Source Differentiated Pork Import Demand for South Korea: Implications to Canadian Exports

by

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Abstract

This study uses the Quadratic Almost Ideal Demand System model to estimate pork import demand in South Korea with the focus on implications to Canadian exports. Pork is highly prized in Asian cuisines, especially in South Korea due to its delicate fat content and texture. South Korea has a limited domestic pork production capability but faces a continuous rise in pork demand which makes importing inevitable.

This study contributes to the current demand analysis literature in several ways: 1) the AIDS model is estimated in quadratic form to ensure a better consistency rather than linearizing the model with a price index; 2) the selected trade data ranges from 2013-2019 which provides an updated estimation from previous literature on South Korea's import demand on source differentiated pork; 3) the findings suggest that pork trade in South Korea is highly competitive but Canada is not well-positioned to capture future market growth. South Korea's unique preference for fatter pork might explain Canadian pork exporters' lack of competitiveness.

Expenditure and price elasticities indicate that Canadian pork is the most inelastic and has the least to gain from an expansion in South Korea's pork expenditures and competitions mainly are from the U.S., Germany, and Netherlands. Although considered minor, both time trend and seasonality are shown to have a significant effect in determining Canadian pork exports to South Korea.

Keywords: Pork demand, QUAIDS Model, Source differentiation, international trade

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(Under the Direction of Professor Sven Anders)

1.Introduction

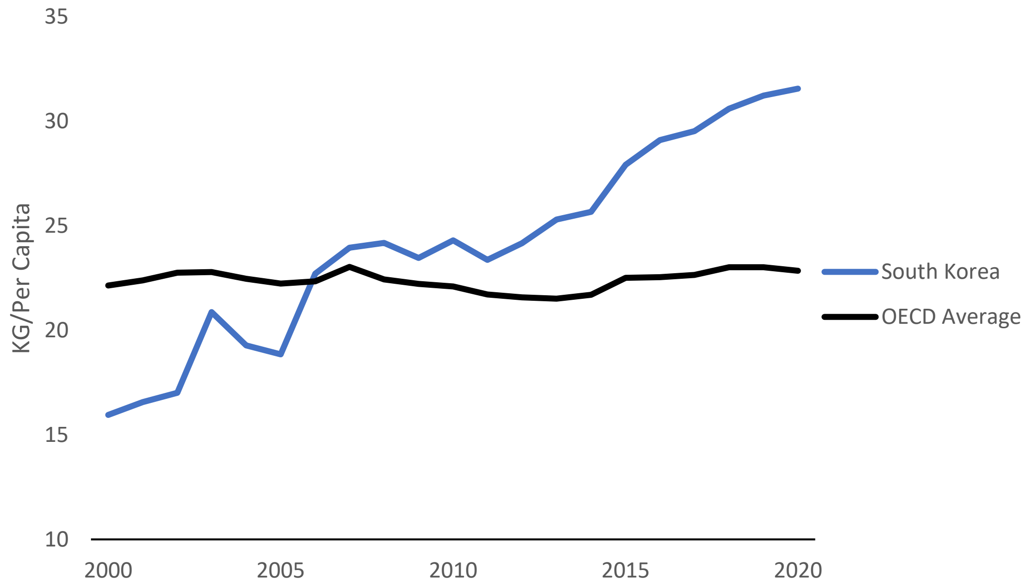
1.1 Overview of South Korea's Pork Market

Pork is the second most-consumed meat in the world, and it has an expanding and highly competitive global market (Pork Checkoff, 2020). South Korea is among the top countries in pork consumption. In 2018, around 2.6 million tonnes of meat were sold in South Korea and half of that was pork products (AAFC,2018). For Canada, pork consumption only took for a quarter of the total meat consumption in 2018 with chicken being the most consumed meat. With the growing demand for pork in South Korea, the commodity's self-sufficiency rate has decreased dramatically. From over 90% in the early 2000s to around 70% in recent years (Ann, 2016), indicating the strong demand for importation in the pork sector.

Consumption

Pork consumption in South Korea has gone through rapid growth since the early 2000s. From 2006 and onwards, the nation has surpassed OECD's average per capita consumption for pork (Chart 1). In 2020, the country reached a per capita pork consumption of 31.6 kilograms which placed itself at 1st in the world (OECD, 2021). South Korea also has one of the most unique consumption preferences for pork products. Consumers in South Korea prefer higher-fat cuts such as Boston butt and belly as they provide rich flavor and taste. In contrast, the western world generally likes lower-fat cuts such as loin or tenderloin. (Choe et al., 2015).

Chart 1. Pork consumption (Kilogram/Per Capita) from 2000 to 2020, South Korea and OECD Average.

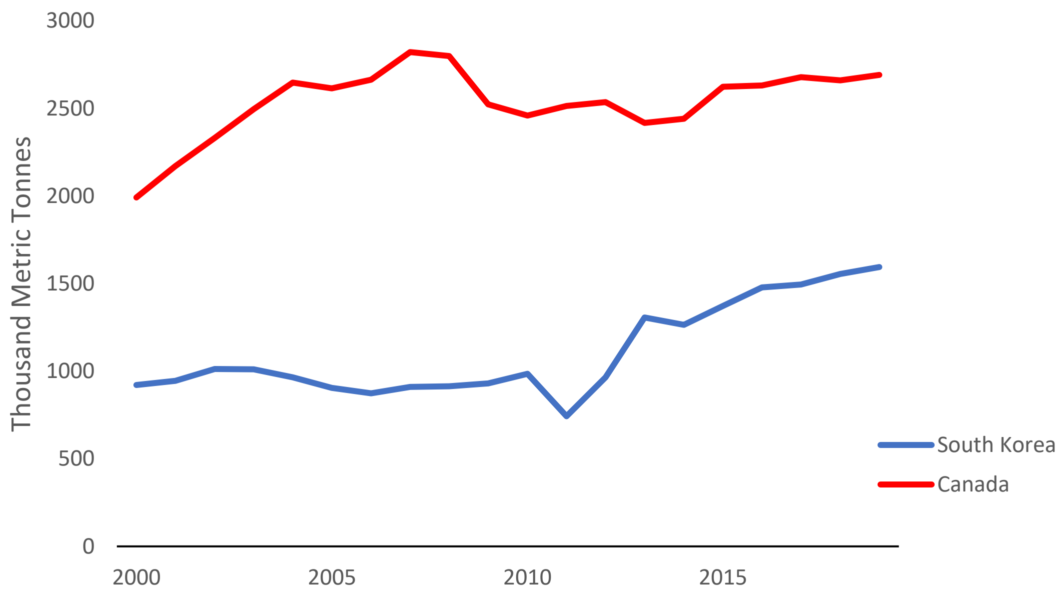


Source: OECD Data, 2021

Production

In 2019, South Korea produced 1.6 million tonnes of pork, which placed itself at 9th in the world (OECD, 2021). Demand for pork and its production is still highly imbalanced due to Korean consumers' unique preferences for specific cuts of the meat. Since 2000, outbreaks of foot and mouth disease have shrunk the small farm operations with reduced profit and caused an overall decrease in production efficiency. Between 2000 and 2009, the number of hog farm operations have decreased from 23,800 to just over 7,900. More and more small operations gave up their business and the pork industry underwent a structural change from small household operations to modernized highly efficient production facilities. The modernization has successfully led to higher production volumes which are shown in chart 2. However, the progress has been limited by imported feed restraints which lead to higher costs in domestic pork production (Veeman et al., 2002).

Chart 2. Pork production (Thousand Metric Tonnes) from 2000 to 2019, South Korea and Canada.



