An Empirical Analysis of Japanese Food Demand with Special Reference to Beef
(日本の食料需要に関する実証分析—特に牛肉について—)

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An Empirical Analysis of Japanese Food Demand with Special Reference to Beef

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DOCTOR OF PHYLOSOPHY

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ABSTRACT

This thesis conducts empirical analysis of food demand in Japan, focusing on beef demand. The thesis takes in to account different datasets from different sources, namely family income expenditure survey and consumers' price index, agriculture and livestock corporation industries and trade statistics of Japan. In this study, monthly, daily and regional pseudo-panel data is used. Factors such as expenditure and price changes, demographics, regions, seasons, time trend, food scare outbreaks (BSE and FMD), tariff reductions, days of the week, public holidays, Golden Week, Bon, o-chūgen and o-seibo are taken in to consideration. The thesis used different estimation techniques like linear approximate quadratic almost ideal demand system (LA-QUAIDS) and the quadratic extension of Working's (1943) models. The estimation results show that there are regional effects on the quantity demanded for gift food categories as Japan has various regional cuisines and food specialties. As for the eating habit, pork is popular in major cities in eastern Japan, while beef is popular in western Japan. Chicken is similar to beef except for Yokohama. In the case of food scare outbreaks, the impact of BSE on the demand for beef is more severe than that of FMD. It also takes longer time to recover than the impact of FMD. In this study, the impacts of trade agreements that are followed by change in tariff rate are also found to be important. Among the domestically produced beef items, dairy beef is the most impacted both by Australian and US agreements, whereas the Wagyu beef is the least impacted by the agreements. Therefore, with respect to the food scare outbreaks and subsequent crisis, meat industries and government agencies need to consider important measures such as strengthening quality control system. Precautions should be made regarding to the domestic beef production before the new trade agreements are signed. Japanese government as well as every stakeholder to consider the factor that could hinder the supply of both domestic and imported beef as well regional beef consumption.

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CHAPTER 1: Introduction

1.1. Research Background

Food in Japan is not only a meal meant to be eaten, but also an important aspect of culture. It is used as one of the socialization tools. For instance, Japanese invest a substantial amount of money on gift-giving (Rupp, 2003). Befu (1964) stated that food is considered the traditional type of gift in Japan. Japanese buy luxury food seasonally as gifts for family, friends, or colleagues. O-chūgen and o-seibo are particularly popular gift-giving events in Japan.

Japanese food consumption pattern has been undergoing dramatic changes over the last several years. There have been increasing consumption of meats, such as beef and dairy products, while there have been decreasing consumption of rice, fish, fresh fruits, as well as fresh and processed vegetables in Japan. Meat consumption, beef in particular, does not have a long history in Japan due to a dietary ban on the eating of flesh from four-legged animals before the Meiji Restoration (Kiple and Ornelas, 2000). However, there has been gradual changes for years and eventually meat products have become important food items in the Japanese diets. The opening of Japan's borders was seen as an opportunity to integrate Western customs into Japanese culture as well as removal of the longstanding social taboo against the eating of meat became a symbol of this integration. Particularly, ever since Japan had started westernization, its food consumption pattern have undergone dramatic changes, and consumption of meat products has been getting more important in the Japanese diet (Chern et al., 2002).

The followings are some of the reasons attributing to the increase in the demand for meat, beef in particular. As it is obviously known historically, Japan had protected its domestic beef market from imported beef through various protectionism policies. As a result of the policies, Japanese consumers had paid four to five times more for beef than do US consumers (Wahl et al., 1991; Weatherspoon and Seale, 1995). However, beef import has rapidly increased due to greater Japanese demand for beef, limitations on increasing domestic beef production, and pressure from beef exporting countries. Trade agreements, such as Beef Market Access Agreement (BMAA) and Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) have attributed to the influx of imported beef in Japan (Lee and Itakura, 2014; Manger, 2005; Takahashi and Maeda, 2018; Todsadee et al., 2012; Wahl et al., 1991). BMAA agreement reduced quota restrictions on imported beef, and agreed to increase beef imports as well as to replace the import quota by an import tariff in 1991 (Coyle, 1984; 1990; Weatherspoon and Seale, 1995). After beef tarification policy of 1991, the quantity demanded for imported beef has increased. However, when compared with other developed countries, per capita consumption of Japan is still very low. For instance, as a developed and top meat per capita consumer, Australia consumes 21.6, 20.1, 39.6 and 9.0 kilograms per capita per year of beef, pork, chicken and mutton respectively, while Japan consumes 7.0, 15.0, 13.4 and 0.1 kilograms per capita per year of beef, pork, chicken and mutton respectively (OECD, 2014)

Meat demand has not shown a steady upward throughout the time. It has been fluctuating due to a growing concern about the health and safety of food, also known as food scare problems. A food scare is an incident of widespread public anxiety about the food supply, especially concerning contamination. It can cause a sudden disruption to food supply chains as well as to food consumption patterns. Public awareness of food scares increased worldwide during the past two decades, with highly publicized cases of foot-and-mouth disease (FMD) and bovine spongiform encephalopathy (BSE) outbreaks reported in EU, US, Canada, Japan, and other regions. Food scares are one of the few shocks that can abruptly eliminate an entire nation from export markets. Such events have both short-run and long-run impacts on consumer preferences (Saghaian et al., 2007). They have far-reaching impacts: an outbreak in one country can dictate the demand pattern of the other countries. For instance, when BSE and its association with a human disease called Creutzfeldt-Jacob's disease (CJD) was announced in March 1996 in the United Kingdom (UK), there was an immediate collapse in the consumption of beef in the following month by 40% in the country. The incidence of BSE in the UK has also impacted the demand in other countries such as Germany and Italy, which had no reported cases of BSE at the time (DTZ Pieda Consulting, 1998). It is also important to understand the negative spillover effect of the food scare crises on other agricultural products from the same country. The outbreak of BSE in December 2003 in the US led some Japanese consumers to refrain from buying not only US beef but also other agricultural products from the US (Ishida et al., 2012). The publicity of the BSE produced a shift of consumer spending from red to white within meat items during the 1990s (Fousekis and Revell, 2004).

There are various previous research outputs where demand for food, meat in particular, has been frequently estimated. Baharumshah and Mohamed (1993), Burki (1997), Osho and Uwakonye (2003), Taljaard et al. (2004), Wadud (2006) and Zhou (2015) are a few among those estimated demand for meat in different countries using Linear Approximated Almost Ideal Demand System (LA/AIDS) model with the effect of traditional economic variables (price and expenditure). Adetunji and Rauf (2012), Basarir (2013), Cupák et al. (2015), Dhraief et al. (2013), Jung and Koo (2002), Lee (2000), Millán (1994), Nayga (1994), Prasad (2010), Salvanes and Devoretz (1997) and Tonsor et al. (2010) estimated demand for food with the incorporation of various demand shifting variables like taste, religion, socio-economics, demographics, region, season, household dynamics and media information in addition to traditional economic variables. The impacts of food scares by Lloyd et al. (2001). The effects of trade agreements on the demand for beef in particular and the demand for meat in general by Hayes et al. (1990), Kawashima and Sari (2010), Matsuda (2014), Mori and Lin (1990), Takahashi and Maeda (2018), and Wahl et al. (1991).

However, with regards to beef demand analysis in Japan from various perspectives has been conducted by Dinku and Matsuda (2017; 2018; 2019). This thesis intends to provide a comprehensive demand system analysis of meat demand in Japan taking in to consideration various factors such as expenditure and price changes, demographic, seasons, regions food scares (BSE and FMD) and bilateral trade agreements, Such as Japan-Australia Economic Partnership Agreement (JAEPA) and Japan-US Free Trade Agreement (*JUSFTA*).

1.2. Overall Study Objectives

In Japan food, meat in particular, is used for different purposes apart from eating. There are various factors that influence the demand for meat in Japan. Economic, demographic, time trend, regional and seasonal characteristics should be considered for a better understanding of the depth and breadth of demand for meat in Japan. There are other reasons why we are motivated to estimate the demand for meat and seafood in Japan; the country is among the top meat importing countries in the world, Japan is home of the world's brand beef 'Wagyu' in particular, and there is clear variation in the consumption pattern among regions with different geographical locations as well as strong and noticeable demographic shifts. In addition, food scares, non-economic demand shifters such as BSE and FMD, are playing significant in the demand for meat, particularly beef. The studies show that each of the food scares has different degrees of impact on the demand for beef. Since the beef consumption in Japan is increasing over time, it is always important to investigate the factors that responsible for the demand shift. Also, the impacts of the JAEPA and *JUSFTA* trade deals is huge on the demand for beef in Japan.

The main objectives of the thesis are as follows:

i. To determine the Economic, demographic, time trend, regional and seasonal effects on the demand for gift food.
ii. To evaluate the effects regional differences on the demand for meat and seafood.
iii. To estimate the impacts of food scares, BSE and FMD, in Japan, and to see the extent to which these effects have spill over to other meats.
iv. To estimate the effects of the public holidays, Golden Week, Bon, end and beginning of the year, months and days of the week on the demand for meat.
v. To estimate the impacts of Japan-Australian EPA and Japan-US FTA on the demand for domestically produced beef items−Wagyu beef, crossbred beef and dairy beef.

The idea of choosing the study to be in Japan is reasonable since the data from Family Income and Expenditure Survey (FIES), Agriculture and Livestock Corporation Industries (ALIC) and Trade Statistics of Japan are very reliable. In addition, Japan is home of the world's brand beef 'Wagyu'. Japan is one of the developed OECD member countries, with low meat consumption per capita. However, in recent times, Japan is also the country in which meat consumption is growing at a very fast rate due to various factors.

The novelty of this thesis is estimating the demand of food gift-giving using household quantitative data in Japan, estimating the effects of the regional differences on the demand for meat and seafood in Japan, the negative impacts of the food scares (BSE and FMD) on the demand for beef, and its spillover effects on the other meat items. Moreover, estimating the impacts of the Japan-Australia EPA and Japan-US FTA on the demand for disaggregated domestically produced beef−Wagyu beef, crossbred beef and dairy beef, and imported US beef as well as Australian beef. Therefore, as far as our knowledge is concerned, this study is the first to estimate the impacts of the above factors on the demand for meat, beef in particular, in Japan.

1.3. Materials and Methodology

In many countries there are few or no panel data of consumers' expenditure. For Japan, however, there exists a series of independent cross sectional data in which household surveys are carried out every month. New samples of cross-section are drawn each quarter so the individual households cannot be traced over time. Deaton (1985) suggests that the use of pseudo panel data is an alternative econometric method for estimating demand models of individual household behavior. Therefore, since micro data is not available in the Family Income Expenditure Survey of Japan, the aggregate micro data has been used in this study. All the price and expenditure data are deflated using Consumer Price Index (CPI). Daily and monthly aggregated pseudo panel data for two or more person households were used. These data and CPI are published by the Statistics Bureau, Ministry of Internal Affairs and Communications of Japan. There are also other data sources, the quantity and wholesale prices of both imported and domestic beef items are published by the Agriculture and Livestock Industries Corporation, and the data for the quantity of exported Japanese beef is published by the Trade Statistics of Japan. In our data, there various non-economic factors, such as regions, seasons, time trend, months, days of the week, public holidays (observances), Golden Week, Bon, and end and beginning of the year as well as BSE and FMD are aimed to be estimated for their impacts on the demand for beef in particular and food in general. However, there are couple of limitations in our data, for instance lack of data for other demographic groups such as gender, age and race. In addition, the omission of the data of Fukushima (April and May 2011) as a result Great East Japan Earthquake. SHAZAM econometrics software was applied for our model.

The econometrics models that have been chosen for this study are the almost ideal demand system (AIDS) and Engel Curve models. The AIDS is a consumer demand model (Deaton and Muellbauer, 1980). It is a versatile system capable of studying various aspects of food demand. However, the AIDS model has difficulty of capturing the effects of non-linear Engel curve because it has budget share equations that are linear in the logarithm of expenditure. The quadratic form of the AIDS model (QUAIDS), which was first developed by Banks, Blundell, and Lewbel (1997), is not only more versatile in modelling consumer expenditure, but also it restores the relevant properties of AIDS. In this study, we included demand shifters such as demographic variables, monthly and regional dummy variables. The demand shifters are incorporated in a manner that maintains theoretical properties of the model. The estimated demand system must be closed under unit scaling (CUUS) (Alston, Chalfant, and Piggott, 2001). With the inclusion of the demand shifters, the original nonlinear QUAIDS does not fulfill the property of CUUS. The linear version (LA/QUAIDS), which was developed by Matsuda (2006), embraces the characteristics of CUUS even with demand shifters. Therefore, we employed the LA/QUAIDS.

In addition, An Engel curve, which describes how expenditure relates to the demand for a particular good/service holding the price fixed, is employed. Working (1943) finds the tendency for the proportion of expenditure devoted to food decreases in an arithmetic progression as total expenditure increases in a geometric progression. This relationship applies for families of every size, occupation, and community. At an individual level, as total expenditure per person increases, the proportion of an expenditure devoted to food decreases. Leser (1963) investigates various forms of Engel functions that are satisfying the additivity criterion. He suggests that a form of relationship used by Working (1943) has great advantageous.

However, the Working-Lesser Engel curve has difficulty in capturing non-linear effects of expenditure because it has a budget share equation that are linear in the logarithm of expenditure. Analysis of the household budget surveys have pointed to more curvature in the Engel curve relationship than which is permitted by the standard Working-Lesser form. The appropriate form that can support generalization in the shape of Engel curve relationship is shown by a quadratic extension of Working's model. The quadratic extension of the Working's model, which is used in Banks et al. (1997), restores the relevant properties of its linear counterpart and allows more flexibility in expenditure change.

1.4. Structure of the thesis

This thesis is divided into six chapters; chapter one reports about introduction of the thesis. Chapter is about demand for food gift-giving in Japan. Chapter three reports regional effects on the demand for meat in Japan. Chapter four evaluates the impact of the BSE and FMD outbreaks on meat demand: an Engel curve analysis of Japanese daily data. Chapter five presents effects of bilateral trade agreements on the demand for beef in Japan: the case of Japan-Australia EPA and Japan-US FTA, and chapter six reports the summary and conclusions as well as policy recommendation.

CHAPTER 2: Demand for Food Gift-Giving in Japan

This chapter presents food gift-giving in Japan. Gift-giving is a social, cultural and economic practices that are prevalent across all cultures and societies around the world. Gift exchanges play important roles in connecting and integrating societies. The benefits of gift exchanges, which extend beyond the economic use, have been analyzed by several authors (Hollenbeck, Peters, and Zinkhan, 2006; Komter and Vollebergh, 1997; Sherry, 1983; Wolfinbarger and Gilly, 1996). Weddings, births, funerals, birthday parties, Christmas, Valentine's Day, Mother's and Father's Day, exams, promotions, jubilees, moving house, welcome or farewell parties, graduations, anniversaries, Thanksgiving Day, White Day, o-chūgen (mid-year gift) and o-seibo (year-end gift) are some of the familiar gift-exchange occasions (Belk, 1975; Fischer and Arnold, 1990; Kimura and Belk, 2005; Netemeyer, Andrews, and Durvasula, 1993; Otnes and Ruth, 1994; Rucker, Freitas, and Dolstra, 1994; Yau, Chan, and Lau, 1999). White Day, o-chūgen and o-seibo are particularly popular in Japan. Valentine's Day (February 14) and White Day (March 14) are celebrated in a unique style. Valentine's Day in Japan is when women give gifts to men, and White Day is when men give gifts to women.

In Japan, as in many parts of the world, the gift-giving is extremely important, and a common part of Japanese culture. It is not only an integral part of personal relationship building but also essential for building person-to-corporate relationships. It extends beyond holidays and special occasions (United States Department of Commerce, 2015). Japanese invest a substantial amount of money on gift-giving (Rupp, 2003). Befu (1964) stated that food is considered the traditional type of gift in Japan. Japanese buy luxury food seasonally as gifts for family, friends, or colleagues. The country has various regional cuisines and food specialties such as fruits, vegetables, seafood and beef. Even though most of the local products are now available nationwide, products that have specific local features and limited scale of production can let the products retain a luxury status (Frost and Sullivan, 2015). Gift-giving has changed in many different ways. Possible gifts as well as gift-giving occasions have been diversified but overall gift expenditure has declined (Minowa et al., 2011). The decline of gift expenditure is in part due to change of gift-giving practice over time. Previously dominant gift food items and markets are largely attributable to older Japanese. Seasons have tremendous effects on demand because of the seasonal nature of the gifts. Both corporate and personal gift-giving seasons are predominantly around mid-year (summer) and end of the year (Rupp, 2003).

The topic of gift-giving has gained importance in the field of consumer behavior (Beatty et al., 1991; Camerer, 1988; Green and Alden, 1988; Carroll et al., 2005; Minowa and Gould, 1999; Ward and Tran, 2007). Most of the studies have employed qualitative data. However, very few studies, such as Camerer (1988) and Carroll et al. (2005), have employed quantitative data for the gift and charity-giving studies using double-hurdle model. Economic, demographic, time trend, regional and seasonal characteristics should be considered for a better understanding of the depth and breadth of demand for gift food in Japan using quantitative data. As far as our knowledge is concerned, this study is the first to use household quantitative data for the gift-giving demand estimation in Japan. The study will contribute to the growing research on gift exchange. It will also provide empirical evidence which could be helpful as a reference for policy and business evaluations. The next sections of the chapter are discussion of data and model part, and followed by a discussion of empirical results. Finally, it offers some concluding remarks.

2.1. Data and Model

This study uses monthly aggregated pseudo panel data for two or more person households for 52 major cities in Japan for the period from January 2000 through December 2017. In total, a sample of 10,884 observations. However, the sample size reduces to 10,882 due to the omission of the two observations of Fukushima (April and May, 2011) as a result of the Great East Japan Earthquake. The data are available only from January 2008 to December 2017 for Hamamatsu and Sakai cities, and from January 2013 to December 2017 for Sagamihara city. Our expenditure data include food consumed in the household and gift food. It also incorporates eating-related entertainment to a small degree, for instance, the expenditure data for a household's eating out and inviting others to eating out are included. The data are from Family Income and Expenditure Survey (FIES) and Consumer Price Index (CPI), both published by the Statistics Bureau of the Ministry of Internal Affairs and Communications of Japan.

Considering changes in the prices, all expenditure data for cereals, seafood, meat, milk/eggs, vegetables, fruits, confectioneries, cooked food, beverages, alcohol and eating out were deflated using the CPI. The iterative seemingly unrelated regression was used to estimate the system of twelve equations. This study employs two types of dummy variables into the demand system, namely, monthly dummy variables to see seasonal variations for food gift-giving and city dummy variables to see the effects of 52 major cities on the demand for gift food. Tokyo is considered the baseline city. Demographic variables are also incorporated in to our data set to see their roles on the households' gift-giving behavior. The demographic variables include the number of persons per household (household size, z_1), the number of persons under the age of 18 in the household (number of minors, z_2), the number of persons over the age of 65 in the household (number of seniors, z_3), and the number of earners in the household (number of earners, z_4).

The Almost Ideal Demand System (AIDS) is a consumer demand model (Deaton and Muellbauer, 1980). It is a versatile system capable of studying various aspects of food demand. However, the AIDS model has difficulty of capturing the effects of non-linear Engel curve because it has budget share equations that are linear in the logarithm of expenditure. The quadratic form of the AIDS model (QUAIDS), which was first developed by Banks et al. (1997), is not only more versatile in modelling consumer expenditure, but also it restores the relevant properties of AIDS. In this study, we included demand shifters such as demographic variables, monthly and regional dummy variables. The demand shifters are incorporated in a manner that maintains theoretical properties of the model. The estimated demand system must be closed under unit scaling (CUUS) (Alston et al., 2001). With the inclusion of the demand shifters, the original nonlinear QUAIDS does not fulfill the property of CUUS. The linear version (LA/QUAIDS), which was developed by Matsuda (2006), embraces the characteristics of CUUS even with demand shifters. Therefore, we employ the LA/QUAIDS.

According to Matsuda (2006), the LA/QUAIDS equation is put as:

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \log p_j + \beta_i \log \frac{y}{P^C} + \frac{\lambda_i}{P^Z} \left(\log \frac{y}{P^C} \right)^2 \quad i, j = 1,2,.....,n \tag{1}$$

where w_i is the share of expenditure allocated to good i, y is the total expenditure on all the goods in the system, p_j is the price of good j, and α_i, β_i, γ_{ij} and λ_i are parameters to be estimated. P^C is the loglinear analogue of the Laspeyres price index and shown as:

$$\log P^C = \sum_{i=1}^{n} \overline{w}_i \log p_i \tag{2}$$

P^C is invariant to changes in units. ¯ stands for the sample mean. We apply index P^Z as proposed by Matsuda (2006):

$$\log P^Z = \sum_{i=1}^{n} (w_i - \overline{w}_i) \log \frac{\overline{p}}{p_i} \tag{3}$$

where P^Z could be seen as a zero degree homogenous analogue of the Törnqvist price index and is also invariant to changes in units.

We included the effects of time trend, demographics, cities and months as regressors in the empirical model. Our empirical model of the LA/QUAIDS is, therefore, specified as:

$$w_i = \alpha_{i0} + \alpha_{i1}t + \sum_{k=1}^{4}\alpha_{i,1+k}z_k + \sum_{m=1}^{11}\alpha_{i,5+m}D_m + \sum_{r=1}^{51}\alpha_{i,16+r}M_r + \sum_{j=1}^{12}\gamma_{ij}\log p_j + \beta_i \log\frac{y}{P^C} + \frac{\lambda_i}{P^Z}\left(\log\frac{y}{P^C}\right)^2 \quad i = 1,2,....,12 \tag{4}$$

where t indicates the time trend, z_k are demographic variables, D_m are monthly dummy variables and M_r are city dummy variables.

To be consistent with economic theory, parameters of demand equations must satisfy adding up, homogeneity and Slutsky symmetry restrictions as follows:

$$\sum_{i=1}^{12}\alpha_{i0} = 1 \quad \sum_{i=1}^{12}\alpha_{ih} = 0 \qquad h = 1,2,...,67 \tag{5}$$

$$\sum_{i=1}^{12}\gamma_{ij} = 0 \quad \sum_{i=1}^{12}\beta_i = 0 \quad \sum_{i=1}^{12}\lambda_i = 0 \quad j = 1,2,...,12 \tag{6}$$

$$\sum_{j=1}^{12}\gamma_{ij} = 0 \qquad i = 1,2,...,12 \tag{7}$$

$$\gamma_{ij} = \gamma_{ji} \qquad i,j = 1,2,...,12 \tag{8}$$

Expenditure, uncompensated and compensated price elasticities are calculated as:

$$\varepsilon_i = 1 + \frac{\beta_i}{w_i} + \frac{2\lambda_i}{w_i P^z}\log\frac{y}{P^C} \qquad i = 1,2,.....,12 \tag{9}$$

$$\varepsilon_{ij} = -\delta_{ij} + \frac{\gamma_i}{w_i} - \frac{\beta_i \overline{w}_j}{w_i} - \frac{\lambda_i}{w_i P^Z}\left[2\overline{w}_j + (w_j - \overline{w}_j)\log\frac{y}{P^C}\right]\log\frac{y}{P^C} \quad i,j = 1,2,.....,12 \tag{10}$$

$$\varepsilon^C{}_{ij} = \varepsilon_{ij} + \varepsilon_i w_j \text{ (Slutsky Equation)} \qquad i,j = 1,2,......,12 \tag{11}$$

Monthly rates of shift (%/month) are calculated as:

$$\frac{10^2}{q_i}\frac{\partial q_i}{\partial t} = \frac{10^2}{w_i}\frac{\partial w_i}{\partial t} = \frac{10^2\alpha_{i1}}{w_i} \qquad i = 1,2,...,12 \tag{12}$$

Demographic effects (%/person), seasonal (monthly) effects (%) and regional (city) effects (%) are calculated in the same way, replacing t with z_k, D_m, M_r.

2.2. Empirical Results

Table 2.1. Estimates of expenditure and uncompensated price elasticities at the mean share

Demand q_i	Expenditure y	Price p_j Cereals	Seafood	Meat	Milk/ Eggs	Vegetables	Fruits	Oils/ Fats	Confectioneries	Cooked food	Beverages	Alcohol	Eating out
Gift-use													
Cereals	1.263 ***	-0.564 **	-0.209	-0.438 ***	-0.065	0.174	-0.155	-0.124	0.401 *	-0.329 **	-0.060	-0.109	0.216
Seafood	1.073 ***	-0.123	-1.164 ***	-0.011	-0.039 **	-0.140 **	-0.150 **	-0.102 **	-0.272 **	-0.142 **	0.067	0.193 **	0.810 ***
Meat	1.119 ***	-0.601 ***	-0.027	-0.814 ***	-0.003	0.236 **	-0.082	0.244 **	0.186	-0.139	-0.152	-0.150	0.183
Milk/ Eggs	0.684 ***	-0.560	-0.543 **	-0.009	-0.267	0.167	-0.270	-0.157	0.104	0.576	0.733	0.608	-1.065 *
Vegetables	1.099 ***	0.204	-0.258 **	0.194 **	0.019	-1.096 ***	0.189 **	0.065	-0.343 **	-0.068	0.210 *	0.054	-0.272
Fruits	1.506 ***	-0.088	-0.150 ***	-0.041	-0.019 *	0.070 *	-1.117 ***	0.004	-0.335 ***	0.031	-0.014	-0.112 **	0.266 **
Oils/ Fats	1.330 ***	-0.290	-0.396 **	0.403 **	-0.044	0.125	0.031	-1.465 ***	-0.079	0.544 **	0.012	-0.188	0.017
Confectioneries	0.569 ***	0.089 ***	-0.033	0.036 *	0.002	-0.027	-0.025	0.008	-0.760 ***	0.072 ***	-0.062 **	0.060 **	0.072
Cooked food	0.860 ***	-0.251 **	-0.171 *	-0.074	0.051	-0.040	0.100	0.199 **	0.313 **	-0.775 ***	0.076	-0.022	-0.265
Beverages	1.194 ***	-0.067	0.117	-0.130	0.093	0.212 *	-0.007	0.008	-0.650 ***	0.092	-1.253 ***	-0.103	0.494
Alcohol	1.120 ***	-0.077	0.234 **	-0.083	0.050	0.035	-0.141 **	-0.058	0.154	-0.033	-0.065	-1.159 ***	0.023
Eating out	1.130 ***	0.032	0.157 ***	0.016	-0.017 *	-0.031	0.095 ***	0.004	-0.091 *	-0.054	0.054	0.003	-1.300 ***
Home-use													
Cereals	0.770 ***	-0.621 ***	-0.068 ***	-0.092 ***	-0.045 ***	-0.080 ***	-0.033 ***	0.033 ***	-0.033 ***	-0.019	0.021	0.018	0.148 ***
Seafood	1.021 ***	-0.088 ***	-0.946 ***	0.063 ***	0.067 ***	-0.071 ***	-0.007	-0.055 ***	-0.043 ***	0.101 ***	-0.041 ***	-0.002	0.001
Meat	0.861 ***	-0.101 ***	0.083 ***	-0.848 ***	-0.016 **	-0.014 *	0.005	0.002	0.029 ***	0.051 ***	0.018 **	-0.016	-0.054 **
Milk/ Eggs	0.756 ***	-0.082 ***	0.157 ***	-0.020	-0.948 ***	-0.011	0.058 ***	0.039 ***	0.094 ***	-0.015	0.146 ***	0.022	-0.194 ***
Vegetables	0.845 ***	-0.067 ***	-0.039 ***	-0.009	-0.009 *	-0.655 ***	0.016 ***	-0.040 ***	-0.035 ***	-0.018 *	-0.009	0.018 **	0.004
Fruits	1.114 ***	-0.111 ***	-0.026 **	-0.012	0.056 ***	0.016	-0.867 ***	0.005	-0.069 ***	0.046 **	0.036 ***	-0.061 ***	-0.127 ***
Oils/ Fats	0.724 ***	0.072 ***	-0.088 ***	0.017	0.044 ***	-0.092 ***	0.019 **	-0.963 ***	0.114 ***	0.064 ***	-0.064 ***	0.030	0.123 ***
Confectioneries	0.816 ***	-0.046 ***	-0.038 ***	0.040 ***	0.061 ***	-0.056 ***	-0.025 ***	0.068 ***	-0.902 ***	0.051 ***	-0.101 ***	0.027	0.106 ***
Cooked food	0.960 ***	-0.033 **	0.088 ***	0.030 ***	-0.016 *	-0.033 ***	0.021 ***	0.014 *	0.020 *	-0.982 ***	-0.027 **	0.025 *	-0.068 **
Beverages	1.013 ***	0.014	-0.074 ***	0.018	0.123 ***	-0.041 ***	0.030 ***	-0.068 ***	-0.151 ***	-0.068 ***	-0.859 ***	-0.087 ***	0.150 ***
Alcohol	1.316 ***	-0.015	-0.033	-0.073 ***	-0.005	-0.010	-0.059 ***	0.003	0.006	0.023	-0.117 ***	-0.796 ***	-0.239 ***
Eating out	1.448 ***	0.020	-0.041 ***	-0.084 ***	-0.093 ***	-0.071 ***	-0.043 ***	0.001	0.000	-0.108 ***	0.025 **	-0.073 ***	-0.981 ***

Note. The significance levels are 1%, 5% and 10%, and denoted by ***, **, *, respectively.

