food is thrown away, contributing to food waste.[4] The Food and Agriculture Organization (FAO, 2011) of the United Nations presumes that about one-third of the food intended for human consumption is lost or wasted, equal to almost 1.3 billion tons each year, and approximately half of all wasted food is fruits and vegetables. Thus, the enormous amounts of resources used for global food production are also wasted. In the developed world, food waste is generally much more severe per-capita than in developing countries. The FAO found that, in North America and Europe, the food waste per capita was 95−115 kilograms per year, while in sub-Saharan Africa and South/Southeast Asia, this figure is only 6−11 kilograms per year (FAO, 2011).

Food waste can happen at all stages of the food supply chain, from production to consumption. However, the causes of food waste vary depending on the degree of development of the country. While over 40 percent of significant loss occurs in post-harvest and processing in developing countries, the most food waste occurs at the retail and consumer levels (e.g., household consumption) in developed countries (Gustafsson et al., 2013).

[4] According to The Food and Agriculture Organization of the United Nations (2014), food loss means that quality or quantity of food could be decreased while food waste is a portion of food loss and mentions quality or quantity of food dumping or alternative use of food for human consumption over the total food supply chain. Food losses and waste reach around US$ 680 billion in industrialized countries and US$ 210 billion in developing countries (FAO, 2011).

Consumer behavior, such as inadequate food purchasing plans and habits, is related to food waste as it can be an essential factor affecting household consumption (Kantor et al., 1997). Thus, marketing activities and actions targeted to consumers can work effectively to reduce food waste in developed countries.

From a microeconomic perspective, food waste starts at the farm, where the food supply chain begins. There are various reasons for food waste, including insects, pests, birds, disease, and weather fluctuations (Buzby et al., 2014). Ugly food is not aesthetically appealing (Parfitt et al., 2010), and it is assumed that neither retailers nor customers want to purchase it (Gunders, 2012), leading to additional waste. According to the FAO, fruits and vegetables are the largest contributors to food loss (about 20% of all loss) during the production stage. In addition, harvesting and transportation can increase the amount of food loss; bruised and damaged produce is unsellable to retailers, and storage with a lack of refrigeration or pest control can make food inedible (Vogliano & Brown, 2016). At the next stage in the food supply chain, processing and packaging, food is evaluated in terms of size, color, weight, appearance, and blemishes, and unsatisfactory products are culled. This causes 10−40 percent of produce to be lost before it reaches retailers (Buzby et al., 2014).

Once agricultural food is ready after harvest, transportation, and processing, it can be sold in the retailer and food service sectors. Food losses at the retail stage in the United States are estimated at 43 billion pounds in 2008, corresponding to 10 percent of the total food supply (Buzby et al., 2011). The major cause of food loss at the retail level is perishability, and thus foods such as fruits and vegetables are more subject to loss. Additionally, consumers' expectations for aesthetically perfect food are also critical

causes of food waste. At the final stage, consumption, consumers dispose of 15−50 percent of all the food they purchase (Papargyropoulou et al., 2014).

2.2. The ugly food campaign

An emerging global food trend, the ugly food campaign, intends to change consumers' purchasing habits. The primary objective of this campaign is to reduce food waste through the sales of suboptimal fruits and vegetables that would otherwise be thrown away by farmers, retailers, and consumers. Ugly food is shipped from farmers to retailers, only to be abandoned, then transported back and wasted. To overcome this problem, as part of the ugly food campaign, retailers sell ugly food at a lower price compared to normal produce. People can also develop positive attitudes toward environmental technologies and policies after experiencing some of the advantages of consumption of ugly food (Brookhuis et al. 2013). Further, tasting unfamiliar food is to promote consumers' acceptance of ugly produce (Tuorila et al., 1998) and increase consumption. In general, consumers might accept and purchase misshapen or blemished fruits and vegetables if they become used to seeing such produce in stores and have the opportunity to eat ugly food.

In European countries, some supermarkets have already taken the initiative and exposed consumers to ugly food. In this way, ugly fruits and vegetables, which are considered to have no economic value, can be transformed into valuable products (Crang et al. 2012; Havercamp, 2015). For instance, recipe books and blogs can use ugly fruits and vegetables as ingredients in dishes to promote using ugly food instead of throwing it away. Intermarché, a supermarket chain in France, sold juice and soup made from ugly

fruits and vegetables to avoid wasting this produce before it reaches consumers. Intermarché used a refined term, inglorious fruits and veggies, in its marketing strategy, which was reported to be a huge success. In addition, the Waste & Resources Action Programme (WRAP) in the UK, which works with retailers to handle food waste, reported that British supermarkets, including Asda, Sainsbury, and Tesco, are making positive efforts to sell ugly produce. In Germany, Culinary Misfits, the Rewe Group, and Edeka[5] processed and sold ugly produce at a discount. In Switzerland, Coop, a food chain, introduced misshapen vegetables as unique products sold at 60 percent of the price of normal food. In Portugal, the Ugly Fruit Cooperative (Cooperativa Fruta Feia)[6] tried to connect consumers and producers who want to sell ugly fruits and vegetables. The Fruta Feia model works through weekly cooperative purchasing of misshapen produce from local producers, which cannot be sold at regular markets, and then selling this suboptimal produce directly to participating consumers at about half the price of normal produce.

In North and South America, consumers tend to select fruits and vegetables with the best appearance when shopping for fresh produce. However, Loblaws, a Canadian supermarket chain, encourages customers to purchase misshapen and blemished produce by selling it at a 30 percent discount compared to normal produce. Similar marketing strategies have been implemented at other stores, such as Real Canadian Superstore, Zehrs, and Your Independent Grocer. Curiosity about ugly food has also spread to the United States. U.S. grocery stores, including Walmart, Giant Eagle, and Whole Foods, have various solutions for marketing ugly produce. For example, Walmart claimed that

[5] It has the brand entitled nobody is perfect.
[6] It means ugly fruit in Portuguese.

food waste is an ugly problem to face and marketed weather-damaged apples in Floridian grocery stores under the brand I'm Perfect. Chefs working for Bon Appetit Management, a food-service company, use ugly fruits and vegetables as abnormal or off-size ingredients in their recipes. Chefs play an important role in the use of ugly fruits and vegetables in the supply chain (Mugica, 2017). In Rio de Janeiro, Brazil, the supermarkets Zona Sul and SuperPrix have sold ugly food at a low price compared to normal food (Henz & Porpino, 2017).

Ugly produce is also gaining popularity in some Asian and Oceanian countries. Woolworths was the first supermarket in Australia to launch the Odd Bunch, a collection of fresh fruits and vegetables with a cheaper price and imperfect appearance, at a national scale. Harris Farm, a Sydney-based grocer, initiated a similar campaign entitled Imperfect Picks, and the wholesale food business Spade & Barrow offered a home box delivery service for imperfect produce. The number of companies in Japan using ugly agricultural products is gradually increasing. For example, JINRI utilized ugly vegetables from local farmers to make pickles, and Kodawarin sold purée made from mushy vegetables. In South Korea, sellers seek to help farmers and urban citizens cooperate through the consumption of ugly agricultural products. For instance, apples damaged due to hail, called dimple apples, have been popular in South Korean markets and sell for 35 percent less than normal apples. In addition, some social corporations, such as Farmersface, have sold only ugly food since 2012.

There is a movement to elevate the consumption of ugly food through street food. According to Larcher and Camerer (2015), street food is gradually spreading from

Europe to the rest of the world. It can create bonds between consumers, agricultural producers, and rural economies. It has the power to connect customers through a social network to create a big fan base, preserve food culture, and determine its direction in the future. Instead of forsaking ugly food that does not meet aesthetic standards, street food can use ugly food and create a new food trend by actively informing consumers about it. In addition to the direct consumption of ugly food, there is a movement to increase indirect consumption of ugly food through donation. Even though donation of excess produce to non-profit organizations is considered a loss to retailers, it is beneficial since it promotes a positive image of the stores (Lebersorger & Schneider, 2014).[7] Nevertheless, only a small percentage of wasted food is actually donated to charities since the risks of donating surplus food−such as the potential to unknowingly harm recipients−can be an obstacle for many food companies (Cohen, 2006; Vogliano & Brown, 2016). However, the Bill Emerson ,Good Samaritan Act, signed by President Clinton on October 1, 1996, protects companies from the risks of donating food that may later be harmful to recipients (America, 2015).

[7] The Supplemental Nutrition Assistance Program (SNAP) is the largest nutrition assistance program to serve more than 46 million eligible low-income Americans per year administered by the USDA at the cost of more than $75 billion. The objectives of SNAP are to augment participants' food security and their contact with a healthy diet.

2.3. Literature review

Empirical research on consumer preferences regarding ugly produce is limited (Loebnitz et al., 2015; de Hooge et al., 2017; Aschemann-Witzel et al., 2017; Louis & Lombart, 2018) and largely focuses on European countries. However, there has been much research on food waste behavior (Buzby and Hyman, 2012; Koivupuro et al., 2012; Quested et al., 2013; Schneider and Obersteiner, 2007; Spottswood, 2018; Stefan et al., 2013; Stensgård & Hanssen, 2015; Wassermann and Schneider, 2015). The demographics influencing consumers' general food waste behavior might also influence their preferences regarding purchase and consumption of ugly produce (de Hooge et al., 2017). However, the findings of research on food waste behavior do not directly translate into preferences for imperfect products. The literature review in this thesis begins by discussing why people do not buy ugly food. The second section investigates the impact of various factors on the consumption of ugly food. Finally, the last section examines which features of ugly food should be emphasized to increase ugly food sales and consumption.