Source: OECD Data, 2021

Trade

While the pork demand continued to rise, importation became inevitable due to the severe imbalance between supply and demand in the pork sector. The U.S., Canada and EU were the first three main competitors for a share of the Korean pork import market. After 1997, the industry became more competitive with South Korea liberalizing its pork industry (Foreign Agricultural Services, 1997). The domestic pork industry now faces fierce competition from among numerous exporters (see table 1) unlike beef or poultry where the number of exporters is much smaller.

Table1. List of countries eligible for meat exports to Korea

Meat Types	Eligible Exporting Countries
Beef	*Netherlands, New Zealand, Denmark, Mexico, The USA, Uruguay, Chile, Canada, Australia*
Pork	*Netherlands, New Zealand, Denmark, ~~Germany~~, Mexico, The USA, Belgium, Brazil(Santa Catarina only), Sweden, Switzerland, Spain, ~~Slovak Republic~~, Ireland, The UK, Austria, Italy(Processed pork meat only), Chile, Canada, Portugal, ~~Poland~~, France, Finland, ~~Hungary~~, Australia*[1]
Poultry meat	*~~Netherlands~~, ~~Denmark~~, The USA, ~~Lithuania~~, , Brazil, ~~Sweden~~, ~~The UK~~, Chile, Canada, Thailand, ~~Poland~~, ~~France~~, ~~Finland~~, ~~Philippines(chicken only)~~, ~~Hungary~~, Australia*[2]

Source: Animal and Plant Quarantine Agency List of Countries eligible for export to Korea (qia.go.kr)

The goal for studying import demand is to gain an enhanced understanding of how pork exporters can better position themselves in capturing future market growth by looking at expenditure and price elasticities. It also enables Canadian pork exporters to know their competitiveness against other major exporting countries.

1.2 Overview of Canada's Pork Market and its Exporting Position

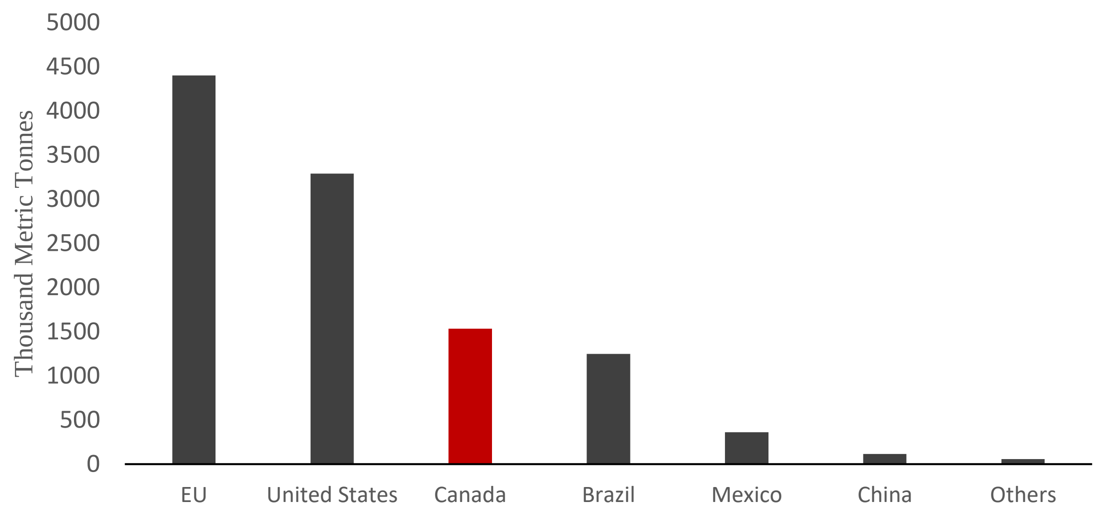
Canada, being a sparsely populated country with the second-largest land area in the world is renowned for its vast landscapes and bountiful resources. The agriculture and agri-food system is considered a key driver for Canada's economy both in domestic and international markets. In

[1] *Suspension of import because of African swine fever(ASF) outbreak : Poland(19 Feb. 2014), Hungary(24 Apr. 2018), Slovak Republic(26 Jul. 2019), Germany(10 Sep. 2020)

[2] * Suspension of import because of High pathogenicity avian influenza(HPAI) outbreak :
Poland(3 Jan. 2020), Philippines(17 Mar. 2020), Netherlands(30 Oct. 2020),
The UK(04 Nov. 2020), France(17 Nov. 2020), Denmark(17 Nov. 2020), Sweden(18 Nov. 2020), Lithuania(08 Jan. 2021), Hungary(08 Jan. 2021), Finland(12 Feb. 2021)

2018, it accounted for 7.4%of Canada's GDP and provided one in eight jobs in Canada (AAFC, 2020). In the pork sector, Canada stands as the third-largest pork exporter in the world behind the United States and the EU. The three major exporters accounted for over 85% of the world's total pork exports.

Chart 3: Global pork exports 2021, by leading country



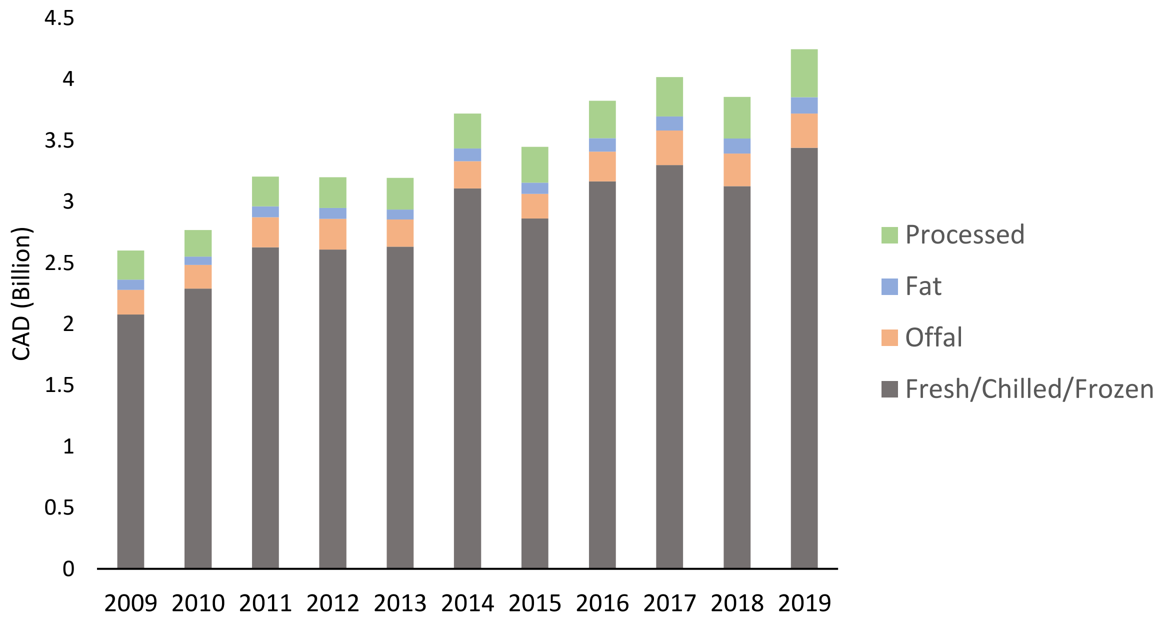
Source: USDA, 2021

The main breeds of pigs that are raised for pork on Canadian farms are Yorkshire (the Large White), Landrace, Duroc and Hampshire (Ontario Pork,2021). The Canadian Yorkshire is used successfully in many crossbreeding programs where the growth rate and carcass composition can be enhanced by having a lower fat and higher lean content (Ellis et al., 1999). Breeds like Landrace, Duroc, and Hampshire also share the common characteristics of the high-quality carcass, superior feed efficiency and leanness (CPI, 2006).