Table 2.1 reports the estimates of expenditure and uncompensated price elasticities at the mean share. All expenditure elasticities are positive and significant at the 1% level. Our empirical model is a conditional demand system. Expenditure is just for food. Most of the gift food categories are relatively expenditure elastic, while a few of them such as milk/eggs (0.684), confectioneries (0.569) and cooked food (0.860) are expenditure inelastic. To be more precise, the expenditure elasticities for fruits (1.506) and oils/fats (1.330) are the most elastic. As for the household's own-use (hereafter "home-use") food, seafood (1.021), fruits (1.114), beverages (1.013), alcohol (1.316) and eating out (1.448) are expenditure elastic, while seven of the twelve categories are expenditure inelastic. The results clearly show that gift food categories are relatively more expenditure elastic than regularly consumed food. Uncompensated price elasticities contain both income and substitution effects. All the uncompensated own-price elasticities are negative, and most of them are statistically significant. Oils/fats gift (-1.465) is the most own-price elastic. This means that oils/fats gift is relatively sensitive to its own price changes. This result is sensible as cooking oil gifting is a long-standing tradition among the Japanese. As for the home-use food, all food categories are own-price inelastic. Among the estimates of 132 uncompensated cross-price elasticities, 22 pairs are significant gross substitutes for gift food categories, whereas 25 pairs are found to be significant gross complements. For home-use food categories, 40 pairs are significant gross substitutes, while 58 pairs are found to be significant gross complements.

Table 2.2. Estimates of compensated price elasticities at the mean share

Demand q_i	Price p_j											
	Cereals	Seafood	Meat	Milk/ Eggs	Vegetables	Fruits	Oils/ Fats	Confectioneries	Cooked food	Beverages	Alcohol	Eatig out
Gift-use												
Cereals	-0.513 **	-0.128	-0.401 ***	-0.059	0.218 *	-0.055	-0.102	0.738 ***	-0.267 *	-0.016	-0.042	0.628 *
Seafood	-0.080	-1.095 ***	0.020	-0.035 *	-0.102 *	-0.065	-0.083 *	0.014	-0.089	0.104	0.250 ***	1.160 ***
Meat	-0.556 ***	0.045	-0.781 ***	0.002	0.275 ***	0.007	0.264 ***	0.484 **	-0.083	-0.113	-0.091	0.548 *
Milk/ Eggs	-0.533	-0.498 *	0.010	-0.264	0.192	-0.216	-0.145	0.286	0.609	0.757 *	0.644	-0.842
Vegetables	0.249 *	-0.187 *	0.226 ***	0.024	-1.057 ***	0.276 ***	0.084	-0.050	-0.013	0.248 **	0.112	0.087
Fruits	-0.028	-0.053	0.003	-0.012	0.123 ***	-0.998 ***	0.030	0.067	0.105 **	0.038	-0.035	0.760 ***
Oils/ Fats	-0.237	-0.310 *	0.442 ***	-0.038	0.172	0.136	-1.442 ***	0.276	0.610 **	0.058	-0.118	0.451
Confectioneries	0.111 ***	0.003	0.053 **	0.005	-0.007	0.020	0.018	-0.608 ***	0.101 ***	-0.043	0.090 ***	0.258 ***
Cooked food	-0.217 *	-0.116	-0.049	0.055	-0.009	0.169 **	0.214 **	0.542 ***	-0.733 ***	0.105	0.024	0.015
Beverages	-0.019	0.194	-0.096	0.099 *	0.254 **	0.088	0.029	-0.332	0.151	-1.212 ***	-0.040	0.883 ***
Alcohol	-0.032	0.306 ***	-0.050	0.055	0.075	-0.052	-0.039	0.452 ***	0.022	-0.026	-1.100 ***	0.389
Eating out	0.077 *	0.230 ***	0.049 *	-0.012	0.009	0.185 ***	0.024	0.210 ***	0.002	0.093 ***	0.063	-0.931 ***
Home-use												
Cereals	-0.549 ***	0.008	-0.021 *	-0.007	0.015	-0.003	0.069 ***	0.023 *	0.073 ***	0.063 ***	0.054 ***	0.276 ***
Seafood	0.007	-0.846 ***	0.157 ***	0.118 ***	0.054 ***	-0.033 ***	-0.008	0.031 ***	0.224 ***	0.014 *	0.045 ***	0.171 ***
Meat	-0.021 *	0.167 ***	-0.769 ***	0.027 ***	0.092 ***	-0.038 ***	0.042 ***	0.091 ***	0.155 ***	0.065 ***	0.024 **	0.089 ***
Milk/ Eggs	-0.012	0.230 ***	0.050 ***	-0.910 ***	0.081 ***	-0.087 ***	0.074 ***	0.149 ***	0.076 ***	0.187 ***	0.057 ***	-0.068 **
Vegetables	0.011	0.043 ***	0.069 ***	0.033 ***	-0.551 ***	-0.048 ***	-0.001	0.026 ***	0.083 ***	0.036 ***	0.057 ***	0.144 ***
Fruits	-0.008	0.083 ***	0.091 ***	0.112 ***	0.153 ***	-0.824 ***	0.056 ***	0.012	0.180 ***	0.096 ***	-0.009	0.058 *
Oils/ Fats	0.139 ***	-0.017	0.084 ***	0.080 ***	-0.003	-0.048 ***	-0.930 ***	0.166 ***	0.152 ***	-0.025	0.063 ***	0.244 ***
Confectioneries	0.030 *	0.042 ***	0.116 ***	0.102 ***	0.044 ***	-0.006	0.105 ***	-0.843 ***	0.149 ***	-0.058 ***	0.065 ***	0.241 ***
Cooked food	0.057 ***	0.182 ***	0.119 ***	0.032 ***	0.085 ***	-0.058 ***	0.058 ***	0.090 ***	-0.866 ***	0.024 **	0.070 ***	0.092 ***
Beverages	0.108 ***	0.025 *	0.111 ***	0.174 ***	0.083 ***	-0.069 ***	-0.021	-0.078 ***	0.054 **	-0.804 ***	-0.040	0.318 ***
Alcohol	0.108 ***	0.095 ***	0.048 **	0.061 ***	0.152 ***	-0.008	0.063 ***	0.102 ***	0.181 ***	-0.046	-0.735 ***	-0.021
Eating out	0.154 ***	0.100 ***	0.050 ***	-0.021 **	0.106 ***	-0.014 *	0.068 ***	0.105 ***	0.067 ***	0.103 ***	-0.006	-0.740 ***

See notes to Table 2.1.

Table 2.2 presents estimates of compensated price elasticities at the mean share. Compensated price elasticities are reduced to contain only the substitution effects. They are compensated for the income effects of the price changes. All twelve compensated own-price elasticities are negative and most of them are statistically significant. Seafood (-1.095), vegetables (-1.057), oils/fats (-1.442), beverages (-1.212) and alcohol (-1.100) are relatively own-price elastic for the gift food categories, whereas none of the home-use food categories are own-price elastic. The difference in own-price elasticities of gift-use and home-use food categories is due to the demanded quantity difference. As for compensated cross-price elasticities, 19 pairs are significant substitutes and five pairs are significant complements for the gift food categories. Meat has the most number of substitute pairs. For home-use food categories, 52 pairs are substitutes and three pairs are complements. Seafood and meat have the most substitute pairs. Substitute pairs are dominant for both gift and home-use food categories, which is consistent with the theory of Hicks (1946).

Table 2.3. Estimates of monthly rates of shift and demographic effects at the mean share

Demand q_i	Monthly rate of shift (%/month)		Demographic variable z_k							
			Number of persons per household (z_1) (%/person)		Number of persons per household under the age of 18 (z_2) (%/person)		Number of persons per household over the age of 65 (z_3) (%/person)		Number of earners per household (z_4) (%/person)	
	Gift-use	Home-use	Gift-use	Home-use	Gift-use	Home-use	Gift-use	Home-use	Gift-use	Home-use
Cereals	0.059	-0.028 ***	22.677	15.004 ***	-6.501	-8.813 ***	-0.397	-0.407	-18.560	-4.828 ***
Seafood	-0.142 ***	-0.227 ***	3.042	3.424 ***	2.808	-19.207 ***	22.210 ***	27.202 ***	-10.137	4.068 ***
Meat	0.097 ***	0.073 ***	0.994	10.409 ***	-10.229	-2.070 *	-10.533	1.048	-3.440	6.525 ***
Milk/ Eggs	0.176 *	-0.003	7.162	1.847 *	-5.778	6.752 ***	-0.214	11.330 ***	-16.439	-2.611 ***
Vegetables	-0.173 ***	-0.055 ***	5.862	5.733 ***	-19.632	-15.033 ***	22.569 **	8.861 ***	-0.304	-4.963 ***
Fruits	-0.046 **	-0.106 ***	10.598	8.547 ***	-2.799	-7.660 ***	11.535	24.331 ***	-6.523	-7.111 ***
Oils/ Fats	-0.068	0.038 ***	15.984	11.689 ***	-6.629	-8.232 ***	-5.651	2.592 ***	-18.737	-4.356 ***
Confectioneries	-0.026 ***	0.055 ***	3.793	3.389 ***	1.305	11.917 ***	-5.087 *	-3.922 ***	-2.979	-2.638 ***
Cooked food	0.155 ***	0.070 ***	18.781 **	0.386	-16.651 *	-2.211 *	-0.656	3.378 ***	-14.229 **	5.837 ***
Beverages	-0.092 *	0.128 ***	8.483	2.356 *	-5.544	-2.313	-18.805 *	-11.045 ***	-10.669	-7.746 ***
Alcohol	-0.136 ***	-0.019 **	0.732	6.290 ***	8.409	-15.765 ***	-15.985 **	-9.643 ***	-4.614	7.132 ***
Eating out	0.072 ***	0.053 ***	14.368 ***	22.966 ***	5.078	32.019 ***	0.473	-27.134 ***	13.906 ***	1.454

See notes to Table 2.1.

Table 2.3 reports the estimates of monthly rates of shift and demographic variables at the mean share. The linear time trend has significant effects on most of the food categories, i.e. ten of the twelve for gift and eleven of the twelve for home-use food categories. For the gift food categories, as the time goes by, demand for meat (0.097%), milk/eggs (0.176%), cooked food (0.155%) and eating out (0.072%) increases, while demand for seafood (-0.136%), vegetables (-0.173%), fruits (-0.046%), confectioneries (-0.026%), beverages (-0.092%) and alcohol (-0.136%) decreases. As for the home-use food, demand for meat (0.07%), oils/fats (0.04%), confectioneries (0.055%), cooked food (0.070%), beverages (0.128%) and eating out (0.053%) increases, while demand for cereals (-0.028%), seafood (-0.227%), vegetables (-0.055%), fruits (-0.106%) and alcohol (-0.019%) decreases. When the family size increases, the effect on demand for cooked food gift (18.781%) is positive, while it is negative on invitation to eating out (-14.368%). As for home-use food, an increase of family size has positive effects on demand for eight of the twelve categories, whereas it has negative effects on demand for three of the twelve categories. When there are more minors in the household, demand for cooked food gift (-16.651%) is negative, whereas minors have significant effects on eleven of the twelve home-use food categories. From the real life point of view, especially the effects on demand for milk/eggs home-use is reasonable because children usually tend to consume more milk due to its nutritional values and health benefits. When the number of seniors increases, demand for seafood (22.210%) and vegetables (22.569%) gifts is positive, while demand for confectioneries (-5.087%), beverages (-18.805%) and alcohol (-15.985%) gifts is negative. As for the home-use food, the number of seniors has significant effects on demand for ten of the twelve food categories with the exception of cereals and meat. As the number of earners in the household increases, demand for invitation to eating out (13.906%) is positive, while demand for cooked food gift (-14.229%) is negative. This is probably true because earners may prefer inviting people to eating out as an entertainment over gifting a cooked food. As for home-use, the number of earners has significant effects on eleven of the twelve food categories.

Table 2.4. Estimates of regional effects at the mean share (%, Gift-use)

	City with a population of one million or more										
Demand q_i	Sapporo	Sendai	Saitama	Kawasaki	Yokohama	Nagoya	Kyoto	Osaka	Kobe	Hiroshima	Fukuoka
Cereals	12.723	20.553 **	10.561	5.816	-2.974	17.089 *	24.355 ***	16.748 *	10.052	6.805	2.359
Seafood	62.264 ***	103.530 ***	-3.497	3.158	-4.844	-21.789 ***	-9.598	-12.170 **	-0.730	22.059 ***	97.910 ***
Meat	3.666	32.480 ***	-0.375	3.712	14.193 *	17.243 **	33.246 ***	34.906 ***	77.160 ***	22.344 ***	2.597
Milk/ Eggs	-2.110	34.012 **	9.601	30.556 **	7.303	-9.708	22.299	4.272	-3.273	18.634	-4.967
Vegetables	43.940 ***	-22.470 ***	4.010	16.999 **	-12.442 *	-20.556 ***	66.875 ***	28.504 ***	-14.509 **	-6.418	-18.220 **
Fruits	24.647 ***	23.150 ***	17.399 **	14.310 *	3.084	3.020	-12.239	-2.758	-10.398	20.019 ***	-3.350
Oils/ Fats	-24.505 **	22.375 **	35.062 ***	20.043 *	-1.413	-19.253 *	-13.567	-6.788	-11.898	15.033	2.913
Confectioneries	-1.147	11.550 ***	10.586 ***	5.662 ***	3.353	-2.361	1.035	-13.636 ***	-8.717 ***	-7.711 ***	-4.511 **
Cooked food	-27.831 ***	-31.236 ***	1.673	0.567	41.675 ***	-7.625	-0.335	0.117	2.271	6.006	-12.923 **
Beverages	-0.971	-13.217	15.695 *	-7.186	3.776	-20.830 **	7.188	-2.743	-7.448	-14.183 *	7.264
Alcohol	0.412	6.738	1.790	-12.008 **	-9.874 *	-10.266 *	2.194	3.735	0.830	42.871 ***	-10.677 *
Eating out	-18.448 ***	-35.169 ***	-18.081 ***	-10.486 ***	-7.129 ***	10.268 ***	-9.831 ***	5.926 **	4.236	-12.474 ***	-10.604 ***

See notes to Table 2.1.

Estimates of regional effects at the mean share are reported in Table 2.4. The cities are located almost at the center of Japan. Tokyo is used as the baseline city. Regions have significant effects on demand for the gift food categories, predominantly seafood, meat, vegetables and confectioneries as well as invitation to eating out. For instance, demand is high for gift meat

(77.160%) in Kobe. This makes sense that western part of Japan, particularly Kobe, is known for its beef. Demand is high for fruits (24.647%) in Sapporo. The reason could be due to Hokkaido's neighbor prefectures, such as Aomori, Iwate and Akita are famous for the production of various fruits. As for the vegetables (66.875%), demand is high in Kyoto presumably because of supply of vegetables originating in Kyoto prefecture also known as *Kyō-yasai*.

Table 2.5. Estimates of seasonal effects at the mean share (%, Gift-use)

Demand q_i	February	March	April	May	June	July	August	September	October	November	December
Cereals	16.446 ***	5.942	13.375 ***	4.222	67.071 ***	103.870 ***	26.533 ***	64.568 ***	116.470 ***	30.567 ***	20.023 ***
Seafood	-16.814 ***	-21.645	-17.800 ***	-22.331 ***	-11.895 ***	11.287 ***	-23.244 ***	-24.890 ***	-14.000 ***	28.365 ***	126.450 ***
Meat	-34.620 ***	-42.050 ***	-28.426 ***	-24.277 ***	9.818 **	59.350 ***	-14.422 ***	-34.310 ***	-25.862 ***	55.241 ***	193.750 ***
Milk/ Eggs	19.941 ***	15.200 **	24.568 ***	14.269 **	18.473 ***	4.950	-5.512	7.721	4.298	1.965	12.679
Vegetables	-5.219	-0.120	26.470 ***	21.192 ***	41.101 ***	47.009 ***	14.020 ***	17.467 ***	37.695 ***	58.707 ***	84.415 ***
Fruits	29.507 ***	4.773	-3.901	-5.993	57.418 ***	51.906 ***	45.971 ***	111.020 ***	57.368 ***	65.327 ***	23.728 ***
Oils/ Fats	-13.287 ***	-15.253 ***	-12.405 **	-15.335 ***	42.142 ***	109.850 ***	16.876 ***	-16.147 ***	-14.341 ***	61.571 ***	86.415 ***
Confectioneries	23.472 ***	27.987 ***	4.141 ***	-2.310 **	-17.008 ***	-13.938 ***	13.198 ***	-10.957 ***	-9.677 ***	-11.006 ***	6.610 ***
Cooked food	-20.583 ***	-23.997 ***	-0.925	-18.516 ***	-21.237 ***	-6.794 **	-20.804 ***	-23.265 ***	-12.811 **	-9.336 ***	15.842 ***
Beverages	-5.831	-1.610	16.410 ***	66.318 ***	67.810 ***	96.985 ***	19.451 ***	-3.736	-3.527	14.090 ***	34.373 ***
Alcohol	-23.695 ***	-25.238 ***	-10.106 ***	-16.991 ***	56.339 ***	112.890 ***	29.642 ***	-20.365 ***	-15.100 ***	15.392 ***	71.499 ***
Eating out	-13.386 ***	-8.214 ***	-0.530	6.287 ***	-26.846 ***	-60.032 ***	-25.368 ***	-11.911 ***	-13.934 ***	-33.407 ***	-87.449 ***

See notes to Table 2.1.

The effects of seasons on the gift food categories are reported in Table 2.5. Seasons have significant effects on almost all the twelve food categories. Demand for the food categories is positive in a number of months. The effects of seasons are particularly high in September for cereals (64.568%) and fruits (111.020%), and similarly high in October for cereals (116.470%) and fruits (57.368%). These results seem reasonable due to the harvest of rice and various fruits during the autumn season. In the past, there had been a pervasive Japanese custom of giving a freshly harvested crop to neighbors and relatives (Befu, 1968). As far as confectioneries are concerned, demand is high in February (23.472%) and March (27.987%), this can be attributed to Valentine's Day and White Day celebrations, respectively. Invitation to eating out is the highest in May (6.287%). It is probably due to the Golden Week's effects as the holiday stretches from late April up to early May every year. With the exception of confectioneries, cooked food and eating out, all gift food categories are positively demanded in mid-year and end-year periods. During these seasons, o-chūgen and o-seibo are among the most popular gift-giving occasions. Food is considered as the traditional gift for the occasions (Befu, 1968). Moreover, most Japanese employees receive substantial bonuses twice a year, i.e. in summer (mostly June and July) and at end of the year (Freeman and Weitzman, 1987).

2.3. Conclusion

In this study, a comprehensive demand system, LA/QUAIDS, is employed to estimate demand for twelve food categories for gift-use and home-use, respectively in Japan. The calculated expenditure elasticities show that nine of the twelve gift food categories are expenditure elastic, while only seafood, fruits, beverages, alcohol and eating out are expenditure elastic for home-use food categories. This suggests that gift food is relatively more luxurious than food that is routinely consumed in a household. As for compensated own-price elasticities, seafood, vegetables, oils/fats, beverages and alcohol are relatively own-price elastic for gift food categories, whereas none of the home-use food categories are own-price elastic. Majority of the compensated cross-price elasticities are positive and small in magnitude (below unity) for both gift and home-use food categories, suggesting that most of the pairs are substitutes but the competition among the substitutes is not very strong. Moreover, the signs of some compensated cross-price elasticities are different from those of uncompensated cross price elasticities, implying that income effects are also very important for decision making for a Japanese household. The linear time trend has small but significant effects on the vast majority of gift and home-use food categories. Demographic variables are found to be very determinant in a Japanese household for the food that is regularly consumed. The results clearly show that demographic variables have significant effects more on the home-use food categories than gift food categories. Similarly, there are also regional effects on the quantity demanded for gift food categories because Japan has various regional cuisines and food specialties. As a case in point, demand for meat gift is high in Kobe supposedly as a result of famous brand called Kobe beef. In a similar manner, vegetable gifts are also popular in Kyoto because of the supply of vegetables originating in Kyoto prefecture also known as *Kyō-yasai*.

The seasonal effects on a gift-giving and household consumption for food categories have implications for policy. Our results reveal that the pattern of seasonal effects is clear on the gift food categories. The findings have significant implications for the gift food market in particular. For instance, rice and fruits suppliers can give much attention during harvest seasons because demand for rice and fruits is high due to newly harvested gift crops. Confectioneries demand is higher in February and March due to Valentine's Day and White Day events, respectively. During summer and end-year seasons, demand for the majority of the food categories is higher than other seasons, because food gift giving is major part of Japanese tradition of o-chūgen and o-seibo.

Therefore, to the best our knowledge, our paper is the first to provide the empirical evidence for the practice of gift-giving in Japan. The results are useful not only for researchers as a reference for further studies, but also for the food industries and administrative agencies in Japan.

CHAPTER 3: Regional Effects on the Demand for Meat in Japan

This chapter presents an estimation of the demand of eight food items (beef, pork, chicken, ham, sausage, bacon, fresh seafood and processed seafood) with the incorporation of major city effects along with other demand shifting variables. Meat consumption, beef in particular, does not have a long history in Japan due to a dietary ban on the eating of flesh from four-legged animals before the Meiji Restoration (Kiple and Ornelas, 2000). Beef consumption was restricted on religious grounds. However, there has been gradual changes for years and eventually meat products have become important food items in the Japanese diets. The opening of Japan's borders was seen as an opportunity to integrate Western customs into Japanese culture. Removal of the longstanding social taboo against the eating of meat became a symbol of this integration. Particularly, ever since Japan had started westernization, its food consumption pattern have undergone dramatic changes, and consumption of meat and poultry products has been getting more important in the Japanese diet as the diets have become more westernized as a result of income per capita increase (Chern et al., 2002).

In 1988 under pressure from the United States, Australia and Canada, Japan had agreed to slowly open its beef market. Analysis of the agreement, Beef Market Access Agreement (BMAA), indicates that lifting of trade barriers and subsequent reduction in prices could result in a substantial increase in beef consumption in Japan. The dramatic price changes in beef have also influenced the prices and consumption levels of all meats and meat substitutes (Wahl et al., 1991). After meat market liberalization, its per capita consumption trend has been steady upward for years. However, compared with other developed countries, per capita consumption of Japan is still very low. For instance, as a developed and top meat per capita consumer, Australia consumes 21.6, 20.1, 39.6 and 9.0 kilograms per capita per year of beef, pork, chicken and mutton respectively, while Japan consumes 7.0, 15.0, 13.4 and 0.1 kilograms per capita per year of beef, pork, chicken and mutton respectively (OECD, 2014). On the other hand, Japan is among the world's largest consumer of fish and fishery products. Japanese households used to spend more on seafood than on beef, pork and chicken combined but seafood consumption is declining year by year (Statistics Japan, 2014).

From Japanese meat consumption trend history, meat consumption share has been affected by political decrees, social taboos, and income and relative price changes. However, there are also other very complex forces that might be influencing meat consumption pattern in the Japanese households. It appears possible that changing of demographics, taste, quality, food safety, linear time trend and variation among the regions as well as seasons can also be important factors that can change demand for meat and seafood. More importantly, due to stagnating per capita income and stable prices, demand analysis incorporating only traditional economic variables in the demand system may not have power to predict the future food consumption in Japan (Mori and Clason, 2004).

In this paper, we mainly focus on the effects of regional differences on the demand for meat and seafood in the Japanese households. Even though the influence of demographic changes and rising of modern eating habits are changing consumption patterns, there are reasons to believe that regional differences do still exist and play important role in influencing demand for food, demand for meat and seafood in particular. In addition, meat production is also different from region to region due to agro-ecological differences and availability of the resources are also not evenly the same among all the regions. Thus, these facts may in turn dictate consumption pattern and impact the meat consumption among regions of Japan.

There are various previous research outputs where demand for food, meat in particular, has been frequently estimated. Baharumshah and Mohamed (1993), Burki (1997), Osho and Uwakonye (2003), Taljaard et al. (2004), Wadud (2006) and Zhou (2015) are a few among those estimated demand for meat in different countries using Linear Approximated Almost Ideal Demand System (LA/AIDS) model with the effect of traditional economic variables (price and expenditure). Adetunji and Rauf (2012), Basarir (2013), Cupák et al. (2015), Dhraief et al. (2013), Jung and Koo (2002), Lee (2000), Millán (1994), Nayga (1994), Prasad (2010), Salvanes and Devoretz (1997) and Tonsor et al. (2010) estimated demand for food with the incorporation of various demand shifting variables like taste, religion, socio-economics, demographics, region, season, household dynamics and media information in addition to traditional economic variables. Out of the above literatures, the effects of regions on the demand for food were emphasized by Adetunji and Rauf (2012), Cupák et al. (2015), Millán (1994), Nayga (1994), and Salvanes and Devoretz (1997).