2.3.1. Reasons why people do not purchase ugly food

Loebnitz et al. (2015) were the first researchers to focus on the consumption of imperfect fruits and vegetables (Louis & Lombart, 2018). The authors indicated that abnormalities in terms of food shape could change consumers' purchase intentions and that consumers avoided purchasing extremely unusual fruits and vegetables, even if they buy some abnormal produce, because they think that they are lower quality than normal produce. Similarly, Aschenmann–Witzel et al. (2017) indicated that ugly fruits and vegetables did not create ethical value for consumers; the authors stated that consumers

did not want to help retailers avoid fruit and vegetable waste, instead, choosing the produce that met their high expectations. The authors pointed out that consumers tend to avoid the purchasing discounted suboptimal food as it might cause food waste at home and be a waste of money; thus, their purchase decision was motivated by a desire to avoid the guilt caused by food waste.

2.3.2. The impact of various factors on the consumption of ugly food

A strand of literature examines the impact of price on ugly food and food waste behavior. Some retailers offer about a 30 percent discount on ugly fruits and vegetables to promote consumption of imperfect food (Loebnitz et al, 2015). Theotokis et al. (2012), Verghese et al. (2013), and Petruzzelli (2015) found that the proportion of respondents who purchased low-grade produce was positively correlated with higher discounts, indicating that discounted low-grade produce appealed to price-sensitive consumers. Likewise, Aschenmann–Witzel et al. (2017) found that a greater focus on price had a significantly negative impact on the level of food waste at home. Further, households with higher income and single-member households had a lower tendency to become price-focused, whereas females, households with lower income and multi-member households had a higher propensity to become price-focused. Richards and Hamilton (2018) analyzed the relationship between consumption of ugly food and subsidies using data from Imperfect Produce Inc. a California company, concerning the performance of commercial peer-to-peer mutualization systems (CPMSs) over two years. The author reported that a 25 percent subsidy for CPMS transactions led to a 60 percent increase in the amount of ugly food on CPMS and that a 90 percent subsidy for CPMS transactions resulted in a 300

percent increase. Thus, this study implies that the price effect of subsidy policies is elastic in terms of the amount of ugly food consumption. Price-focused policies such as subsidies allow customers to purchase ugly food through the CPMS system, positively affecting (i.e., reducing) food waste by selling food that might be otherwise abandoned.

Another strand of literature investigates the demographic determinants of ugly food disposal and food waste behavior. Petruzzelli (2015) surveyed 322 University of California, Berkeley, students and interviewed 16 vendors in Oakland and Berkeley, California to determine whether consumers are willing to purchase low-grade produce. The author showed that most vendors offered discounted low-grade produce, which they called seconds,[8] and that this obtained a positive response from customers. However, most vendors did not discount so-called mutants[9] low-grade produce and sold them at the normal price since they recognized that consumers would regard that food as a novelty. Petruzzelli (2015) also found that consumers in lower-income neighborhoods purchased more seconds than those in higher-income neighborhoods. This paper illustrates that vendors and consumers react to seconds and mutants in a different way; mutated produce attracts consumers for its novelty, while discounts on seconds could attract more price-focused consumers (Petruzzelli, 2015). Figure 2.1 illustrates the difference between mutants and seconds. In another study, de Hooge et al. (2017) indicated that younger generations were more accepting of and were more likely to consume suboptimal produce than older generations. For food waste behavior, Buzby and Hyman (2012) and Stefan et al. (2013) showed that increasing age is negatively correlated with food waste.

[8] Fruits and vegetables that had pest damage, are bruised, or are not the preferred size
[9] Produce that had abnormality such as twisted carrots

Wassermann and Schneider (2015) showed that young generations produce more avoidable food waste[10] than old generations (i.e., persons between 55 and 60 years old). The results of Austrian studies (Wassermann and Schneider, 2005; Schneider and Obersteiner, 2007) showed that higher education, full-time employment, and younger age positively influence the amount of avoidable food waste in a household. Koivupuro et al. (2012) and Quested et al. (2013) found that a larger household size increases the amount of food waste.

Consumers' preferences regarding suboptimal produce vary depending on whether the consumer is at home or in the supermarket. Aschenmann–Witzel et al. (2017) found that increasing age and higher education had a significant and positive impact on consumers' propensity to select suboptimal food at home. In their study, de Hooge et al. (2017) found that one-fourth of respondents bought abnormally shaped vegetables, while respondents rarely selected ugly apples at the supermarket. In total, 36.9 percent of customers consumed bent cucumbers, and 21 percent consumed apples with spots at home. Thus, apples with spots are selected less frequently at the supermarket than at home. This study implies that consumers are willing to buy and consume abnormally shaped food, but food with abnormal color, such as apples with spots, tends to be rejected at the supermarket. Thus, abnormally colored food must have a more substantial price incentive.

The subjective personal factor of consumer attitudes, including perception and awareness of food waste, has a universally positive impact on the consumption of ugly

[10] Unavoidable food waste refers to inedible food parts such as bones, coffee grounds, and vegetable peel (WRAP, 2008, 2009a).

food according to previous literature. Pollan (2006) indicated that the more people become aware of the way in which their food is produced, the more impact that knowledge has on their purchasing intentions regarding ugly food. Likewise, Petruzzelli (2015) observed that consumers are more inclined to purchase low-grade produce if they are aware that it would be discarded otherwise. Moreover, Loebnitz et al. (2015) indicated that the consumption of ugly produce by consumers with weak pro-environmental self-identities was not different from consumption by those with strong pro-environmental self-identities. However, de Hooge et al. (2017) suggested that consumers with higher awareness of the problems associated with food waste issue often consumed more abnormally shaped fruits and vegetables compared to those with pro-environmental self-identities.

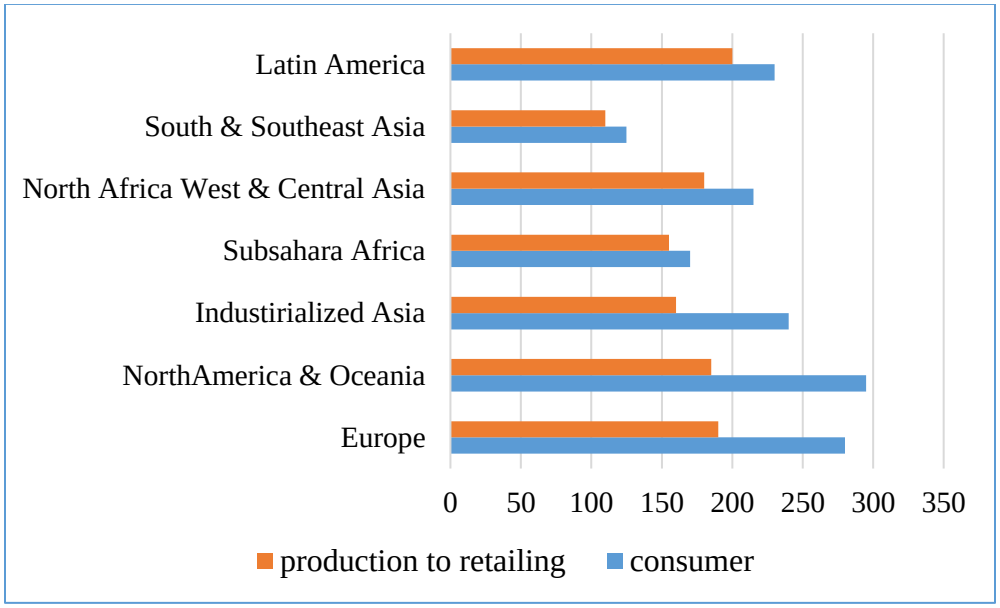
The next strand of literature reviewed here concerns the effect of organic labels for abnormally shaped food. Loebnitz et al. (2015) researched whether the relationship between abnormal food shape and organic labeling affected consumers' purchase intentions, revealing that the two had a significant collaborative effect. However, consumers' intention to purchase extremely misshapen produce is low, even if it is labelled as organic. They illustrated that these results are compatible with the literature on cues: intrinsic cues, such as abnormal food shape, control extrinsic cues, like an organic label. Organic labels cannot change purchase intentions as much as a high-level intrinsic cue such as extremely abnormal food appearance.

2.3.3. Ugly food and advertisement

Previous literature emphasized consumers' responses to aesthetically non-standard fruits and vegetables but did not examine retailers' societal advertisement of imperfect fruits and vegetables. Louis and Lombart (2018) examined retailers' societal advertisement of ugly fruits and vegetables, focusing on three claims and two retailers. The first claim is that non-standard fruits and vegetables have a positive impact on consumers' health, the second is that these fruits and vegetables taste good, and the third is that they have lower prices. The two retailers examined in the study are Intermarché, a classical grocery retailer and Biocoop, an organic retailer.

Investigating the direct and indirect effects of societal advertisements of non-standard fruits and vegetables on consumers' relationship with retailers, the authors indicated that both Intermarché and Biocoop suitably advertise abnormal fruits and vegetables. Retailers should not concentrate on food prices, but on consumers' health and the taste of food. This is especially true for Biocoop, which specializes in organic products. Therefore, the authors suggest that retailers steadily introduce non-standard food in their advertisement, promoting its health benefits and good taste, to familiarize consumers with ugly food and positively impact consumers' purchase intentions.

