SOURCE DIFFERENTIATED BEEF AND SOYBEAN IMPORT DEMAND IN CHINA

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IMPORT DEMAND IN CHINA

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Abstract: Firstly, this study used a Source Differentiated Linear Approximated Almost Ideal Demand System (LA/AIDS) model to estimate beef import demand in China. The conditional price and expenditure elasticities of demand are estimated for each exporting country. The model also estimated how diseases outbreaks and seasonality affect the beef import demand in China. Separability, normality, and endogeneity are tested to validate model. The empirical results showed that Brazilian beef, Uruguayan beef and Australian beef are substitutes to each other. Among the exporters, Brazilian beef has the weakest position in China's beef import market due to the highest price elasticity. Bovine Spongiform Encephalopathy (BSE) has a negative influence on imported beef demand from Brazil and Uruguay but it positively affects Australian beef. Seasonal dummies do have an impact on beef import demand.

Secondly, a differential production approach is used to address China's soybean import from different sources. By clarifying two stage budgeting, a derived demand model is applied for the multiproduct firm. From the results, U.S. is competing with Brazil and Argentina as well as rest of the world (ROW) in exporting soybeans. Brazil and Argentina are complementary to China's soybean imports. Seasonal factors have a great impact on China's soybean imports. The soybean exports increases immediately after harvest season for each soybean source. Seasonality is shown to have a reverse effect on the soybean import from the U.S. and South American countries since they are located in different hemispheres.

Key words: imports, demand system, elasticities.

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CHAPTER I

INTRODUCTION

1.1 Backgrounds

Over the past 30 years, economic growth and urbanization have contributed to not only an increase in income but also a change in the dietary pattern in China. Of all the meat types, pork currently still plays the biggest role in traditional Chinese cuisine. The higher incomes start contributing to a greater demand for meat sources of higher proteins, such as beef.

1.2 Problem Statement

Even though beef consumption only takes about 13.8% of total meat consumption in China in 2018, it keeps sustained growth year by year. Total beef consumption and beef consumption per capita in China have both increased recently. In 2018, total beef consumption reached 8.2 million metric tons, increasing 6.7% over 2017. Beef consumption per capita is 4.1 kilograms/capita, 2.5% higher than last year. Total domestic beef production in 2018 is 7.2 million metric tons (OECD 2018). The shortfall between consumption and production has resulted in very high growth in the trade of beef. However, most beef producers in China suffer from low productivity due to scattered and self-sufficient patterns. The gap between beef demand and domestic production is getting wider, along with the growth of per capita consumption. On one hand, the low domestic beef supply drives the beef price up. On the other hand, it leads to China importing beef to meet its huge beef demands (Longworth 2011). Moreover, the ongoing trade war leads a very large price fluctuation of beef imported to the mainland market in China this year. Policy evaluations, simulations, and even welfare analysis need estimates of demand responsiveness on prices and expenditure. Reliable estimations can help government make relevant decisions. Therefore, for both beef producers in the world and domestic beef consumers in China, it is important to know: (1) how economic and non-economic factors affect beef import demand in China and (2) how beef exporters can adjust their production and price in the competitive beef market in China.

1.3 Objectives:

The primary objective is to increase the precision of policy analyses of the factors that impact Chinese import demand for source differentiated beef. The specific objective is to estimate the economic parameters such as price and expenditure elasticities and the effect of non-economic factors such as disease outbreaks and seasonality on China import demands for source-differentiated beef.

1.4 Literature Review

Published studies on import beef demand in China are limited. But there are several studies analyzing meat imports in China. Cheng and Gao (2015) estimated the factors that affect meats imports in China during 1995-2010. They indicated that import price has a negative effect while real GDP has a positive effect on quantity imported of meat (Cheng 2012). Ortega (2016), utilized data from an in-store choice experiment to evaluate consumer willingness-to-pay for select food quality attributes (food safety, animal welfare, Green Food and Organic certification) taking into account country-of-origin information. They explored the various relationships between the quality attributes and found evidence of preference heterogeneity. Their results show that Beijing consumers value food safety information the most, and are willing to pay more for Australian beef products than for domestic or other beef (Ortega 2016).

As for the methodologies, Almost Ideal Demand System (AIDS) model and Rotterdam model are widely used in demand system analysis.