The aforementioned studies, that included the effects of regions in their demand system, were conducted using data of other countries than Japan. Capps et al. (1994) estimated the demand for meat in Japan using the Rotterdam Model. Wahl et al. (1991, 1992) and Yang and Koo (1994) also estimated the demand for meat in Japan using the AIDS model. Ishida et al. (2010), Matsuda (2014), and Peterson and Chen (2005) included the effect of bovine spongiform encephalopathy (BSE) on meat demand in Japan. However, none of them considered the impact of regions on the demand for meat and seafood except Wessells and Wilen (1994), who estimated the demand elasticities of seafood by categorizing the households to three regions; average Japanese households, northern Japanese households and southern Japanese households. Therefore, to our knowledge there are few studies in Japan that estimated the demand for meat and seafood with the effects of regional differences in detail. Therefore, estimating demand for meat and seafood with the incorporation of regional differences is reasonable as the data from Family Income and Expenditure Survey (FIES) are very reliable. There are several reasons why we are motivated to estimate the demand for meat and seafood in Japan; the country is among the top meat importing countries in the world, Japan is home of the world's brand beef 'Wagyu' in particular, and there is clear variation in the consumption pattern among regions with different geographical locations as well as strong and noticeable demographic shifts.

This paper aims to estimate the demand of eight food items (beef, pork, chicken, ham, sausage, bacon, fresh seafood and processed seafood) with the incorporation of major city effects along with other demand shifting variables into the linear approximated quadratic almost ideal system (LA/QUAIDS; Matsuda, 2006) in addition to traditional economic variables. The results might be useful for the meat and seafood producers, importers, stakeholders and policy makers. The data and model is shown in the next section, and followed by empirical results and the conclusion.

3.1. Data and Model

In many countries there are few or no panel data of consumers' expenditure. For Japan, however, there exists a series of independent cross sectional data in which household surveys are carried out every month. New samples of cross-section are drawn each quarter so the individual households cannot be traced over time. Deaton (1985) suggests that the use of pseudo panel data is an alternative econometric method for estimating demand models of individual household behavior. Moffitt (1993) and Collado (1997) further extend the approach of Deaton (1985) to nonlinear and dynamic models. In our study, therefore, monthly aggregated pseudo panel data is used for two or more person households for 49 major cities from January 2000 through December

2014, yielding a sample of 8,820 observations. However, the sample size reduces to 8,818 due to the omission of the two observations of Fukushima (April and May, 2011) as a result of the Great East Japan Earthquake. The data is from Family Income and Expenditure Survey and Consumer Price Index, both published by the Statistics Bureau of the Ministry of Internal Affairs and Communications.

The nominal prices and expenditure were deflated using the general consumer price index. The iterative seemingly unrelated regression was used to estimate the system of eight equations. Monthly, city and BSE dummy variables are included in the demand system. To see the effects of 49 major cities on the demand for meat and seafood, Tokyo is considered the baseline city. Our data set also incorporates demographic variables which are very important and influence the household demand for the food items. The demographic variables used in this study are the number of persons per household (household size, z_1), the number of persons under the age of 18 in the household (number of youngsters, z_2), the number of persons over the age of 65 in the household (number of seniors, z_3), and the age of the head of the household (age of the head, z_4). In order to check the correlation among z_1, z_2 and z_3, we calculated the variance inflation factors (VIF). The results justify the use of these demographic variables because the maximum value of the VIF is 2.057 ($\ll 10$), which indicates that there is no multicollinearity. In addition, the linear time trend is also included in the data set.

Deaton and Muellbauer (1980) combined the translog and Rotterdam models into the almost ideal demand system (AIDS), which has the best properties of the two. The AIDS is a versatile system capable of studying various aspects of food and its various components. On the contrary, the AIDS model has difficulty of capturing the effects of non-linear Engel curve because it has budget share equations that are linear in the logarithm of expenditure. The quadratic form of the AIDS model (QUAIDS), which was first developed by Banks et al. (1997), however, restores the relevant properties of its linear counterpart (AIDS) system and allows flexible quadratic Engel curves as well as retains integrability. By introducing the quadratic expenditure, the model gains more flexibility in which it positively contributes to the quality of model outputs. In our study, variables other than prices and expenditure, which are called demand shifters, such as time, demographic variables, and seasonal, regional and BSE dummy variables are included in the demand system. The demand shifters are incorporated in a manner that maintains theoretical properties of the model, and the estimated demand system must be closed under unit scaling

(CUUS; Alston et al., 2001). With the demand shifters the original nonlinear QUAIDS does not fulfill the property of CUUS. The LA/QUAIDS was developed by Matsuda (2006), as it embraces the characteristics of CUUS even with demand shifters. The comprehensiveness and advantage of the LA/QUAIDS was clearly depicted in Yohannes and Matsuda (2015, 2016). Therefore, we employ the LA/QUAIDS. The variation of expenditure in our pseudo panel data is smaller than micro data but larger than time series data. In addition, the Wald test on our data rejects the linear approximate AIDS (LA/AIDS) against the LA/QUAIDS at the 1% significance level.

According to Matsuda (2006), the LA/QUAIDS equation is put as:

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \log p_j + \beta_i \log \frac{y}{P^C} + \frac{\lambda_i}{P^Z}\left(\log \frac{y}{P^C}\right)^2 \quad i, j = 1,2,.....,n \tag{1}$$

where w_i is the share of expenditure allocated to good i, y is the total expenditure on all the goods in the system, p_j is the price of good j, and α_i, β_i, γ_{ij} and λ_i are parameters to be estimated. P^C is the loglinear analogue of the Laspeyres price index and shown as:

$$\log P^C = \sum_{i=1}^{n} \overline{w}_i \log p_i \tag{2}$$

P^C is invariant to changes in units. $^-$ stands for the sample mean. We apply index P^Z as proposed by Matsuda (2006):

$$\log P^Z = \sum_{i=1}^{n} (w_i - \overline{w}_i) \log \frac{\overline{p}}{p_i} \tag{3}$$

where P^Z could be seen as a zero degree homogenous analogue of the Törnqvist price index and is also invariant to changes in units.

We first included the cross effects of cities and months as regressors in the empirical model, but the estimated coefficients of the cross effects are not significant. Our empirical model of the LA/QUAIDS is, therefore, specified as:

$$w_i = \alpha_{i0} + \alpha_{i1}t + \sum_{k=1}^{4}\alpha_{i,1+k}z_k + \sum_{m=1}^{11}\alpha_{i,5+m}D_m + \sum_{r=1}^{48}\alpha_{i,16+r}M_r + \sum_{b=1}^{6}\alpha_{i,64+b}S_b + \sum_{j=1}^{8}\gamma_{ij}\log p_j + \beta_i \log\frac{y}{P^C} + \frac{\lambda_i}{P^Z}\left(\log\frac{y}{P^C}\right)^2$$

$$i = 1,2,....,8 \tag{4}$$

where t indicates the time trend, z_k are demographic variables, D_m are monthly dummy variables, M_r are city dummy variables and S_b are BSE dummy variables. We include S_b to estimate the effects of the BSE outbreak in Japan (September 2001) and set it based on preliminary estimations.

To be in line with economic theory, parameters of the demand equations must satisfy adding up, homogeneity and Slutsky symmetry restrictions as follows:

$$\sum_{i=1}^{8} \alpha_{i0} = 1 \qquad \sum_{i=1}^{8} \alpha_{ih} = 0 \qquad h = 1,2,\ldots,70 \tag{5}$$

$$\sum_{i=1}^{8} \gamma_{ij} = 0 \qquad \sum_{i=1}^{8} \beta_i = 0 \qquad \sum_{i=1}^{8} \lambda_i = 0 \qquad j = 1,2,\ldots,8 \tag{6}$$

$$\sum_{j=1}^{8} \gamma_{ij} = 0 \qquad i = 1,2,\ldots,8 \tag{7}$$

$$\gamma_{ij} = \gamma_{ji} \qquad i, j = 1,2,\ldots,8 \tag{8}$$

Expenditure and uncompensated and compensated price elasticities are calculated as:

$$\varepsilon_i = 1 + \frac{\beta_i}{w_i} + \frac{2\lambda_i}{w_i P^z} \log \frac{y}{P^C} \qquad i = 1,2,\ldots\ldots,8 \tag{9}$$

$$\varepsilon_{ij} = -\delta_{ij} + \frac{\gamma_i}{w_i} - \frac{\beta_i \overline{w}_j}{w_i} - \frac{\lambda_i}{w_i P^Z}\left[2\overline{w}_j + (w_j - \overline{w}_j)\log \frac{y}{P^C}\right]\log \frac{y}{P^C} \qquad i, j = 1,2,\ldots\ldots,8 \tag{10}$$

$$\varepsilon^C{}_{ij} = \varepsilon_{ij} + \varepsilon_i w_j \text{ (Slutsky Equation)} \qquad i, j = 1,2,\ldots\ldots\ldots,8 \tag{11}$$

Monthly rates of shift (%/month) are calculated as:

$$\frac{10^2}{q_i}\frac{\partial q_i}{\partial t} = \frac{10^2}{w_i}\frac{\partial w_i}{\partial t} = \frac{10^2 \alpha_{i1}}{w_i} \qquad i = 1,2,\ldots,8 \tag{12}$$

Demographic effects (%/person, %/year old), seasonal (monthly) effects (%), regional (city) effects (%) and BSE effects (%) are calculated in the same way, replacing t with z_k, D_m, M_r or S_b. When the effect of household size z_1, the number of youngsters z_2 or the number of seniors z_3 is calculated, it is implicitly assumed that the number of persons aged 18 to 65 in the household increases or decreases corresponding to the increase of z_1, z_2 or z_3 with the other regressors being constant.

3.2. Empirical Results

Table 3.1. Descriptive statistics of variables (excluding dummies)

Variable	Mean	Standard deviation	Minimum	Maximum
Expenditure share of beef (w_1)	0.133	0.049	0.021	0.364
Expenditure share of pork (w_2)	0.147	0.031	0.045	0.268
Expenditure share of chicken (w_3)	0.075	0.019	0.026	0.150
Expenditure share of ham (w_4)	0.035	0.015	0.010	0.159
Expenditure share of sausage (w_5)	0.043	0.010	0.013	0.121
Expenditure share of bacon (w_6)	0.015	0.004	0.003	0.056
Expenditure share of fresh seafood (w_7)	0.329	0.041	0.199	0.530
Expenditure share of processed seafood (w_8)	0.223	0.041	0.138	0.432
Price of beef (p_1)	1.000	0.070	0.693	1.269
Price of pork (p_2)	1.000	0.073	0.683	1.299
Price of chicken (p_3)	1.000	0.079	0.680	1.273
Price of ham (p_4)	1.000	0.084	0.671	1.244
Price of sausage (p_5)	1.000	0.068	0.695	1.249
Price of bacon (p_6)	1.000	0.087	0.645	1.252
Price of fresh seafood (p_7)	1.000	0.071	0.778	1.552
Price of processed seafood (p_8)	1.000	0.065	0.766	1.397
Expenditure (y)	1.000	0.219	0.483	2.712
Number of persons per household (z_1)	3.118	0.184	2.580	4.130
Number of persons per household under the age of 18 (z_2)	0.676	0.140	0.220	1.300
Number of persons per household over the age of 65 (z_3)	0.626	0.133	0.210	1.380
Age of the head of the household (z_4)	55.176	2.698	47.000	64.000

Note. Prices and expenditure are normalized by their respective means.

Descriptive statistics of variables are used to provide simple summaries of the sample and shown in Table 3.1. Fresh seafood (0.329) and processed seafood (0.223) have the highest expenditure shares at the mean, while bacon (0.015), ham (0.035) and sausage (0.043) have the lowest expenditure shares at the mean.

Table 3.2. Estimates of expenditure and price coefficients

Left-hand variable w_i	Regressor										
	$\log p_1$	$\log p_2$	$\log p_3$	$\log p_4$	$\log p_5$	$\log p_6$	$\log p_7$	$\log p_8$	$\log \frac{y}{Pc}$	$\frac{1}{P^z}\left(\log \frac{y}{Pc}\right)^2$	R^2
Beef	0.034 ***	0.032 ***	-0.016 ***	-0.039 ***	-0.006 *	0.005 ***	0.001	-0.012 **	0.037 ***	-0.022 ***	0.862
	(4.128)	(5.974)	(-4.119)	(-8.534)	(-1.692)	(2.950)	(0.146)	(-2.282)	(15.16)	(-6.187)	
Pork		0.010 *	-0.029 ***	0.006	-0.004	-0.006 ***	-0.006 *	-0.004	-0.042 ***	0.003	0.856
		(1.686)	(-7.393)	(1.617)	(-1.275)	(-3.611)	(-1.680)	(-0.960)	(-26.73)	(1.276)	
Chicken			0.038 ***	-0.002	0.008 ***	-0.001	-0.009 ***	0.009 ***	-0.020 ***	0.002	0.833
			(10.13)	(-0.714)	(3.439)	(-0.392)	(-3.243)	(3.363)	(-19.42)	(1.596)	
Ham				0.004	0.020 ***	0.007 ***	-0.002	0.006 *	0.006 ***	-0.004 *	0.545
				(0.968)	(8.047)	(4.597)	(-0.624)	(1.665)	(4.283)	(-1.895)	
Sausage					-0.011 ***	-0.005 ***	-0.005 ***	0.004 *	-0.021 ***	0.011 ***	0.735
					(-3.372)	(-3.584)	(-2.868)	(1.876)	(-31.00)	(11.23)	
Bacon						0.000	0.002	-0.003 **	-0.005 ***	0.002 ***	0.613
						(0.289)	(1.534)	(-2.373)	(-12.72)	(4.625)	
Fresh seafood							0.036 ***	-0.015 **	0.040 ***	-0.010 **	0.703
							(4.977)	(-2.311)	(13.11)	(-2.294)	
Processed seafood								0.015 **	0.005 **	0.017 ***	
								(2.038)	(1.973)	(4.394)	

Note. t-values are in the parentheses. The critical values are 2.576, 1.960 and 1.645 for 1%, 5% and 10% significance levels and denoted by *, **, ***, R^2, the square of the correlation between the model's predicted and observed values, is calculated for each of the seven equations.

Table 3.2 reports expenditure and price coefficients of equation (4). The sign and magnitude of the estimated coefficients do not have straightforward economic interpretation, but they are the basis for estimation of elasticities. The log own-price coefficients for all items except ham and bacon are significant. For the log expenditure, all items are significant. For the quadratic log expenditure, all items except pork and chicken are significant. The R^2 ranges from 0.545 to 0.862, which shows that the LA/QUAIDS model can explain our data satisfactorily.

Table 3.3. Estimates of expenditure and uncompensated price elasticities at the mean share

		Price p_j							
Demand q_i	Expenditure y	Beef	Pork	Chicken	Ham	Sausage	Bacon	Fresh seafood	Processed seafood
Beef	1.280 ***	-0.779 ***	0.200 ***	-0.140 ***	-0.301 ***	-0.055 **	0.034 ***	-0.086 **	-0.152 ***
	(69.370)	(-12.443)	(4.944)	(-4.847)	(-8.818)	(-2.164)	(2.627)	(-2.216)	(-3.839)
Pork	0.712 ***	0.256 ***	-0.888 ***	-0.172 ***	0.051 **	-0.013	-0.036 ***	0.051 **	0.039
	(66.211)	(7.014)	(-21.524)	(-6.562)	(2.009)	(-0.645)	(-3.230)	(1.972)	(1.461)
Chicken	0.729 ***	-0.173 ***	-0.338 ***	-0.473 ***	-0.019	0.121 ***	-0.003	-0.027	0.184 ***
	(52.159)	(-3.403)	(-6.608)	(-9.448)	(-0.475)	(3.806)	(-0.173)	(-0.759)	(4.977)
Ham	1.172 ***	-1.137 ***	0.149	-0.074	-0.881 ***	0.554 ***	0.206 ***	-0.119	0.129
	(29.239)	(-8.694)	(1.382)	(-0.864)	(-6.805)	(7.939)	(4.541)	(-1.187)	(1.277)
Sausage	0.510 ***	-0.068	-0.014	0.229 ***	0.472 ***	-1.242 ***	-0.115 ***	0.033	0.194 ***
	(32.263)	(-0.862)	(-0.202)	(4.101)	(8.347)	(-15.932)	(-3.370)	(0.747)	(4.257)
Bacon	0.688 ***	0.381 ***	-0.356 ***	-0.013	0.498 ***	-0.338 ***	-0.970 ***	0.212 ***	-0.102
	(28.080)	(3.306)	(-3.196)	(-0.140)	(4.699)	(-3.447)	(-10.968)	(2.972)	(-1.407)
Fresh seafood	1.122 ***	-0.014	-0.037 ***	-0.036 ***	-0.011	-0.022 ***	0.003	-0.932 ***	-0.073 ***
	(120.963)	(-0.883)	(-3.204)	(-4.338)	(-1.025)	(-3.756)	(0.971)	(-42.567)	(-3.633)
Processed seafood	1.024 ***	-0.057 **	-0.020	0.040 ***	0.025	0.015 *	-0.012 **	-0.076 **	-0.939 ***
	(84.931)	(-2.408)	(-1.155)	(3.211)	(1.611)	(1.757)	(-2.445)	(-2.563)	(-28.881)

See notes to Table 3.2.

Table 3.3 reports the estimates of expenditure and uncompensated price elasticities at the mean share. All the expenditure elasticiticies are positive and significant at the 1% level. Beef, ham, fresh seafood and processed seafood are expenditure elastic, whereas pork, chicken, sausage and bacon are expenditure inelastic. Uncompensated price elasticities contain both the income and substitution effects. All the uncompensated own-price elasticities are negative and significant at the 1% level. Sausage (-1.242) is own-price elastic and relatively sensitive to its own-price changes, while beef (-0.779), pork (-0.888), chicken (-0.473), ham (-0.881), bacon (-0.970), fresh seafood (-0.932) and processed seafood (-0.939) are own-price inelastic. Beef is the most expenditure elastic, whereas sausage is the most expenditure inelastic and the most own-price elastic. Among the estimates of the 56 uncompensated cross-price elasticities, 17 are significant gross substitutes. Capps et al. (1994) found that beef is a gross substitute for pork in Japan, showing consistency with our result. On the other hand, 20 are found to be significant gross complements.

Table 3.4. Estimates of compensated price elasticities at the mean share

Demand q_i	Price p_j							
	Beef	Pork	Chicken	Ham	Sausage	Bacon	Fresh seafood	Processed seafood
Beef	-0.609 ***	0.388 ***	-0.043	-0.257 ***	-0.000	0.053 ***	0.335 ***	0.133 ***
	(-9.745)	(9.628)	(-1.499)	(-7.516)	(-0.001)	(4.105)	(8.641)	(3.378)
Pork	0.350 ***	-0.783 ***	-0.118 ***	0.076 ***	0.018	-0.026 **	0.286 ***	0.197 ***
	(9.628)	(-18.992)	(-4.516)	(2.980)	(0.915)	(-2.286)	(11.05)	(7.488)
Chicken	-0.076	-0.231 ***	-0.418 ***	0.007	0.152 ***	0.008	0.213 ***	0.346 ***
	(-1.499)	(-4.516)	(-8.352)	(0.166)	(4.792)	(0.415)	(5.903)	(9.412)
Ham	-0.981 ***	0.322 ***	0.014	-0.840 ***	0.604 ***	0.224 ***	0.267 ***	0.390 ***
	(-7.516)	(2.980)	(0.166)	(-6.491)	(8.662)	(4.926)	(2.687)	(3.882)
Sausage	0.000	0.062	0.267 ***	0.490 ***	-1.220 ***	-0.107 ***	0.201 ***	0.308 ***
	(-0.001)	(0.915)	(4.792)	(8.662)	(-15.65)	(-3.146)	(4.513)	(6.780)
Bacon	0.472 ***	-0.254 **	0.039	0.521 ***	-0.308 ***	-0.960 ***	0.439 ***	0.051
	(4.105)	(-2.286)	(0.415)	(4.926)	(-3.146)	(-10.85)	(6.151)	(0.702)
Fresh seafood	0.135 ***	0.128 ***	0.049 ***	0.028 ***	0.026 ***	0.020 ***	-0.562 ***	0.176 ***
	(8.641)	(11.05)	(5.903)	(2.687)	(4.513)	(6.151)	(-25.79)	(8.791)
Processed seafood	0.079 ***	0.131 ***	0.117 ***	0.061 ***	0.059 ***	0.003	0.261 ***	-0.711 ***
	(3.378)	(7.488)	(9.412)	(3.882)	(6.780)	(0.702)	(8.791)	(-21.977)

See notes to Table 3.2.

Compensated price elasticities are reduced to contain only the substitution effects, which are compensated for the income effects on quantity demanded. Table 3.4 reports the estimates of compensated price elasticities at the mean share. Compensated own-price elasticities of all the eight items are negative and significant at the 1% level. Only sausage (-1.220) is own-price elastic, meaning it is responsive to its price changes. Among the estimates of the 28 pairs of compensated cross-price elasticities, 18 pairs are significant substitutes for each other, while 4 pairs are significant complements for each other. As Hicks (1946) states theoretically, substitutes are found dominant over complements. Fresh and processed seafood are significant substitutes for all or almost all other items. Similar results are depicted by Capps et al. (1994) using Japanese data.

Table 3.5. Estimates of monthly rates of shift and demographic effects at the mean share

Demand q_i	Monthly rate of shift (%/month)	Demographic variable z_k: Number of persons per household z_1 (%/person)	Number of persons per household under the age of 18 z_2 (%/person)	Number of persons per household over the age of 65 z_3 (%/person)	Age of the head of the household z_4 (%/year old)
Beef	0.018 ***	-7.539 ***	2.291	3.479	-0.315 **
	(2.839)	(-3.145)	(0.804)	(0.843)	(-1.972)
Pork	0.194 ***	14.505 ***	4.165 **	-12.003 ***	-0.249 ***
	(49.593)	(10.374)	(2.505)	(-4.987)	(-2.668)
Chicken	0.334 ***	13.509 ***	6.840 ***	-14.651 ***	-0.656 ***
	(65.082)	(7.439)	(3.169)	(-4.689)	(-5.413)
Ham	0.039 ***	-7.912	7.035	-7.189	0.064
	(2.710)	(-1.519)	(1.136)	(-0.803)	(0.185)
Sausage	0.158 ***	12.190 ***	15.514 ***	-15.622 ***	-0.487 ***
	(25.081)	(5.930)	(6.349)	(-4.419)	(-3.548)
Bacon	0.222 ***	5.551 *	11.541 ***	-29.119 ***	-0.056
	(22.650)	(1.741)	(3.045)	(-5.313)	(-0.265)
Fresh seafood	-0.164 ***	-3.694 ***	-6.653 ***	10.410 ***	0.274 ***
	(-52.367)	(-3.068)	(-4.647)	(5.026)	(3.412)
Processed seafood	-0.062 ***	-5.687 ***	-1.457	1.507	0.257 **
	(-15.000)	(-3.632)	(-0.783)	(0.559)	(2.460)

See note to Table 3.2.

Table 3.5 reports the estimates of monthly rates of shift (time trends) and effects of demographic variables at the mean share. The time has significant effect on the quantity demanded for all of the eight items. With all other regressors kept constant, as the time goes by, the demand for all meat items increases, whereas the demand for fresh seafood and processed seafood decreases. The household size has significant effects on all the items with the exception of ham. As the household size increases, the demand for pork, chicken, sausage and bacon increases, while demand for beef, fresh seafood and processed seafood decreases. The result makes sense because the two most popular types of meat in Japan are pork and chicken. Even though there were embargo on the consumption of meat from four-legged animals, pork was not absolutely prohibited by some of the rulers. It depended on who had control of the government (Ishige, 2001). Therefore pork consumption in Japan has been around for a long time. For instance, wild boars were domesticated and used both as working animals on the farms as well as for consumption. Since then, consumption of boar meat and later pork has been popular in Japan. On the other hand, many Japanese households had been growing chickens in their backyards until several decades ago. Therefore, consumption of chickens is also familiar in Japan. As the number of youngsters increases, the demand for pork, chicken, sausage and bacon increases significantly, while the demand for fresh seafood decreases. When the number of seniors increases, the demand for fresh seafood increases, while the demand for pork, chicken, sausage and bacon decreases. When the age of the head increases, the demand for fresh and processed seafood increases, while the demand for beef, pork, chicken and sausage decreases significantly.

Table 3.6. Estimates of regional effects at the mean share

	City with a population of one million or more										
Demand	Eastern					Western					
q_i	Sapporo	Sendai	Saitama	Kawasaki	Yokohama	Nagoya	Kyoto	Osaka	Kobe	Hiroshima	Fukuoka
Beef	-45.288 ***	-36.800 ***	-10.520 ***	-11.909 ***	-4.953 ***	13.849 ***	49.383 ***	48.353 ***	49.734 ***	34.687 ***	23.022 ***
	(-30.465)	(-24.703)	(-7.078)	(-8.004)	(-3.357)	(9.459)	(33.021)	(33.416)	(33.018)	(23.780)	(15.474)
Pork	3.993 ***	2.563 ***	3.227 ***	4.058 ***	5.622 ***	-5.971 ***	-12.869 ***	-11.772 ***	-7.532 ***	-10.440 ***	-10.086 ***
	(4.603)	(2.951)	(3.722)	(4.677)	(6.533)	(-6.993)	(-14.740)	(-13.946)	(-8.573)	(-12.272)	(-11.533)
Chicken	-6.887 ***	-15.666 ***	-0.039	-1.596	1.505	1.357	14.975 ***	8.580 ***	18.235 ***	7.646 ***	26.997 ***
	(-6.116)	(-13.890)	(0.034)	(-1.417)	(1.347)	(1.224)	(13.216)	(7.830)	(15.988)	(6.923)	(23.779)
Ham	-20.031 ***	-9.517 ***	10.543 ***	12.985 ***	11.216 ***	22.255 ***	-7.794 **	-11.854 ***	0.471	-6.776 **	-16.539 ***
	(-6.203)	(-2.942)	(3.266)	(4.018)	(3.500)	(6.999)	(-2.399)	(-3.772)	(0.144)	(-2.139)	(-5.079)
Sausage	15.743 ***	2.085 *	5.058 ***	5.937 ***	8.028 ***	10.972 ***	-4.491 ***	-10.948 ***	-4.006 ***	4.525 ***	-7.533 ***
	(12.359)	(1.634)	(3.973)	(4.659)	(6.353)	(8.751)	(-3.502)	(-8.832)	(-3.105)	(3.622)	(-5.866)
Bacon	9.520 ***	4.167 **	3.614 *	1.379	7.169 ***	-8.437 ***	-15.449 ***	-28.720 ***	-17.369 ***	-5.524 ***	-3.650 *
	(4.823)	(2.108)	(1.832)	(0.698)	(3.661)	(-4.343)	(-7.775)	(-14.953)	(-8.688)	(-2.854)	(-1.834)
Fresh seafood	4.272 ***	2.715 ***	-0.244	0.235	-1.747 **	-2.065 ***	-8.602 ***	-1.927 ***	-6.411 ***	2.948 ***	-7.821 ***
	(5.719)	(3.626)	(-0.327)	(0.314)	(-2.357)	(-2.806)	(-11.459)	(-2.650)	(-8.469)	(4.021)	(-10.379)
Processed seafood	19.864 ***	22.365 ***	1.633 *	1.356	-2.463 **	-6.745 ***	-10.202 ***	-15.254 ***	-19.539 ***	-20.194 ***	-0.583
	(20.446)	(22.973)	(1.681)	(1.395)	(-2.555)	(-7.049)	(-10.444)	(-16.131)	(-19.848)	(-21.183)	(-0.594)

See notes to Table 3.2.