While pork is one of the most versatile meats for cooking as it plays an essential role in a healthy diet with its rich nutrients, the meat has not been exploited to its full potential in our domestic market. In the past 20 years, Canadian pork production has grown from 1.1 million metric tons(1990) to 2.3 million metric tonnes (2020), yet the domestic consumption of pork has shown a declining trend. Prodege (2020) conducted a survey where it interviewed over 5,400 Canadians about their opinions on their willingness to reduce meat consumption. The results showed some 37% of Canadian adults are willing to cut back on their meat consumption and over 17% are likely to reduce meat consumption in the near future. Only 30% of the sampled population showed no intention of reducing their meat consumption. With the already declining pork consumption volume (chart 2.) and the continuous growth in pork production, exportation becomes the foundation for supporting the prosperity of the pork industry in Canada. Therefore, in comparison with other meats, the pork exporting rate in percentage of production is significantly higher than those of beef and chicken. In 2019, more than 62% of the pork produced in Canada has been exported, the percentage is 43% for beef and only 11% for chicken (StatsCan, 2019).

Chart 4 shows the composition of Canada’s pork exports by different products. Fresh, chilled, or frozen pork (HS Code: 0203) accounted for over 80% of the total exported pork products. Processed pork (HS Code: 021011/2/9) averaged around 8% from 2009 to 2019. Major importers of Canadian fresh, chilled, or frozen pork include Japan, United States, China, Mexico, South Korea, the Philippines, and Australia.

Chart 4: Canadian Pork Exports by Product 2009-2019



Source: CPI, 2020 Canadian Pork Exports - Industry information - Canada Pork International

1.3 Objectives

The primary objective for this project is to enhance future decision making regarding the competitiveness of Canadian pork in the South Korean market by studying the top 7 exporters' (The U.S., Canada, Chile, Germany, Netherlands, Spain, and ROW) monthly trade data from January 2013 to December 2019. The specific objective is to apply the Source-differentiated quadratic AIDS model to estimate economic parameters such as price and expenditure elasticities and non-economic factors like seasonality on Korea's import demand for source-differentiated pork. Studying those different elasticities and non-economic factors can allow pork exporters to have a better understanding of South Koreans' buying preferences for pork from various sources.

The expectation is to generate results that can better position the Canadian pork exporting sector to allow a more precise strategic decision-making in the future.

1.4 Literature Review

While the literature on analyzing the import pork demand in South Korea is limited, there are a number of international trade-related studies that focused on other commodities with different empirical methods. Wang and Reed(2013) employed an Error Correction Model (ECM) and the standard AIDS model to investigate the U.S. import demand for fishery products from 1999 to 2012. Findings suggested that the overall imports of fishery products are insensitive to price changes and China, Vietnam, and Thailand are shown to be more competitive. Where they would have the most to gain when expenditure increase on the imported fishery products.

Measuring competitiveness in international trade is a disputed concept, which does not have a widely accepted definition in economics (Ahearn et al., 1990). Sarker and Ratnasena (2014) studied the international competitiveness of wheat, beef, and pork sectors in Canada using the Balassa's Revealed Comparative Advantage (BRCA) index and the Normalized Revealed Comparative Advantage (NRCA) index with longitudinal annual data from 1961 to 2011. Their results demonstrated that Canada has its competitiveness in the wheat sector but not in the beef or pork sectors. Empirical results also suggested the lowering labour cost of meat processing can enhance its competitiveness globally.

Competitiveness can also be measured from an import demand's perspective like Wang and Reed (2013)'s study. As for the methodologies, the Rotterdam model and the Almost Ideal Demand System (AIDS) model are the two most used models for demand system analysis.

The Rotterdam model developed by Theil (1965) and Barten (1966) is advantageous in estimating with linear estimation procedures and imposing theoretical restrictions for easy testing.

Mutondo and Henneberry (2007) used the Rotterdam model to estimate U.S. source differentiated meat demand with quarterly data from 1995 to 2005. The study also generated dummy variables that indicated seasonality and the occurrence of bovine spongiform encephalopathy (BSE) outbreaks. While seasonality was shown to have a significant effect in determining U.S. meat demand, BSE outbreaks were shown to have little impact. The empirical results on price and expenditure elasticities indicated that U.S. grain-fed beef and U.S. pork have a competitive advantage in the meat markets. Canadian beef had the higher expenditure elasticities meaning it would gain the most from an expansion in U.S. meat expenditures.

Koo et al. (1993) estimated the Korean meat demand with a linear AIDS model and investigated if the demand structure in meat consumption has changed over time. The study used annual data from 1970 to 1989 on per capita consumption of beef, pork, and chicken. As the goal was to determine whether Korea went through structural changes in the meat demand, Woo et al. did not include the place of origin of the meat products. The results suggested that the income effect of price changes decreased for all types of meat over time with meat transitioning from a loosely defined luxury good to more of a necessity. Specifically, the price elasticity of beef was relatively inelastic before and after the structural change. Demand for pork became less price elastic and demand for chicken became more price elastic after the structural change.

Koo and Yang (1994) published another article regarding the Japanese meat import demand where they specified the source differentiated AIDS model as the methodology of their study. Annual data from 1973 to 1990 was used and four meat groups were categorized: beef, pork, poultry, and other meat. Pork was found to be the largest import, accounting for over 40% followed by beef (30%) and poultry (10%). In the pork sector, the empirical results indicated that Taiwan had the highest expenditure elasticity followed by the EU. Canadian and U.S. pork exports to Japan had a minor impact (-0.155 and -0.007) when market size changes. In terms of the own-price elasticities, pork imports were generally priced elastic with the EU (-2.561) and Canada (-1.203) being the most sensitive regions. The significantly negative cross-price elasticities revealed an intense substitution relationship in the Japanese pork import market, with Taiwan and the EU having the strongest substitution relationship followed by the competition between Canada and the U.S.

This study uses a more recent set of trade data and employs the quadratic AIDS model with the aim to not only provide an update on the limited literature about South Korea's import demand on source differentiated pork but also deliver insights for Canadian pork exporters regarding their competitiveness against other foreign exporters.

2. Methodology

2.1 Conceptual Framework

The overall framework of this study follows similar procedures from Davis and Jensen's (1994) article on applying the two-stage utility maximization theory to model the import demand system. Therefore, we do not consider the imported fresh/chilled/frozen pork products as final goods but rather see them as inputs that need to be repackaged and reprocessed by domestic firms in the importing country. Under this condition, we can construct an import demand system and derive the source differentiated pork demand by using a two-stage-budgeting function. In other words, source differentiation allows imperfect substitutions among goods from different origins (Yang and Koo, 1994).

The first stage budgeting is determined by the expenditure on imported pork with the utility maximization as the objective:

$$Max\ U\ (Xi) s.t. = pi\ qi. \tag{1}$$

X_i in this case stands for the positive expenditure of imported pork and p_i is the price of pork.

In the second stage budgeting, we can develop the source-differentiated pork demand equation with the cost minimization as the objective:

$$Min\ X_i = p_i\ q_i\ s.t.\ v\ (q_i) = U. \tag{2}$$

Marshallian (uncompensated) demand can be expressed as:

$$q_i = g_i(X_i, p_i) \tag{3}$$

By differentiating the cost function (2), we can obtain the Hicksian (compensated) demand:

$$q_i = s_i(p_i, u). \tag{4}$$

Then, the source-differentiated pork demand can be shown as:

$$q_{ih} = q_{ih}(p_i, X_i). \tag{5}$$

qih stands for the quantity demanded for pork i from source h ($h = 1, 2, \dots, n$) and pi is the vector of prices for source differentiated pork. Xi represents the total expenditure on pork i.