Rotterdam model, developed by Theil (1965) and Barten (1966), has a good performance in estimating demand systems. The model appears good at recovering true elasticities when aggregation is done within weakly separable branches of a utility tree. The parameters in Rotterdam model are linear and easy to be restricted.

Mutondo and Henneberry (2007) used the Rotterdam model to estimate the U.S. source-differentiated meat demand (Mutondo 2007). Their estimated elasticities indicated that U.S. grain-fed beef and U.S. pork have a competitive advantage in U.S. beef and pork markets. BSE outbreaks in Canada and the U.S. had small impacts on meat demand while seasonality has a significant effect on the U.S. meat consumption patterns.

Andrew and Amanda (2014) estimated source-differentiated wine demand in China using the absolute price version of the Rotterdam demand system. Their results confirm that Chinese consumers have higher preference on French wine than the wine from other sources. Even though Australian wine has a solid standing in China wine market, the expenditure elasticity indicates that Australia will continue to account for about 20% of the foreign wine market in China (Andrew 2014).

The Almost Ideal Demand System (AIDS) model, developed by Deaton and Muellbauer (1980), is considered to be flexible in demand system analysis. The functional form is simplified and easy to interpret. It is also easy to test the demand properties such as homogeneity and symmetry conditions.

Yang and Koo (1994) developed the source differentiated AIDS model to estimate Japanese meat import demand. Their results indicate that the U.S. had the largest potential for beef exports to Japan. Taiwan has a big share in pork market and Thailand and China are strong in the poultry market. The U.S. competes with Canada and Taiwan in the pork market. The U.S. competes with Thailand in the poultry market.

Taljaard, Alemu and Van Schalkwyk (2004) used a Linear Approximated Almost Ideal Demand System (LA/AIDS) model to estimate meat demand in South Africa. They tested for separability and expenditure exogeneity. The results showed expenditure is exogenous and the chicken can be classified as a necessity in budget share group.

Few recent studies specifically analyzed beef import in China. In regression analysis, the dependent variables may be influenced not only by quantitative variables such as income and price, but also by qualitative variables such as BSE disease and seasonality dummies. This paper fills a gap currently present in the empirical literature by combining source-differentiated analysis and time series data specifically addressed to beef demand. This paper applies the Linear Approximated AIDS model with dummies on the source-differentiated beef imports from the Customs of China. What's more, a separability test and endogeneity test will be addressed. As China is an emerging market for beef, new market potential and policy implications are discussed.

CHAPTER II

METHODOLOGY

2.1 Conceptual Framework

We begin by aassuming that the imported frozen beef is consumed after repackaging and reprocessing by different firms and these firms deal with the beef separately. Thus, it is considered as a utility-based demand system (Davis and Jensen). Under these assumptions, importing firms determine the quantity of beef they need to import. In addition, they also decide the different sources to import. All the imported beef should have shipment and quantity records in China Custom systems.

Given this assumption, an import demand system can be determined to derive source differentiated beef demand by using a two stage-budgeting function. In the first stage budgeting, expenditure on imported beef is determined with the utility maximization as an objective:

(1) $$\text{Max } U\,(X_i, X_j, \ldots, X_z\,) \text{ s.t.} = p_i\, q_i,$$

where Marshallian demands is:

(2) $$q_i = g_i(X_i, p_i).$$

In the equations above, X_i, X_j, …, X_z stand for the non-negative expenditure on different meat categories. p_i is the price of beef, X_i is the expenditure of imported beef.

In the second stage budgeting, the quantity demand equation for source-differentiated beef can be developed with the cost minimization as an objective:

$$\text{(3)} \qquad \text{Min } X_i = p_i\, q_i \text{ s.t. } v\,(q_i)=U.$$

Through differentiation of cost function (3) or substitution of Marshallian demand (2), Hicksian Demands can be obtained:

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

Following, the quantity demanded for beef imported from source *h* can be expressed as:

$$\text{(5)} \qquad q_{i_h} = q_{i_h}\ (p_{i_1}, p_{i_2}, \dots, p_{i_m}, X_i),$$

where *h* stands for different sources (*h=1,…,m*), q_{i_h} is the quantity demanded for beef *i* from country *h*, *p* is the price of beef from different countries, and X_i is the expenditure spent on beef *i*.