Table 3.6 reports the estimates of regional effects at the mean share. Located almost at the center of Japan, Tokyo is used as the baseline city. The regional effects on the demand for most of the items are significant in all the cities. The results reveal that there is a substantial evidence for the difference in meat and seafood demand between eastern and western major cities in Japan. In the cities located in the eastern part of Japan, that is, Sapporo, Sendai, Saitama, Kawasaki and Yokohama, the demand for beef is less than in Tokyo, whereas the demand for pork is more than in Tokyo. In the major cities located in the western part, that is, Nagoya, Kyoto, Osaka, Kobe, Hiroshima and Fukuoka, on the other hand, the demand for beef is more than in Tokyo, whereas the demand for pork is less than in Tokyo. Pork is popular in the eastern part of Japan, while beef and chicken are popular in the western part. In the eastern part of Japan pork is often used in *niku-*

jaga and curry and rice, while beef is often used in the western part. It is said that beef is popular in western Japan historically because bulls were mainly used in agricultural production in the western part, whereas horses were mainly used in the eastern part. The difference in demand for bacon is similar to pork, that for chicken is similar to beef except for Yokohama, that for sausage is similar to pork except for Nagoya and Hiroshima, that for fresh seafood is similar to pork except for Saitama, Yokohama and Hiroshima, and that for processed seafood is similar to pork except for Yokohama. For ham the regional effect is positive in Saitama, Kawasaki, Yokohama, Nagoya and Kobe, whereas it is negative in Sapporo, Sendai, Kyoto, Osaka, Hiroshima and Fukouka. Yokohama has characteristics of both the eastern and western major cities probably because it is adjacent to the baseline city Tokyo. In general, our result can be supported by Wessells and Wilen (1994), who found out substantial diversity in patterns of household demand for different types of seafood across regions in Japan.

Table 3.7. Estimates of seasonal effects at the mean share

Demand q_i	January	February	March	April	May	June	July	August	September	October	November
Beef	16.402 ***	8.697 ***	9.103 ***	11.031 ***	14.109 ***	11.983 ***	12.246 ***	19.919 ***	10.790 ***	10.502 ***	6.762 ***
	(13.106)	(7.188)	(7.631)	(9.093)	(11.677)	(9.762)	(9.908)	(16.233)	(8.716)	(8.675)	(5.942)
Pork	21.906 ***	24.795 ***	19.857 ***	19.300 ***	17.528 ***	20.083 ***	18.123 ***	17.485 ***	21.610 ***	22.484 ***	21.685 ***
	(30.004)	(35.122)	(28.530)	(27.246)	(24.862)	(28.030)	(25.116)	(24.413)	(29.898)	(31.783)	(32.623)
Chicken	10.853 ***	10.430 ***	5.741 ***	6.930 ***	3.933 ***	4.159 ***	-2.233 **	-5.451 ***	8.205 ***	11.654 ***	10.759 ***
	(11.445)	(11.374)	(6.351)	(7.525)	(4.294)	(4.471)	(-2.383)	(-5.862)	(8.736)	(12.674)	(12.452)
Ham	-89.500 ***	-93.165 ***	-87.473 ***	-80.397 ***	-74.934 ***	-56.728 ***	-18.568 ***	-51.063 ***	-76.542 ***	-84.651 ***	-62.473 ***
	(-32.913)	(-35.436)	(-33.742)	(-30.475)	(-28.539)	(-21.267)	(-6.913)	(-19.158)	(-28.439)	(-32.154)	(-25.235)
Sausage	6.459 ***	14.789 ***	17.798 ***	24.753 ***	26.062 ***	22.440 ***	19.051 ***	20.214 ***	25.586 ***	25.939 ***	19.675 ***
	(6.013)	(14.246)	(17.384)	(23.736)	(25.155)	(21.316)	(17.961)	(19.193)	(24.062)	(24.902)	(20.095)
Bacon	14.295 ***	28.732 ***	29.643 ***	32.266 ***	33.706 ***	33.198 ***	22.041 ***	19.410 ***	29.346 ***	31.317 ***	28.628 ***
	(8.585)	(17.833)	(18.677)	(19.965)	(20.993)	(20.334)	(13.396)	(11.893)	(17.788)	(19.368)	(18.852)
Fresh seafood	9.950 ***	9.239 ***	9.439 ***	7.233 ***	7.539 ***	6.030 ***	0.960	4.732 ***	8.616 ***	6.478 ***	5.438 ***
	(15.819)	(15.190)	(15.746)	(11.860)	(12.417)	(9.773)	(1.546)	(7.679)	(13.842)	(10.645)	(9.499)
Processed seafood	-30.901 ***	-29.015 ***	-26.231 ***	-26.772 ***	-28.078 ***	-28.452 ***	-22.207 ***	-25.830 ***	-31.200 ***	-28.546 ***	-26.019 ***
	(-37.774)	(-36.691)	(-33.631)	(-33.718)	(-35.541)	(-35.465)	(-27.487)	(-32.230)	(-38.540)	(-36.073)	(-34.939)

See notes to Table 3.2.

Table 3.7 reports the estimates of seasonal effects on the demand at the mean share. They are significant at the 1% level for all items in almost all months. Beef, pork, sausage, bacon and fresh seafood are demanded more in all the months from January through November than in December, whereas the ham and processed seafood are demanded more in December than in the other months. However, the demand for chicken is less in July and August and more in other months than December. The demand for beef is the most in August, when the demand for barbecue is also the most.

Demand q_i	1st Quarter (Oct-Dec 2001)	2nd Quarter (Jan-Mar 2002)	3rd Quarter (Apr-Jun 2002)	4th Quarter (Jul-Sep 2002)	5th Quarter (Oct-Dec 2002)	Later (Jan 2003-)
Beef	-50.597 ***	-28.090 ***	-17.981 ***	-13.134 ***	-10.804 ***	-7.068 ***
	(-39.496)	(-22.141)	(-14.191)	(-10.366)	(-8.485)	(-10.340)
Pork	16.907 ***	11.443 ***	10.978 ***	9.375 ***	8.202 ***	7.826 ***
	(22.408)	(15.224)	(14.723)	(12.541)	(10.868)	(18.870)
Chicken	9.880 ***	5.190 ***	0.651	-0.644	0.657	-7.976 ***
	(10.00)	(5.181)	(0.654)	(-0.645)	(0.651)	(-14.291)
Ham	-8.624 ***	-4.788 *	-7.087 **	-12.292 ***	-6.912 **	-4.829 ***
	(-3.062)	(-1.707)	(-2.554)	(-4.417)	(-2.459)	(-3.124)
Sausage	-0.765	-3.007 ***	-0.206	-3.397 ***	-3.095 ***	-4.820 ***
	(-0.677)	(-2.633)	(-0.180)	(-2.978)	(-2.673)	(-7.278)
Bacon	1.302	1.858	-1.662	-2.690	-2.783	-2.613 **
	(0.736)	(1.022)	(-0.895)	(-1.455)	(-1.510)	(-2.274)
Fresh seafood	7.550 ***	5.891 ***	4.454 ***	4.595 ***	2.823 ***	3.293 ***
	(11.663)	(9.272)	(7.130)	(7.315)	(4.435)	(9.506)
Processed seafood	5.920 ***	-0.066	-2.077 ***	-2.548 ***	-1.511 *	-1.268 ***
	(6.997)	(-0.079)	(-2.548)	(-2.667)	(-1.825)	(-2.869)

Table 3.8. Estimates of BSE outbreak effects at the mean share

See notes to Table 3.2.

Table 3.8 reports the effects of BSE outbreak in Japan (September 2001). The outbreak of BSE had huge negative effects on the demand for beef and the effects declined as time went by. The effects were positive on the demand for pork, chicken and fresh seafood, which are fresh items other than beef and substitutes for beef except chicken, and they also declined as time went by.

3.3. Conclusion

In this study a comprehensive demand system, the LA/QUAIDS, is employed to estimate the demand for eight meat and seafood items in the Japanese households. The calculated expenditure elasticities show that beef, ham, fresh seafood and processed seafood can be considered as luxury items, while pork, chicken, sausage and bacon can be classified as necessity in the eight items.

As for compensated own-price elasticities, all the items are inelastic with the exception of sausage. The own-price effects are significant in all the items. Majority of the compensated cross-price elasticities are positive and small in magnitude (below unity) suggesting that most of the food items are substitutes, but the competition among the substitutes is not very severe. In addition, income effects are also very important in the Japanese households' decision making as the signs of quite a few compensated cross-price elasticities are different from those of uncompensated cross price elasticities.

The time and demographic variables have significant effects on the demand for most of the items. As far as the regional difference is concerned, the effects on beef is opposite to pork. Pork is popular in major cities in eastern Japan, while beef are popular in western Japan. Chicken is similar to beef except for Yokohama. Sausage, bacon, fresh seafood and processed seafood are demanded more in the eastern part than in the western part of Japan with a few exceptions. The regional meat and seafood demand variation clearly reveals that there is distinct difference in consumption and dietary habits among the regions as there are distinct customs embedded historically in the individual regions. The agro-ecological variation also seems play an important role in providing region-specific resources, food items dominated by certain regions in particular. Based on the data, our results econometrically support the practical knowledge of the food industry, especially the industry of the items estimated in our study, about regional demand variation of meat and seafood products and may help the industry target production and supply more efficiently according to the regional preferences.

CHAPTER 4: Evaluating the Impact of the BSE and FMD Outbreaks on Meat Demand: An Engel Curve Analysis of Japanese Daily Data

Chapter four presents an estimation of the impacts of non-economic factors, emphasizing on the role of food scares, on the demand for meat. Meat demand analysis in Japan has captured attention of many economists. It is in part due to Japan being the nation that has likely experienced the most dramatic shifts in the dietary preferences. Japanese meat consumption is growing so quickly that it has pushed fish consumption per capita to its lowest level since the 1960s (MAFF, 2015). Demand for the meat items has been increasing over decades as a result of westernization of Japanese diets. Westernization of the diets can be manifested through changes of consumers' lifestyle and changes in food supply chains, that is, increases in the number of supermarkets and convenience stores. Besides, the meat market is relatively more liberal than before (Chern et al., 2002; Wahl et al., 1991). As a case in point, residents of Tokyo, for the first time in history, are consuming more meat than seafood. Between 1970 and 2005, the total amount of beef and pork consumed within the city increased by about 160% and 90%, respectively. This popularity of meat-centered diet and the corresponding decline in fish consumption resulted in major changes of the average Japanese menu (Our World, 2010).

However, meat demand has not shown a steady upward throughout the time. It has been fluctuating due to a very decisive economic factors such as price, income/expenditure and tariff (Capps et al., 1994; Eales and Unnevehr, 1993; Wahl et al., 1992; Wahl et al., 1991; Yang and Koo, 1994). The impacts of non-economic factors have also been great. There are various estimates of meat demand with the inclusion of non-economic factors in their demand equations: health information, product promotion, advertisement, season, food scares, etc. (Brester and Shroeder, 1995; Fidan and Klasra, 2005; Johnson et al., 1998; Kinnucan et al., 1997; McGuirk et al., 1995; Peterson and Chen, 2005; Piggott and Marsh, 2004; Tonsor and Marsh, 2007; Ward and Lambert, 1993; Ward et al., 2002).

There is a growing concern about the health and safety of food, also known as food scare problems. A food scare is an incident of widespread public anxiety about the food supply, especially concerning contamination. It can cause a sudden disruption to food supply chains as well as to food consumption patterns. Public awareness of food scares increased worldwide during the past two decades, with highly publicized cases of foot-and-mouth disease (FMD) and bovine spongiform encephalopathy (BSE) outbreaks reported in EU, US, Canada, Japan, and other regions. Food scares are one of the few shocks that can abruptly eliminate an entire nation from export markets. Such events have both short-run and long-run impacts on consumer preferences (Saghaian et al., 2007). They have far-reaching impacts: an outbreak in one country can dictate the demand pattern of the other countries. For instance, when BSE and its association with a human disease called Creutzfeldt-Jacob's disease (CJD) was announced in March 1996 in the United Kingdom (UK), there was an immediate collapse in the consumption of beef in the following month by 40% in the country. The incidence of BSE in the UK has also impacted the demand in other countries such as Germany and Italy, which had no reported cases of BSE at the time (DTZ Pieda Consulting, 1998). It is also important to understand the negative spillover effect of the food scare crises on other agricultural products from the same country. The outbreak of BSE in December 2003 in the US led some Japanese consumers to refrain from buying not only US beef but also other agricultural products from the US (Ishida et al., 2012). The publicity of the BSE produced a shift of consumer spending from red to white within meat items during the 1990s (Fousekis and Revell, 2004).

The BSE that shocked Europe in 1990s, the first case in Japan was reported by the Ministry of Agriculture, Forestry and Fisheries (MAFF) on September 10, 2001 in dairy herds in Chiba prefecture. The demand for beef fell drastically, resulting in considerable economic damage to Japanese beef producers as well as food service industries. By the end of November 2001, Japanese beef consumption fell by 70% due to the eroded consumers' confidence (McCluskey et al., 2005). Japanese consumers reacted negatively to US beef along with Japanese dairy beef even though there was no report of BSE in the US at the time (Yeboah and Maynard, 2004).

The FMD is also another problem for meat consumers and producers. It is a highly contagious disease. FMD-free countries usually ban imports of animals and animal products from the infected country when it is detected, because importing countries often have a difficult time in keeping the disease outside their country and from spreading once it enters. It is often referred to as an economic disease because of the magnitude of economic harm it can cause to producers. The UK experienced a severe FMD in 2001. When the FMD was eradicated, 221 days later, more than 2000 cases of FMD had been confirmed and over six million animals were destroyed. FMD was reported in Miyazaki and Hokkaido prefectures in March 2000. This was the first outbreak in Japan since 1908. According to Lloyd et al. (2001), the impact of the FMD in 2000 on beef demand was very little. In addition, the impact of the disease on meat consumption lasted for short period of time. In 2010, ten years later, the disease was diagnosed again in Miyazaki prefecture.

The scale and severity of the impacts of the two food scares are different. Saghaian et al. (2007) estimate the consumers' reaction to the BSE, FMD and E.Coli, and the results show that each of the food scares has different degrees of impact on the demand for beef. For instance, comparison of the impacts of BSE and bird flu shows that BSE has larger impact on consumers' meat demand than does the bird flu (Ishida et al., 2010). The variations of the impacts might depend on the characteristics of each disease, such as incubation period, cure rate and infection risk.

Therefore, this article aims to contribute to the growing literature on the impact of non-economic factors, emphasizing on the role of food scares. The study reports an Engel curve estimation of demand for beef, pork and chicken. We mainly estimate the effects of the BSE in 2001 and FMD in 2010 in Japan, and the extent to which these effects have spill over to other meats. We also compare the impacts of BSE and FMD, and draw implication to consumers. In addition, we also estimate the effects of the consumption expenditure, public holidays, Golden Week, Bon, end and beginning of the year, months and days of the week. The next section is the model, data set, followed by the empirical results and conclusion.

4.1. The Model

Demand analysis, which uses the traditional economic variables such as price and income, plays an important role in estimating the consumers' behavior. However, in such a case where we have only daily data for expenditure changes but no data for daily price changes, the application of an Engel curve model is an appropriate choice to see the consumer behavior. An Engel curve describes how expenditure relates to the demand for a particular good/service holding the price fixed.

Working (1943) finds the tendency for the proportion of expenditure devoted to food decreases in an arithmetic progression as total expenditure increases in a geometric progression. This relationship applies for families of every size, occupation, and community. At an individual level, as total expenditure per person increases, the proportion of an expenditure devoted to food decreases. Leser (1963) investigates various forms of Engel functions that are satisfying the additivity criterion. He suggests that a form of relationship used by Working (1943) has great advantageous.

However, the Working-Lesser Engel curve has difficulty in capturing non-linear effects of expenditure because it has a budget share equation that are linear in the logarithm of expenditure. Analysis of the household budget surveys have pointed to more curvature in the Engel curve relationship than which is permitted by the standard Working-Lesser form. The appropriate form that can support generalization in the shape of Engel curve relationship is shown by a quadratic extension of Working's model. The quadratic extension of the Working's model, which is used in Banks et al. (1997), restores the relevant properties of its linear counterpart and allows more flexibility in expenditure change.

The equation of the model is defined as a budget share of a particular good being a function of expenditure and other variables holding the price fixed. Hence our empirical quadratic extension of Working's model is specified as

$$w = \alpha_0 + \alpha_1 t + \sum_{m=1}^{42} \theta_m D_m + \beta \log y + \gamma (\log y)^2 \tag{1}$$

where w is the expenditure share of the good, y is meat expenditure, t indicates time, D_m represent dummy variables and α, β , γ and θ are parameters to be estimated.

According to Matsuda (2006), the expenditure elasticity is calculated as

$$\varepsilon = \frac{y}{q}\frac{\partial q}{\partial y} = 1 + \frac{\beta}{w} + \frac{2\gamma}{w}\log y \tag{2}$$

where q is the quantity of the good. Daily rates of shift or time trend (%/day) are calculated as

$$\frac{10^2}{q}\frac{\partial q}{\partial t} = \frac{10^2}{w}\frac{\partial w}{\partial t} = \frac{10^2 \alpha_1}{w} \tag{3}$$

Monthly, day-of-the-week, public holidays, Golden Week, Bon, end- and beginning-of-the-year as well as the BSE and FMD effects (%) are calculated in the same way, replacing t with D_m and α_1 with θ_m.

4.2. Data Set

Daily aggregated pseudo panel data is used for the two or more person households at a nationwide level from January 1, 2000 through October 31, 2016, yielding a sample of 6,149 observations. The data is from the Family Income Expenditure Survey (FIES) and the Consumer Price Index (CPI). Both of the FIES and CPI are published by the Statistics Bureau, Ministry of Internal Affairs and Communications of Japan. The daily expenditure for the individual goods (pq) and consumption expenditure (y) are deflated using the monthly price index. Since the data for the price is not available on a daily basis, monthly price indices are found to be appropriate in deflating the daily expenditures.

During the holidays and holiday seasons, spending time with family by preparing meals at home as well as going out for eating and drinking are common practices to do. The practices, in turn, may influence the demand for the food items. On the other hand, sudden outbreaks of the food scares that may have direct relation to food safety may also influence the consumption pattern, too.

In this study, the effects of non-economic factors like months, days of the week, public holidays (observances), Golden Week, Bon, and end and beginning of the year as well as BSE and FMD are aimed to be estimated. The corresponding dummy variables representing the factors are included in the data set, D_1 through D_{41}. The breakdown of the dummy variables are as follows: D_1 to D_{11} represent monthly dummy variables for February through December while January is considered to be the baseline month. D_{12} to D_{17} are dummy variables for the day-of-the-week effects, running from Tuesday to Sunday while Monday is considered to be the baseline for the days of the week. D_{18} is the dummy variable for the public holidays. D_{19} is the dummy variable for Golden Week. D_{20} dummy variable represents Bon holidays, days assumed to cover from August 13 to 16. D_{21} to D_{33} represent dummy variables for the end and beginning of the year (end of the year is assumed to cover from December 24 to 31, whereas beginning of the year is assumed to cover from January 1 to 5). D_{34} to D_{38} dummy variables represent the BSE effects, it covers two years after the outbreak. The first year is divided into quarters and the second year is just considered as a single dummy variable. Finally, D_{39} to D_{42} are dummy variables for the FMD effects, representing three quarters.

In 2003, Japan imposed tariff on the beef import. It was aimed at giving relief for the local producers. Ultimately, it was assumed to have played a role for the beef demand to shift to domestic beef products. To protect its domestic farms that are producing sensitive commodities such as beef, rice and milk, Japan has been using tariff-rate quotas (TRQ). The quota is a fixed volume of product. Imports which are brought in within the quota pay a lower tariff, while imports outside the quota face much higher tariffs. Therefore, to see the effects of newly introduced beef tariff, we included 10 day dummy variables before the tariff was imposed, and 30 days after it was imposed. However, the result shows that the parameters are statistically insignificant for the vast majority of the days for both before and after the implementation of the tariff. As a result, we removed the effects of the 2003 beef import tariff from the study.

4.3. Empirical Results

Table 4.1. Parameter estimates

	log *y*	log *y*^{2}	Trend	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Tue	Wed
Beef	-0.006	0.000	-0.000	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.000	-0.000	-0.000	-0.000	0.000	0.001	0.000
	(-59.71)	(0.496)	(-12.44)	(1.244)	(-2.103)	(-1.630)	(-0.526)	(-0.079)	(-2.383)	(2.924)	(-1.295)	(-2.147)	(-1.311)	(3.558)	(12.47)	(4.366)
Pork	-0.009	0.005	0.000	0.000	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.000	-0.000	-0.001	0.001	0.000
	(-121.6)	(23.03)	(53.34)	(0.568)	(-10.01)	(-9.267)	(-10.61)	(-10.26)	(-15.43)	(-11.15)	(-10.29)	(-6.216)	(-2.682)	(-6.490)	(35.69)	(6.654)
Chicken	-0.004	0.003	0.000	-0.000	-0.001	-0.000	-0.001	-0.001	-0.001	-0.001	-0.001	-0.000	-0.000	0.000	0.001	0.000
	(-102.5)	(21.77)	(33.18)	(-3.201)	(-12.26)	(-10.12)	(-12.53)	(-14.87)	(-23.20)	(-22.57)	(-12.16)	(-7.281)	(-3.339)	(0.392)	(34.06)	(10.41)

	Thu	Fri	Sat	Sun	Holiday	GW	Bon	Dec24	Dec25	Dec26	Dec27	Dec28	Dec29	Dec30	Dec31	Jan1
Beef	0.000	0.001	0.003	0.003	0.002	0.002	0.003	0.002	0.001	0.001	0.003	0.006	0.012	0.024	0.030	-0.000
	(3.974)	(10.34)	(55.98)	(68.22)	(25.34)	(12.73)	(15.45)	(6.344)	(3.240)	(3.411)	(9.041)	(18.52)	(40.74)	(75.81)	(97.00)	(-0.523)
Pork	-0.000	-0.000	0.001	0.002	0.001	-0.001	-0.001	-0.002	-0.001	0.000	0.001	0.001	0.003	0.003	0.001	-0.006
	(-0.794)	(-3.100)	(17.80)	(48.02)	(10.25)	(-5.695)	(-6.555)	(-7.219)	(-3.266)	(0.818)	(4.042)	(5.542)	(12.41)	(13.60)	(3.875)	(-22.28)
Chicken	0.000	0.000	0.000	0.001	0.000	-0.000	-0.000	0.003	-0.000	-0.000	0.001	0.001	0.003	0.006	0.004	-0.003
	(6.097)	(1.914)	(13.00)	(32.97)	(9.619)	(-4.970)	(-4.352)	(22.43)	(-2.200)	(-1.150)	(3.919)	(9.994)	(25.40)	(43.86)	(31.42)	(-19.46)

	Jan2	Jan3	Jan4	Jan5	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Year 2	Quarter 1	Quarter 2	Qaurter 3	Later	Constant	Adjusted R^2
Beef	0.003	0.003	0.001	0.001	-0.003	-0.003	-0.001	-0.001	-0.000	-0.001	-0.000	-0.000	0.000	0.008	0.832
	(11.55)	(8.928)	(3.562)	(2.108)	(-18.05)	(-14.21)	(-6.754)	(-4.194)	(-3.923)	(-3.048)	(-2.409)	(-2.006)	(4.287)	(75.32)	
Pork	-0.005	-0.004	-0.002	-0.001	0.001	0.001	0.001	0.001	0.000	-0.001	-0.001	-0.001	-0.000	0.008	0.887
	(-22.21)	(-19.88)	(-8.160)	(-2.680)	(8.632)	(6.571)	(5.213)	(6.143)	(2.304)	(-6.555)	(-6.264)	(-4.408)	(-7.148)	(114.5)	
Chicken	-0.002	-0.002	-0.001	-0.000	0.001	0.001	0.001	0.001	0.000	-0.000	-0.000	-0.000	0.000	0.004	0.883
	(-18.59)	(-17.19)	(-11.00)	(-3.475)	(9.603)	(9.508)	(7.100)	(6.854)	(5.015)	(-1.099)	(-2.233)	(-1.512)	(2.907)	(87.72)	

Note. t-values are in the parentheses. The critical values are 2.576, 1.960 and 1.645 for 1%, 5% and 10% significance levels, respectively.
Adjusted R^2 was calculated for each of the three equations.

To test the existence of the unit root, we employ the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests to find all variables except dummies stationary. The Engel curve model is estimated using the Cochrane-Orcutt method. Table 4.1 reports the parameter estimates. Most of the coefficients are statistically significant including the log expenditure as well as quadratic log expenditure. The magnitude and sign of the estimated coefficients do not have straightforward economic interpretations. However, they are a basis for the estimation of expenditure elasticities and other effects on the demand. The goodness of fit of the model to our data set, adjusted R^2 ranges from 0.832 to 0.887, indicating that the model explains our data set very well.

Expenditure Elasticities and daily rates of shift

Table 4.2. Estimates of expenditure elasticity and daily rate of shift at the sample mean

Quantity q	Expenditure y	Daily rate of shift (%/day)
Beef	0.300 ***	-0.004 ***
	(25.566)	(-12.441)
Pork	0.140 ***	0.006 ***
	(19.781)	(35.485)
Chicken	0.135 ***	0.007 ***
	(15.962)	(33.180)

Note. t-values are in the parentheses. The critical values are 2.576, 1.960 and 1.645 for 1%, 5% and 10% significance levels and denoted by *, **, ***, respectively.