By estimating the price and expenditure elasticities, we can expect that the own-price elasticity would have a negative impact on the quantity demanded for pork and the cross-price elasticity would also have a negative effect on the pork demand from the competing country. As for the expenditure elasticity, we expect it would have a positive impact on the pork demand. Non-economic factors such as seasonality can also play an important role and its impact on pork demand is expected to be dynamic depending on the specific season.

2.2 Model Specification

A Quadratic AIDS model is employed as the methodology in this study. Along with the Rotterdam model, both methodologies have been widely used in the literature in estimating demand elasticities. Specifically, the AIDS model has a flexible functional form, and it is consistent with consumer demand theory where it satisfies all three theoretical restrictions: 1) Adding-up, to add up to the total expenditure which equal to one, 2) Homogeneity, to impose homogenous of degree zero in prices, and 3) Symmetry, to satisfy the Slutsky symmetry (Deaton and Muellbauer, 1980).

Following Kang and Koo (1994), the general source-differentiated AIDS can be written as:

$$w_{ih\ t} = \alpha_{ih} + \sum_{j}^{n}\sum_{k}^{n}\gamma_{ihjk}\, ln\left(p_{jk\ t}\right) + \beta_{ih} ln\left(\frac{X_t}{P^{*}{}_t}\right). \quad (6)$$

Where α, β, γ are the estimated parameters. Subscripts i and j denote goods, and h and k denote sources. $w_{ih\ t}$ represents at time t, the expenditure share of good i is coming from source $h. X$ is the total expenditure on imports, and P^{*} is the translog price index given as (Deaton and Muellbauer, 1980):

$$lnP^{*}{}_t = \alpha_0 + \sum_{i}^{n}\sum_{h}^{m}\alpha_{ih}\ln(P_{ih\ t}) + \frac{1}{2}\sum_{i}^{n}\sum_{h}^{m}\sum_{j}^{n}\sum_{k}^{n}\gamma_{ih\ jk} * lnPih\ t * lnPjk\ t. \quad (7)$$

To address seasonality and time trend effects in South Korean pork imports, the empirical model specification will include seasonal (quarterly) dummy variables and a time trend. The seasonal dummies indicate Spring (April through June), Summer (July through September), and Fall (October through December).

Keeping the translog price index makes the system non-linear which adds difficulties on estimations. So, studies like Yang and Koo (1994), Mutondo and Henneberry (2007) use the Stone's price index $LnP = \sum_{i=1}^{n} w_i \, ln \, P_i$ suggested by Deaton and Muellbauer (1980) to overcome the non-linear issue. This project keeps the model as quadratic and follows the procedures imposed by Banks, Blundell, and Lewbel (1997). The linearized AIDS model suffers from several shortcomings. Buse (1994) argued that the linearized AIDS system suffers from an inconsistent SUR estimator where a consistent IV estimator cannot be constructed. Furthermore, the linearized AIDS model has difficulty capturing non-linear Engel curve effects.

According to Banks et al (1997), the expenditure share equation changes from equation (6) to the following:

$$w_{ih\,t} = \alpha_{ih} + \sum_{j}^{n} \sum_{k}^{n} \gamma_{ihjk} \, ln(p_{jk\,t}) + \beta_{ih} ln\left(\frac{X_t}{a(p)}\right) + \frac{\lambda_{ih}}{b(p)} \left\{ ln\left[\frac{X_t}{a(p)}\right] \right\}^2 \qquad (8)$$

By differentiating equation (8) with respect to ln$X$ and ln$p$, we can obtain

$$\mu_i \equiv \frac{\partial w_i}{\partial lnX} = \beta_i + \frac{2\lambda_{ih}}{b(p)} \left\{ ln\left[\frac{X}{a(p)}\right] \right\},$$

$$\mu_{ij} \equiv \frac{\partial w_i}{\partial lnp_j} = \gamma_{ij} - \mu_i \left(\alpha_j + \sum_{k}^{n} \gamma_{jk} lnP_k \right) - \frac{\lambda_{ih}\beta_j}{b(p)} \left\{ ln\left[\frac{X}{a(p)}\right] \right\}^2 \qquad (9)$$

The adding-up, homogeneity, and symmetry restrictions are given by:

$$\sum_i^n \alpha_i = 1, \sum_i^n \beta_i = 0, \sum_j^n \gamma_{ij} = 0, \sum_i^n \lambda i = 0, \text{ and}$$

$$\gamma_{ij} = \gamma_{ji} \tag{10}$$

Based on the parameter estimates of the above model specification, we can obtain expenditure elasticity, Marshallian (uncompensated) price elasticities, and Hicksian (compensated) price elasticities as follows:

$$e_i = \frac{\mu_i}{w_i} + 1,$$

$$e_{ij}^m = \frac{\mu_{ij}}{w_i} - \delta_{ij},$$

$$e_{ij}^h = e_{ij}^m + e_i w_j. \tag{11}$$

The expenditure elasticities contain a positive β and a negative λ. δ_{ij} is the Kronecker delta, which is equal to 1 if $i = j$ and 0 if $i \neq j$. The Slutsky equation is used to calculate the Hicksian elasticities

2.3 Data collection and estimation method

In order to estimate elasticities, the key variables are import quantity and prices. Monthly import volume and value data for pork from different sources are needed. This study uses the 4-digit HS code: 0203 (Meat of Swine, fresh, chilled, or frozen) as the commodity classification for pork products. Seven years of monthly trade data from January 2013 to December 2019 were acquired from the United Nations' COMTRADE (Commodity Trade Statistics) and ITC's (International Trade Centre) Trade Map databases. The top 6 pork exporting countries (The U.S., Canada, Chile, Germany, Netherlands, Spain, and ROW) are selected as the sources (exporters to Korea) for our AIDS model. All other pork exporters to Korea were aggregated into a Rest of the World (ROW[3]) trade agent grouping.

Due to the unavailability of price data, unit values (US $/KG) for the aggregate pork products (HS:0203) served as proxies of import prices, which are determined by dividing the total monthly import values (US $) by the total monthly import quantities (KG).

This study uses the statistical software STATA and the **quaids** command package designed by Poi (2012). The **quaids** package enables the estimation of both linearized and quadratic AIDS models. Furthermore, non-economic variables can also be incorporated using Ray's (1983) method. Expenditure, Marshallian, and Hicksian elasticities are also computed by the **quaids** command package.

3. Results and Discussion

3.1 Descriptive Statistics

Table 1 shows the descriptive statistics for pork products from January 2013 to December 2019. The according units are in Kilograms, US Dollars, and US$/kg.

Table2. Descriptive Statistics

Exporter	Mean	Std.Dev	Min	Max
Canada				
Quantity	3200598.3	565514.9	2018647	5910889
Value	7866419.5	2142078.1	4211973	16337217
Price	2.456	.476	1.653	3.33
Chile				
Quantity	2496527.4	608202.35	1154236	4431724
Value	9446660	2435881.2	4327635	17315103

[3] Rest of the eligible pork exporting countries to South Korea. Refer to table 1 for the full list.