Given the economic variables above, by estimating the price and expenditure elasticities, it can be hypothesized that own price would have a negative impact while expenditure would have a positive impact on the quantity demanded for beef. The price of the beef imported from other competing markets can also be hypothesized to have a negative effect on quantity demanded for beef from one certain country like Brazil.

Except for price elasticities, some non-economic factors also affect import beef demand. It can also be assumed that quarantinable diseases would have negative impacts on the quantity demanded of beef import.

2.2 Empirical Model Specifications:

As for model selecting, the almost ideal demand system (AIDS) and the Rotterdam model have been used frequently in import demand estimations. Compared with the Armington model with strong assumptions, they are more flexible, plausible and convenient. For this study, a linear approximated source differentiated AIDS (LA/AIDS) model is used.

Specific Objective (LA/AIDS Model):

General AIDS model derives from the expenditure function, which can be rewritten as:

(6) $$w_i = \alpha_i + \sum_i^n \gamma_{ij}\, lnP_j + \beta_i \ln\left(\frac{X}{P^*}\right),$$

where w_i is the expenditure share of good *i*, such as the expenditure share of beef. $\alpha_i, \beta_i, and\ \gamma_{ij}$ are parameters to be estimated and P_j is the nominal price of good *j*. X is the total expenditure on imported beef. P^* is the price index.

Deaton and Muellbauer (1980) calculated the translog price index by:

(7) $$\ln P^* = \alpha_0 + \sum \alpha_j\, lnP_j + \frac{1}{2}\sum_i^n \sum_j^n \gamma_i * lnP_i * lnP_j.$$

In the equation above, the price index P^* in the share equation (6) makes the system non-linear, which adds difficulties on estimations. Green and Alston (1991), Moschini Moro and Green (1994), and Asche and Wessels (1997) have compared linear and non-linear specifications with Monte Carlo studies in estimating AIDS systems. Their results indicated linear AIDS performs reasonably well. To overcome the non-linear problem, Deaton and Muellbauer (1980) suggested the Stone's price index to replace the translog price index. The Stone's price index is

(8) $$LnP = \sum_{i=1}^{n} w_i ln\, P_i.$$

Eales and Unnevehr (1988) argued that the Stone's price index causes a simultaneity problem since the dependent variable w_i also appears on the right hand side in LA/AIDS. Eales (1988), Yang and Koo(1994), and Taljaard (2004) replaced $w_{i,t}$ by lagged share $w_{i,t-1}$, where *t* stands for the time period.

To address the objective that determining how BSE disease and seasonality affect beef imports in China, the BSE dummy variable and seasonality variables will be included in the LA/AIDS. So the final LA/AIDS model can be expressed as follows:

(9) $$w_{it} = \sum_{j}^{n} \gamma_{ij}\, lnP_{jt} + \beta_i \left(LnX_t - \sum_{i=1}^{n} w_{i,t-1} ln\, P_{it}\right) + \sum_{q=1}^{2} \delta_i\, BSE_{qt} + \sum_{l=1}^{4} \theta_i D_{lt},$$

where *t* represents time period. δ represents the coefficient for BSE indicator. Θ represents the coefficient for seasonality. BSE stands for BSE indicator variable. $BSE =$ 1 means that BSE disease occurs. Otherwise, $BSE = 0$. D_l stands for seasonal dummy variables. D_1represents the first quarter (Jan-Mar). D_2 represents second quarter (Apr-Jun). D_3 represents the third quarter (Jul-Sep). D_4 represents the fourth quarter (Oct-Dec). $D_1 = 1$means Quarter I. Otherwise, $D_1 = 0$. D_2=1means Quarter II. Otherwise, D_2=0.

D_3=1: Quarter III. D_3=0: Otherwise. D_4=1: Quarter IV. D_4=0: Otherwise. The constant intercept is deleted to avoid multicollinearity problem.