The expenditure elasticity estimates are statistically significant and positive for beef, pork and chicken as reported in Table 4.2. The estimates imply that the items are necessities. Beef, in particular, has an elasticity estimate of 0.300, greater than pork and chicken. It indicates that demand for beef is the most responsive to expenditure changes probably because it is usually more expensive than pork and chicken. The study by Johnson et al. (1998) could witness the fact that beef has a great response to expenditure changes. Similarly, Xi et al. (2004) and Yang and Koo (1994) report that beef is expenditure responsive and a luxury in Japan. In our study, however, the expenditure elasticity estimate for beef is less than one, possibly because expenditure changes daily in our data. Consumers respond less to expenditure changes in a short run than in the long run.

In the same table, estimates of the daily rate of shift are also reported. There is a significant effect of time trend on all of the items. Accordingly, the demands for pork and chicken are slightly increasing as time goes by while the demand for beef is slightly declining. The results are on condition of keeping all other determinant factors constant and considering only the daily time effects.

Monthly Effects

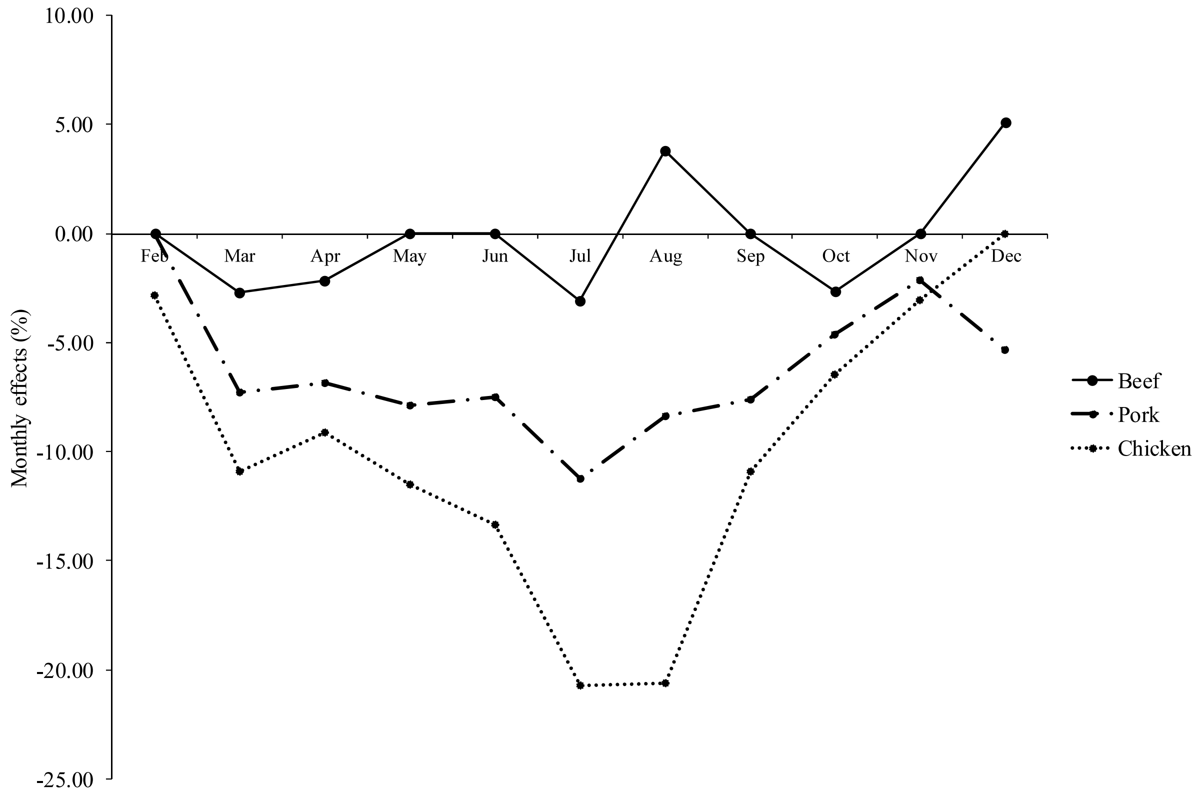

Fig.. 4.1. Estimates of monthly effects

Fig. 4.1 illustrates the significant effects of months on the demand. In August and December, beef demand is more than in January by 3.822% and 5.126%, respectively. It makes sense that in summer beef barbecue is popular in Japan. In December, beef consumption is the highest due to the end-of-the-year parties as well as celebrations of holidays including Christmas. The demand for pork is low, on the other hand, probably due to the fact that in special events more expensive food items such as beef are preferred. Peterson and Chen (2005) report that demand for pork is popular when demand for beef is unpopular and vice versa, because they are substitute items for each other.

Day-of-the-Week Effects

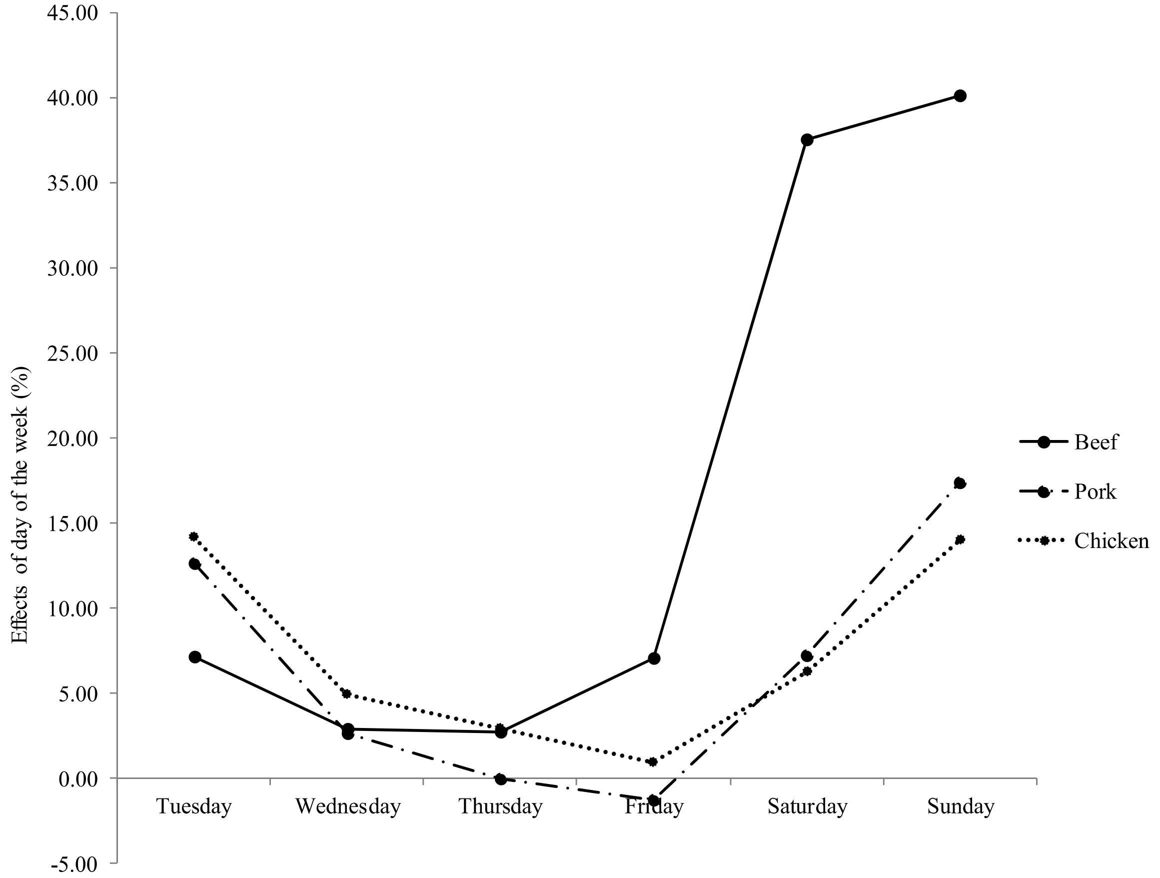

Fig.4. 2. Estimates of day of the week effect

Days of the week have significant effects on the demand for all of the items, as shown in Fig. 4.2. Demand for beef is higher on weekends (Saturdays and Sundays) and highest on Sundays. As for the pork, demand is the highest on Sundays and followed by Tuesdays. However, for chicken it is the highest on Tuesdays, and followed by Sundays. According to Haines et al. (2003), in the US, the effect of days of the week on the demand for food and drinks is significant. The demand for the items is higher on Tuesdays than the other weekdays. The effects of Tuesdays is unprecedented and interesting. AEON, the largest retailer in Asia and by far the largest supermarket chain in Japan, has sales and bargains on Tuesdays for food items. Presumably our result is consistent with the marketing strategy and practice of AEON.

Holiday Effects

Table 4.3. Estimates of public holiday, Golden Week and Bon effects at the sample mean (%)

Quantity q	Public holiday	Golden Week	Bon
Beef	24.393 ***	21.038 ***	34.507 ***
	(25.368)	(12.804)	(15.587)
Pork	5.943 ***	-5.420 ***	-8.600 ***
	(10.123)	(-5.745)	(-6.653)
Chicken	6.689 ***	-5.803 ***	-6.871 ***
	(9.620)	(-4.996)	(-4.362)

See notes to Table 4.2.

The effects of holidays, which are public holidays, Golden Week and Bon, are shown in Table 4.3. The effects of the three holidays on beef are the highest of the three items. Beef is demanded more on the public holidays than ordinary days. The effects of Golden Week and Bon are the highest on beef. Beef is not consumed on a regular basis by many Japanese households due to its relatively high price. Therefore, it is mainly enjoyed in special events such as parties. On the other hand, the effects, especially of Golden Week and Bon, on pork and chicken are different from that on beef. These two holidays have negative impacts on the demand for pork and chicken, which makes sense in that pork and chicken are more affordable and more likely to be consumed on a routine basis. Hence, these items might not be primary choices in special events.

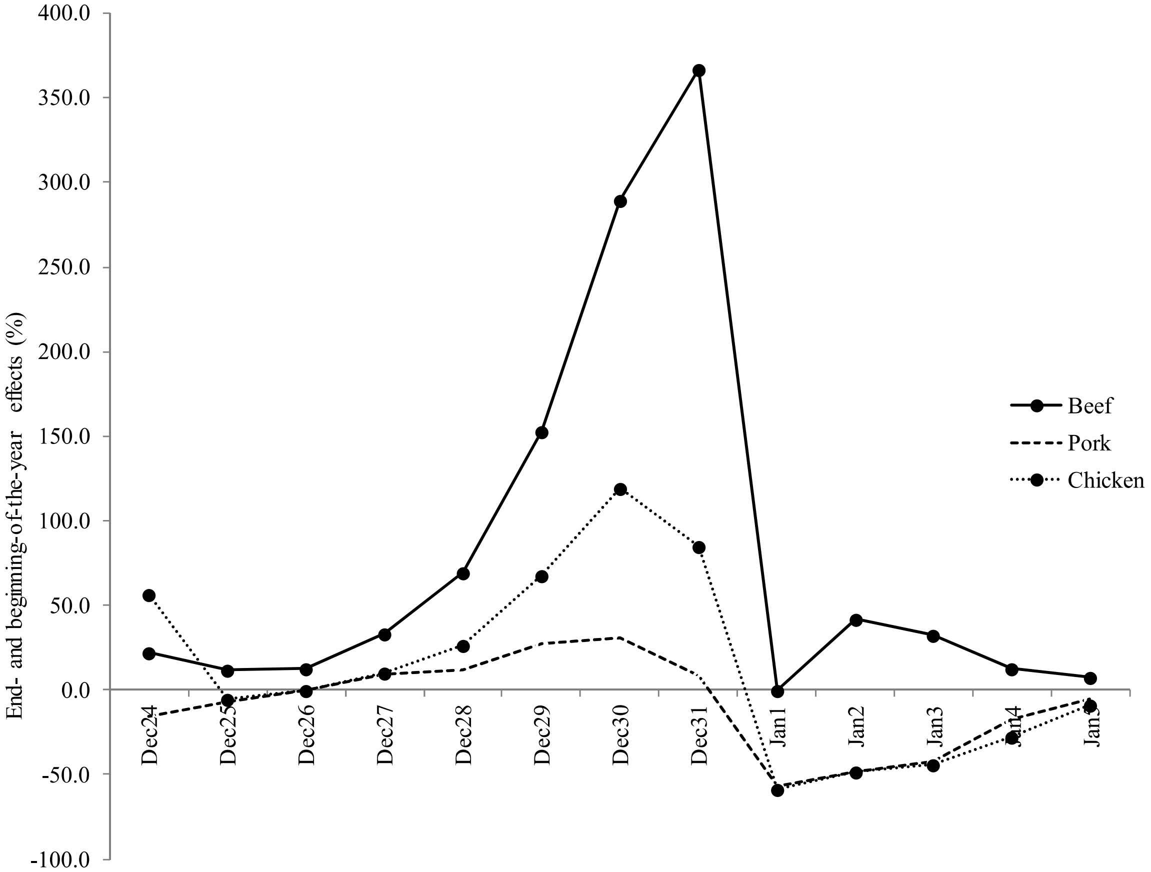

Fig. 4.3. Estimates of end- and beginning-of-the-year effects

Fig. 4.3 shows the effects of the end and beginning of the year. The effects are statistically significant for almost all of the items. The demand for beef and chicken is high on Christmas Eve (December 24). Chicken is the most demanded item on Christmas, with the increase up to 56.131%. Chicken is preferred at Christmas in Japan unlike turkey in the US. There is an immediate slip of the demand on the next day (December 25) for beef and chicken. However, on December 26 it shows a sign of recovery for all of the three items. The demand for pork and chicken reaches its peak on December 30, whereas for beef the peak is December 31. After December 31, there is a declining trend in the demand for beef as a consequence of the beginning-of-the-year effects.

BSE Effects

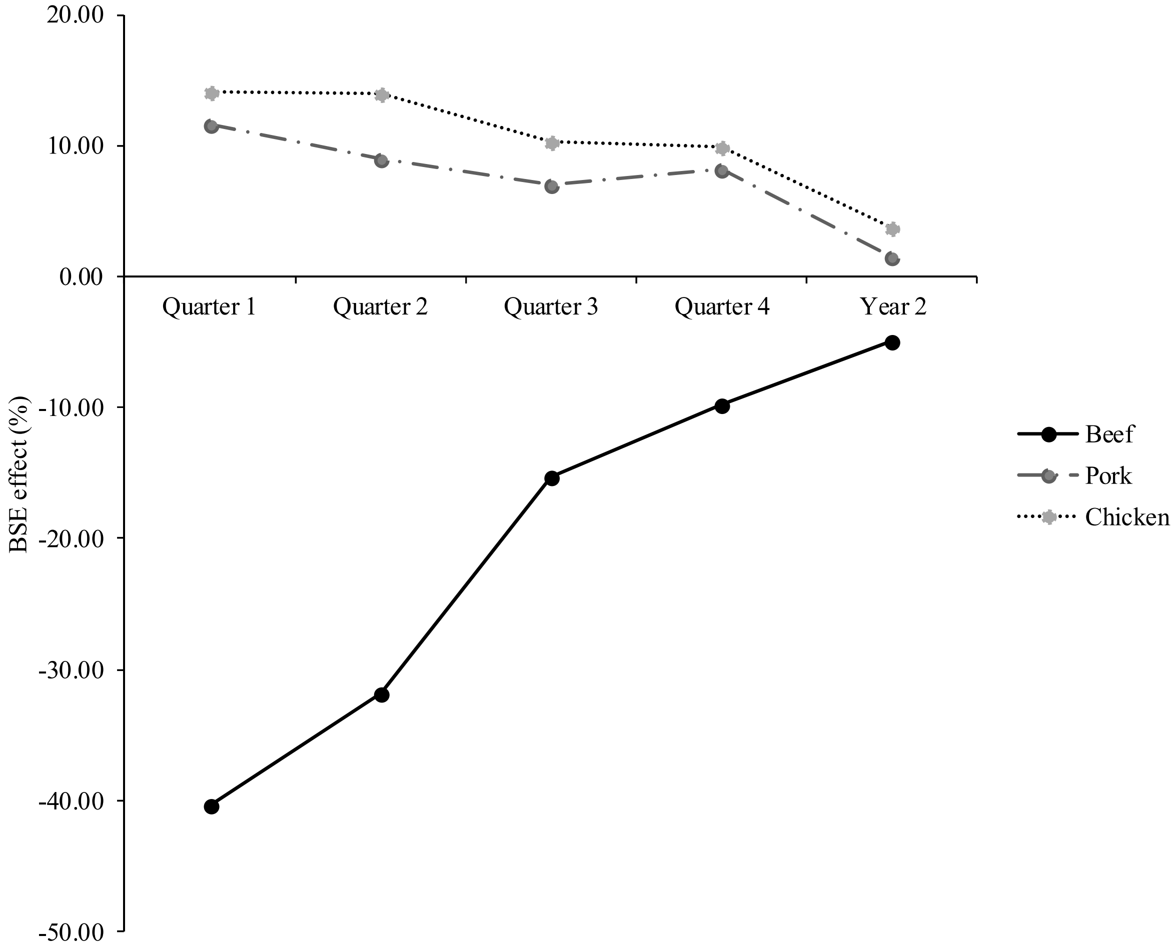

Fig. 4.4. Estimates of BSE outbreak effects

Fig. 4.4 illustrates the BSE effects on the demand. After the incidence, from the first through fourth quarter, the effect of BSE is significant, and has a negative impact on the demand for beef. It is down by 40.333%, 31.847%, 15.290% and 9.719% in each quarter, respectively. As for the pork, it is positively impacted by the outbreak, gaining the demand by 11.659%, 8.897%, 7.068% and 8.143% in each quarter, respectively. Capps et al. (1994) consider pork to be a substitute for beef when there is a beef crisis in Japan. The demand response of chicken is similar to that of pork: 14.053%, 14.000%, 10.300% and 9.968% for each quarter, respectively. The significant effect of BSE on beef consumption is shown in the study of Yeboah and Maynard (2004).

To see the persistent effects of BSE, the second year after the outbreak is analyzed. The falling rate of demand declined to 4.910% for beef, suggesting that the demand response to BSE declines over time. After the fourth quarter, it seems that the demand for the three items is slowly returning to normal. It took twenty one months to recover in the Netherlands under normal conditions (Mangen and Burrell, 2001). However, if aggressive marketing campaign is launched to restore consumers' confidence in beef, the recovery time can be shortened to five months (Fox and Peterson, 2004).

FMD Effects

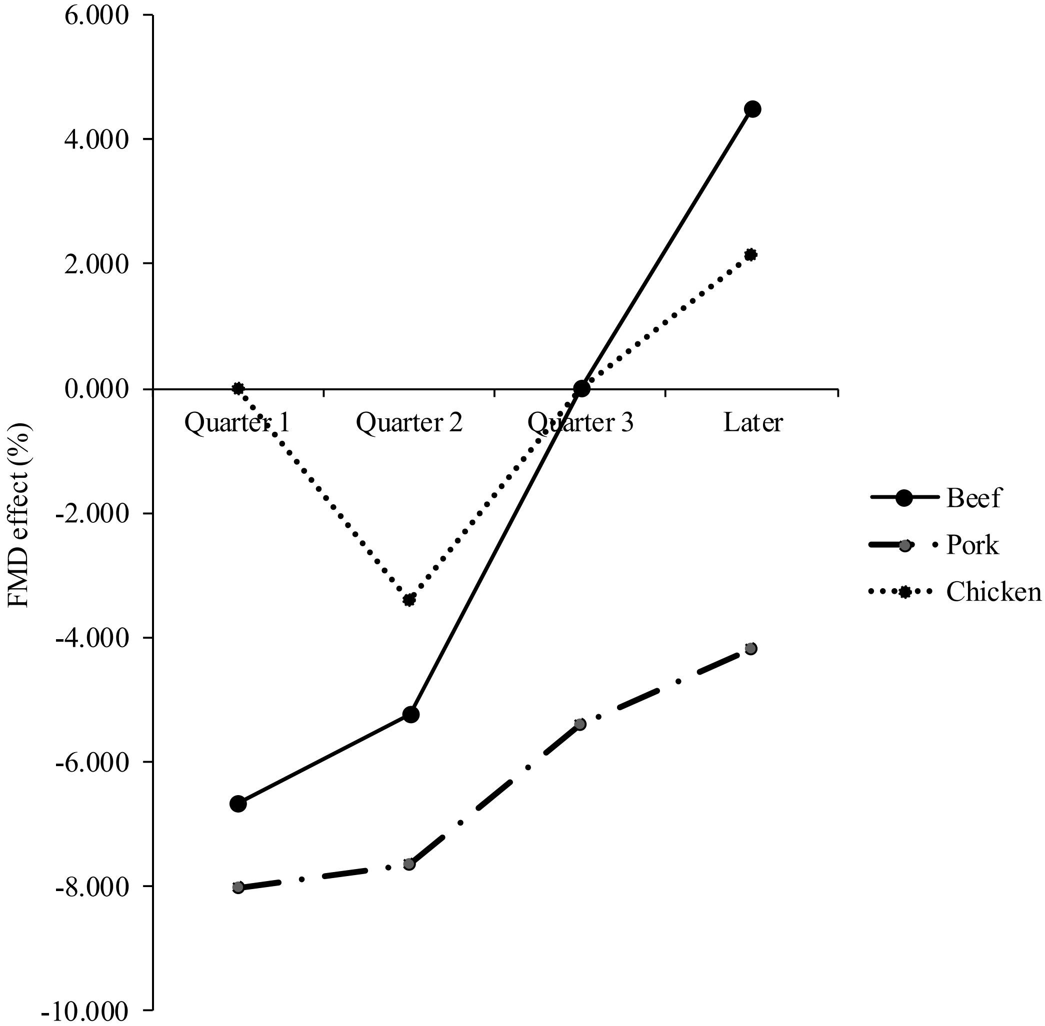

Fig. 4.5. Estimates of FMD outbreak effects

Fig. 4.5 illustrates the FMD effects on the demand. In our graphs insignificant estimates are regarded as 0. The disease has a significant negative effect on beef in the first two quarters. The demand for beef declines by 6.668% and 5.246% in the first and second quarters unlike the much larger effects of BSE. The effects of the disease on pork are similar to that of beef as the demand for pork also falls gradually because of the nature of the FMD disease. It affects all cloven hoofed (split hoof) animals domestic as well as wild bovids. For instance, susceptible animals include cow, buffalo, sheep, pig, antelope, deer, bison, etc. The result shows that the FMD impact lasted for two quarters for beef, which is shorter than the impact of BSE. Even though FMD is a zoonosis, a disease transmissible to humans, it crosses the species barrier with difficulty and with little effect. Given the high incidence of the disease in animals, both in the past and in more recent outbreaks worldwide, its occurrence in human is rare. Therefore, experience of the human infection is limited (Prempeh et al., 2001). A study shows that consumers who recognize that FMD poses no significant human health risk experience a welfare gain when beef price falls as a result of the FMD crisis whereas those who are skeptical about the disease do not gain (Paarlberg et al., 2005).

The percentage of animals that die directly from the FMD disease is low. However, its global impact is colossal due to the fact that a huge number of animals are affected by the disease. It is highly contagious, affects many species and it is not easily contained within one farm or one population. If an outbreak occurs because one farmer does not protect his/her animals, others may suffer. Therefore, it is arguably one of the most important livestock diseases in terms of economic impact throughout the world (Pendell et al., 2007). Similarly, in the UK, FMD impacts all the animals with the exception of poultry but with different levels of severity (Chopra and Bessler, 2005). However, in our finding FMD has a negative effect on the demand for chicken, too, possibly due to the fear emanating from the nature of the disease. FMD can attack a broad range of livestock animals. Consumers might have refrained from consuming chicken to avoid the probable risk of being infected by the disease.

Our result indicates that consumers understand the difference between the health risks associated with BSE and FMD. The demand response to FMD is negative for all of the three items. Paarlberg et al. (2005) also reported that consumers understand the distinctive nature of the two diseases.

There is a huge significant difference between the impacts of the two diseases. The demand response of beef to FMD is much smaller than that to BSE in the first two quarters. Consumers respond strongly to BSE, while they respond slightly to FMD. FMD does not have huge human health risks while BSE can be fatal. The effects of BSE are positive on pork and chicken.

4.4. Conclusion

In this study, a quadratic extension of the Working's model has been employed to estimate the demand for beef, pork and chicken using daily data. The expenditure elasticity estimates show that beef, pork and chicken can be considered necessities. Months, days of the week, public holidays, Golden Week, and Bon as well as the end and beginning of the year have significant effects on the demand for most of the meat items.

As far as the food scare effects are concerned, we have understood that there is a gradual shift in the structure of consumer demand following the BSE and FMD outbreaks. That is, BSE reduces demand for beef and raises demand for pork and chicken. FMD reduces demand for beef, pork and chicken. The broad-spectrum effects of FMD include the reduction in the demand for chicken. As a result of fear of the disease, consumers might have refrained from consuming even chicken. The impact of BSE and FMD persisted for different periods. The impact of BSE on the demand for beef is more severe than that of FMD. In the first quarter alone, it is over six times as strong as the impact of FMD. It also takes longer time to recover than the impact of FMD. The impact of BSE is much more persistent than the impact of FMD, which suggests that consumers recognize, unlike BSE, FMD poses no significant human health risks.

Thus, meat industries and government agencies need to consider important measures such as strengthening quality control system and reliable information sources. In order to combat the consumers' exposure to negative information, it is very crucial that consumers need to access reliable information to evaluate the real risks associated with the consumption of meat. Otherwise, consumers overreact to every food scares regardless of their specific risks. In our finding, negative effects of FMD are shown even on the demand for chicken while the disease mainly affects four-legged livestock animals.

CHAPTER 5: Effects of bilateral trade agreements on the demand for beef in Japan: the case of Japan-Australia EPA and Japan-US FTA

This chapter presents the analysis of the impacts of bilateral trade agreements on the demand for beef in Japan. Historically, Japan has protected its domestic beef market from imported beef through various protectionism policies. As a result of the policies, Japanese consumers had paid four to five times more for beef than do US consumers (Wahl et al., 1991; Weatherspoon and Seale, 1995). However, beef import has rapidly increased due to greater Japanese demand for beef, limitations on increasing domestic beef production, and pressure from beef exporting countries. Trade agreements, such as Beef Market Access Agreement (BMAA) and Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) have attributed to the influx of imported beef in Japan (Lee and Itakura, 2014; Manger, 2005; Takahashi and Maeda, 2018; Todsadee et al., 2012; Wahl et al., 1991). BMAA agreement reduced quota restrictions on imported beef, and agreed to increase beef imports as well as to replace the import quota by an import tariff in 1991 (Coyle, 1984; 1990; Weatherspoon and Seale, 1995). After beef tarification policy of 1991, the quantity demanded for imported beef has increased, particularly beef imported from the US, whereas the quantity demanded for domestic dairy beef has decreased. Australia complained that US beef import was given favorable treatment by Japan, in which the US denied the allegations and suggested that Japanese consumers prefer US grain-fed beef to the Australian grass-fed beef (Coyle and Dyck, 1989; Kawashima and Sari, 2010; Takahashi and Maeda, 2018; Yang and Koo, 1994). Beef items in Japan are highly segmented, and it is prepared differently depending the type of cut, whether the beef is Wagyu or dairy, domestic or imported and grain-fed or grass-fed. However, still there could be some truth to the argument that Japanese consumers prefer US grain-fed beef to the Australian grass-fed beef because US beef has similar texture with the Japanese beef (Obara, 2010).