Price	3.789	.373	2.875	4.536
Germany				
Quantity	7183341.9	2634561.1	1917182	11239600
Value	22535920	8703618.1	6949383	39532027
Price	3.156	.329	2.495	3.864
Netherlands				
Quantity	1428287.4	614180.78	503212	2892552
Value	5000155.1	2021827	2135244	9792630
Price	3.572	.423	2.657	4.31
United States of America				
Quantity	12060233	3777210.3	5366900	21656153
Value	33313854	9871074.2	14923462	59359296
Price	2.791	.31	2.397	3.683
Spain				
Quantity	4829988.1	2083782.5	922528	10738899
Value	13899777	6734948.9	2171269	33401843
Price	2.8	.414	2.082	3.887
ROW				
Quantity	6410565.1	1345990.2	3512696	10982985
Value	20174619	4838558.8	11154000	34573000
Price	3.137	.235	2.558	3.638

Table 3. Average monthly market share by quantity (2013-2019)

	Market share (%)	Rank
United States of America	31.9	1
Germany	18.5	2
ROW	17.6	3
Spain	12.3	4
Canada	9.1	5
Chile	6.9	6
Netherlands	3.7	7

The U.S. shows a dominant position in exporting pork to Korea. It has averaged a monthly export of 12 million kilograms of pork products over the period 2013 to 2019. On average, it also captured over 31% of South Korea's pork import market share. It accounted for more market share than Germany (18.5%) and Spain (17.6%) combined considering the two countries are the 2nd and 3rd largest exporters (excluding ROW). Canada on the other hand has averaged a monthly export of 3.2 million kilograms of pork products to South Korea over the same period. The average import price of Canadian pork products is $2.456/KG, making it the lowest among all 7 exporters. The standard deviation (0.476) on Canadian pork price also indicates that the price tends to be the most volatile in comparison with other exporters. In contrast, the standard deviation (0.31) on the U.S. pork price is relatively more stable. The most expensive pork exporter is Chile ($3.789/KG), followed by Netherlands ($3.572/KG), Germany ($3.156/KG), and ROW ($3.137/KG). Even with the lowest average price, Canada only captured 9.1% of the monthly pork import market share which is around half of what South Korea imports from Germany (18.5%). There is also a tendency for countries with lower market share to experience a more volatile price on their pork exports to South Korea.

Chart 5 below shows the average annual pork prices from the top exporting countries and regions. The grey bar indicates the average price from all 7 exporting countries. Coloured lines represent each countries' average price over the 2013 to 2019 period.

Pork import from Canada has always had a lower price than the world's average while Netherlands and Chile showed the opposite. However, all three exporters show higher volatility in price compared to countries like the U.S. and Germany. Meanwhile, pork from Germany and ROW follow the closest to the world's average price.

Chart 5. Average Price on the source-differentiated pork products($US/KG)

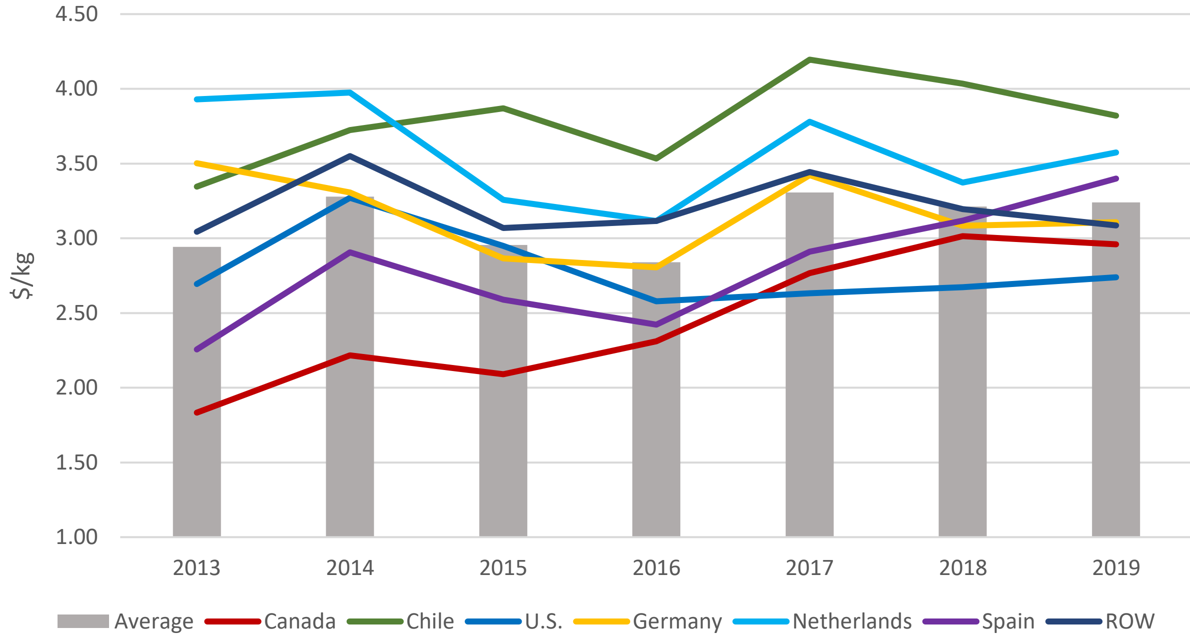
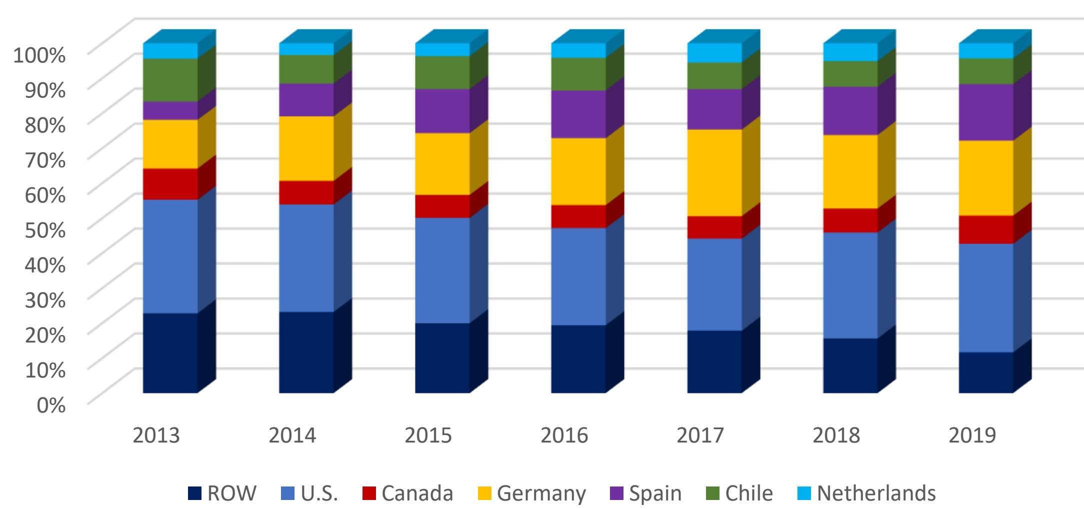


Chart 6. Average Expenditure (%) on source-differentiated pork products



Due to the low price point on Canadian pork, the expenditure also remained small where it only captured 7.15% of market share on average. Expenditure on Canadian pork peaked in 2013 with an 8.92% market share and fell into the 5-7% range until 2019, where the share percentage was able to climb back to 8%. On the other hand, pork from the U.S. was able to capture over 30% of the market share consistently with the exception of 2016 and 2017. Pork from Germany experienced the largest growth in 2017 where the expenditure rose from 19.14% to 24.76%.