Then the general conditions for import demand will be tested by imposing three general demand restrictions:

(10) Adding-up: $\sum_{i}^{n} \gamma_{ij} = 1$, $\sum_{i}^{n} \beta_i = 0$, $\sum_{i}^{n} \delta_i = 0$, and $\sum_{i}^{n} \theta_i = 0$

Homogeneity: $\sum_i^n \gamma_{ij} = 0$

Symmetry: $\gamma_{ij} = \gamma_{ji}$

In adding-up condition for each price variable, the parameters of log prices from all countries add up to one. For expenditure variable, the parameters of log expenditure from all countries sums up to 0. Mutondo and Henneberry (2007) estimate the demand system for meat in the U.S. with BSE and seasonal dummies. For each BSE dummy variable, the parameters of BSE dummies for all countries adds up to 0. For each seasonal dummy variable, the parameters of seasonal dummies for all countries adds up to 0.

Conditional price and expenditure elasticities in Two Stage budgeting

The two stage budgeting assumption results in a conditional demand system for beef within the meat categories. Thus, compensated (Hicksian) and uncompensated (Marshallian) elasticities are calculated as follows:

Marshallian own price elasticity (ε_{ii}^{M}):

(11) $$\varepsilon_{ii}^{M} = -1 + \frac{\gamma_{ij}}{w_i} - \beta_i$$

Marshallian cross price elasticity (ε_{ij}^{M}):

(12) $$\varepsilon_{ij}^{M} = \frac{\gamma_{ij}}{w_i} - \beta_i \frac{w_j}{w_i}$$

Hicksian own price elasticity (ε_{ii}^{H}):

(13) $$\varepsilon_{ii}^{H} = -1 + \frac{\gamma_{ij}}{w_i} + w_i$$

Hicksian cross price elasticity(ε_{ij}^{H}):

(14) $$\varepsilon_{ij}^{H} = \frac{\gamma_{ij}}{w_i} + w_j$$

Expenditure elasticity (η_i):

(15) $$\eta_i = 1 + \frac{\beta_i}{w_i}$$

2.3 Hypothesis Tests

2.3.1 Separability Test

The multi-stage budgeting divides total expenditure on imported goods into different groups like food and non-food groups. Furthermore, it can be divided into meat groups and other non-meat groups. Meat products are important sources of protein in the Chinese diet. Chinese consumers spend a large portion of their food budget for meat products. Among the meat groups, beef could be considered as a substitute or complement for other meats. The existence of weak separability between two commodities indicates that the marginal rate of substitution between two commodities in the same group does not depend on the quantity consumed of commodity in other groups. Based on this point, a number of unrelated parameters could be reduced in estimations. In this paper, separability is assumed between meat and non-meat groups and also between beef and other meat types. In China, pork, poultry, and beef imports occupies 95% of the whole meat import. Thus, a separability test is done with the hypothesis that imported beef is separable from the other major imported meats. The hypothesis is tested by the method developed by Moschini and Green (1994).

Null hypothesis: *Imported beef is separable from the other major imported meats.*

The utility functions for tested hypothesis can be expressed as follows:

(16) $$U = U\left[q_{beef}, f(\, q_{pork}, q_{poultry)}\right],$$

where the utility function for major imported meats (U) is a function of quantity imported of beef, pork, and poultry.

Base on the null hypothesis, the marginal rates of substitution between imported beef and other imported meats are independent from the quantity imported of the other meats:

(17) $$\frac{\pi_{beef,pork}}{\pi_{beef,poultry}} = \frac{\theta_{pork}}{\theta_{poultry}}.$$

Green (1994), Boonsaeng and Wohlgenant (2009) developed the above equation (17) in the LA/AIDS model with the cross price and expenditure elasticities:

(18) $$\frac{\pi_{beef,pork}}{\pi_{beef,poultry}} = \frac{(\gamma_{beef,pork}+w_{beef}w_{pork})}{(\gamma_{beef,poultry}+w_{beef}w_{poultry})}\text{, and } \frac{\theta_{pork}}{\theta_{poultry}} = \frac{(w_{pork}+\beta_{pork})}{(w_{poultry}+\beta_{poultry})},$$

where γ is the cross price elasticity, $w_{pork}, w_{poultry.}$and w_{beef} are the budget shares of pork, poultry and beef, and β is the expenditure elasticity. Then a likelihood ratio test will be used to test the hypothesis with the restricted and unrestricted models. The restrictions to demand equations can be imposed in 3 cases.

Case 1: Unrestricted model: No restriction imposed. Restricted model: Homogeneity, symmetry and separability imposed.

Case 2: Unrestricted model: No restrictions imposed. Restricted model: Separability imposed.