Figure 2.1 Food losses and waste per capita (kg/year)



Source: Food and Agriculture Organization of the United Nations (http://www.fao.org/save-food/resources/keyfindings/en/)

Figure 2.2 The Comparison between mutants and seconds

Mutants	Seconds
	
	

CHAPTER 3 – DATA AND VARIABLES

3.1. Data

Most of the previous literature on suboptimal foods is based on experimental subjects' self-reported outcomes regarding purchase and consumption of ugly produce in surveys and interviews with food images (Aschemann-Witzel et al., 2017; de Hooge et al., 2017; Loebnitz, Schuitema, & Grunert, 2015; Louis & Lombart, 2018; Petruzzelli). The most significant problem associated with this research method is the possibility that consumers will behave differently when facing actual produce in a supermarket (de Hooge et al., 2017). Thus, five years of real consumption data is utilized in this thesis to analyze the factors impacting the consumption and sales of ugly apples.

The dataset used in this paper is from the Agricultural Food Consumer Panel (hereafter called consumer panel) analysis conducted by the Rural Development Administration (RDA) of South Korea between 2013 and 2017. The RDA is a government department responsible for research, development, dissemination, and training concerning agricultural science and technology. A consumer panel was designed so that the collected purchase information could be utilized for agricultural production, distribution, and research and development (R&D).

The consumer panel constitutes 1,486 household panels in metropolitan cities that are registered for consumer panel data, including daily purchase records. Data about ugly apple purchases were extracted from this dataset. Since there were few daily observations

concerning ugly apples,[11] the sample size for the current study was 352 observations. The daily purchase data from a single household are treated as one observation. Thus, one household panel could have multiple observations. A panel is defined in this dataset as the member of the household who mainly purchases agricultural products, regardless of whether the individual is the head of the household. An unbalanced dataset is defined as a category of data that is not observed in certain years, while a balanced dataset is defined as a category in which all elements of the data are observed in all time settings. In this study, observations regarding ugly apples are considered unbalanced panel data.

3.2. Background of variable selection

This thesis utilizes variables employed in previous studies that examined consumers' preferences regarding the consumption of suboptimal food with a binary logistic regression or a linear regression (Aschemann-Witzel et al., 2017; de Hooge et al., 2017). The factors influencing food waste are also broadly investigated. Most studies on suboptimal food and food waste consider socio-demographic factors, behavioral factors such as shopping habits, and attitudinal factors such as valuation of certain features when purchasing food. We will use socio-demographics and attitudinal factors due to the limit of the data.

Concerning socio-demographics, food away from home (FAFH) is additively examined since the expenditure variable of FAFH is a dependent variable that is equal to that of ugly apples. Many more studies have focused on consumer purchasing behaviors for FAFH than on suboptimal food, and researchers have identified socio-demographic

[11] 30 observations in 2013, 23 observations in 2014, 73 observations in 2015, 98 observations in 2016, and 128 observations in 2017

factors that significantly influence the amount of expenditure on FAFH (Cai, 1998; Cupak et al., 2016; Fabiosa, 2008; Ham et al., 2004; Jang et al., 2007; Manrique & Jensen, 1998; Mihalopoulos & Demoussis, 2001; Ogundari et al., 2015; Yen, 1993). The literature on three topics[12] generally uses similar socio-demographic variables. Thus, this study utilizes age, gender, job, family members, household income, education, and place of residence as socio-demographic factors to investigate the relationship between consumers' socio-demographic attributes and ugly apple expenditure.

In the study of ugly food, there are two critical independent variables: one is the markets in which ugly apples are purchased and the other is consumers' attitude toward the consumption of general items. Studies examining the markets in which suboptimal food is purchased have no examples that can be used to compare different markets. In addition, most previous studies on FAFH mainly analyzed the factors impacting consumption and then recommended marketing strategies and actions for restaurants. Few studies investigated the link between the type of food facility and the elements influencing FAFH consumption (McCracken & Brandt, 1987; Nayga Jr & Capps Jr, 1994). This study analyzes the sales of ugly apples at the retail level and suggests concrete marketing strategies to increase the sales of ugly apples for suppliers. Identifying and measuring which types of markets have higher ugly apple sales can lead to the development of improved marketing strategies for ugly apples.

The distinct difference in variables associated with suboptimal food, food waste, and FAHF is consumers' attitude. This variable is generally used for analysis of suboptimal food and food waste, not for analysis of FAFH. It can be used to determine

[12] Suboptimal food, food waste, and FAFH

which marketing actions retailers or the government should take to promote ugly apple sales. In particular, examination of consumers' attitude provides significant implications regarding which characteristics of ugly apples—price, quality, country of origin, or food stability—should be emphasized to increase the consumption and sales of ugly apples.

3.3. Variables selection and descriptive statistics

The dependent variable is daily household expenditure on ugly apples, which has a mean of ₩10,161 with a minimum value of ₩2,000 and a maximum value of ₩60,000. The unit of expenditure is the Korean currency, the won (₩). The independent variables are household socio-demographics, including family size, gender, job, age, household income, education, and place of residence. Table 3.1 illustrates the percentage of variables based on the means of the variables. In this study, family size is defined as the number of household members and considered a continuous variable, which has a mean value of 3.44. Gender refers to the sex of the panel that purchased ugly apples, and it is a self-explanatory variable. Table 3.2 shows that 93 percent of the sample is female.

Job refers to the occupation of the panel and is used as a dummy variable which divided into breadwinners and male or female homemakers. In prior literature, job usually referred to the type of occupation from which the head of household or panel received earnings in the past 12 months (Cai, 1998; Ham, Hwang, & Kim, 2004). However, this thesis defines two jobs—breadwinners and homemakers—because it is assumed that homemakers try to save more money than breadwinners. Table 3.2 illustrates that about 59 percent of the sample are homemakers.

Age is recorded as a continuous variable but is then grouped into four brackets. It is used as a categorical and dummy variable in the current study. The groups are developed based on previous studies (Cai, 1998; Ham, Hwang, & Kim, 2004). The consumer panel constitutes people over 35 years old in the ugly apple data. Age1 represents people between 35 and 44 years old, who comprise 26 percent of the sample. Age2 represents people between 45 and 54 years old, who comprise 31 percent of the sample. Age3 represents people between 55 and 64 years old, who make up 31 percent of the sample. Finally, Age4 represents people over 65 years old, who account for 11 percent of the sample.

Previous literature generally defined earned income as the total amount of income earned in the past 12 months (Cai, 1998; Ham, & Hong, 2007; Kim & Saghaian, 2016; Manrique & Jensen, 1998). However, the study on FAFH by Bai et al. (2016) used monthly disposable income. This study utilizes earned monthly income, defined as the total amount of income, including the one hundred thousand won (₩100,000) received by all household members as a pension, household members' salary before deductions, and monthly income from owned businesses. Income is a categorical variable and that is grouped into three brackets, following the RDA classification. Lower income means income under ₩25, which comprises about 18 percent of the sample. Middle income refers to income between ₩25 and ₩60, which accounts for about 66 percent of the sample. Higher income refers to income over ₩60, which comprises 16 percent of the sample.

Education, as shown in Table 3.1, is classified into three categories, following previous literature (Almojel, 2016). Lower education indicates a lack of completion of

high school, which makes up about 16 percent of the sample. Middle education indicates completion of high school, which comprises 29 percent of the sample. Higher education indicates post-secondary education, which comprises 56 percent of the sample.

The independent variables include the markets in which consumers purchase ugly apples. The market variable is divided into six categories—mega-scale discount stores, super supermarkets (SSM), department stores, small stores, non-stores, and the Internet—for identification and comparison of the markets selling ugly apples. Mega-scale discount stores, SSMs, and small stores are classified based on the square footage of the store. According to the Small and Medium Business Administration, a government department, in Korea, mega-scale discount stores, which comprise 40 percent of the sample, have an area of over 3,000m^2. SSMs, which comprise 18 percent of the sample, have an area of under 3,000m^2. Small stores, which make up about 13 percent of the sample, have an area of under 150m^2. Department stores account for 8 percent of the sample, and non-stores, which include food trucks and traditional markets, which comprise 11 percent of the sample. The Internet, which includes all online purchases, accounts for about 11 percent of the sample.

The consumer attitude variables are price-consciousness, quality-consciousness, food safety-consciousness, and country of origin-focus. In this dataset, the consumption attitudes of panels are not related to any particular item, but to generic products. The scores for four categorical variables are directly distributed according to the panels' consumption attitudes with a range of 100 points. These variables are also used as dummy variables. Previous literature indicated that consumers' perceptions and attitudes toward food waste and suboptimal food are critical variables associated with the

consumption of imperfect but delicious food (de Hooge et al., 2017; Koivupuro et al., 2012; Petruzzelli, 2015; Quested, Marsh, Stunell, & Parry, 2013).

Price-conscious consumers, who make up about 33 percent of the sample, are defined as those who want to save money when buying products. The perception of savings has been found to be an influential factor in both quantitative and qualitative research (Quested et al., 2013). According to the regular survey conducted by the Worldwide Responsible Accredited Production (WRAP), a large number of respondents reported that price was the most important factor affecting their purchase decisions. Quality-conscious consumers, who account for 33 percent of the sample, are defined as those who think that quality is the most critical factors. These consumers are likely to consume ugly apples, as they consider quality to be more important than the appearance of the product.

Food stability-conscious consumers, who comprise 17 percent of the sample, are characterized by their belief that food safety is the most important factor to consider when purchasing products. Most of the respondents in Petruzzelli's (2015) study stated that variety in the appearance of food was due to genetic mutations and environmental elements, such as pest damage and extreme weather. These consumers are less likely to purchase and consume misshapen and blemished food compared to consumers who are conscious of other factors since they consider ugly food to be unsafe.