The demand for imported beef, particularly beef from the US and Australia, can be manifested by the impacts they have on food chains in Japan. Yoshinoya, Matsuya and Sukiya are the top three largest gyudon[1] chains in Japan. Gyudon chains mainly use imported grain-fed US

[1] Gyudon, or beef bowl, is a popular food chain in Japan. It is relatively inexpensive and typically served as a fast-food item.

beef. On the other hand, McDonald's, western hamburger and Japanese hamburg[2] chains and restaurants use domestic dairy beef and imported grass-fed Australian beef (Obara, 2010; Yamamura and Peterson, 2016). It is clear that US beef and Australian beef are demanded in Japan by separate categories of food chains. Therefore, it is very important to evaluate the impacts of multilateral and bilateral trade deals that Japan signs with beef exporting countries–Australia and US. There is a policy reform through Japan-Australia Economic Partnership Agreement (JAEPA) that was signed in 2014. Most recently, there is a negotiation underway between Japan and US to establish bilateral free trade agreement, also known as Japan-United States Free Trade Agreement (*JUSFTA*). The *JUSFTA* is anticipated to be signed the year of 2019.

This study focuses on the significance of the impacts of the JAEPA and *JUSFTA* trade deals on the demand for beef in Japan. Since the implementation of these agreements have inevitable policy implications, it is important to pay a great attention and critically evaluate the empirical findings of the impacts. Similar studies have been conducted by Hayes et al. (1990), Kawashima and Sari (2010), Matsuda (2014), Mori and Lin (1990), Takahashi and Maeda (2018), and Wahl et al. (1991). Except Takahashi and Maeda (2018), all the above studies have overlooked a particular problem–they aggregated Wagyu beef, crossbred beef and dairy beef as a domestic beef. Ministry of Agriculture, Forestry and Fisheries (MAFF; 2015) considered that Wagyu beef and crossbred beef are differentiated from imported beef, while dairy beef competes with imported beef. The study result of Takahashi and Maeda (2018) is consistent with the consideration of MAFF (2015), and reveals that there is no competitive relationship between Wagyu beef or crossbred beef and imported beef, while there is competitive relationship between dairy beef and imported beef. However, the imported beef were also aggregated as an imported beef, in which Takahashi and Maeda (2018) also failed in terms of disaggregating imported beef items by their source-of-origin. Our study estimates the demand for the disaggregated domestically produced beef–Wagyu beef, crossbred beef and dairy beef, and imported US beef as well as Australian beef, in addition to estimating expenditure and price elasticities. The next section of the paper presents discussion of the data set and model and is followed by a discussion of empirical results. Finally, it offers concluding remarks.

[2] A hamburg steak is a grilled ground beef patty, similar to hamburger (without the bun).

5.1. Data and Model

Five types of beef items, which are both domestically produced and imported, are considered. A monthly time series data is used for Wagyu beef, crossbred beef, dairy beef, US beef and Australian beef[3]. The data period is from April 2007[4] to September 2018, yielding a sample of 138 observations. The quantity and wholesale prices[5] are published by the Agriculture and Livestock Industries Corporation (ALIC; 2019). The same data source is used for estimated closing stock of domestically produced beef and imported beef. However, data for the quantity of exported Japanese beef is published by the Trade Statistics of Japan. The export data for domestically produced Japanese beef is available as one good. Disaggregating in to Wagyu beef, crossbred beef and dairy beef is needed. The wholesale prices are available in nominal values (yen/kg). The expenditure and nominal prices were deflated using the general consumer price index (GCPI). The GCPI is published by the Statistics Bureau of Ministry of Internal Affairs and Communications of Japan.

In our data, the estimated marketing quantity of each the beef items is assumed to be equivalent to the quantity demanded for each of the beef items. The total estimated marketing quantity of the domestically produced beef is calculated by subtracting the quantity of exported beef and the quantity of closing stock change of domestically produced beef from the total quantity of domestically produced beef. Assume that the total estimated marketing quantity of domestically

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[3] Japan is one of the largest beef importing countries in the world, and an important market of US and Australia. The US and Australia are the primary suppliers, and together represent roughly 90% of Japan's 2014 beef imports (Muhammad et al., 2016). Besides sharing the biggest portion of imported beef, US beef and Australian beef are included in this study because of the availability of whole sale (trader's) price for each of the beef items. Moreover, Japanese food chains such as Gyudon, hamburger and hamburg fast foods heavily depend on beef from US and Australia.

[4] The beginning of the data period of this study is determined to be from April 2007, because the monthly data on the price of the crossbred beef type can be obtained from April 2007. Prior to that time, the data for crossbred beef is unavailable. Also, there was a ban of US beef for the period between 2003 and 2006 because of BSE outbreak.

[5] The wholesale prices, for domestically produced beef, are on the basis of per beef-cut. A simple average is calculated to obtain average price for each type of beef. However, for the imported beef items, the wholesale prices are available as per frozen and fresh beef. Hence, the average price calculation is easier than for that of domestically produced beef items.

produced beef is expressed by the equation $L = M - N - O,$ where L is total estimated marketing quantity of domestically produced beef, M is total quantity of domestically produced beef, N is total quantity of exported beef, and O is quantity of closing stock change of domestically produced beef. Similarly, the total estimated marketing quantity of the imported beef is calculated by subtracting the quantity of closing stock change of imported beef from the total quantity of imported beef. Assume that the total estimated marketing quantity of the imported beef is expressed by the equation $P = Q - R$, where P is total estimated marketing quantity of the imported beef, Q is total quantity of imported beef and R is quantity of closing stock change of imported beef.

The disaggregated data for the quantity of domestically produced beef–Wagyu beef, crossbred beef and dairy beef is published by ALIC (2019). However, disaggregated data for the quantities of the closing stock and exported of Wagyu beef, crossbred beef and dairy beef cannot be obtained. The estimated marketing quantity of each of the domestically produced beef is calculated by multiplying the respective ratios of the quantity of each of the domestically produced beef to the total quantity of domestically produced beef by the total estimated marketing quantity of the domestically produced beef. Assume that the estimated marketing quantity of each of the domestically produced beef item is expressed by the equation $S = \frac{T}{M}\ X\ L$, where S is estimated marketing quantity of each of the domestically produced beef, T is quantity of each of the domestically produced beef, M is total quantity of the domestically produced beef, and L is total estimated marketing quantity for domestically produced beef.

Essentially, the same steps are followed to obtain the estimated marketing quantity of each of the imported beef. The estimated marketing quantity of each of the imported beef is calculated by multiplying the respective ratios of the quantity of each of the imported beef to the total quantity of the imported beef by the total estimated marketing quantity of the imported beef. Assume that the estimated marketing quantity of each of the imported beef is expressed by the equation $W = \frac{Y}{Q}\ X\ P,$ where W is estimated marketing quantity of each of the imported beef, Y is quantity of each of the imported beef, Q is total quantity of the imported beef and P is total estimated marketing quantity of imported beef.

The wholesale prices are available for the different cuts of the dressed carcasses regarding to the prices of Wagyu beef, crossbred beef and dairy beef. The wholesale price per beef type is a simple average of prices of different cuts. For the imported beef from Australia and US, the respective average market price of imported beef (Trader's price) is used. The Trader's prices of US and Australia beef are calculated as simple average of prices of carcass cuts of beef from each country. All nominal prices are deflated by using GCPI.

The almost ideal demand system (AIDS) is a consumer demand model (Deaton and Muellbauer, 1980). It is a versatile system capable of studying various aspects of food demand. The quadratic form of the AIDS model (QUAIDS), which was first developed by Banks et al. (1997), is not only more versatile in modelling consumer expenditure, but also it restores the relevant properties of AIDS. In this study, monthly dummy variables, which are demand shifters, are incorporated in a way that the theoretical properties of the model are maintained, and the estimated demand system must be closed under unit scaling (CUUS; Alston et al., 2001). However, QUAIDS falls short in fulfilling the fundamental properties of CUUS. The linear approximate form of QUAIDS (LA/QUAIDS) was developed by Matsuda (2006), it embraces the characteristics of CUUS even when the demand shifters are incorporated in to the model.

According to Matsuda (2006), the LA/QUAIDS equation is expressed as follows:

$$w_{it} = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \log p_{jt} + \beta_i \log \frac{y_t}{P_t^C} + \frac{\lambda_i}{P_t^Z} \left(\log \frac{y_t}{P_t^C} \right)^2 + \varepsilon_{it} \qquad i, j = 1,2,...,n \tag{1}$$

where w_i is the share of expenditure allocated to item i, p_j is the price of item j, y is the total expenditure on all the items in the system and α_i, β_i, γ_{ij} and λ_i are parameters to be estimated. P^C is the loglinear analogue of the Laspeyres price index and shown as:

$$\log P_t^C = \sum_{i=1}^{n} \overline{w}_i \log p_{it} \tag{2}$$

P^C is invariant to changes in units. ¯ stands for the sample mean. We apply index P^Z as proposed by Matsuda (2006):

$$\log P_t^Z = \sum_{i=1}^{n} (w_{i_t} - \overline{w}_i) \log \frac{p_t}{\overline{p}_i} \tag{3}$$

where P_t^Z could be seen as a zero degree homogenous analogue of the Törnqvist price index and is also invariant to changes in units.

We included the effects of time trend and months as regressors in the empirical model. Our empirical model of the LA/QUAIDS is, therefore, specified as:

$$w_i = \alpha_{i0} + \alpha_{i1} t + \sum_{m=1}^{11} \theta_{i,1} D_{mt} + \sum_{j=1}^{5} \gamma_{ij} \log p_{jt} + \beta_i \log \frac{y_t}{P_t^C} + \frac{\lambda_i}{P^Z}\left(\log \frac{y_t}{P_t^C}\right)^2 + \varepsilon_{it} \quad i = 1,2,\ldots,5 \tag{4}$$

where t indicates the time trend and D_m is a monthly dummy variable. To be in line with economic theory, parameters of the demand equations must satisfy adding up, homogeneity and Slutsky symmetry restrictions as follows in Equation (5), (6) and (7), respectively.

$$\sum_{i=1}^{5} \alpha_{i0} = 1 \quad \sum_{i=1}^{5} \theta_{ih} = \sum_{i=1}^{5} \gamma_{ij} = \sum_{i=1}^{5} \beta_i = \sum_{i=1}^{5} \lambda_i = 0 \qquad h = 1,2,\ldots,12, \quad j = 1,2,\ldots,5 \tag{5}$$

$$\sum_{j=1}^{5} \gamma_{ij} = 0 \qquad i = 1,2,\ldots,5 \tag{6}$$

$$\gamma_{ij} = \gamma_{ji} \qquad i, j = 1,2,\ldots,5 \tag{7}$$

Expenditure, uncompensated and compensated price elasticities are calculated as in Equation (8), (9) and (10), respectively.

$$\varepsilon_i = 1 + \frac{\beta_i}{w_i} + \frac{2\lambda_i}{w_i P^z} \log \frac{y}{P^C} \qquad i = 1,2,\ldots,5 \tag{8}$$

$$\varepsilon_{ij} = -\delta_{ij} + \frac{\gamma_i}{w_i} - \frac{\beta_i \overline{w}_j}{w_i} - \frac{\lambda_i}{w_i P^Z}\left[2\overline{w}_j + (w_j - \overline{w}_j)\log \frac{y}{P^C}\right]\log \frac{y}{P^C} \qquad i, j = 1,2,\ldots,8 \tag{9}$$

$$\varepsilon^C{}_{ij} = \varepsilon_{ij} + \varepsilon_i w_j \text{ (Slutsky Equation)} \qquad i, j = 1,2,\ldots,5 \tag{10}$$

Monthly rates of shift (%/month) are calculated as:

$$\frac{10^2}{q_i}\frac{\partial q_i}{\partial t} = \frac{10^2}{w_i}\frac{\partial w_i}{\partial t} = \frac{10^2 \alpha_{i1}}{w_i} \qquad i = 1,2,\ldots,5 \tag{11}$$

Monthly effects (%) are calculated in the same way, replacing t with D_m.

To select a method of estimating the time series data that is suitable for this study, a unit root test is carried out through an augmented Dickey-Fuller (ADF) and a Phillips-Perron (PP) tests (Dickey and Fuller, 1979; Phillips and Perron, 1988). The co-integration tests are used to analyze non-stationary time series processes that have variances and means that vary over time. To perform the co-integration test, the methodology of Engle and Granger (1987) is used.

Based on the results of the unit root and the co-integration tests, the following analysis model is used to estimate the demand structures for beef items in Japan.

$$\Delta w_{it} = \alpha_{i1} + \sum_{m=1}^{11}\theta_{im}\Delta D_{mt} + \sum_{j=1}^{5}\gamma_{ij}\Delta \log p_{jt} + \beta_i \Delta \log \frac{y_t}{P_t^C} + \frac{\lambda_i}{P_t^Z}\Delta\left(\log \frac{y_t}{P_t^C}\right)^2 + \varepsilon_{it} \qquad (12)$$

Here, Δ expresses the first difference from one period before, D_m is the monthly dummy variable that takes 1 for the month *m* and zero for all months other than month *m*, and θ_{im} is the parameter.

The impacts of the JAEPA and *JUSFTA* trade deals on beef demand will be analyzed using the compensated price elasticity estimated by the Equation (10). The following method is used for analyzing the impacts of the JAEPA and *JUSFTA*. When the demand function of item *i* $D_i = D_i(p_1, \ldots, p_5, y, DM_1, \ldots, DM_{11})$ is totally differentiated, and the following Equation can be obtained.

$$dD_i = \sum_{k=1}^{5}\frac{\partial D_i}{\partial p_k}dp_k + \frac{\partial D_i}{\partial y}dy + \sum_{r=1}^{11}\frac{\partial D_i}{\partial DM_r}dDM_r \qquad (13)$$

Where D_i is the quantity demanded for item *i*, and *y* is expenditure.

Assuming that only the prices of the imported beef change, using the price elasticity of demand, Equation (13) can be approximated as the following.

$$\Delta D_i = \eta_{ik}\frac{\overline{D_i}}{\overline{p_k}}\Delta p_k \qquad (14)$$

Here, ΔD_i ($=D_{it}-D_{it-1}$) is the amount of change in the quantity demanded for item *i*, Δp_k ($=p_{kt}-p_{kt-1}$) is the amount of change in the price of item *k*, η_{ik} is the elasticity of demand for item *k*, period *t*-1 is the period before JAEPA or *JUSFTA* comes into effect, and period *t* is the period after the JAEPA or *JUSFTA* comes into effect.

When approximating a differential by difference, it is necessary to use the mean value of before and after the change as levels values. Hence, $\overline{D}_i$ and $\bar{p}_k$ are respectively expressed as follows in Equations (15) and (16).

$$\overline{D_i} = \frac{D_{it} + D_{it-1}}{2} \tag{15}$$

$$\overline{p_k} = \frac{p_{kt} + p_{kt-1}}{2} \tag{16}$$

Therefore, by substituting Equation (15) and (16) in Equation (14), the amount of change in quantity demanded ΔD_i due to the JAEPA or *JUSFTA* can be expressed in Equation (17).

$$\Delta D_i = \frac{\dfrac{\eta_{i4}}{p_4} \Delta p_4}{1 - \dfrac{\eta_{i4}}{2 p_4} \Delta p_4} D_{it-1} \tag{17}$$

Δp_k, which is the amount of change in the price of item k, is calculated as follows.

$$\Delta p_k = p_{kt-1} \frac{1+\gamma_{1k}}{1+\gamma_{2k}} - p_{kt-1} \tag{18}$$

Here, γ_{1k} is the tariff rate of item k after the JAEPA or *JUSFTA* comes into effect, and γ_{2k} is the tariff rate of item k before the JAEPA or *JUSFTA* comes into effect.

In the analysis method used in this study, in Equation (17), $\dfrac{\Delta p_k}{p_k}$ is equal with $\dfrac{2(\gamma_{1k} - \gamma_{2k})}{2 + \gamma_{1k} + \gamma_{2k}}$ (19)

and $\dfrac{\Delta p_k}{p_k}$ is a constant regardless of the price level, there is no need to set a benchmark for price. Therefore, after substituting Equation (19) in Equation (17), the change in demand can be specified as follows.

$$\Delta D_i = \frac{\eta_{ik} \left(\dfrac{2(\gamma_{1k} - \gamma_{2k})}{2 + \gamma_{1k} + \gamma_{2k}} \right)}{1 - \dfrac{\eta_{ik}}{2} \left(\dfrac{2(\gamma_{1k} - \gamma_{2k})}{2 + \gamma_{1k} + \gamma_{2k}} \right)} D_{it-1} \tag{20}$$

The analysis of the JAEPA or *JUSFTA* impact is carried out based on the assumption that the price elasticities of demand do not change after this. However, the elasticity values change is inevitable. Therefore, a sensitivity analysis is performed considering changes in the impacts of the JAEPA or *JUSFTA* is set as δ_i, and δ_i^m, when all the price elasticities of demand for item *i* become *m*(>0) times, can be expressed as follows.

$$\delta_i^m = \frac{200m\delta_i}{200+(1-m)\delta_i} \tag{21}$$

5.2. Empirical Results

Table 5.1. Descriptive statistics of variables of quantity and nominal price

Variable	Mean	Standard Deviation	Minimum	Maximum
Quantity demanded (ton)				
Wagyu beef	12,645.1	2,062.9	9,520.8	19,432.1
Crossbred beef	6,937.8	891.5	4,725.5	9,320.0
Dairy beef	10,796.9	3,863.4	6,974.8	20,515.7
US beef	11,800.3	5,908.1	1,877.5	26,657.4
Australian beef	26,555.5	4,893.6	15,215.7	38,363.4
Price (yen/kg)				
Wagyu beef	3,356.7	421.4	2,698.1	4,182.6
Crossbred beef	2,120.6	287.0	1,748.2	2,672.8
Dairy beef	1,518.5	260.5	1,109.8	1,946.7
US beef	1,662.9	340.9	1,064.7	2,252.1
Australian beef	983.0	176.2	679.0	1,263.2

Note : The prices are nominal prices and in yen/kg, and the quantities are in tons.

Table 5.1 reports the sample means, standard deviations, maximums and minimums of the quantity demanded and nominal prices of the five beef items. The values are used to provide simple summaries of quantity demanded and nominal prices. The monthly quantity demanded of the Australian beef is the highest, while that of crossbred beef is the lowest. The nominal price of Wagyu beef is the highest, while that of the Australian beef is the lowest.

Table 5.2. Results of the unit root test

Variables	Levels			First difference			First seasonal difference		
	ADF test statistics		PP test	ADF test statistics		PP test	ADF test		PP test
	τ_τ^z	lag	z_τ	τ_μ	lag	z_μ	τ_μ	lag	z_μ
w_1	-1.350	5	-35.892 ***	-5.917 ***	4	-163.446 ***	-2.166	12	-105.891 ***
w_2	-2.013	4	-44.207 ***	-6.444 ***	3	-167.342 ***	-3.173 **	12	-61.879 ***
w_3	-1.826	3	-7.825	-6.474 ***	2	-152.862 ***	-2.594 *	12	-20.386 **
w_4	-2.040	9	-94.000 ***	-4.995 ***	8	-169.436 ***	-3.338 **	12	-106.896 ***
w_5	-3.247 *	4	-114.870 ***	-6.344 ***	6	-159.296 ***	-4.170 ***	12	-106.039 ***
$\log p_1$	-2.313	7	-4.157	-4.889 ***	2	-116.700 ***	-1.356	12	-5.333
$\log p_2$	-2.628	7	-7.800	-5.128 ***	2	-113.494 ***	-2.216	12	-9.737
$\log p_3$	-1.893	4	-4.470	-3.142 **	3	-82.697 ***	-1.205	12	-8.363
$\log p_4$	-1.852	3	-3.804	-5.187 ***	2	-115.082 ***	-1.205	12	-4.919
$\log p_5$	-2.815	11	-6.982	-3.014 **	12	-61.586 ***	-2.800 *	12	-11.398 *
$\log (p_1/p_2)$	-2.148	10	-11.325	-3.875 ***	9	-132.362 ***	-1.912	12	-16.119 **
$\log (p_1/p_3)$	-2.590	6	-10.573	-5.299 ***	2	-120.052 ***	-1.836	12	-13.954 *
$\log (p_1/p_4)$	-2.695	12	-4.675	-5.359 ***	2	-114.726 ***	-2.052	12	-6.991
$\log (p_1/p_5)$	-1.996	6	-10.295	-5.582 ***	5	-70.991 ***	-2.319	12	-14.801 **
$\log (p_2/p_3)$	-1.333	2	-4.636	-6.007 ***	2	-133.395 ***	-1.992	12	-10.437
$\log (p_2/p_4)$	-1.770	3	-4.826	-5.415 ***	2	-109.942 ***	-1.899	12	-7.858
$\log (p_2/p_5)$	-3.082	3	-13.095	-5.489 ***	2	-78.408 ***	-2.090	12	-16.512 **
$\log (p_3/p_4)$	-2.595	7	-5.212	-4.048 ***	3	-120.722 ***	-1.820	12	-8.412
$\log (p_3/p_5)$	-2.402	3	-9.552	-5.179 ***	3	-62.565 ***	-2.315	12	-14.679 **
$\log (p_4/p_5)$	-2.190	3	-9.918	-6.180 ***	2	-77.437 ***	-2.410	12	-13.349 *
$\log (y/P^C)$	-3.308 *	4	-121.396 ***	-6.838 ***	4	-169.744 ***	-3.421 **	12	-127.725 ***
$(\log y/P^C)^2$	-6.243 ***	2	-149.521 ***	-5.835 ***	7	-173.031 ***	-4.688 ***	12	-128.649 ***
Critical value at 1% level	-3.96		-29.4	-3.43		-20.6	-3.43		-20.6
Critical value at 5% level	-3.41		-21.7	-2.86		-14.1	-2.86		-14.1
Critical value at 10% level	-3.13		-18.2	-2.57		-11.2	-2.57		-11.2

Note: ***, ** and * indicate that the null hypothesis of "there is a unit root" is rejected at the 1%, 5%, and 10% levels, respectively. The critcal values are referred to Davidson and MacKinnon (1993).

A unit root test is carried out to select the method that is suitable for estimating the time series data for this study. It helps to determine whether our data is stationary or non-stationary. To test the existence of the unit root, we employ the ADF and PP tests. If the results of the tests show the existence of unit root in our data, then the data is non-stationary. In total, 22 variables are used in the LA/QUAIDS model. The ADF and PP tests are employed on each of the levels, first difference (difference from the period right before) and first seasonal difference (difference from 12 periods before). The results of the unit root test are shown in Table 5.2. Most of the levels are not statistically significant, and the results suggest the existence of a unit root. The null hypothesis, which says “unit root exists”, cannot be rejected. For the first seasonal difference, the same null hypothesis cannot be rejected as many of the variables are not statistically significant. However, as for the first difference, the null hypothesis is overwhelmingly statistically significant based on both ADF and PP tests. The results suggest that the null hypothesis can be rejected at the 1% and

5% significance levels for all the variables. The same critical values are used as were used by Davidson and MacKinnon (1993). This shows that the original data used in this study is a non-stationary, and has become stationary after taking the first difference from one period before.

Table 5.3. Results of the co-integration test

Expenditure share equation	Without the restrictions imposed (including the trend variable) $w_i = \alpha_{i0} + \alpha_{i1}t + \sum_{m=1}^{11}\theta_{im}D_m + \sum_{j=1}^{6}\gamma_{ij}\log p_j + \beta_i \log\frac{y}{P^C} + \frac{\lambda_i}{P^Z}\left(\log\frac{y}{P^C}\right)^2$		Without the restrictions imposed (not including the trend variable) $w_i = \alpha_{i0} + \sum_{m=1}^{11}\theta_{im}D_m + \sum_{j=1}^{6}\gamma_{ij}\log p_j + \beta_i \log\frac{y}{P^C} + \frac{\lambda_i}{P^Z}\left(\log\frac{y}{P^C}\right)^2$	
	τ	lag	τ	lag
Wagyu beef	-3.167	7	-3.344	7
Crossbred beef	-4.077	4	-3.797	4
Dairy beef	-4.488	2	-3.156	2
US beef	-3.942	4	-2.900	4
Australian beef	-3.705	4	-3.229	4
Critical value at 1% level	-5.52		-5.25	
Critical value at 5% level	-4.98		-4.71	
Critical value at 10% level	-4.70		-4.42	
Expenditure share equation	With the restrictions imposed (including the trend variable) $w_i = \alpha_{i0} + \alpha_{i1}t + \sum_{m=1}^{11}\theta_{im}D_m + \sum_{j=1}^{5}\gamma_{ij}\log\frac{p_j}{p_6} + \beta_i \log\frac{y}{P^C} + \frac{\lambda_i}{P^Z}\left(\log\frac{y}{P^C}\right)^2$		With the restrictions imposed (not including the trend variable) $w_i = \alpha_{i0} + \sum_{m=1}^{11}\theta_{im}D_m + \sum_{j=1}^{5}\gamma_{ij}\log\frac{p_j}{p_6} + \beta_i \log\frac{y}{P^C} + \frac{\lambda_i}{P^Z}\left(\log\frac{y}{P^C}\right)^2$	
	τ	lag	τ	lag
Wagyu beef	-2.416	4	-2.364	4
Crossbred beef	-4.103	4	-3.526	4
Dairy beef	-3.664	2	-3.100	2
US beef	-3.906	4	-2.644	3
Australian beef	-3.407	4	-3.224	4
Critical value at 1% level	-5.52		-5.25	
Critical value at 5% level	-4.98		-4.71	
Critical value at 10% level	-4.70		-4.42	

Note : The restrictions indicate the homogeneity and symmetry restritions.

To perform a co-integration test, the Engle and Granger (1987) approach is used. Table 5.3 reports the equations and results of four co-integration tests. One, without homogeneity and symmetry restrictions imposed, including the trend variable. Two, without homogeneity and symmetry restrictions imposed, without including the trend variable. Three, with homogeneity and symmetry restrictions imposed, including the trend variable. Four, with homogeneity and symmetry restrictions imposed, without including the trend variable. The null hypothesis states that "there is no co-integration" for each of the expenditure shares of beef. The results show that there is no possibility of rejection of the null hypothesis. All the estimation regressions are carried out by using the first difference, but all the estimated results are not statistically significant even at 10% significance level.