Case 3: Unrestricted model: Homogeneity and symmetry imposed. Restricted model:

Homogeneity, symmetry and separability imposed.

The calculated likelihood ratio (LR) is compared with critical value under the 1 degree of freedom under chi-square distribution:

$$LR = 2(\log L_{un} - logL_{re}), \quad (19)$$

where $\log L_{un}$ is the log-likelihood of the unrestricted model and $logL_{re}$ is the log-likelihood of the restricted model.

2.3.2 Normality Test

As there are 0 values (about 1% of the whole data) on the quantity imported of beef in the dataset, a Shapiro-Wilk test is used to check whether the sample is normally distributed. The Shapiro-Wilk test are done using the R Package micEconAids with residuals of dataset.

2.3.3 Endogeneity Test

In LA/AIDS model, a major concern is endogeneity of the expenditure variable since expenditure share is not only the dependent variable in AIDS but also a Right-Hand-Side (Independent) variable. Edgerton(1993), showed that if the expenditure variable in AIDS is endogenous, the Seemingly Unrelated Regression (SUR) estimators are no longer unbiased.

LaFrance (1991) suggested the Hausman-Wu Test to test the endogeneity of expenditure variable. The null hypothesis for Hausman-Wu test is that the expenditure variable is exogenous (no endogeneity). The Hausman statistic can be written as:

(20) $$\mathrm{m} = (\theta^{*} - \theta)'[Var(\theta^{*}) - Var(\theta)]^{+}(\theta^{*} - \theta),$$

where θ is a consistent and asymptotically efficient estimator while $\theta^{*}$is a consistent but inefficient estimator. If *m* is larger than the chi-squared value with degree of freedom equal to the number of unknown parameters in θ, then the null hypothesis is rejected.

2.3.4 Joint-F Test

Quarterly dummy variables are used to estimate the seasonal effect. A Joint-F test is used to test the impact of seasonality. In the joint F-test, the null hypothesis is that the four coefficients of the seasonal dummy variables are all equal ($\theta_1 = \theta_2 = \theta_3 = \theta_4$).

2.4 Data collection

As for estimating elasticities, the key variables are import quantity and prices. Monthly import volume and value for meat (beef, pork, and poultry) from different sources during 2003 to 2018 (16 years) are needed. The meat imports are categorized as: beef from Brazil; beef from Australia; beef from Uruguay; pork from the U.S.; pork from Denmark; pork from Spain; poultry from Brazil; poultry from the U.S.; poultry from Argentina. A larger number of observations can make the sample more precise and representative. For each kind of meat, the supply sources are top 3 countries in exporting volumes to China. The monthly data sets from 2015, 2016 and 2017 are available on the website of general administration of customs, P.R.China by searching all meat (beef, pork and poultry) product codes and then aggregate the volume and value for total beef, pork and poultry products (Cheng). The data in the rest of the years were purchased from China Cuslink CO. LTD which is an official IT company that is subject to China Custom. Index data for budget shares, Chinese consumer price index are available at National Bureau of Statistics of the People's Republic of China. For the import prices, it is very difficult to investigate retail monthly meat prices. Prices are even more inconsistent by different regions. Thus, the unit price is obtained through dividing the value by the volume.

The restricted seemingly unrelated regression (RSUR) estimation method is used in estimating the parameters of LA/AIDS model. RSUR estimations for the complete demand systems have the same asymptotic distribution as maximum-likelihood estimates (Taljaard, Alemu,and Schalkwyk 2004). The theoretical restrictions of aggregation, homogeneity, and symmetry conditions are imposed to make the model more consistent with economic theory.

CHAPTER III

RESULTS

3.1 Results of Separability Test

The null hypothesis of separability test is that imported beef is separable from other imported meats. The test is done by adding restrictions to demand equations in 3 cases.

The LR values are obtained and presented in Table 1.1. From all the 3 cases, LR are 2.88, 1.351, and 0.194 which are smaller than the critical value 3.84 at DF=1. Therefore, it can be concluded that the imported beef are weakly separable from the major imported meats. Moreover, the demand estimation on imported beef can be done without considering the other imported meats.