Consumers who are focused on the country of origin, who account for 17 percent of the sample, recognize the importance of where produce originated. According to the Act on the Indication of Origin of Agricultural and Marine Products in Korea, origin is

defined as the country, region within country, or area of the sea in which agricultural or marine products are legally produced, harvested, or captured. The background of this Act indicates that the quality of agricultural products could vary due to differences in the cultivation area, climate, soil, cultivation method, and timing, even if the same varieties of crops are planted. Finally, the area in which the panels that consume ugly apples reside were categorized based on administrative districts in Korea. Each region includes metropolitan cities. Seoul and Gyeonggi account for 21 and 65 percent of the sample respectively, and Gwangju and Gyeongsang make up for 2 and 12 percent of the sample respectively.

Table 3.1 Definitions of the variables in the analysis (N=352)

Dependent variable		**Abbreviations**
Purchase	Household daily expenditures on ugly apples	**Uglypurchase**
Explanatory variable		
Family Size	Number of household members	**Family_num**
Gender	1 if a person is Female, 0 if Male	**Female**
Job	1 if a person is a homemaker, 0 if a worker	**Homemaker**
Age		
age1	1 if age is between 35 and 44, 0 otherwise	**Age1**
age2	1 if age is between 45 and 54, 0 otherwise	**Age2**
age3	1 if age is between 55 and 64, 0 otherwise	**Age3**
age4	1 if age is over 65, 0 otherwise	**Age4**
Income	(Unit: ₩100,000)	
Lower income	1 if household income is less than ₩25, 0 otherwise	**Low_in**
Middle income	1 if between ₩20 and ₩60, 0 otherwise	**Mid_in**
Higher income	1 if household income is over ₩60, 0 otherwise	**High_in**
Education		
Lower education	1 if a lack of the completion of high school, 0 otherwise	**Low_edu**
Middle education	1 if the completion of high school, 0 otherwise	**Mid_edu**
Higher education	1 if pre-secondary education, 0 otherwise	**High_edu**
Purchase Market		
Mega-scale discount store	1 if a person purchases at mega-scale, 0 otherwise	**Mega_scale**
Super supermarket	1 if a person purchases at super supermarket, 0 otherwise	**SSM**
Department store	1 if a person purchases at department store, 0 otherwise	**Department**
Small store	1 if a person purchases at small store, 0 otherwise	**Small_store**
Non-store	1 if a person purchases at non-store, 0 otherwise	**Non_store**
Internet	1 if a person purchases through the Internet, 0 otherwise	**Internet**
Consumer Attitude		
Price	1 if a person is price-conscious, 0 otherwise	**Price**
Quality	1 if a person is quality-focused, 0 otherwise	**Quality**
Country of origin	1 if a person is country of origin-focused, 0 otherwise	**Origin**
Food Stability	1 if a person is food stability-conscious, 0 otherwise	**Stability**
Region		
Seoul	1 if a panel lives in Seoul, 0 otherwise	**Seoul**
Gyeonggi	1 if a panel lives in Gyeonggi-do, 0 otherwise	**Gyeonggi**
Gwangju	1 if a panel lives in Gwangju, 0 otherwise	**Gwangju**
Gyeongsang	1 if a panel lives in Gyeongsang, 0 otherwise	**Gyeongsang**

Table 3.2 Descriptive statistics (N=352)

Dependent variable	Observation	Mean	Std. Dev.	Min	Max
Purchase	352	10161.58	9204.16	2000	60000
Explanatory variable	Observation	Mean	Std. Dev.	Min	Max
Family Size	352	3.44	1.13	1.00	7.00
Female	352	0.93	0.25	0.00	1.00
Homemaker	352	0.59	0.49	0.00	1.00
Age					
age1	352	0.26	0.44	0.00	1.00
age2	352	0.31	0.46	0.00	1.00
age3	352	0.31	0.46	0.00	1.00
age4	352	0.11	0.32	0.00	1.00
Income					
Lower income	352	0.18	0.38	0.00	1.00
Middle income	352	0.66	0.47	0.00	1.00
Higher income	352	0.16	0.37	0.00	1.00
Education					
Lower education	352	0.16	0.36	0.00	1.00
Middle education	352	0.29	0.45	0.00	1.00
Higher education	352	0.56	0.50	0.00	1.00
Purchase Market					
Mega-scale discount store	352	0.40	0.49	0.00	1.00
Super supermarket	352	0.18	0.39	0.00	1.00
Department store	352	0.08	0.28	0.00	1.00
Small store	352	0.13	0.33	0.00	1.00
Non-store	352	0.11	0.31	0.00	1.00
Internet	352	0.11	0.31	0.00	1.00
Consumer Attitude					
Food stability	352	0.17	0.38	0.00	1.00
Price	352	0.33	0.47	0.00	1.00
quality	352	0.33	0.47	0.00	1.00
Country of origin	352	0.17	0.38	0.00	1.00
Region					
Seoul	352	0.21	0.41	0.00	1.00
Gyeonggi	352	0.65	0.48	0.00	1.00
Gwangju	352	0.02	0.15	0.00	1.00
Gyeongsang	352	0.12	0.32	0.00	1.00

CHAPTER 4 – METHOD

4.1. Panel model

Panel data generally refer to data involving time series observations of some individuals. Thus, observations in panel data contain at least two dimensions; a time series dimension, denoted by subscript (t) and a cross-sectional dimension, denoted by subscript (i). The advance of applied studies and the methodological development of panel data have been sensational since the seminal paper of Balestra and Nerlove (1966).

The collection of panel data is apparently much more costly than that of time series or cross-sectional data. Nevertheless, panel data have become extensively available in both developing and developed countries. Panel data have advantages over time-series or cross-sectional data by combining the intra-individual dynamics and inter-individual differences: they make a more precise inference of model estimators available, having a higher capacity for capturing the complication of human behavior than a single cross-section or time series data (Hsiao, 2007).

When time series data are not stationary, the distribution of the least-squares in the large sample no longer has a normal distribution (Anderson, 1959; Dickey & Fuller, 1979, 1981; Phillips & Durlauf, 1986). Yet, if panel data are accessible, and observations among cross-sectional units are independent, then one can apply the central limit theorem across cross-sectional units to represent that the limiting distributions of multiple parameters remain asymptotically normal (Binder et al., 2005; Im et al., 2003; Levin et al., 2002; Phillips & Moon, 1999).

4.1.1. The fixed effects model

The following regression model was postulated below.

(1) $$y_{it} = \beta_{1i} + \beta_2 x_{2it} + \beta_3 x_{3it} + e_{it}$$

The intercept β_{1i} captures all behavioral differences between individuals (i), referred to as individual heterogeneity. Individual intercepts are added to control for individual-specific and time-invariant attributes. A model with these components is called a fixed effects model, and the intercepts are called fixed effects. The intercept β_{1i} are different for other individuals, but the slope coefficients β_2 and β_3 are assumed to be constant for all individuals. One method to estimate the fixed effects model is to include an intercept dummy variable for each individual. To illustrate this method, we assume ten individuals (i) and define ten dummy variables as follows:

$$D_{1i}\begin{cases}1 & i=1\\ 0 & otherwise\end{cases} \quad D_{2i}\begin{cases}1 & i=2\\ 0 & otherwise\end{cases} \quad \bullet\bullet\bullet \quad D_{10i}\begin{cases}1 & i=10\\ 0 & otherwise\end{cases}$$

Thus, the above equation (1) can be rewritten such as

(2) $$y_{it} = \beta_{11}D_{1i} + \beta_{12}D_{2i} + \bullet\bullet\bullet + \beta_{1,10}D_{10i} + \beta_2 x_{2it} + \beta_3\beta_{3it} + e_{it}$$

The estimators are called the least squares dummy variable estimator (LSDV). The procedure including a dummy variable for each individual is available only when the number of individuals is small. If the data have a considerable number of individuals, this approach is not suitable (Baltagi, 2008). There is a method that makes relatively easy estimating the fixed effects model with a large number of individuals. After averaging the data across time, the following equation can be rewritten

(3) $$\bar{y}_i = \beta_{1i} + \beta_{2i}\bar{x}_{2it} + \beta_{3i}\bar{x}_{3it} + \bar{e}_i$$

where $\bar{y}_i$ indicates the average value of y_{it} over time in (3). Then, if both equations are subtracted ((1) − (3)), the following equation obtains

$$y_{it} = \beta_{1i} + \beta_2 x_{2it} + \beta_3 x_{3it} + e_{it}$$

$$\bar{y}_i = \beta_{1i} + \beta_{2i}\bar{x}_{2it} + \beta_{3i}\bar{x}_{3it} + \bar{e}_i$$

(4) $$(y_{it} - \bar{y}_i) = \beta_2(x_{2it} - \bar{x}_{2it}) + \beta_3(x_{3it} - \bar{x}_{3it}) + (e_{it} - \bar{e}_i)$$

The last equation (4) indicates that the intercept coefficient β_{1i} has fallen out. The parameter estimates depend only on the variation of the dependent and explanatory variables within individuals.

4.1.2. The random effects model

In the fixed effects model, all individual differences are grasped by differences in the intercept parameter. The intercepts β_{1i} are treated as fixed parameters that can be estimated by using least squares estimator. In the random effects model, the individual differences in the sample are considered to be random rather than fixed since the individuals in the sample are randomly selected. Thus, the intercept parameter β_{1i} can be specified to comprise a fixed part that indicates the population average $\bar{\beta}_1$ and random individual differences from the average population, u_i which are called random error terms.