Table 5.4. Estimates of expenditure, price and monthly coefficients

Parameter	Wagyu beef	Crossbred beef	Dairy beef	US beef	Australian beef
$\log p_1$	0.004				
	(0.291)				
$\log p_2$	-0.001	-0.007			
	(-0.195)	(-0.833)			
$\log p_3$	-0.010	0.000	-0.008		
	(-0.979)	(0.035)	(-0.730)		
$\log p_4$	0.004	0.004	0.005	-0.005	
	(0.421)	(0.833)	(0.626)	(-0.282)	
$\log p_5$	0.003	0.004	0.012	-0.009	-0.011
	(0.229)	(0.696)	(1.181)	(-0.536)	(-0.466)
$\log \frac{y}{P^C}$	-0.029	-0.013 *	-0.015	0.010	0.046 **
	(-1.577)	(-1.819)	(-1.489)	(0.505)	(2.124)
$\frac{1}{P^Z}\left(\log \frac{y}{P^C}\right)^2$	-0.010 *	-0.004 *	-0.004	0.003	0.015 **
	(-1.795)	(-1.782)	(-1.218)	(0.424)	(2.136)
January	-0.055 ***	0.014 ***	0.024 ***	0.011	0.006
	(-7.594)	(5.222)	(6.082)	(1.360)	(0.638)
February	-0.057 ***	0.008 **	0.016 ***	0.022 **	0.010
	(-6.554)	(2.280)	(3.147)	(2.246)	(0.808)
March	-0.060 ***	0.008 **	0.019 ***	0.023 **	0.010
	(-6.054)	(2.004)	(3.327)	(1.999)	(0.729)
April	-0.061 ***	0.003	0.006	0.024 **	0.027 **
	(-6.186)	(0.809)	(1.156)	(2.143)	(2.054)
May	-0.060 ***	0.010 **	0.018 ***	0.034 ***	-0.002
	(-5.285)	(2.263)	(3.041)	(2.855)	(-0.157)
June	-0.054 ***	0.007	0.021 ***	0.027 *	-0.002
	(-4.320)	(1.395)	(3.327)	(1.909)	(-0.098)
July	-0.043 ***	-0.002	0.008	0.054 ***	-0.017
	(-3.844)	(-0.473)	(1.360)	(4.285)	(-1.163)
August	-0.064 ***	0.003	0.021 ***	0.046 ***	-0.006
	(-5.531)	(0.683)	(3.218)	(3.495)	(-0.369)
September	-0.064 ***	0.002	0.019 ***	0.048 ***	-0.004
	(-5.335)	(0.456)	(2.829)	(3.572)	(-0.262)
October	-0.051 ***	0.006	0.022 ***	0.030 **	-0.006
	(-4.133)	(1.227)	(3.510)	(2.287)	(-0.411)
November	-0.006	0.004	0.013 ***	0.006	-0.017
	(-0.662)	(1.103)	(2.785)	(0.662)	(-1.595)

Note : t-values are in the parentheses. The critical values are 2.576, 1.960 and 1.645 for 1%, 5% and 10% significance levels and denoted by ***, ** and *, respectively.

Table 5.4 reports expenditure, price and seasonal dummy coefficients of Equation (4). The sign and magnitude of the estimated coefficients do not have a straightforward economic interpretation, but they are the basis for estimation of elasticities. The log-expenditure of crossbred beef and Australian beef are statistically significant. The quadratic log-expenditure of Wagyu beef, crossbred beef and Australian beef are statistically significant. The seasonal dummies are statistically significant for most of the months and for most of the beef items.

Table 5.5. Estimates of expenditure and uncompensated price elasticities at the mean share

		Price p_j				
Demand q_i	Expenditure y	Wagyu beef	Crossbred beef	Dairy beef	US beef	Australian beef
Wagyu beef	0.920 ***	-0.961 ***	0.006	-0.016	0.026	0.025
	(18.071)	(-30.693)	(0.346)	(-0.549)	(0.774)	(0.641)
Crossbred beef	0.895 ***	0.027	-1.043 ***	0.016	0.049	0.056
	(15.472)	(0.514)	(-15.771)	(0.392)	(1.160)	(1.057)
Dairy beef	0.894 ***	-0.032	0.014	-1.045 ***	0.055	0.114
	(12.591)	(-0.499)	(0.412)	(-12.662)	(0.861)	(1.377)
US beef	1.060 ***	0.006	0.017	0.023	-1.039 ***	-0.067
	(8.924)	(0.099)	(0.618)	(0.468)	(-9.300)	(-0.615)
Australian beef	1.213 ***	-0.063	-0.008	0.028	-0.075	-1.095 ***
	(12.075)	(-1.240)	(-0.300)	(0.559)	(-0.937)	(-9.876)

See notes to Table 5.4.

Table 5.5 reports the estimates of expenditure and uncompensated price elasticities at the mean share. All the expenditure elasticities are positive and significant at the 1% level. Imported Australian beef (1.213) and US beef (1.060) are expenditure elastic, while the domestically produced beef–Wagyu beef (0.920), crossbred beef (0.895) and dairy beef (0.894) are expenditure inelastic. Wagyu beef is relatively the most expenditure elastic from the domestically produced beef items. Uncompensated price elasticities contain both the income and substitution effects. All the uncompensated own-price elasticities are negative and significant at the 1% level. Except Wagyu beef (-0.961), all the beef items–crossbred beef (-1.043), dairy beef (-1.045), US beef (-1.039) and Australian beef (-1.095) are uncompensated own-price elastic. Australian beef is the most own-price elastic. Most of the uncompensated cross-price elasticity values are positive, but none of them are statistically significant.

Table 5.6. Estimates of compensated price elasticities at the mean share

Demand q_i	Price p_j				
	Wagyu beef	Crossbred beef	Dairy beef	US beef	Australian beef
Wagyu beef	-0.633 ***	0.120 ***	0.111 ***	0.176 ***	0.225 ***
	(-17.718)	(6.314)	(4.024)	(5.970)	(6.577)
Crossbred beef	0.346 ***	-0.932 ***	0.139 ***	0.196 ***	0.251 ***
	(6.314)	(-13.944)	(3.489)	(5.094)	(5.295)
Dairy beef	0.287 ***	0.125 ***	-0.922 ***	0.201 ***	0.308 ***
	(4.024)	(3.489)	(-11.315)	(3.353)	(4.018)
US beef	0.384 ***	0.148 ***	0.169 ***	-0.866 ***	0.164
	(5.970)	(5.094)	(3.353)	(-8.297)	(1.643)
Australian beef	0.370 ***	0.143 ***	0.195 ***	0.123	-0.831 ***
	(6.577)	(5.295)	(4.018)	(1.643)	(-7.955)

See notes to Table 5.4.

Compensated price elasticities are reduced to contain only the substitution effects, which are compensated for the income effects on quantity demanded. Table 5.6 reports the estimates of compensated price elasticities at the mean share. Compensated own-price elasticities of all the five beef items are negative and statistically significant at the 1% level. Among the estimates of the ten pairs of compensated cross-price elasticities, nine pairs are significant substitutes for each other. The remaining one pair is not statistically significant though it is a substitute as well. As Hicks (1946) states, theoretically substitutes are dominant. Similar results are depicted by Capps et al. (1994) using Japanese data. The cross-price elasticities between imported beef and domestically produced beef show that reducing the price of US beef would significantly decrease the demand for domestically produced beef. For instance, the elasticity of demand for dairy beef due to change in price of US beef is 0.201, which is the most elastic among the other beef items that are substitutes of US beef. Similarly, the cross-price elasticity of dairy beef due to change in the price of Australian beef is 0.308, again this is also the most elastic among the other beef items that are substitutes of Australian beef. The elasticity values make sense that the prices of dairy beef, US beef and Australian beef are competitive. The three beef items could be good substitutes of one another. Our result could be supported by Mori and Lin (1990), in which their study shows that there is weak competitive relationship between Wagyu beef and imported beef, whereas there is a better competitive relationship between dairy beef and imported beef. The estimation results of our demand structure for beef is consistent with the consideration of the MAFF (2015) that Wagyu beef and crossbred beef are differentiated from imported beef, whereas dairy beef competes with imported beef. The demand for US beef and Australian beef has not been distinctly analyzed neither by Matsuda (2014) nor Takahashi and Maeda (2018), aggregate data of the imported beef was used in both the studies. The estimated results support the importance of the notion of evaluating the effects trade deals on the disaggregated imported beef items, and ultimately the impacts on the local beef market.

Table 5.7. Estimates of seasonal effects at the mean share (%)

Demand q_i	January	February	March	April	May	June	July	August	September	October	November
Wagyu beef	-15.375 ***	-15.852 ***	-16.666 ***	-17.085 ***	-16.817 ***	-15.033 ***	-12.129 ***	-17.921 ***	-18.036 ***	-14.370 ***	-1.620
	(-7.594)	(-6.554)	(-6.054)	(-6.186)	(-5.285)	(-4.320)	(-3.844)	(-5.531)	(-5.335)	(-4.133)	(-0.662)
Crossbred beef	11.566 ***	6.248 **	6.048 **	2.446	7.985 **	5.511	-1.671	2.528	1.744	4.698	3.232
	(5.222)	(2.280)	(2.004)	(0.809)	(2.263)	(1.395)	(-0.473)	(0.683)	(0.456)	(1.227)	(1.103)
Dairy beef	17.455 ***	11.651 ***	13.624 ***	4.627	13.084 ***	15.619 ***	6.072	15.242 ***	13.624 ***	15.979 ***	9.138 ***
	(6.082)	(3.147)	(3.327)	(1.156)	(3.041)	(3.326)	(1.360)	(3.218)	(2.829)	(3.510)	(2.785)
US beef	6.419	13.656 **	14.025 **	14.848 **	21.026 ***	16.456 *	33.020 ***	27.813 ***	29.045 ***	18.165 **	3.967
	(1.359)	(2.246)	(1.999)	(2.143)	(2.854)	(1.909)	(4.285)	(3.495)	(3.572)	(2.287)	(0.662)
Australian beef	2.771	4.813	4.738	12.550 **	-1.044	-0.726	-7.817	-2.589	-1.857	-2.865	-7.947
	(0.638)	(0.808)	(0.729)	(2.054)	(-0.157)	(-0.098)	(-1.163)	(-0.369)	(-0.262)	(-0.411)	(-1.595)

See notes to Table 5.4.

Table 5.7 reports the estimates of seasonal effects on the demand at the mean share. Demand for Wagyu beef is statistically significant at 1% level for almost all the months with the exception of November. Wagyu beef is demanded more in December than in each of the remaining eleven months. Crossbred beef is demanded significantly more in January (11.566%), February (6.248%), March (6.048%) and May (7.985%) than in December. The demand for dairy beef is positive from January through November. The demand is the highest in January (17.455%) and followed by summer through fall seasons; June (15.619%), August (15.242%), September (13.624%) and October (15.979%). Demand for US beef seems very popular in July (33.020%), August (27.813%) and September (29.045%). The demand for dairy beef and US beef is big in August in terms of magnitude, when the demand for barbecue is supposedly at its peak. The demand for the Australian beef is positive and statistically significant in April (12.550%).

Table 5.8. The estimated marketing quantity of each of the beef from January to December 2018 (benchmark of quantity demanded)

(Unit: thousand tons)

	Wagyu beef	Crossbred beef	Dairy beef	US beef	Australian beef
Estimated marketing quantity	147.029	88.162	90.523	242.520	308.936

Table 5.8 reports a one-year total of estimated marketing quantity also known as quantity demanded from January to December 2018, which is used as a benchmark for the quantity demanded for each of the beef items. This benchmark data overlaps with our data period of this study, for the time from January to September 2018.

The estimate results of the impacts of the JAEPA and *JUSFTA* on the demand for Wagyu beef, crossbred beef, dairy beef, US beef and Australian beef are reported in Table 5.9 and Table 5.10. The impacts are estimated using Equation (20). The tariff rates of the JAEPA and *JUSFTA* are applied on the same data period, from April 2007 to September 2018, but with different quantity demanded benchmarks. To see the impacts of the JAEPA and *JUSFTA* simultaneously, the quantity demanded benchmark that is used for *JUSFTA* is the final quantity[6] that we have after the effect of JAEPA on the original benchmark. For the change in the quantity demanded for each beef, the delta method is used to estimate the standard error and to test the significance of the change. It is assumed that the tariff rate declines from 38.5% (temporary rate) to 28.5% on the first year after the *JUSFTA*[7] comes into effect, and declines to 10% at the 15th year after the *JUSFTA* comes into effect. As for the JAEPA, the agreement has distinct tariff rates for frozen and fresh beef. The tariff facing Australian frozen beef falls from 38.5% to 30.5% at the first year after the JAEPA comes into effect, and phases down to 19.5% over 18 years. The tariff facing Australian fresh beef falls from 38.5% to 32.5% at the first year after the agreement comes into effect, and phases down

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[6] $D_{it} = D_{it-1} + \Delta D_i$, where D_{it} is quantity demanded benchmark for *JUSFTA* for the item *i*, Δ expresses the change in quantity demanded and D_{it-1} *i*s the initial quantity demanded benchmark (quantity demanded benchmark for JAEPA) for the item *i*.

[7] Japan and US are negotiating to bring *JUSFTA* into effect. As of now, *JUSFTA* has not been signed, and that makes obtaining the actual tariff rates difficult. To obtain the tariff rates in order to estimate the impacts of the *JUSFTA*, we use the experiences of TPP (Takahashi and Maeda, 2018). In TPP agreement, the tariff reduces from 38.5% to 27% on the first year and to 9% on the 16th year after TPP comes into effect.

to 23.5% over 15 years. To obtain an aggregated Australian beef tariff, the weighted tariff rate is calculated. Accordingly, the contents of the JAEPA and the assumed contents of the *JUSFTA* documents show that the tariff rates will be reduced from 38.5% to 10% for *JUSFTA* and from 38.5% to 21.23% for JAEPA at its 15th after the agreement comes into effect.

Table 5.9. Analysis results of the impacts of the JAEPA and *JUSFTA* (after fifteen years)

(Unit: thousand tons, %)

Beef	Japan-Australia Economic Partnership Agreement (JAEPA)				Japan-United States Free Trade Agreement (*JUSFTA*)				Overall JAEPA and *JUSFTA*			
	Bench-mark quantity	Change in the quantity demanded by the JAEPA	Percent-age change	Quantity demanded after the JAEPA comes into effect	Bench-mark quantity	Change in the quantity demanded by the *JUSFTA*	Percent-age change	Quantity demanded after the *JUSFTA* comes into effect	Bench-mark quantity	Total change in the quantity demanded	Percent-age change	Quantity demanded after both agreements come into effect
Wagyu beef	147.029	-4.343 *** (-6.675)	-2.954	142.687	142.687	-5.649 *** (-6.090)	-3.842	137.038	147.029	-9.992	-6.796	137.038
Crossbred beef	88.162	-2.889 *** (-5.384)	-3.277	85.272	85.272	-3.743 *** (-5.208)	-4.245	81.530	88.162	-6.632	-7.522	81.530
Dairy beef	90.523	-3.635 *** (-4.100)	-4.015	86.889	86.889	-3.920 *** (-3.431)	-4.330	82.969	90.523	-7.555	-8.346	82.969
US beef	242.520	-5.235 * (-1.661)	-2.159	237.285	237.285	52.319 *** (7.473)	21.573	289.604	242.520	47.084	19.414	289.604
Australian beef	308.936	36.142 *** (7.516)	11.699	345.078	345.078	-9.633 * (-1.667)	-3.118	335.445	308.936	26.509	8.581	335.445
All domestically produced beef	325.714	-10.867	-3.336	314.848	314.848	-13.312	-4.228	301.536	325.714	-24.178	-7.423	301.536
All beef	877.171	20.040	2.285	897.211	897.211	29.375	3.274	926.586	877.171	49.415	5.633	926.586

See notes to Table 5.4.

The impacts of the JAEPA and *JUSFTA* on the quantity demanded for the beef items are estimated using the tariff rates at 15th year after the agreements come into effect, as reported in Table 5.9. The imported US beef price will be reduced by 22.937% and the Australian beef price will be reduced by 13.298% as a result of tariff reductions, which is calculated by using Equation (19). The quantity demanded for US beef increases by 21.573%, and the quantity demanded for Australian beef increases by 11.699% as a result of tariff reductions. The changes in the quantities demanded for Wagyu beef, crossbred beef, and dairy beef are statistically significant. The test results suggest that both JAEPA and *JUSFTA* have significant impacts on the demand for domestically produced beef. The impact of JAEPA on dairy beef is the biggest, and dairy beef demand declines by 4.015%. Similarly, *JUSFTA* has similar impact on the demand for dairy beef. The demand for the dairy beef declines by 4.330%. The impact on the dairy beef is the biggest among the domestically produced beef items. Both the agreements have bigger impact on the dairy beef than on Wagyu beef or crossbred beef. Considering a total of domestically produced beef, the quantity demanded falls by 3.336% because of the JAEPA deal. On the other hand, when a total of all beef–Wagyu beef, Crossbred, dairy beef, US beef, Australian beef is considered, the quantity demanded rises by 2.285%. As for the *JUSFTA* effects on a total of domestically produced beef, the quantity demand falls by 4.228%, whereas the quantity demanded rises by 3.274% for a total of all the five beef items. When the simultaneous effects[8] of the agreements are considered, the quantity demanded for US beef increases by 19.414% and the quantity demanded for Australian increases by 8.581%. As far as the demand for the domestically produced beef items is concerned, the simultaneous effects are bigger than the effects of individual trade agreements. The quantity demanded for Wagyu beef, crossbred beef and dairy beef decreases by 6.796%, 7.522% and 8.346%, respectively. The simultaneous effects on the total of domestically produced beef items show a decline by 7.423%, whereas on a total of all five beef items the quantity demanded increases by 5.633%.

Table 5.10. Analysis results of the impacts of the JAEPA and *JUSFTA* (after one year)

(Unit: thousand tons, %)

Beef	Japan-Australia Economic Partnership Agreement (JAEPA)				Japan-United States Free Trade Agreement (*JUSFTA*)				Overall JAEPA and *JUSFTA*			
	Bench-mark quantity	Change in the quantity demanded by the JAEPA	Percent-age change	Quantity demanded after the JAEPA comes into effect	Bench-mark quantity	Change in the quantity demanded by the *JUSFTA*	Percent-age change	Quantity demanded after the *JUSFTA* comes into effect	Bench-mark quantity	Total change in the quantity demanded	Percent-age change	Quantity demanded after both agreements come into effect
Wagyu beef	147.029	-1.744 *** -6.616	-1.186	145.286	145.286	-1.904 *** (-6.009)	-1.310	143.382	147.029	-3.647	-2.481	143.382
Crossbred beef	88.162	-1.161 *** -5.330	-1.317	87.001	87.001	-1.266 *** (-5.131)	-1.455	85.735	88.162	-2.427	-2.753	85.735
Dairy beef	90.523	-1.464 *** -4.051	-1.617	89.059	89.059	-1.332 *** (-3.378)	-1.496	87.727	90.523	-2.796	-3.089	87.727
US beef	242.520	-2.097 * -1.651	-0.865	240.424	240.424	16.115 *** (8.028)	6.703	256.539	242.520	14.018	5.780	256.539
Australian beef	308.936	13.892 *** (7.781)	4.497	322.828	322.828	-2.971 * (-1.651)	-0.920	319.857	308.936	10.921	3.535	319.857
All domestically produced beef	325.714	-4.369	-1.341	321.346	321.346	-4.502	-1.401	316.844	325.714	-8.870	-2.723	316.844
All beef	877.171	7.427	0.847	884.598	884.598	8.643	0.977	893.240	877.171	16.069	1.832	893.240

See notes to Table 5.4.

[8] The results of the overall effects of JAEPA and *JUSFTA* are reported in Table 9.

Table 5.10 reports the effects of JAEPA and *JUSFTA* on the demand for domestically produced beef as well as for imported US and Australian beef, for the first year after the agreements come into effect. The beef tariff for the JAEPA is 31.36%, while the beef tariff for the *JUSFTA* is assumed to be 28.50% for the first year. The demand for Australian beef increases by 4.497% because of JAEPA. The demand for US beef increases by 6.703% because of *JUSFTA*. The changes of the quantity demanded are statistically significant for all the beef items. As for the simultaneous effects, the demand for the total of domestically produced beef declines by 2.723%, while for the total of all beef rises by 1.832%.

The increase of the demand for US beef and Australian beef in Japan suggests that trade deals are important for the beef exporting countries. The dramatic fall in beef price, as a result of tariff reductions, would lead to more influx of beef imports. The TPP agreement has criteria to be triggered as a safeguard when the total volume imported exceeds the upper limit (Takahashi and Maeda, 2018). Unlike TPP, the JAEPA agreement has no safeguard criterion. In fact, Australia agreed to never face 'snapback tariff of 50%', which is the WTO safeguard privilege Japan has possessed for beef import. The maximum move Japan can make is getting back to where the tariff began (38.5%).

Table 5.11. Results of sensetivity analysis with regard to the price elasticity of demand (after fifteen years)

(Unit: %)

Beef	Japan-Australia Economic Partnership Agreement (JAEPA)			Japan-United States Free Trade Agreement (*JUSFTA*)			Overall JAEPA and *JUSFTA*		
	Percentage change in quantity demanded (price elasticity 0.75 times)	Percentage change in quantity demanded (standard)	Pecentage change in quantity demanded (price elasticity 1.5 times)	Percentage change in quantity demanded (price elasticity 0.75 times)	Percentage change in quantity demanded (standard)	Pecentage change in quantity demanded (price elasticity 1.5 times)	Percentage change in quantity demanded (price elasticity 0.75 times)	Percentage change in quantity demanded (standard)	Pecentage change in quantity demanded (price elasticity 1.5 times)
Wagyu beef	-2.223 75.278	-2.954 100.000	-4.398 148.901	-2.895 75.362	-3.842 100.000	-5.708 148.573	-1.866 75.233	-2.481 100.000	-3.698 149.076
Crossbred beef	-2.468 75.308	-3.277 100.000	-4.876 148.781	-3.201 75.400	-4.245 100.000	-6.301 148.425	-2.072 75.259	-2.753 100.000	-4.101 148.975
Dairy beef	-3.027 75.378	-4.015 100.000	-5.963 148.509	-3.265 75.408	-4.330 100.000	-6.426 148.394	-2.326 75.291	-3.089 100.000	-4.598 148.850
US beef	-1.623 75.203	-2.159 100.000	-3.221 149.195	15.755 73.031	21.573 100.000	34.204 158.551	4.304 74.462	5.780 100.000	8.797 152.199
Australian beef	8.648 73.919	11.699 100.000	18.077 154.519	-2.348 75.293	-3.118 100.000	-4.641 148.840	2.640 74.670	3.535 100.000	5.350 151.337

The analysis of the impacts of the JAEPA and *JUSFTA* on the change of the quantities demanded for beef is based on the assumption that the price elasticities of the demand do not change after this. However, the possibility of change in elasticities in the future is inevitable. A sensitivity analysis is performed, and it is reported in Table 5.11. Equation (21) is employed for the sensitivity analysis. The percentage change of the quantity demanded due to the impact of the JAEPA is 11.699% for the Australian beef. According to the results of the sensitivity analysis, the change in price elasticities of demand are expected to be less than 18.10 times. The percentage change of the quantity demanded as a result of the *JUSFTA* is 21.573% for the US beef. The change in price elasticities of demand is expected to be less than 10.27 times. In the results of sensitivity analysis, if there are no changes in the direction of the changes, it is said that the results of the original simulation are robust (Hosoe et al., 2016). Therefore, it is possible to conclude that analysis results of the impacts of the JAEPA and *JUSFTA*, which are analyzed using Equation (20), are robust. The percentage changes due to elasticity changing to 0.75 or 1.50 are reported in Table 11. The 0.75 and 1.50 elasticity values are assumed numbers that are used for the simulation purpose.

5.3. Conclusion

This paper analyses the impacts of bilateral trade agreements on the demand for beef in Japan. Even though one of the objectives of the agreements is trade liberalization, there are concerns on the impacts of the agreements on the domestic beef production. The LA/QUAIDS, which is a comprehensive demand system, is employed to econometrically evaluate the current demand structure for Wagyu beef, crossbred beef, dairy beef, US beef and Australian beef in Japan. In our data, disaggregating of imported beef into the country-of-origin has been carried out, which has not been done so far. ADF and PP test results reveal that our data is a non-stationary time series, and taking the first difference from one period before is important to convert the data to have a stationary nature. Engle and Granger (1987) co-integration test results show that there is no co-integration relationship among the time series data for beef in Japan.

The estimated expenditure elasticities show that US beef and Australian beef are expenditure elastic, while Wagyu beef, crossbred beef and dairy beef are expenditure inelastic. It suggests that the response of demand for imported beef is larger than that for domestically produced beef. The JAEPA and *JUSFTA* trade deals have significant impacts on the quantities demanded for all the beef items. The impacts have implications of policy for domestically produced beef–Wagyu, crossbred and dairy because there is a decline in demand for domestically produced beef by 3.336% and 4.228% as a result of the JAEPA and *JUSFTA* impacts, respectively. Among the domestically produced beef items, dairy beef is the most impacted both by Australian and US agreements, whereas the Wagyu beef is the least impacted by the agreements. It makes sense that since the Wagyu beef is considered as high quality beef and its price is not competitive with the prices of imported beef items.

An increase of a low-cost US and Australian beef has a short-run benefit to the Japanese consumers. In the long-run, it increases the dependency on the beef imports by decreasing domestic beef production. Beef import in Japan is mainly dominated by the US and Australia, and that makes it even more difficult to obtain an adequate supply of beef in an event of beef crisis with these countries. Therefore, there should be a comprehensive policy plan that enables the sustainable supply of domestically produced beef, in which by extension help sustain the livelihoods of beef cattle farmer in Japan, dairy cattle farmers in particular.

Therefore, to the best of our knowledge, our paper is the first to provide the empirical evidence for the impacts of the JAEPA and *JUSFTA* on a disaggregated domestic as well as imported beef items. The results are useful not only for researchers as a reference for further studies, but also for the food industries and administrative agencies in Japan. Using the assumed tariff rates for the *JUSFTA* is one of the limitations of this study. To analyze the impacts of *JUSFTA* more accurately, it will be necessary to get the finally signed agreement's document in order to use the actual tariff rates, and perform a more detailed analysis.

CHAPTER 6: Summary, Conclusions and Implications

6.1. Summary

This thesis uses different datasets from different sources namely; Family Income Expenditure Survey (FIES) and Consumers Price Index (CPI) both published by Ministry of Internal Affairs and Communications of Japan, Agriculture and Livestock Corporation Industries (ALIC) and Trade statistics of Japan. The estimation techniques used are also different; Linear Approximate Quadratic Almost Ideal Demand System (LA-QUAIDS) and the quadratic extension of Working's models. The thesis has analyzed the meat consumption behavior in Japan from a national, regional, seasonal, holidays, food scare outbreaks and tariff reductions point of views.