Table 1.1. Separability Test in LA/AIDS Model of Beef Import in China

Null Hypothesis: Imported beef is separable from other imported meats			
	Likelihood Ratio	DF	Chi-squared Value (5% significance)
Separability Test in Case 1	2.88	1	3.84
Separability Test in Case 2	1.351	1	3.84
Separability Test in Case 3	0.194	1	3.84

Case 1: Unrestricted model: No restriction imposed. Restricted model: Homogeneity, symmetry and separability imposed.

Case 2: Unrestricted model: No restrictions imposed. Restricted model: Separability imposed.

Case 3: Unrestricted model: Homogeneity and symmetry imposed. Restricted model: Homogeneity, symmetry and separability imposed.

3.2 Results of Normality Test

A Shapiro-Wilk test is applied to test whether the residuals of beef import data is normally distributed. Because of the inspection of BSE disease in North America in 2003, China banned beef imports from Uruguay for 6 months from January 2004 to June 2004. Also, Brazilian beef was banned until January 2005, which is the reason for 0 values among the beef dataset. From Table 1.2, with the zero values included, all the p values are greater than 0.05, which makes the residuals of data normally distributed. Furthermore, the estimation method may change to a Tobit SUR. However, the 0 values in the dataset are caused by the BSE indicator which is also considered as an independent variable in LA/AIDS estimation. To better estimate the impact of BSE dummies, the 0 values should be kept. Therefore, normality is reasonable in this case.

Table 1.2. Shapiro-Wilk Test

Null Hypothesis: The residuals for demand equation are normally distributed

	W statistics	# of Zero	Included or Not	DF	P-Value	Critical Value	Result
Beef_Uruguay	0.919	6	Y	186	0.068	0.05	Fail to reject
Beef_Uruguay	0.893	6	N	192	0.358	0.05	Fail to reject
Beef_Brazil	0.819	12	Y	180	0.085	0.05	Fail to reject
Beef_Brazil	0.813	12	N	192	0.188	0.05	Fail to reject
Beef_Australia	0.901	0	Y	192	0.42	0.05	Fail to reject
Beef_ROW	0.898	0	Y	192	0.814	0.05	Fail to reject

3.3 Results of Endogeneity Test

The Hausman-Wu Test is conducted to examine the endogeneity problem of expenditure variable. From Table 1.3, the calculated chi-squared statistics for all beef imports in the system are smaller than the critical chi-squared value with 1 degree of freedom at the 5% significance level, indicating that the null hypothesis, namely that expenditure variable is exogenous, cannot be rejected. Therefore, the SUR estimators are used to estimate the LA/AIDS model for beef import demand in China. The instruments which are used in the Hausman-Wu test are the first lags of all budget share, price and expenditure variables, BSE and seasonal dummies. In this case, the null hypothesis that expenditure on imported beef is exogenous is failed to reject in conditional demand function. Nevertheless, the derivation of the AIDS model starts with an expenditure function, representing the Price Invariant Generalized Logarithmic (PIGLOG) preference (Deaton and Muellbauer 1988). In the first-stage budgeting or unconditional demand system, the expenditure is endogenous since it is a function of price and utility. Jaehong and Davis (2000) have argued about the power of the Hausman Test in terms of testing endogeneity. They stated that if the correlation between the instruments and the potential endogenous variable is low, the parameter is inaccurate and the instrumental variable estimator will have poor properties and the standard statistical inferences could be misleading. To validate the Hausman test, some instrument variables are falsely chosen to exaggerate the properties when they are not actually highly correlated with expenditure variable. As a result, the likelihood of falsely accepting exogeneity increases. Furthermore, they pointed out the Hausman Test can only test for the existence of endogeneity, but not the severity or the degrees of endogeneity. The exogenous expenditure is also reasonable in China’s import demand system. In China, government-owned enterprise groups control the national industries or economic arteries. The large international purchase is usually made by meeting rigid domestic demand and political targets so China is an example where expenditure could truly be exogenous.

Table 1.3. Hausman -Wu Test of the Expenditure Endogeneity

Null Hypothesis: Expenditure variable is exogenous (not endogenous)

	Calculated Chi-Square Stat	DF	Critical Value (5% significance level)
Beef_Australia	0.331	1	3.84
Beef_Uruguay	1.924	1	3.84
Beef_Brazil	1.498	1	3.84
Beef_ROW	1.515	1	3.84
System	5.268	4	9.49

3.4 Results for Joint F Test

The joint F test is done to test if seasonal dummies affect the LA/AIDS system. The null hypothesis is all four coefficients for seasonal dummies are equal. The results in Table 1.4 showed that the P value for all the 4 cases are smaller than 0.01. Thus, it can be concluded that source differentiated beef import demand in China is affected by seasons.