(5) $$\beta_{1i} = \bar{\beta}_1 + u_i$$

If β_{1i} is replaced by this equation (5) in (1), we obtain

$$y_{it} = \beta_{1i} + \beta_2 x_{2it} + \beta_3 \beta_{3it} + e_{it}$$

$$= (\bar{\beta}_1 + u_i) + \beta_2 x_{2it} + \beta_3 \beta_{3it} + e_{it}$$

$$= \bar{\beta}_1 + \beta_2 x_{2it} + \beta_3 \beta_{3it} + (e_{it} + u_i)$$

(6) $$= \bar{\beta}_1 + \beta_2 x_{2it} + \beta_3 \beta_{3it} + v_{it}$$

where $\bar{\beta}_1$ is the intercept parameter and the combined error (v_{it}) are composed of the random error terms (u_i) and the idiosyncratic error terms (e_{it}) in (6).[13] The assumptions of the combined error in the random effects model are summarized as follows: the combined error has expectation zero, E(v_{it}) = 0, and homoscedasticity, var(v_{it}) = $\sigma_e^2 + \sigma_u^2$. Errors for individuals i are correlated, cov(v_{it}, v_{is}) = σ_u^2 for t ≠ s, and errors for other individuals are uncorrelated, cov(v_{it}, v_{js}) = 0 for i ≠ j. Besides, the combined error is not correlated with any of the explanatory variables in the random effects model, cov(e_{it}, x_{2it})= 0, cov(e_{it}, x_{3it})= 0, cov(u_i, x_{2it}) = 0, cov(u_i, x_{3it}) = 0.

Under the autocorrelation, the least squares estimator is unbiased and consistent, but not minimum variance. The minimum variance estimator for the random effects model is a generalized least squares (GLS) estimator developed for the assumptions of the model. The GLS can be obtained by applying the least squares to a transformed model (7) below. The transformed model is

(7) $(y_{it} - \theta\bar{y}_i) = \bar{\beta}_1 (1 - \theta) + \beta_2(x_{2it} - \theta\bar{x}_{2i}) + \beta_3(x_{3it} - \theta\bar{x}_{3i}) + (v_{it} - \theta\bar{v}_i)$

[13] The random effects error has two components: u_i is for the individual and e_{it} is for the regression.

where $\bar{y}_i$, $\bar{x}_{2i}$ and $\bar{x}_{3i}$ are the individual means. The key transformed parameter θ is defined as

(8) $$\theta = 1 - \frac{\sigma_e}{\sqrt{T\sigma_u^2+\sigma_e^2}}$$

where T is the number of panels in (8). When θ = 1, it indicates that σ_e^2 is identical to zero so that the random effects estimator is equal to the fixed effects estimator. When θ = 0, it represents σ_u^2 is equal to zero. Thus, the random effects estimator is identical to the pooled least squares estimator.

4.2. Model selection and validation

To analyze the determinants explaining the consumption and sales of ugly apples in South Korea, the following regression model was postulated as:

$$Uglypurchase_{it} = \beta_0 + \beta_1 \text{Family\_num}_{it} + \beta_2 \text{Female}_i + \beta_3 \text{Homemaker}_{it} + \beta_4 \text{Age2}_i + \beta_5 \text{Age3}_i + \beta_6 \text{Age4}_i + \beta_7 Mid\_in_{it} + \beta_8 High\_in_{it} + \beta_9 \text{Low\_edu}_i + \beta_{10} \text{Mid\_edu}_i + \beta_{11} SSM_{it} + \beta_{12} Department_{it} + \beta_{13} Small\_store_{it} + \beta_{14} Non\_store_{it} + \beta_{15} Internet_{it} + \beta_{16} Quality_{it} + \beta_{17} Origin_{it} + \beta_{18} Stability_{it} + \beta_{19} Seoul_i + \beta_{20} Gwangju_i + \beta_{21} Gyeongsang_i + \alpha_m + \alpha_y + u_i + e_{it}$$

The dependent variable is the amount of daily expenses on ugly apples incurred by a household panel. Time-invariant variables are those that are constant or change at a constant rate over time across individuals such as age,[14] gender, education, or residential area in the model. Meanwhile, time-variant variables are those that are random or

[14] Age variable leads to the same change among individuals.

unpredictable over time across individuals such as family size, homemaker,[15] income, purchasing markets, and consumers' attitudes in the model. The daily expenditure on ugly apples is likely to vary over time. The classification between time-invariant and time-variant variables follows the attributes of this data.

The influence of time is controlled by primarily employing monthly fixed effects since the observations are based on daily data. Yearly fixed effects are also included in the model as the observations are scarce in some years. Monthly and yearly fixed effects are denoted by α_m and α_y respectively. Regional fixed dummies are omitted due to the collinearity. If unobserved individual differences are present and the assumptions of the random effects model hold, then the random effects estimator is preferred. The random effects estimator allows us to estimate the effects of time-invariant variables. Furthermore, the random effects estimator is a GLS estimation while the fixed effects estimator is a least squares estimator. The least squares estimator has a larger variance than the GLS estimator in large samples (Hill et al., 2011).

4.2.1. Model selection

To select appropriate independent variables, the multicollinearity and the Akaike Information Criteria (AIC) will first be checked. The multicollinearity indicates that two or more variables in a multiple regression model are so highly correlated that the impact of a specific coefficient on the dependent variable cannot be precisely estimated. Under multicollinearity, variance and standard error of the individual coefficients increase and then the confidence interval of the coefficients becomes broader. Thus, the individual

[15] They can be workers or male or female homemakers over time.

coefficients become inaccurate estimators. To find whether there is the multicollinearity in this model, the variance inflation factors (VIF) approach is utilized. According to Table 4.1, this model does not have the multicollinearity since all variables are smaller than 10 regarding VIF.

As for the next step, Akaike (1969) and Schwartz (1978) suggested the criteria to decide how many variables a linear model should have. Thus, AIC and SIC can be utilized as criteria for a model selection among various models. AIC and SIC stand for the Akaike Information Criterion and the Schwarz information criterion. The basic idea of the additional term in AIC is to control the fit of various specifications by penalizing an additive increase in the number of independent variables. For the parsimonious model, the current model with the least AIC value is selected.

Moreover, it needs to decide which model form is selected for the given variables. The best way to compare these four models such as linear-linear, linear-log, log-linear, and log-log is to use a method called the generalized Box-Cox (1964) model. This model nests these four models into one. After implementing the Box-Cox model, the best functional form can be selected. Then the consequences of parameters can be interpreted through the regression of the model. According to Table 4.2, it includes the outcome of likelihood-ratio tests on three standard functional form specifications. Table 4.2 illustrates that the linear, multiplicative inverse, and log specification are firmly rejected. Thus, the current linear-linear model is maintained.

Subsequently, the Hausman test can be used to differentiate between random and fixed effects models in panel data. The random effects model is preferred to the fixed

effects model due to higher efficiency under the null hypothesis, while the fixed effects model is preferred to the random effects model due to consistency under the alternative hypothesis. According to the Hausman test, the outcome is statistically insignificant since the p-value (0.39) is larger than even the 10 percent significance level. Thus, the null hypothesis cannot be rejected and the random effects model is appropriate.

4.2.2. Model validation

Before implementing the random effects model, the assumption of the model must be satisfied. First, the normality of the combined error is checked. The errors after modeling should be normal to draw a valid conclusion by p-value for hypothesis testing (Kim, 2015). If the normality of the errors is not satisfied, a valid conclusion cannot be drawn based on statistical inference in linear regression analysis.

In a similar vein, the combined error after modeling is required to become normally distributed with a mean of zero in linear panel regression. When the combined error is not normally distributed, the reason for non-normality has to be determined, and proper actions should be taken. In the case where the data distribution skews to the left or right, the natural logarithm could help make the combined error normal. Many extreme outliers in dataset also lead to a skewed distribution (Buthmann, 2018). To check the normality of the combined error, a quantile-quantile (Q-Q) plot can be an appropriate graphical tool.[16] If both quantiles come from the same distribution, the points forming a

[16] A Q-Q plot is a scatterplot generated by plotting two sets of quantiles. A Q-Q plot sorts a sample data in ascending order, plotting them versus quantiles computed from a theoretical distribution (Ford, 2015).

line are roughly straight and the combined error is normal. Figure 4.1 illustrates that the log transformation makes the distribution of the dependent variable normal.

To confirm the effect of the log transformation for the combined error, Figure 4.2 illustrates the quantiles of the combined error against the quantiles of a normal distribution before and after the transformation, and represents a histogram overlaid by a kernel density estimate. Before the natural log transformation, the plot falls along a line in the middle line and then curves off in the extremities. This style of Q-Q plot indicates this data have more extreme values than would be expected under normality. Both the kernel density estimate and the histogram indicate that the distribution of the combined error skewed to the right. Contrary to the result, after the natural log transformation, the extremities are likely to converge into the straight line. Thus, the combined error is likely to be seen as normally distributed after the transformation in the Q-Q plot, the histogram, and the kernel density estimate.

Second, there is a possibility that heteroscedasticity and autocorrelation exist in the random effects model, since the panel data simultaneously has the characteristics of the cross-sectional and time-series data. The random effects model has the assumption that the variance of the combined error is constant over individuals. According to the Breusch-Pagan test, the null hypothesis that the model has the heteroscedasticity cannot be rejected since the p-value is larger than the 10 percent significance level.

Under the heteroscedasticity, the least squares have the biased estimator since they no longer satisfy the Gauss-Markov assumption. The least squares no longer have the minimum variance as well. Furthermore, the random effects model has the

assumption of the autocorrelation. For the correlation, the assumption of the random effects model excludes the contemporaneous correlation, a particular type of serial correlation, which means the errors of each cross-sectional unit are correlated in the same time period (t).