Chapter one presents the introduction of the whole studies incorporated into the thesis. Chapter two is about estimation of demand for twelve food categories for gift-use and home-use, respectively in Japan. The expenditure elasticities show that nine of the twelve gift food categories are expenditure elastic, while only seafood, fruits, beverages, alcohol and eating out are expenditure elastic for home-use food categories. This suggests that gift food is relatively more luxurious than food that is routinely consumed in a household. Demographic variables have significant effects more on the home-use food categories than gift food categories. There are also regional effects on the quantity demanded for gift food categories as Japan has various regional cuisines and food specialties. For instance, demand for meat gift is high in Kobe supposedly as a result of famous brand called Kobe beef.

Chapter three presents about regional effects on the demand for meat and seafood in Japan. The results of the estimate shows that time and demographic and regional variables have significant effects on the demand for most of the food items. The effects of regions on beef is opposite to pork. Pork is popular in major cities in eastern Japan, while beef is popular in western Japan. Chicken is similar to beef except for Yokohama. Sausage, bacon, fresh seafood and processed seafood are demanded more in the eastern part than in the western part of Japan with a few exceptions.

The results of the impacts of food scares are shown in chapter 4, and it reports about evaluation of the impacts of the BSE and FMD outbreaks on meat demand. Also, the impacts of the months, days of the week, public holidays, Golden Week, and Bon as well as the end and beginning of the year are included in this chapter. The latter factors have significant effects on the demand for most of the meat items. The result shows that there is a gradual shift in the structure of consumer demand following the BSE and FMD outbreaks. That is, BSE reduces demand for beef and raises demand for pork and chicken. FMD reduces demand for beef, pork and chicken. The broad-spectrum effects of FMD include the reduction in the demand for chicken. FMD is not chicken's disease. However, as a result of fear of the disease, consumers might have refrained from consuming even chicken. The impact of BSE on the demand for beef is more severe than that of FMD. In the first quarter alone, it is over six times as strong as the impact of FMD. It also takes longer time to recover than the impact of FMD.

This study includes the impacts of bilateral trade agreements on the demand for beef. Chapter five presents Japan-Australia EPA and Japan-US FTA effects. The estimated expenditure elasticities show that US beef and Australian beef are expenditure elastic, while Wagyu beef, crossbred beef and dairy beef are expenditure inelastic. It suggests that the response of demand for imported beef is larger than that for domestically produced beef. The JAEPA and *JUSFTA* trade deals have significant impacts on the quantities demanded for all the beef items. Among the domestically produced beef items, dairy beef is the most impacted both by Australian and US agreements, whereas the Wagyu beef is the least impacted by the agreements.

6.2. Conclusion

After including various factors, such as demographics, regions, seasons, time trend, food scare outbreaks, tariff reductions, days of the week, public holidays, Golden Week, Bon, o-chūgen and o-seibo into our estimation systems, the results reveal that the factors have conclusively played significant roles in determining the demand for food, meat in particular in this thesis. Based on estimation results of these studies, several conclusions have been reached. The following major conclusions could be drawn.

Firstly, there is significant implications for the gift food market in particular. For instance, rice and fruits suppliers can give much attention during harvest seasons because demand for rice and fruits is high due to newly harvested gift crops. Similarly, confectioneries companies targeting February and March months due to Valentine's Day and White Day events, respectively. During summer and end-year seasons, demand for the majority of the food categories is higher than other seasons, because food gift giving is major part of Japanese tradition of o-chūgen and o-seibo.

Secondly, the regional meat and seafood demand variation clearly reveals that there is distinct difference in consumption and dietary habits among the regions as there are distinct customs embedded historically in the individual regions. In addition, the agro-ecological variations seem play an important role in providing region-specific resources, food items dominated by certain regions in particular. Therefore, the practical knowledge of the food industry, especially the industry of the items estimated in our study, about regional demand variation of meat and seafood products and may help the industry target production and supply more efficiently according to the regional preferences.

Thirdly, the estimation results shows that the impact of BSE is much more persistent than the impact of FMD, which suggests that consumers recognize that unlike BSE, FMD poses no significant human health risks. In order to combat the consumers' exposure to negative information, it is very crucial that consumers need to access reliable information to evaluate the real risks associated with the consumption of meat. Otherwise, consumers overreact to every food scares regardless of their specific risks. In our finding, negative effects of FMD are shown even on the demand for chicken while the disease mainly affects four-legged livestock animals.

Fourthly, an increase of a low-cost US and Australian beef has a short-run benefit to the Japanese consumers. In the long-run, it increases the dependency on the beef imports by decreasing domestic beef production. Beef import in Japan is mainly dominated by the US and Australia, and that makes it even more difficult to obtain an adequate supply of beef in an event of beef crisis with these countries.

6.3. Implications

With respect to the food scare outbreaks and subsequent crisis, meat industries and government agencies need to consider important measures such as strengthening quality control system and reliable information sources. In order to combat the consumers' exposure to negative information, it is very crucial that consumers need to access reliable information to evaluate the real risks associated with the consumption of meat. In this thesis, the impacts of trade agreements on the demand for beef are also very significant. The results are useful not only for researchers as a reference for further studies, but also for the food industries and administrative agencies in Japan. Using the assumed tariff rates for the *JUSFTA* is one of the limitations of this study. To analyze the impacts of *JUSFTA* more accurately, it is recommended to obtain the finally signed agreement's document in order to use the actual tariff rates, and perform a more detailed analysis.

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Appendix

Table A.1. Estimates of expenditure and price coefficients

Left-Hand Variable w_i	Regressor														
	$\log p_1$	$\log p_2$	$\log p_3$	$\log p_4$	$\log p_5$	$\log p_6$	$\log p_7$	$\log p_8$	$\log p_9$	$\log p_{10}$	$\log p_{11}$	$\log p_{12}$	$\log \frac{y}{Pc}$	$\frac{1}{Pz}\left(\log \frac{y}{Pc}\right)^2$	R^2
Gift-use															
Cereals	1.796 *	-0.774	-1.732 ***	-0.257	0.736	-0.540	-0.480	1.897 **	-1.272 **	-0.204	-0.383	1.213	1.059 ***	-0.453 ***	0.265
Seafood		-1.031	-0.058	-0.253 **	-0.889 **	-0.930 **	-0.650 **	-1.633 **	-0.893 **	0.446	1.275 ***	5.390 ***	0.471 ***	-0.066	0.463
Meat			0.551	-0.008	0.698 **	-0.210	0.717 **	0.632	-0.386	-0.430	-0.418	0.645	0.345 ***	0.069	0.446
Milk/ Eggs				0.329 *	0.070	-0.133	-0.073	0.009	0.252	0.324	0.265	-0.525 *	-0.142 ***	0.036	0.070
Vegetables					-0.325	0.696 **	0.237	-1.119 **	-0.221	0.755 *	0.209	-0.847	0.351 ***	0.475 ***	0.242
Fruits						-0.610	0.098	-1.585 ***	0.442	0.029	-0.692 *	3.434 ***	4.009 ***	0.650 **	0.337
Oils/ Fats							-0.797	0.016	0.972 **	0.040	-0.296	0.216	0.573 ***	0.711 ***	0.241
Confectioneries								3.331 **	1.362 *	-2.060 ***	0.980	-1.830	-11.50 ***	-0.550 **	0.547
Cooked food									1.078	0.350	-0.144	-1.540	-0.694 ***	-0.093	0.137
Beverages										-0.849	-0.319	1.918 *	0.667 ***	0.527 ***	0.226
Alcohol											-0.807	0.330	0.631 ***	10.547 ***	0.422
Eating out												-8.403 **	4.230 ***	-2.362 ***	
Home-use															
Cereals	3.328 ***	-0.838 ***	-1.053 ***	-0.524 ***	-1.005 ***	-0.391 ***	0.212 ***	-0.461 ***	-0.436 ***	0.081	0.068	1.019 ***	-2.139 ***	0.875	0.425
Seafood		0.547 ***	0.637 ***	0.662 ***	-0.670 ***	-0.057	-0.530 ***	-0.406 ***	1.012 ***	-0.391 ***	-0.010	0.044	0.208	2.027 ***	0.839
Meat			1.283 ***	-0.211 ***	-0.289 ***	-0.006	-0.039	0.170 **	0.319 **	0.101	-0.203 *	-0.710 ***	-1.283 ***	-0.833 **	0.804
Milk/ Eggs				0.198 *	-0.206 ***	0.240 ***	0.137 **	0.379 ***	-0.221 **	0.665 ***	0.052	-1.171 ***	-1.219 ***	0.758 ***	0.502
Vegetables					4.007 ***	0.118 **	-0.580 ***	-0.569 ***	-0.454 ***	-0.214 ***	0.135	-0.272	-1.901 ***	0.198	0.677
Fruits						0.534 ***	0.040	-0.236 ***	0.231 ***	0.164 ***	-0.216 ***	-0.420 ***	0.443 ***	-1.342 ***	0.533
Oils/ Fats							0.110	0.431 ***	0.144 *	-0.362 ***	0.079	0.356 ***	-1.273 ***	-0.063	0.561
Confectioneries								0.611 ***	0.210	-0.809 ***	0.134	0.545 ***	-1.339 ***	-1.286 ***	0.594
Cooked food									0.163	-0.356 ***	0.280	-0.894 ***	-0.477 ***	1.825 ***	0.609
Beverages										0.764 ***	-0.463 ***	0.818 ***	0.068	0.039	0.730
Alcohol											1.011 ***	-0.866 ***	1.462 ***	-0.211	0.448
Eating out												1.550 **	7.452 ***	-1.987 *	

Note. The significance levels are 1%, 5% and 10%, and denoted by ***, **, *, respectively. R^2, the square of the correlation between the model's predicted and observed values, is calculated for each of the eleven equations. The estimates are multiplied by 100.

Table A.1 reports the estimates of expenditure and price coefficients of equation (4). The sign and magnitude of the estimated coefficients do not have straightforward economic interpretation. However, they are basis for the estimation of elasticities. For gift food categories, the log own-price coefficients for cereals (1.796), milk/eggs (0.325), confectioneries (3.331), and eating out (-8.403) are statistically significant. The log expenditure coefficients for the twelve food categories are significant. The quadratic log linear expenditure coefficients are significant for all food categories except seafood, meat, milk/eggs and cooked food. As for home-use food categories, most of the log own-price, log expenditure and quadratic log expenditure coefficients are statistically significant. The estimated R^2 ranges from 0.070 to 0.547 for the gift food, while it ranges from 0.425 to 0.839 for the home-use food categories. It shows that the LA/QUAIDS model explains our data satisfactorily.

Table A.2. Estimates of monthly effects at the sample mean (%)

Quantity q_i	February	March	April	May	June	July	August	September	October	November	December
Beef	1.543	-2.696 **	-2.144 *	-0.791	-0.161	-3.088 **	3.822 ***	-1.621	-2.656 **	-1.611	5.126 ***
	(1.222)	(-2.122)	(-1.664)	(-0.604)	(-0.126)	(-2.424)	(2.934)	(-1.270)	(-2.096)	(-1.243)	(3.678)
Pork	0.425	-7.310 ***	-6.843 ***	-7.905 ***	-7.490 ***	-11.262 ***	-8.355 ***	-7.604 ***	-4.617 ***	-2.108 ***	-5.340 ***
	(0.596)	(-10.205)	(-9.426)	(-10.709)	(-10.408)	(-15.695)	(-11.364)	(-10.580)	(-6.471)	(-2.887)	(-6.790)
Chicken	-2.839 ***	-10.934 ***	-9.152 ***	-11.516 ***	-13.339 ***	-20.738 ***	-20.647 ***	-10.891 ***	-6.474 ***	-3.038 ***	0.383
	(-3.201)	(-12.259)	(-10.119)	(-12.528)	(-14.872)	(-23.196)	(-22.568)	(-12.156)	(-7.281)	(-3.339)	(0.392)

Note. t-values are in the parentheses. The critical values are 2.576, 1.960 and 1.645 for 1%, 5% and 10% significance levels and denoted by *, **, ***, respectively.

Table A.3. Estimates of days of the week effects at the sample mean (%)

Quantity q_i	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Beef	7.189 ***	2.883 ***	2.710 ***	7.039 ***	37.592 ***	40.162 ***
	(12.468)	(4.371)	(3.982)	(10.368)	(56.052)	(68.203)
Pork	12.636 ***	2.648 ***	-0.336	-1.275 ***	7.224 ***	17.374 ***
	(35.647)	(6.654)	(-0.825)	(-3.136)	(17.849)	(48.001)
Chicken	14.233 ***	4.944 ***	2.978 ***	0.937 *	6.282 ***	14.069 ***
	(34.065)	(10.413)	(6.097)	(1.922)	(13.011)	(32.972)

See notes to Table A.2.

Table A.4. Estimates of end- and beginning-of-the-year effects at the sample mean (%)

Quantity q_i	Dec24	Dec25	Dec26	Dec27	Dec28	Dec29	Dec30
Beef	22.157 ***	12.219 ***	12.763 ***	33.730 ***	69.245 ***	152.910 ***	289.920 ***
	(6.385)	(3.285)	(3.441)	(9.084)	(18.597)	(40.897)	(76.081)
Pork	-15.340 ***	-7.404 ***	1.748	8.906 ***	12.250 ***	27.581 ***	30.819 ***
	(-7.333)	(-3.351)	(0.797)	(4.058)	(5.568)	(12.482)	(13.667)
Chicken	56.131 ***	-5.781 **	-3.007	10.436 ***	26.643 ***	67.954 ***	119.630 ***
	(22.479)	(-2.172)	(-1.135)	(3.935)	(10.020)	(25.449)	(43.937)

Quantity q	Dec31	Jan1	Jan2	Jan3	Jan4	Jan5
Beef	366.950 ***	-1.913	42.358 ***	32.198 ***	12.740 ***	7.121 **
	(97.327)	(-0.452)	(11.614)	(8.969)	(3.584)	(2.123)
Pork	8.655 ***	-56.731 ***	-48.397 ***	-42.622 ***	-17.412 ***	-5.520 ***
	(3.879)	(-22.517)	(-22.431)	(-20.066)	(-8.251)	(-2.730)
Chicken	84.772 ***	-58.897 ***	-48.454 ***	-44.136 ***	-28.006 ***	-8.396 ***
	(31.467)	(-19.438)	(-18.596)	(-17.207)	(-11.012)	(-3.584)

See notes to Table A.2.

Table A.5. Estimates of BSE outbreak effects at the sample mean (%)

Quantity q_i	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Year 2
Beef	-40.333 ***	-31.847 ***	-15.290 ***	-9.719 ***	-4.910 ***
	(-18.566)	(-14.670)	(-7.135)	(-4.537)	(-4.356)
Pork	11.659 ***	8.976 ***	7.068 ***	8.143 ***	1.455 **
	(9.566)	(7.370)	(5.879)	(6.775)	(2.304)
Chicken	14.053 ***	14.000 ***	10.300 ***	9.968 ***	3.727 ***
	(9.231)	(9.202)	(6.859)	(6.640)	(4.721)

See notes to Table A.2.

Table A.6. Estimates of FMD outbreak effects at the sample mean (%)

Quantity q_i	Quarter 1	Quarter 2	Quarter 3	Later
Beef	-6.668 ***	-5.246 **	-1.765	4.500 ***
	(-3.048)	(-2.409)	(-0.807)	(4.287)
Pork	-8.044 ***	-7.652 ***	-5.404 ***	-4.201 ***
	(-6.555)	(-6.264)	(-4.408)	(-7.148)
Chicken	-1.684	-3.408 **	-2.316	2.136 ***
	(-1.099)	(-2.233)	(-1.512)	(2.907)

See notes to Table A.2.

SUMMARY (ENGLISH)

An Empirical Analysis of Japanese Food Demand with Special Reference to Beef

In this research, the multifaceted importance of food in Japan has been discussed. The importance of food in Japan is not only as a meal to be eaten, but also one of the important tools of socialization. Japanese invest a substantial amount of money on gift-giving. Food is considered the traditional type of gift in Japan. Japanese buy luxury food seasonally as gifts for family, friends, or colleagues. O-chūgen and o-seibo are particularly popular gift-giving events in Japan.

Japanese food consumption pattern has been undergoing dramatic changes over the last several years. There have been increasing consumption of meats, such as beef and dairy products, while there have been decreasing consumption of rice, fish, fresh fruits, as well as fresh and processed vegetables in Japan. Meat consumption, beef in particular, does not have a long history in Japan due to a dietary ban on the eating of flesh from four-legged animals before the Meiji Restoration. However, there has been gradual changes for years and eventually meat products have become important food items in the Japanese diets. The followings could be some of the contributing factors; the opening of Japan's borders was seen as an opportunity to integrate Western customs into Japanese culture and removal of the longstanding social taboo against the eating of meat became a symbol of this integration. For long time, Japan had protected its domestic beef market from imported beef through various protectionism policies. Now, beef import has rapidly increased due to greater Japanese demand for beef, limitations on increasing domestic beef production, and pressure from beef exporting countries.

The dramatic price changes in beef have also influenced the prices and consumption levels of all meats and meat substitutes. There are also other demand shifting variables, such as taste, religion, socio-economics, demographics, region, season, household dynamics and media information, time trend, food scare outbreaks, tariff reductions, days of the week, public holidays, Golden Week, Bon, o-chūgen and o-seibo that impacts the demand for beef. Beef demand analysis in Japan has captured attention of many economists. It is in part due to Japan being the nation that has likely experienced the most dramatic shifts in the dietary preference.

Deaton (1985) suggests that the use of pseudo panel data is an alternative econometric method for estimating demand models of individual household behavior. Therefore, since micro

data is not available in the family income expenditure survey (FIES) of Japan, the aggregate micro data has been used in this study. All the price and expenditure data are deflated using consumer price index (CPI). Daily and monthly aggregated pseudo panel data for two or more person households were used. The FIES and CPI data are published by the Statistics Bureau, Ministry of Internal Affairs and Communications of Japan. There are also other data sources, the quantity and wholesale prices of both imported and domestic beef items are published by the agriculture and livestock industries corporation (ALIC), and the data for the quantity of exported Japanese beef is published by the Trade Statistics of Japan. In this data, there are various non-economic factors, such as regions, seasons, time trend, months, days of the week, public holidays (observances), Golden Week, Bon, and end and beginning of the year, BSE and FMD as well as JAEPA and *JUSFTA* are aimed to be estimated for their impacts on the demand for beef in particular and food in general.

The estimation techniques that have been chosen for the studies in this thesis are the linear approximate quadratic almost ideal demand system (LA/QUAIDS) and quadratic extension of Working's models. The AIDS a versatile system capable of studying various aspects of food demand. However, the AIDS model has difficulty of capturing the effects of non-linear Engel curve because it has budget share equations that are linear in the logarithm of expenditure. The quadratic form of the AIDS model (QUAIDS), which was first developed by Banks et al. (1997), is not only more versatile in modelling consumer expenditure, but also it restores the relevant properties of AIDS. The linear version (LA/QUAIDS), which was developed by Matsuda (2006), embraces the characteristics of closed under unit scaling (CUUS) even with demand shifters.

Working (1943) finds the tendency for the proportion of expenditure devoted to food decreases in an arithmetic progression as total expenditure increases in a geometric progression. This relationship applies for families of every size, occupation, and community. At an individual level, as total expenditure per person increases, the proportion of an expenditure devoted to food decreases. Leser (1963) investigates various forms of Engel functions that are satisfying the additivity criterion. He suggests that a form of relationship used by Working (1943) has great advantageous. However, the Working-Lesser Engel curve has difficulty in capturing non-linear effects of expenditure because it has a budget share equation that are linear in the logarithm of expenditure. The appropriate form that can support generalization in the shape of Engel curve relationship is shown by a quadratic extension of Working's model.

LA/QUAIDS is used to estimate the demand for twelve food categories for gift-use and home-use, respectively in Japan. The expenditure elasticities show that nine of the twelve gift food categories are expenditure elastic, while only seafood, fruits, beverages, alcohol and eating out are expenditure elastic for home-use food categories. This suggests that gift food is relatively more luxurious than food that is routinely consumed in a household. Demographic variables have significant effects more on the home-use food categories than gift food categories. There are also regional effects on the quantity demanded for gift food categories as Japan has various regional cuisines and food specialties. For instance, demand for meat gift is high in Kobe supposedly as a result of famous brand called Kobe beef. In the study of regional effects on the demand for meat, the effects of regions on beef is opposite to pork. Pork is popular in major cities in eastern Japan, while beef is popular in western Japan. Chicken is similar to beef except for Yokohama.

The quadratic extension of Working's model is used to estimate the impacts of the BSE and FMD outbreaks on the demand for meat. Also, the impacts of the months, days of the week, public holidays, Golden Week, and Bon as well as the end and beginning of the year are evaluated. The latter factors have significant effects on the demand for most of the meat items. The result shows that there is a gradual shift in the structure of consumer demand following the BSE and FMD outbreaks. That is, BSE reduces demand for beef and raises demand for pork and chicken. FMD reduces demand for beef, pork and chicken. The broad-spectrum effects of FMD include the reduction in the demand for chicken. FMD is not chicken's disease. However, as a result of fear of the disease, consumers might have refrained from consuming even chicken. The impact of BSE on the demand for beef is more severe than that of FMD. It also takes longer time to recover than the impact of FMD.

The LA/QUAIDS model is used to estimate Japan-Australia EPA and Japan-US FTA effects. The estimated expenditure elasticities show that US beef and Australian beef are expenditure elastic, while Wagyu beef, crossbred beef and dairy beef are expenditure inelastic. It suggests that the response of demand for imported beef is larger than that for domestically produced beef. The JAEPA and *JUSFTA* trade deals have significant impacts on the quantities demanded for all the beef items. Among the domestically produced beef items, dairy beef is the most impacted both by Australian and US agreements, whereas the Wagyu beef is the least impacted by the agreements.

SUMMARY (JAPANESE)

An Empirical Analysis of Japanese Food Demand with Special Reference to Beef

要　旨

日本の食料需要に関する実証分析―特に牛肉について―

本学位論文は，時系列データと疑似パネルデータに需要分析の計量モデルを適用することで，特に牛肉に焦点を当てながら日本における食料需要を実証的に分析したものであり，主要部分は 6 つの章から成り立っている．これらの章は，日本の食料需要に関する 4 編の独立した論文からなる本論（第 2～5 章），および序論（第 1 章）と結論（第 6 章）より構成されている．

本学位論文は，ミクロ経済学の理論と計量経済学・推測統計学の方法に基づいて需要システムおよびエンゲル曲線の推定による計量分析を実施することで，分析の信頼性が高められている．日本の食料需要を計量経済学的に分析した実証研究にはこれまでに大きな蓄積があるが，本論の部分を構成する第 2 章から第 5 章までの 4 つの章はいずれも，既存研究で分析されてこなかった課題を初めて明らかにした独創的な研究である．

まず第 1 章では，序論として本学位論文の背景，問題意識，分析方法，および論文の構成を概観している．

つづく第 2 章では，国内の主要 52 都市における 2000 年 1 月から 2017 年 12 月までの疑似パネルデータに需要システムのモデル linear approximate quadratic almost ideal demand system (LA/QUIADS; Matsuda, 2006)を適用し，食品 12 品目（穀類，魚介類，肉類，乳卵類，野菜・海藻，果物，油脂・調味料，菓子類，調理食品，飲料，酒類，外食）について贈答用需要と家庭用需要を推定している．その結果，季節効果は家庭用需要よりも贈答用需要で顕著であり，季節によって贈答用需要が集中的に増加することが明らかになっている．例えば，穀類や果物はそれぞれの収穫期，菓子類はバレンタインデーやホワイトデーに贈答用需要が大きく増加すること，またほとんどの品目の贈答用需要は中元と歳暮の時期に集中することが確認できる．

第 3 章では，国内の主要 49 都市における 2000 年 1 月から 2014 年 12 月までの疑似パネルデータに需要システムの LA/QUIADS を適用し，肉類を中心とする食品 8 品目（牛肉，豚肉，鶏肉，ハム，ソーセージ，ベーコン，生鮮魚介，魚介加工品）の家計需要を推定した結果，価格や支出の効果，人口統計的効果，BSE 発生の効果，および季節効果とともに，明確な地域効果を確認している．特に，豚肉は東日本で，牛肉と鶏肉は西日本でより好まれるという一般的認識が計量経済学的に裏付けられている．また，ソーセージ，ベーコン，生鮮魚介，および魚介加工品は，概ね西日本よりも東日本で多く需要される傾向にあることが示されている．

第4章では，2000年1月1日から2016年10月31日までの日次データを用い，日本における牛肉，豚肉，鶏肉の需要をエンゲル曲線の推定により分析している．ワーキングモデルを対数2次に拡張したエンゲル曲線を用いて推定した結果，日本における狂牛病の発生は牛肉需要に甚大なマイナスの影響を与え，牛肉から豚肉，鶏肉への需要シフトを招いたことが示されている．また，口蹄疫は牛肉，豚肉，鶏肉の需要にマイナスの影響を与えたが，狂牛病の影響は口蹄疫の影響よりも遙かに大きく，持続期間も長いことが明らかになっている．狂牛病と口蹄疫の影響が違うのは，人体に対する狂牛病の健康リスクの方がずっと大きいからだと考えられる．

第5章では，2007年4月から2018年9月までの時系列データに需要システムのLA/QUIADSを適用し，牛肉5品目（国産和牛肉，国産交雑牛肉，国産乳用牛肉，米国産牛肉，豪州産牛肉）の国内需要を推定し，さらに推定結果に基づいて日豪経済連携協定(EPA)と仮想的な日米自由貿易協定(FTA)が国内需要に与える影響についてシミュレーションを行っている．その結果，国産牛肉のなかで需要が日豪EPAと日米FTAの影響を最も強く受けるのは乳用牛肉であり，影響が最も小さいのは和牛肉であること，また両協定により米国産牛肉と豪州産牛肉の需要は増加することが示されている．価格の低い米国産牛肉と豪州産牛肉の需要が増えることで消費者の便益が向上する一方で，国産牛肉の持続的供給は損なわれることになる．国産牛肉の持続的供給と国内牛肉生産者の生計維持を可能にする包括的な政策が望まれる．

最後に第6章では，本学位論文全体のまとめと結論を示すとともに，政策・ビジネスインプリケーションの提示を行っている．

LIST OF PUBLICATIONS

Title: Regional Effects on the Demand for Meat in Japan

Authors: Sisay Yemenu Dinku and Toshinobu Matsuda

Journal Name: Journal of Japanese Society of Agricultural Technology Management
Issue: Vol. 24, No. 3: 103-117
Section Covered: Chapter 3: Regional Effects on the Demand for Meat in Japan

Title: Evaluating the Impact of the BSE and FMD Outbreaks on Meat Demand: An Engel Curve Analysis of Japanese Daily Data
Authors: Sisay Yemenu Dinku and Toshinobu Matsuda
Journal Name: Journal of Japanese Society of Agricultural Technology Management
Issue: Vol. 25, No. 1: 1-12
Section Covered: Chapter 4: Evaluating the Impact of the BSE and FMD Outbreaks on Meat Demand: An Engel Curve Analysis of Japanese Daily Data