Chart 7. Annual Import Value of Canadian and U.S. Pork(US$)

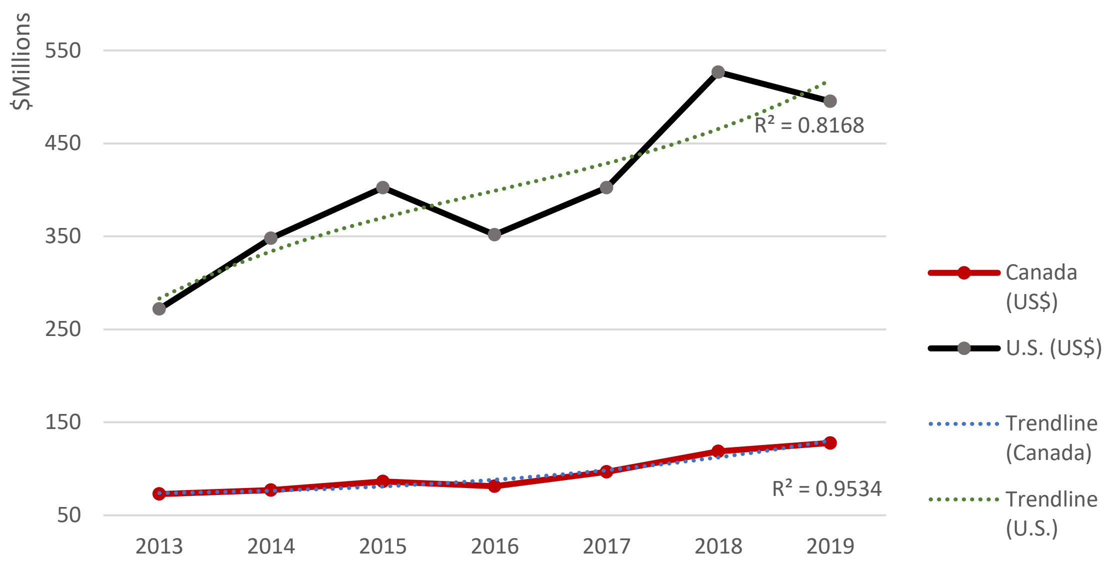


Chart 7 represents South Korea's annual import value of both Canadian and U.S. pork. The annual import value of Canadian pork products has grown from $72 million to over $127 million. On average, Canadian pork exports to South Korea experienced a 10.9% annual growth rate from 2013 to 2019. The annual import value of U.S. pork has also undergone rapid growth, from $272 million in 2013 to $495 million in 2019 with an average annual growth rate of 11.7%. The import value of U.S. pork peaked in 2018 reaching $526 million and dipped to $495 million in 2019. Trading with the U.S. seems more volatile compared to Canada. However, both trendlines indicate an upward growing trend with Canada having a higher R^2 value.

3.2 AIDS Model Estimates

Table 4. Parameter Estimates of the QUAIDS Model

Variable	Coefficient	Variable	Coefficient
α_1	.69255517***	γ_{75}	-0.080
α_2	.89001945***	γ_{66}	-2.5730506***
α_3	0.072	γ_{76}	-0.251
α_4	2.9588537***	γ_{77}	.18616676***
α_5	-.71699131**	λ_1	.00586355*
α_6	-2.9344182***	λ_2	.01029957*
α_7	0.038	λ_3	0.000
β_1	-.12764576***	λ_4	.05128989***
β_2	-.18761657**	λ_5	-.00960554**
β_3	-0.008	λ_6	-.05387203***
β_4	-.72886973***	λ_7	-0.004
β_5	.18364891**	η_{time1}	.00007004**
β_6	.81336364***	η_{time2}	0.000
β_7	0.055	η_{time3}	.00003891*
γ_{11}	-0.044	η_{time4}	-.00017859*
γ_{21}	-.11026286*	η_{time5}	0.000
γ_{31}	0.009	η_{time6}	.00013965***
γ_{41}	-.35204366**	η_{time7}	-.00011567**
γ_{51}	.08953176*	$\eta_{spring1}$	.00118463*
γ_{61}	.41866239**	$\eta_{spring2}$	0.001
γ_{71}	-0.011	$\eta_{spring3}$	-0.000
γ_{22}	-0.053	$\eta_{spring4}$	0.001
γ_{32}	0.009	$\eta_{spring5}$	-.00243291**
γ_{42}	-.58476812**	$\eta_{spring6}$	0.001
γ_{52}	0.124	$\eta_{spring7}$	-.00221074**
γ_{62}	.60610984**	$\eta_{summer1}$	0.001

γ_{72}	0.009	$\eta_{summer2}$	0.002
γ_{33}	-0.001	$\eta_{summer3}$	.00074516*
γ_{43}	-0.036	$\eta_{summer4}$	-.00740193***
γ_{53}	-0.043	$\eta_{summer5}$	0.000
γ_{63}	0.055	$\eta_{summer6}$	.0023623***
γ_{73}	0.005	$\eta_{summer7}$	.00180248*
γ_{44}	-2.2275754***	η_{fall1}	0.001
γ_{54}	.6585238***	η_{fall2}	0.001
γ_{64}	2.4006844***	η_{fall3}	-0.000
γ_{74}	0.141	η_{fall4}	-.00619335***
γ_{55}	-0.092	η_{fall5}	0.001
γ_{65}	-.6572279***	η_{fall6}	.00211212**
		η_{fall7}	.0026243***
		ρ_{time}	-.00685622***
		ρ_{spring}	-.12508412**
		ρ_{summer}	-.10605877*
		ρ_{fall}	-.12186846*

Note: * p<.05; ** p<.01; *** p<.001. Subscripts: 1 (Canada), 2(Chile), 3(Netherlands), 4(U.S.), 5(Spain), 6(Germany), and 7(ROW). Time (Time trend).

Table 4 above shows the parameter estimates of the source-differentiated QUAIDS model. Adding-up and homogeneity are automatically imposed during the estimation process with the **quaids** command.

$\alpha, \beta, and\ \gamma$ are the estimated intercept, expenditure, own and cross-price parameters of the source differentiated AIDS model. Where γ_{21} represents the cross-price parameter for pork from Chile and pork from Canada. Five out of seven Engel curves vectors (λ) are quadratic for source-differentiated pork, meaning that the QUAIDS model is more appropriate than the linearized

AIDS model. The demographic effect on pork demand(η) indicates that the time trend is significant for Canada, Netherlands, the U.S., Germany, and ROW. Even though the time trend (η_{time}) only has a minor impact, the estimated parameters show the U.S. and ROW are negatively affected, meaning as time goes, the import demand for pork will decrease from the U.S. and ROW. The rest of the countries are positively affected, meaning they will gain more shares as time goes (assuming everything else constant). Seasonality ($\eta_{spring/summer/fall}$) is only significant in less than half of the countries and it also does not impose large impacts on the demand for source-differentiated pork. While the effect is minimal, consumers in South Korea tend to demand more pork from Canada, Spain and ROW during Spring, Netherlands, the U.S., Germany, and ROW during Summer, and the U.S., Germany, and ROW during Fall. Lastly, the demographic effect on expenditure (ρ) shows less intuitive results, where it concludes time trends and seasonality having significant negative impacts on the expenditure of source-differentiated pork.

3.3 Calculated Elasticities

Table 5 displays the estimation results of the expenditure elasticities for the QUAIDS model.

Table 5. Expenditure Elasticities

	Canada	Chile	Netherlands	U.S.	Spain	Germany	ROW
Expenditure	0.51 (0.13)	0.66 (0.18)	0.82 (0.15)	1.14 (0.09)	1.33 (0.13)	1.01 (0.07)	0.93 (0.08)

Note: Numbers in parentheses are the corresponding standard errors.