To resolve the heteroscedasticity and correlation beyond the assumption of the random effects model and the incorrect standard errors,[17] the cluster-robust standard errors need to be utilized. Taking the example for this situation, the existence of heteroscedasticity and contemporaneous correlation at time t is represented as the following variance-covariance matrix.

$$\Omega_t = \begin{bmatrix} \sigma_1^2 & \cdots & \sigma_{n1} \\ \vdots & \ddots & \vdots \\ \sigma_{1n} & \cdots & \sigma_n^2 \end{bmatrix}$$

The clusters are the time-series observations on individuals. Thus, this data has 148 clusters in the sample of total 352 observations since one panel can have multiple observations on each other date. The cluster-robust standard errors correct the standard errors in the presence of heteroscedasticity and correlation, although the estimators no longer have minimum variance (Hill et al., 2011).

Finally, endogeneity in the random effects model would be tested. Explanatory variables which are correlated with the combined error (v_{it}) are called endogenous variables, while those that are not correlated with the combined error are called

[17] Under the heteroscedasticity and the serial correlation, the standard error of the least squares is not appropriate and then the conventional t-test and F-test are no longer valid.

exogenous variables. The correlation between a random explanatory variable and the combined error (v_{it}) causes the estimators of the least squares to be inconsistent.

To check for any correlation between the explanatory variables and the random error (u_i) in a random effects model, the Hausman test can be utilized. This test compares the estimates from the fixed effects model with those from the random effects model. If there is no correlation between the explanatory variables and u_i, the estimators of fixed and random effects should be similar. According to the Hausman test, the null hypothesis that the difference between estimators is zero is not rejected even at the 10 percent significance level. Thus, u_i is not correlated with the explanatory variables. As an ensuing test, an instrument variable[18] can be utilized to test any correlation between an assumed endogenous variable and the idiosyncratic error (e_{it}) in the random effects model through the two-stage least squares (2SLS). The following analysis is based on the premise that there is no endogeneity between the explanatory variables and e_{it}, because we believe variables such as demographics and income are exogenous.

[18] An instrument variable 1) does not have a direct effect on y, 2) not correlated with the error term, and 3) strongly correlated with the endogenous explanatory variable. To become a strong instrument, there must have an effect of an instrument variable on the endogenous variable, and an instrument variable has to be a statistically significant effect. The usual rule of thumb is that the F-test statistic should be greater than 10. This also translates into the absolute t-statistic for significance being greater than 3.16 (Hill et al., 2011).

Table 4.1 Mulitcollinearity test

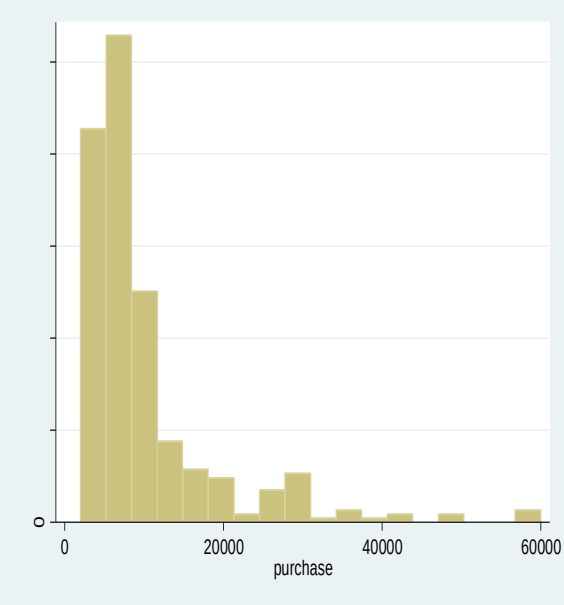
Variable	VIF	1/VIF
Age4	2.86	0.35
Lower education	2.77	0.36
Female	2.77	0.36
Age3	2.71	0.37
Higher income	2.46	0.41
Middle income	2.42	0.41
Age2	2.19	0.46
Family_num	1.87	0.54
Gwangju	1.65	0.61
Middle education	1.64	0.61
Food quality	1.57	0.64
Gyeongsang	1.57	0.64
Department	1.57	0.64
Country of origin	1.54	0.65
Homemaker	1.53	0.65
Seoul	1.49	0.67
Small store	1.38	0.72
Super supermarket	1.37	0.73
Food stability	1.29	0.78
Non-store	1.28	0.78
Internet	1.26	0.79
Mean VIF	1.87	

Table 4.2 Box-Cox test

Test H_0:	Restricted log likelihood	LR statistic chi2	P-value Prob > chi2
theta = -1	-3423.10	85.8	0.00
theta = 0	-3390.54	20.69	0.00
theta = 1	-3586.49	412.58	0.00

Figure 4.1 Results of the log transformation for the dependent variable

(A) Before the log transformation



(B) After the log transformation

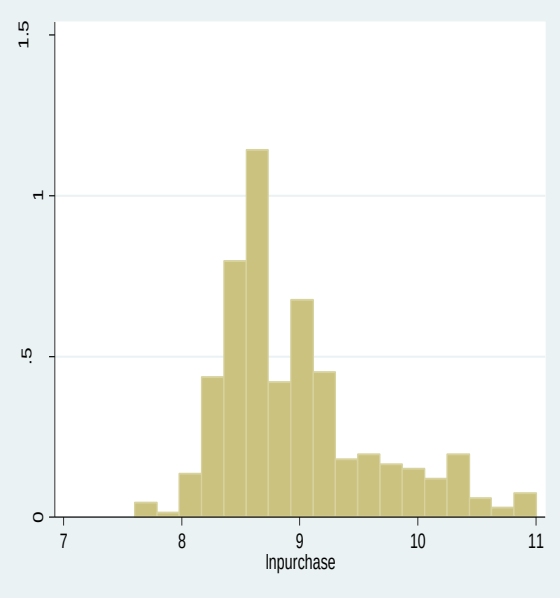
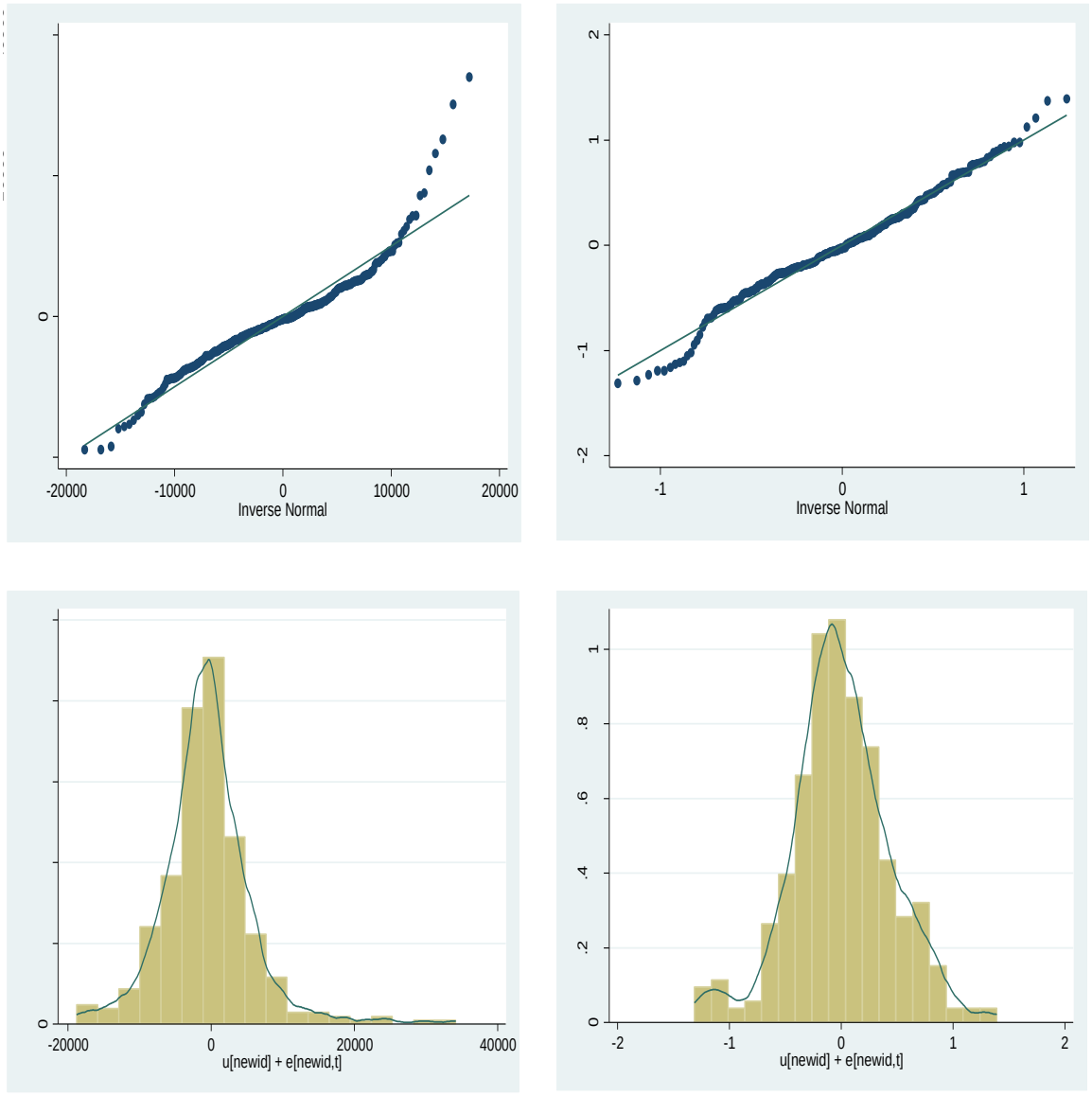


Figure 4.2 Q-Q plots, histograms, and kernel density estimates for the combined error

(A) Before the log transformation

(B) After the log transformation



CHAPTER 5 – RESULTS

This chapter investigates the outcomes of the random effects model with a log-linear model and STATA (StataCorp, 2013). Before performing random effects estimation, the presence of random effects needs to be double checked using the Hausman test since the dependent variable is transformed into the natural logarithm. The result is equivalent to that of the first Hausman test. Furthermore, random effects need to be verified using the Breusch-Pagan Lagrangian Multiplier (LM) test with the STATA command XTTEST0. The result indicates that the null hypothesis[19] is rejected and there are random individual differences among members of the sample. Rejection of the null hypothesis leads to the conclusion that the random effects model, not the pooled least squares model, is appropriate.