Table 1.4. Joint F Test of Seasonal Dummies

Null Hypothesis: $\theta_1 = \theta_2 = \theta_3 = \theta_4$

Country	F stat	P value	Significance at 1%
Brazil	9.93	0.003	rejected
Australia	9.12	0.002	rejected
Uruguay	12.45	0.004	rejected
ROW	10.39	0.001	rejected

3.5 Parameter estimates of LA/AIDS model

With the demand restrictions imposed as well as dummy variables included, the restricted LA/AIDS model can be estimated by means of restricted seemingly unrelated regression (RSUR). The demand equation for ROW is dropped during estimation and the missing estimated value can be calculated by the parameters from the other 3 equations under the adding up restriction. The RSUR parameter estimates and t-ratios for the LA/AIDS demand model are reported in Table 1.5. For Brazil, Uruguay and ROW, the coefficients for BSE indicators of Canada and US are all negative, which indicates that expenditure share of beef from these countries is decreased when BSE was inspected. However, Australia has both positive coefficients on these 2 BSE indicators which indicates BSE increases the expenditure share on beef imported from Australia. By comparing the coefficients among the seasonal dummies, the coefficients of D1 and D4 for Brazil, Australia and Uruguay are larger than D2 and D3, which means beef import expenditure shares for these 3 countries are increasing significantly during the first quarter and the fourth quarter of a year. The possible reason may be that the Lunar Chinese New Year and Spring Festivals are usually celebrated in the late winter and early spring when domestic consumers increase beef consumption accordingly.

Table 1.5. Parameter Estimates of the LA/AIDS Model

Explanatory variables	Brazil	Australia	Uruguay	ROW
P_Beef_Brazil	-0.161 *(-2.37)***	0.078 *(3.16)***	0.02 *(1.42)**	0.063
P_Beef_Austrlia	0.092 *(3.75)***	-0.056 *(-1.1)**	-0.13 *(-9.95)****	0.094
P_Beef_Uruguay	-0.038 *(-1.3)**	-0.15 *(-2.05)**	-0.11 *(-1.13)**	0.298
P_Beef_ROW	0.006 *(1.38)***	0.001 *(1.06)**	0.015 *(2.77)***	-0.022
Exp	-0.009 *(-8.23)****	-0.05 *(-1.45)**	0.17 *(3.23)***	-0.111
BSE_Canada_2003	-0.002 *(-1.35)**	0.01 *(2.21)***	-0.009 *(-1.33)**	-0.003
BSE_U.S._2003	-0.001 *(-13.6)****	0.003 *(2.15)***	-0.017 *(-2.12)***	-0.002
D1	0.01 *(2.38)***	0.06 *(3.45)***	0.01 *(2.34)***	-0.08
D2	0.003 *(14.08)****	0.004 *(21.82)****	0.002 *(1.29)**	-0.009
D3	0.002 *(1.44)**	0.001 *(2.02)**	0.008 *(1.23)**	-0.011
D4	0.063 *(3.07)***	0.01 *(3.05)***	0.05 *(3.09)***	-0.003

System weighted R square = 0.4686

* denotes significance at 10%

** denotes significance at 5%

*** denotes significance at 1%

3.6 Conditional price and expenditure elasticities

The price and expenditure elasticities in the conditional LA/AIDS demand equation are estimated and shown in table 1.6-1.8. The own and cross compensated (Hicksian) price elasticities are calculated as in equation (13) and (14). The own and cross uncompensated (Marshallian) price elasticities are calculated using equation (11) and (12). The expenditure elasticities are calculated as shown in the equation (15). The Marshallian elasticities can explain both income and price impacts while the Hicksian elasticities can only tell the price effects (Taljaard, Alemu,and Schalkwyk 2004). According to the t values in the table, all the estimated elasticities are statistically significant at 5% significance level except for unknown ROW since the ROW equation was dropped during the RSUR procedure. For both (Hicksian and Marshallian) own price elasticities, the value for all countries are negative which conforms with economic theory. All the uncompensated own price elasticities are smaller than the compensated own price elasticities. Hicksian and Marshallian own price elasticities for Brazil are -1.57 and -1.01, which are the most elastic since the absolute values are greater than 1 and is the biggest among them.