The result indicates that as import demand in South Korea increases, pork products from Spain, the U.S., and Germany will capture the most shares. Specifically, the expenditure elasticities show Spanish (1.33), German (1.01), and U.S. (1.14) pork products are considered as luxury items since they benefit over-proportionally as for every additional percentage increase in Korean import demand for pork, they increase by more than 1 percent. The results are not surprising as Spain's black (Iberico) and Mangalica swine breeds are famous for their glossy marbling fat contents (Jamon.com, 2021). U.S. pork's competitive price, quality and taste is also well perceived by Korean consumers (Russell, 2012). In contrast, Netherlands and Chile will be less sensitive to South Korea's expenditure change. Pork from Canada is the least sensitive with the lowest expenditure elasticity value, which suggests that when import demand increases, South Korea will spend the least portion of its expenditures on Canadian pork products.

Table 6. Hicksian (Compensated) Own and Cross-Price Elasticities

	Canada	Chile	Netherlands	U.S.	Spain	Germany	ROW
Canada	**-0.6**	-0.08	0.21	0.5	-0.01	0.27	-0.29
	(0.16)	*(0.18)*	*(0.1)*	*(0.22)*	*(0.19)*	*(0.16)*	*(0.19)*
Chile	-0.07	**0.13**	0.21	-0.04	-0.12	0.02	-0.13
	(0.15)	*(0.33)*	*(0.12)*	*(0.3)*	*(0.25)*	*(0.22)*	*(0.25)*
Netherlands	0.35	0.42	**-0.97**	-0.13	-0.97	1.02	0.28
	(0.16)	*(0.24)*	*(0.24)*	*(0.26)*	*(0.26)*	*(0.24)*	*(0.3)*
U.S.	0.12	-0.01	-0.02	**-0.7**	0.49	-0.02	0.14
	(0.05)	*(0.09)*	*(0.04)*	*(0.18)*	*(0.1)*	*(0.08)*	*(0.09)*
Spain	-0.01	-0.09	-0.36	1.23	**-0.43**	-0.15	-0.19
	(0.12)	*(0.19)*	*(0.09)*	*(0.26)*	*(0.28)*	*(0.16)*	*(0.19)*
Germany	0.1	0.01	0.23	-0.03	-0.09	**0.03**	-0.24
	(0.06)	*(0.1)*	*(0.05)*	*(0.13)*	*(0.09)*	*(0.11)*	*(0.1)*
ROW	-0.11	-0.06	0.07	0.23	-0.12	-0.25	**0.24**
	(0.07)	*(0.12)*	*(0.07)*	*(0.14)*	*(0.12)*	*(0.11)*	*(0.17)*

Note: Own-price elasticities are marked in bold. Numbers in parentheses are the corresponding standard errors.

The Hicksian or compensated elasticities are reduced to only price effects, meaning they are compensated for the effect of a change in the relative income on demand, unlike the Marshallian price elasticities where they can contain both the income and price effects (Taljaard et al.). While pork from Canada (-0.6), Netherlands (-0.97), the U.S. (-0.7) and Spain (-0.43) have the expected negative signs for their Hicksian own-price elasticities, suggesting that with an additional price increase, the import demand for pork from those origins will decrease. Chile (0.13), Germany (0.03), and ROW (0.24) showed otherwise. South Korea's demand for pork from Canada is relatively inelastic. It is more elastic than pork from Chile, Spain, Germany, and ROW but less elastic compared to the Netherlands and the U.S. Results also indicate that Spanish and Canadian pork hold the market power in South Korea, meaning the price increase will have less of an impact on the pork demand from those two countries.

The Hicksian cross-price elasticities show that pork from Chile, Spain, and ROW are complements of Canadian pork as they all show negative signs, while the Netherlands, the U.S. and Germany's pork are substitutes. Pork from the U.S. is the number one competitor for Canada followed by pork from Germany and Netherlands.

Table 7. Marshallian (Uncompensated) Price Elasticities

	Canada	Chile	Netherlands	U.S.	Spain	Germany	ROW
Canada	**-0.64**	-0.13	0.19	0.35	-0.07	0.17	-0.39
	(0.16)	(0.18)	(0.1)	(0.22)	(0.19)	(0.16)	(0.19)
Chile	-0.11	**0.07**	0.18	-0.24	-0.2	-0.11	-0.25
	(0.15)	(0.34)	(0.12)	(0.3)	(0.25)	(0.21)	(0.24)
Netherlands	0.29	0.34	**-1.01**	-0.4	-1.08	0.84	0.11
	(0.17)	(0.24)	(0.24)	(0.26)	(0.26)	(0.24)	(0.31)
U.S.	0.04	-0.11	-0.07	**-1.04**	0.35	-0.24	-0.07
	(0.05)	(0.09)	(0.04)	(0.18)	(0.1)	(0.08)	(0.09)

Spain	-0.1	-0.21	-0.42	0.84	**-0.59**	-0.41	-0.44
	(0.12)	(0.19)	(0.09)	(0.27)	(0.28)	(0.15)	(0.19)
Germany	0.03	-0.08	0.18	-0.33	-0.21	**-0.17**	-0.43
	(0.06)	(0.1)	(0.05)	(0.13)	(0.09)	(0.11)	(0.1)
ROW	-0.18	-0.14	0.03	-0.05	-0.23	-0.43	**0.07**
	(0.07)	(0.12)	(0.07)	(0.14)	(0.12)	(0.1)	(0.18)

Note: Own-price elasticities are marked in bold. Numbers in parentheses are the corresponding standard errors.

The Marshallian price elasticities take account for both income and price effects and they show the relationship between pork price from Canada (as an example) on the assumption of the U.S. price (as an example) holding the consumer's income constant (Taljaard et al.). With the added income effects, Chile (0.07) and ROW (0.07) become the only two with positive signs. Pork from Canada (-0.64), Netherlands(-1.01), the U.S.(-1.04), Spain(-0.59), and Germany(-0.17) all showed a slightly higher absolute value compared to the Hicksian own-price elasticities, making them relatively more elastic, thus more sensitive to price increases. The Marshallian estimates also changed the price elasticity of German pork from 0.03 to -0.17 which indicates that the market power is held by Germany (-0.17), Spain(-0.59), and Canada(-0.64) since they are among the most inelastic countries yet carrying a negative sign. This result corresponds well with the descriptive statistics as the above three countries are among the top 4 pork exporters to South Korea (excluding ROW).

Based on the negative Marshallian cross-price elasticities, pork from Chile, Spain, and ROW are considered complements of the ones from Canada and pork from the Netherlands, the U.S. and Germany are considered as substitutes. Therefore, if consumers in South Korea choose to substitute for pork from Canada, the U.S. is likely to benefit the most with a cross-price elasticity of 0.35, followed by the Netherlands with a cross-price elasticity of 0.19, and Germany at 0.17.

On the other hand, if South Korean consumers decide to substitute for pork the U.S., Canadian and Spanish pork will be the only two exporters benefitting with the cross-price elasticity of 0.04 and 0.35.

Table 9 below provides the summary of the price responsiveness of South Korea's source-differentiated pork import demand with a focus on imports from Canada.

Table 8. Summary of price responsiveness of source-differentiated pork import demand in South Korea (focus on implications with Canada)

		Price of fresh/chilled/frozen pork from:						
		Canada	*Chile*	*Netherlands*	*U.S.*	*Spain*	*Germany*	*ROW*
Imports from:	*Canada*	Inelastic	Weak Complement	Weak Substitute	Weak Substitute	Weak Complement	Weak Substitute	Weak Complement
	Chile	Weak Complement	Inelastic					
	Netherlands	Weak Substitute		Elastic				
	U.S.	Weak Substitute			Elastic			
	Spain	Weak Complement				Inelastic		
	Germany	Weak Substitute					Inelastic	
	ROW	Weak Complement						Inelastic

Canadian pork exporters are faced with several challenges in the South Korean market. Having the lowest expenditure elasticity and pork pricing, Canadian pork will have the least benefit to capture when South Korea expands its pork consumption. There is a need to improve the quality and taste perception of Canadian pork in the Korean market. This becomes especially important when the U.S. pork is considered as a substitute where the perception of U.S. pork products is generally more favoured (expenditure elasticity of 1.14 on U.S. pork). Knowing the pork consumption characteristics in South Korea is also important for Canadian pork exporters so that they can deliver pork products that match the consumer preferences.