To analyze the factors explaining the consumption and sales patterns for ugly apples in South Korea, the random effects model is set up with monthly and yearly fixed dummies. A cluster-robust standard error is utilized to resolve the heteroscedasticity and autocorrelation in the final analysis. The random effects estimates are presented in Table 5.1. In the linear regression model, the marginal effect is equal to the relevant slope coefficient. The Appendix compares the marginal effects and elasticities. The primary advantage of the random effects model is that it enables determination of efficient estimators that employ both within- and between-group variations. It also permits estimation of time-invariant variables, unlike the fixed effects estimator.

[19] H_0: $\sigma_u^2 = 0$, it means there is no random individual heterogeneity.

Table 5.1 shows Wald Chi-square statistic is 281.16 and the p-value is 0.00. This result is statistically significant since the p-value is smaller than a 5 percent significance level. Thus, we can reject the null hypothesis and this outcome provides very strong evidence that at least one of the independent variables is an important predictor of expenditures on ugly apples. R-square is 0.5, which means the independent variables explain 50 percent of the variation of expenditures on ugly apples. Table 5.1 shows the values of σ_u, σ_e, and rho (ρ). Rho indicates the ratio of the variance of the error term (u_i) representing individual heterogeneity in the total variance of the error term. In total, u_i accounts for 54 percent of the variance of expenditures on ugly apples that is not explained by the independent variable.

5.1. Socio-demographics and the consumption of ugly apples

To increase the consumption of ugly apples, it is imperative to identify the characteristics of the consumers who purchase them. Table 5.1 illustrates the major socio-demographic determinants that positively influence consumption of ugly apples, holding everything else constant and measuring at the sample mean.

The first hypothesis assumes that younger people would consume more ugly apples than older people. Age3 is statistically significant at the 10 percent significance level, and older people (Age3)[20] tend to have 24 percent less daily expenditure on ugly apples compared to younger people (Age1).[21] This result confirms the hypothesis, indicating that younger people are more likely to choose to purchase ugly apples than older people. Thus, retailers need to target young people in marketing strategies to

[20] Age3 shows those between 55 and 64 years old.
[21] Age1 indicates those between 35 and 44 years old.

increase ugly apple sales. This finding aligns with the results obtained by de Hooge et al. (2017), which indicate that younger consumers are tolerant of purchase and consumption of suboptimal produce and have less inclination to waste suboptimal produce. In contrast, Aschenmann–Witzel et al. (2017) stated that age is negatively correlated with food waste; increasing age had a positively significant impact on the inclination to select the suboptimal food rather than optimal food at home.

The second hypothesis concerns whether those earning lower income consume more ugly apples than those with other income. Table 5.1 illustrates that income has a substantial effect on daily expenditure on ugly apples. Middle-income households' daily expenditure on ugly apples is likely to be 18 percent lower than that of lower-income households. This result is statistically significant at the 10 percent significance level. This result shows that lower-income households would comparatively purchase and consume more ugly apples than middle-income households. This finding is consistent with the conclusion made by Aschenmann–Witzel et al. (2017): higher-income households have a lower tendency to become price-focused and are less likely to purchase and consume ugly apples, even if they are sold at a 30 percent discount.

Several socio-demographic determinants of ugly apple consumption were found to be insignificant. A single-income family usually features higher price elasticity on demand than a dual-income family. The hypothesis that homemakers consume more ugly apples than breadwinners is not valid since the coefficients are not statistically significant. Panels' level of education was also not found to be a significant factor influencing the consumption of ugly apples. However, Aschemann-Witzel (2017) illustrated that

respondents with higher levels of education are more likely to select imperfect food than optimal food at home.

5.2. Markets at which ugly apples are purchased

The relationship between what consumers are willing to purchase and what grocery stores are currently selling needs to be elucidated (Petruzzelli, 2015). Ugly apple sales can increase the profits of farmers and retailers. We hypothesize that more ugly apples will be sold in a mega-scale discount store than in any other markets; online markets risk discrepancy between the product and image, and mega-scale discount stores can afford more discounts on ugly apples compared to other markets.

Table 5.1 illustrates that small-stores are negatively correlated with daily expenditure on ugly apples, with 21 percent less ugly apples compared to mega-scale discount stores. This result is statistically significant at the 10 percent significance level. It is reasonable to conclude that mega-scale discount stores have better ugly apple sales than small stores since the former can offer a high discount through bulk purchases and mass sales.

The Internet and non-store markets are positively correlated with the consumption of ugly apples, featuring 99 percent and 70 percent more sales of ugly apples, respectively, compared to mega-scale discount stores. These results are statistically significant at the one percent significance level. Consumers can easily obtain ugly apples on the Internet and in non-store markets, but they cannot freely access ugly apples at mega-scale discount stores. These results imply that the purchase of ugly apples is considerably associated with the accessibility to ugly apples.

In South Korea, fruits blemished or bruised by natural disasters such as typhoons and hail were previously used as ingredients in drinks or thrown away in landfills. However, recently, the local government in a region affected by a natural disaster negotiated with a large-scale store to promote consumption of ugly apples. This indicates that, in the case of natural disasters, general store markets may temporarily sell ugly apples. However, it is most convenient for consumers to purchase ugly apples from food trucks, traditional markets and on the Internet. In Korea, the online purchase of agricultural products sharply increased since 2014. Figure 5.1 illustrates eleven years of time series data concerning online markets' sales growth for cereals, meat, fish, vegetables, fruit, and fresh food.

This finding is in accordance with Richards and Hamilton (2018), who revealed the potential of CPMSs and indicated that a range of food items could affect consumers' preferences and help drive indirect network effects in the CPMS market. The author stated that CPMS companies such as Uber, Airbnb, and Liquid could boost consumers' enthusiasm to purchase products in a sharing economy (Bardhi & Eckhardt, 2012; Belk, 2014; Fraiberger & Sundararajan, 2017; Lamberton & Rose, 2012; Möhlmann, 2015; Sundararajan, 2014) and that CPMS markets could be a desirable business model for ugly food.

5.3. Advertising strategy to promote ugly apples

Since consumers might prefer products with which they are familiar, an exposure strategy (Zajonc, 1968) might change the purchase intentions of consumers regarding ugly apples. Tuorila et al. (1998) indicated that tasting unfamiliar food is an effective strategy to enhance consumer's recognition of products. This thesis identifies which characteristics

of ugly apples are essential for advertising strategies to promote ugly apples by comparing price-conscious consumers and non-price-focused consumers, who emphasize quality, food safety, and country of origin.

This research hypothesizes that price-conscious consumers purchase more ugly apples than non-price-focused consumers, since the apples are discounted by about 30 percent but they are just as delicious as normal apples. Table 5.1 illustrates that consumers' attitude has a substantial effect on daily expenditure on ugly apples; quality-conscious consumers tend to have 11 percent more expenditure on ugly apples compared to price-conscious consumers. This result is statistically significant at the 10 percent significance level.

The results of this study have the following implications. First, they confirm common sense, according to which people will not eat ugly apples if they do not taste good, no matter how much cheaper they are than normal apples. Thus, it is indispensable to do an advertisement that emphasizes quality rather than price to increase ugly apple sales. Second, current price discounts for ugly apples may be insignificant enough to attract price-focused consumers. Price-conscious consumers generally mean that they select some cheaper products among the same products or similar kinds of products. Correspondingly, they do not unconditionally purchase cheap ugly apples instead of normal apples since ugly and normal apples are different each other. If the current price of ugly apples is not low enough compared to that of standard apples, consumers could avoid purchasing ugly apples, no matter how price-oriented they are. Thus, a strong price-incentive is required to increase the ugly apple sales.

These findings are consistent with the outcome reported by Louis and Lombart (2018). The authors examined the effect of Intermarché's and Biocoop's advertisements for ugly fruits and vegetables, concluding that the content of the advertisements should highlight consumers' health and the taste of food rather than price. Theotokis, Pramatari, and Tsiros (2012) also indicated that the perceived lower quality of ugly produce leads to higher discounts. In contrast, Verghese et al. (2013) claimed that consumers need the incentive of price discounts to purchase imperfect produce. Supporting this finding, the ugly food marketing campaigns of supermarkets such as the French retailer Intermarché and the Dutch retailer Albert Heijn for ugly foods have successfully attracted consumers with price discounts (Aschemann-Witzel et al., 2016).