4. Conclusion

This project imposes the utility maximization theory to model the demand system and uses the quadratic AIDS model to estimate the corresponding parameters and elasticities. Summary statistics show that on average, Canadian pork captured 9.1% of the total import quantity. The price of Canadian pork is among the lowest among the 7 countries and regions in our project. The estimated expenditure elasticity showed that Canadian pork is the least sensitive to the change in income. Both Hicksian and Marshallian price elasticities indicated that pork imports from Canada are relatively inelastic and holds market power towards price changes. Competitions from the U.S., Netherlands, and Germany need to be brought to attention by Canadian pork exporters. Time trend and seasonality (Spring) showed a positive role in serving Canadian pork to South Korean consumers.

It is worth noticing that Canada's crossbreeding programs have made Canadian swine achieve an optimal level of leanness. While this unique feature may seem attractive to many western countries, consumers in South Korea still prefer pork that contains a high amount of fat contents. The difference in consumer's taste profile plays a big role in the source differentiated import demand and it can also act as a probable reason for why Canadian pork is relatively inelastic in expenditure. In order to maintain and expand its market share in the Korean pork import market, Canada needs to continue to promote the quality and taste profiles of its pork products despite its low pricing.

There are certain limitations with this study. The study aggregated all fresh, chilled, and frozen pork products into one category, where using more disaggregated data based on the HS classifications could generate a more precise result. In addition, it could be worthwhile to include domestic price data and other non-economic factors such as Free Trade Agreements (FTAs) to further rich the demand model.

References

- *A. Deaton, J. Muellbauer. (1980). An Almost Ideal Demand System. The American Economic Review (70), 312-26.*
- *AAFC. (2020, 11 20). Overview of the Canadian agriculture and agri-food sector 2018. Retrieved from Government of Canada: https://agriculture.canada.ca/en/canadas-agriculture-sectors/sector-overviews-data-and-reports/overview-canadian-agriculture-and-agri-food-sector-2018*
- *Agency, A. a. (2021). List of Countries Eligible for Export to Korea. Retrieved from APQA: https://www.qia.go.kr/english/html/Animal_livestock/02AnimalLivestock_quar_ins_info_eng.jsp#this*
- *Ahearn M, D. Culver, R. Schoney. (1990). Usefulness and limitations of COP estimates for evaluating international competitiveness: A comparison of Canadian and US wheat. American Journal of Agricultural Economics 72 (5), 1283-91.*
- *Ann, S.-M. (2016, May 29). S. Korea's self-sufficiency of beef, pork drops in 2015. Retrieved from The Korea Herald: http://www.koreaherald.com/view.php?ud=20160529000190*
- *Board, N. P. (2021). Facts & Statistics. Retrieved from Pork Checkoff: https://porkcheckoff.org/pork-branding/facts-statistics/*
- *Buse, A. (1994). Evaluating the Linerized Almost Ideal Demand System. American Journal of Agricultural Economics (76), 781-793.*
- *Canada Pork International. (2006). The Canadian Pork Story. Ottawa: Canada Pork International.*
- *Ellis, M., McKeith, F. K., & Miller, K. D. (1999). The Effects of Genetic and Nutritional Factors on Pork Quality - Review. Asian-Australasian Journal of Animal Sciences, 12(2), 261-270.*

- *Foreign Agricultural Services. (1997). "General Market Overviews, Attache Query Detail.". Retrieved from FAS Online: https://www.fas.usda.gov/*
- *George C. Davis and Kim L. Jensen. (1994). Two-Stage Utility Maximization and Import Demand Systems Revisited: Limitations and an Alternative. Journal of Agricultural and Resource Economics 19 (2), 409-424.*
- *J. Banks, R.Blundell, and A. Lewbel. (1997). Quadratic Engel curves and consumer demand. Review of Economics and Statistics (79), 527-539.*
- *Jamon.com. (2021). The Pig Breeds. Retrieved from Jamon.com: https://www.jamon.com/pig-breeds.html*
- *Jee-Hwan Choe, Han-Sul Yang, Sang-Hoon Lee and Gwant-Woong Go. (2015). Characteristics of pork belly consumption in South Korea and their health implication. Journal of Animal Science and Technology 57,22.*
- *Jobst, N. (2019, August). Sector Trend Analysis – Meat trends in South Korea. Retrieved from Agriculture and Agri-Food Canada: http://www.agr.gc.ca.login.ezproxy.library.ualberta.ca/eng/industry-markets-and-trade/international-agri-food-market-intelligence/reports/sector-trend-analysis-meat-trends-in-south-korea/?id=1563465223559*
- *Michele M. Veeman, Terrence S. Veeman and Shiferaw Adilu. (2002). Analysis of East Asian Meat Import Demand: Market Prospects for Alberta and Canada . Edmonton: University of Alberta.*
- *Mutondo, J., & Henneberry, S. (2007). A Source-Differentiated Analysis of U.S. Meat Demand. Journal of Agricultural and Resource Economics, 32(3), 515-533.*
- *OECD. (2021). Meat Consumption. doi:10.1787/fa290fd0-en*
- *Ontario Pork. (2021). Pigs of the World & Life of a Pig. Retrieved from Ontario Pork: https://www.ontariopork.on.ca/Public-Education*

- *Poi, B. P. (2012). Easy deman-system estimation with quaids. The Stata Journal, 433-446.*
- *PR Taljaard, ZG Alemu & HD van Schalkwyk. (2004). The Demand for Meat in South Africa: An Almost Ideal Estimation. Agrekon, 43, 430-443.*
- *Russell, C. (2012, July 16). U.S. Pork Tops Korean Blind Taste Test. Retrieved from National Hog Farmer: https://www.nationalhogfarmer.com/marketing/us-pork-tops-korean-blind-taste-test*
- *Seung-Ryong Yang, Won W. Koo. (1994). Japanese Meat Import Demand Estimation with the Source Differentiated AIDS Model. Journal of Agricultural and Resource Economics, 19 (2), 396-408.*
- *Theil, H. (1965). The Information Approach to Demand Analysis. Econometrica 33(1), 67-87.*
- *USDA. (2021). Livestock and Poultry: World Markets and Trade. Retrieved from United States Department of Agriculture: https://usda-library-cornell-edu.login.ezproxy.library.ualberta.ca/concern/publications/73666448x*
- *Watters, A. (2020). Livestock and Products Annual: Canada. Ottawa: USDA Foreign Agricultural Service. Retrieved from https://apps-fas-usda-gov.login.ezproxy.library.ualberta.ca/newgainapi/api/Report/DownloadReportByFileName?fileName=Livestock%20and%20Products%20Annual_Ottawa_Canada_09-01-2020*
- *Won W. Koo, Yang Seung-Ryong, Lee Chang-Buhm. (1993). Estimation of Demand for Meat in Korea. Journal of Rural Development, 205-222.*
- *Xiaojun Wang, Michael Reed. (2013). Estimation of Import Demand for Fishery Products in the U.S. Using the Source-Differentiated AIDS Model. Agricultural & Applied Economics Association. Washington, DC.*