Table 5.1 Results of the random effects model (N=352)

Dependent Variable		
Purchase	Household daily expenditures on ugly apples	
Explanatory Variable	Coefficient	Robust Standard Error
Family Size	-0.040	0.034
Female	0.017	0.144
Homemaker	-0.033	0.076
Age2	-0.071	0.106
Age3	-0.235*	0.121
Age4	-0.157	0.167
Middle income	-0.184*	0.095
Higher income	-0.043	0.156
Lower education	-0.059	0.143
Middle education	-0.040	0.093
Super supermarket	0.001	0.146
Department	-0.038	0.093
Small store	-0.213*	0.120
Non-store	0.704***	0.126
Internet	0.986***	0.152
Food Stability	0.149	0.003
Food Quality	0.112*	0.065
Country of origin	0.162	0.104
Seoul	0.040	0.109
Gwangju	0.721***	0.242
Gyeongsang	0.006	0.119
sigma_u	0.389	
sigma_e	0.360	
rho	0.538	
R-squared	0.495	
Wald Chi2	281.16	
Prob >Chi2	0.000	

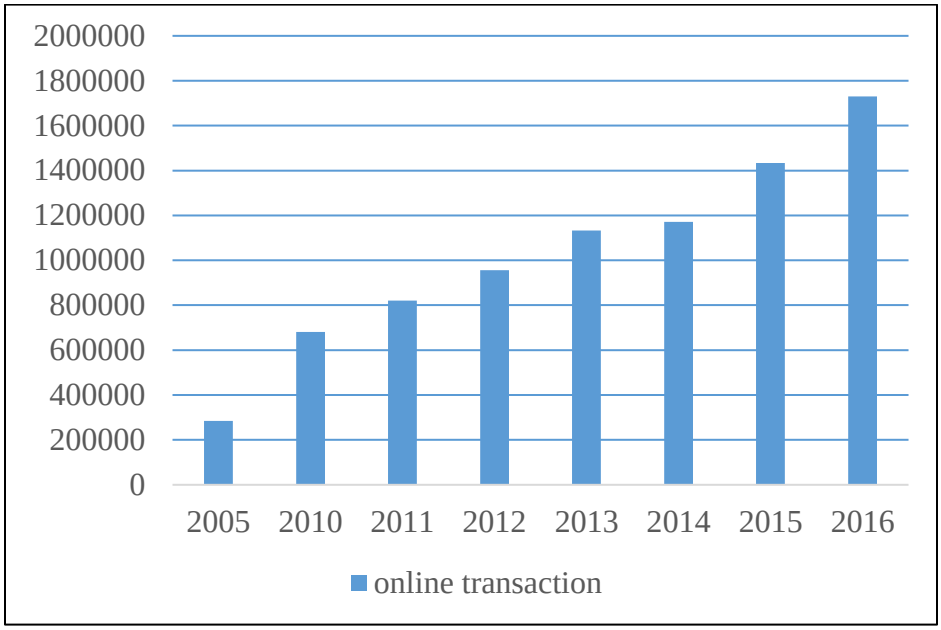
Month and year effects (Table 5.2) are included in this model but omitted from the Table.
***, **, * indicate significance at 1%, 5% and 10%.

Table 5.2 Results of the fixed dummies (N=352)

Variable	Coefficient	Robust Standard Error
1.month2	-0.01	0.14
1.month3	-0.20	0.14
1.month4	-0.12	0.16
1.month5	-0.24*	0.13
1.month6	-0.34**	0.14
1.month7	-0.26**	0.12
1.month8	-0.51***	0.17
1.month9	-0.41**	0.20
1.month10	-0.27*	0.18
1.month11	-0.18	0.14
1.month12	-0.18	0.12
1.year2	0.27***	0.14
1.year3	0.22**	0.12
1.year4	-0.03	0.10
1.year5	0.01	0.12

***, **, * indicate significance at 1%, 5% and 10%.

Figure 5.1 Online transactions for agriculture, livestock, and marine products



Source: Korea Rural Economic Institute (2017), (unit: one-million won)

CHAPTER 6 – CONCLUSION

6.1. Summary

The FAO indicated that approximately half of all wasted food is fruits and vegetables. One substantial source of food waste at the production and consumption stages is aesthetic abnormalities. These abnormalities can prevent ugly food from being sold at markets or cause it to be unconsumed and wasted, even if it is just as delicious as normal food. To prevent such food waste globally, ugly food campaigns have been designed to encourage consumption of ugly food. They started in Europe, but have since spread all over the world. Research needs to elucidate why people consume ugly food despite the profusion of standard food. The fundamental reason is that consumers have broader choices when both ugly food and conventional food is offered. In addition, consuming ugly food prevents environmental contamination by reducing food waste.

To research the problem of food waste due to non-standard appearance, this thesis examines ugly apples since apples are the most common, representative, and readily accessible fruit. The primary purpose of this study is to suggest marketing strategies and actions to facilitate consumption and sales of ugly apples, and then expand these strategies and actions to other ugly fruits and vegetables. To accomplish this goal, this study first confirmed the socio-demographic factors that affect the consumption of ugly apples. It determined which markets, including stores and non-stores, sell more ugly apples. It also examined which features of ugly apples should be emphasized in advertising for ugly apples to appeal to consumers.

For analysis of the consumption and sales of ugly apples, data from the consumer panel collected by the Rural Development Administration (RDA) in Korea is employed in this paper. In total, 352 observations between 2013 and 2017 are examined. The study employed the random effects model for panel analysis. The marginal effects were also estimated to determine the expected expenditures on ugly apples. The results indicated, in terms of socio-demographics, younger people and lower-income households are likely to consume more ugly apples. Regarding the markets in which ugly apples are purchased, online markets and non-stores such as food trucks and traditional markets are likely to sell more ugly apples compared to mega-scale discount stores. In addition, it is necessary to utilize marketing strategies that emphasize quality rather than price to advertise ugly apples.

6.2. Implications

Based on the results of this research, there are several implications regarding the promotion of ugly apple consumption and sales, and the results could be extended to marketing strategies for other ugly fruits and vegetables in the future. First, an environment in which retailers sell ugly apples should be developed. To foster this environment, a plan should be created to promote retailers who sell ugly apples as admirable. Additionally, policymakers need to establish an official certification system for retailers who sell ugly food. Certification would provide consumers with an image of retailers as good Samaritans that are striving to reduce food waste and eliminate the negative perception of retailers that sell ugly apples. The ugly food campaign can create markets in which grocery retailers sell imperfect produce and make a profit, and have the

opportunity to differentiate themselves from their competitors. It can also be an alternative way to solve the food waste problem and reduce the environmentally adverse effects of food waste.

Moreover, the government and retailers could invest in advertising to alter consumers' behavior and cause them to be open to unfamiliar products. Instead of emphasizing price, such advertising should be focused on the fact that the quality of ugly food is equivalent to that of standard food. Further, retailers need to implement marketing strategies to sell ugly apples at all times online markets, which are readily accessible to consumers.

Furthermore, there is a need for change in consumers' attitudes and perceptions regarding the consumption of ugly apples to foster sustainable changes (Heller & Keoleian, 2003). However, it is difficult to change attitudes and perceptions in a short period due to individuals' long consumption habits. As a strategy for achieving change, policymakers need to expose people to ugly food from early childhood. Children need to experience the reality that ugly fruits and vegetables, including apples, are not different from normal produce except appearance. If children can look at crooked carrots, dinged apples, misshapen potatoes, or small peaches and understand that these foods taste good, struggling farmers may benefit and food waste may be reduced.

6.3. Limitations and opportunities for future research

Consumer panel data offers a superb opportunity to investigate households' daily expenditures on ugly apples. However, there was a lack of data regarding households' expenditure activities in this study. Future research is needed with larger samples. Concerning future research, the impact of price on ugly food needs to be investigated in order to identify the price elasticity on quantity demanded. Calculating price elasticity reveals the percentage of variation in the quantity demanded in response to a one-percent change in the price of ugly apples. Lower price for ugly apples can undoubtedly enhance consumption of them. However, according to the results of this study, quality-focused customers consume more ugly apples than price-conscious consumers in terms of daily expenditure on ugly apples. This result implies that the current price discounts for ugly apples might be not significant enough to attract price-focused consumers; no matter how price-conscious consumers are, they might avoid purchasing ugly apples due to non-satisfaction with the price. Thus, identifying the price elasticity of ugly apples can stimulate consumption of ugly apples. In this data, the calculation of the price elasticity on quantity demanded is difficult, since the units by which the quantity demanded of ugly apples are determined are non-standard.

Petruzzelli (2015) indicated that price-discounted seconds could attract more price-conscious consumers, while mutants could attract consumers as novelty products, and consumers between markets in low- and high-income areas responded differently to mutants and seconds. Therefore, future research should examine consumers' reactions to ugly apples with different deviations in appearance, such as mutants and seconds.

APPENDIX

The comparison between Marginal effects and Elasticities (N=352)

Variable	Marginal effect	Elasticity
Family Size	-0.04	-0.015
Female	0.017	0.002
Homemaker	-0.033	-0.002
Age2	-0.071	-0.002
Age3	-0.235*	-0.007*
Age4	-0.157	-0.002
Middle income	-0.184*	-0.013*
Higher income	-0.043	-0.001
Lower education	-0.059	-0.001
Middle education	-0.04	-0.001
Super supermarket	0.001	0.00
Department	-0.038	0.00
Small store	-0.213*	-0.003*
Non-store	0.704***	0.009***
Internet	0.986***	0.012***
Stability	0.149	0.055
Quality	0.112*	0.002*
Country of origin	0.005	0.012
Seoul	0.033	0.001
Gwangju	0.721***	0.002***
Gyeongsang	-0.01	0.00

***, **, * indicate significance at 1%, 5% and 10%.

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