As for the Marshallian cross price elasticities, all the cross price elasticities among these 3 main sources are positive. In this case, all of the three sources are substitutes to each other. The Marshallian cross price elasticities between Brazil and Uruguay (0.62 and 0.28) are greater than those between Brazil and Australia which indicates that if price of beef from Brazil increases, China will import more Uruguayan beef than Australian beef. Same, if Australian beef price increases, China will import more Brazilian beef than Uruguayan beef. If Uruguayan beef price increases, China will import more Brazilian beef than Australian beef. Therefore, in terms of the Marshallian cross price comparison, Brazilian beef has a weakest position in China's beef import market, which can be easily affected by price changes. Among these values, the expenditure elasticities of Australian beef is the highest which means with the same amount increase of income, Chinese consumer will buy more Australian beef than beef from other sources. A probable reason is that product added value of Australian beef is higher than the others since majority of import beef from Australia is Angus beef which is known for high quality.

Table 1.6. Compensated (Hicksian) Price Elasticities

	Brazil	Australia	Uruguay	ROW
Brazil	-1.57 (-8.99)***	0.33 (1.75)*	0.49 (17.33)***	0.12
Australia	0.36 (8.87)***	-0.65 (-10.45)***	0.35 (6.12)***	0.09
Uruguay	0.62 (17.12)***	0.29 (3.11)**	-1.01 (-10.22)***	0.15
ROW	0.15 (2.67)**	0.11 (7.05)***	0.09 (7.23)***	-0.23

* denotes significance at 10%
** denotes significance at 5%
*** denotes significance at 1%

Table 1.7. Uncompensated (Marshallian) Price Elasticities

	Brazil	Australia	Uruguay	ROW
Brazil	-1.01 (-6.74)***	0.17 (7.75)***	0.36 (6.26)***	0.07
Australia	0.34 (1.97)*	-0.23 (-8.21)***	0.35 (0.82)	0.06
Uruguay	0.58 (4.92)**	0.12 (7.69)***	-0.44 (-7.12)*	0.05
ROW	0.02 (10.35)***	0.04 (2.56)**	0.02 (1.93)*	-0.13

* denotes significance at 10%
** denotes significance at 5%
*** denotes significance at 1%

Table 1.8. Expenditure Elasticities

	Brazil	Australia	Uruguay	ROW
Expenditure	1.09 (29.11)***	1.44 (19.36)***	0.97 (24.45)***	1.17

* denotes significance at 10%
** denotes significance at 5%
*** denotes significance at 1%

3.7 Conclusion and summary

This study used a LA/AIDS model to estimate beef import demand in China. Conditional price and expenditure elasticities of demand are estimated for each exporting country. The article also estimated how disease outbreaks and seasonality affect beef import demand in China. Separability, normality, and endogeneity were tested to validate the model. The empirical results showed that: imported beef is weakly separable from other meats. Expenditure endogeneity could not be rejected. Brazilian beef, Uruguayan beef and Australian beef are substitutes to each other. Brazilian beef has the weakest position in China's beef import market due to the highest price elasticity. A contribution of this study is to test and estimate the non-economic variables like BSE and season dummies. BSE diseases have a negative influence on imported beef demand from Brazil and Uruguay and positive influence on imported beef demand from Australia. Seasonal dummies have an impact on beef import demand. In the first and fourth quarter during traditional festivals, China imports more beef than those in the second and the third quarter

3.8 The limitations of the study

Firstly, there are 18 “0 values” in data collection which may cause the normality problem as well as censored response problem (Shonkwiler and Yen1999). The results may be misleading and biased. A Tobit SUR estimating method may be a good way to solve it. Secondly, Davis (2000) has questioned the power of Hausman test when testing endogeneity. It is difficult to find a “perfect” instrument that can be both highly correlated with potential endogenous expenditure and meanwhile uncorrelated with other disturbance. Thirdly, the unconditional price elasticities are not obtained since the monthly times series for the whole meat group consumption is not available. However, based on the two stage budgeting, the equation for unconditional elasticity is still provided in this study:

(20) $$\varepsilon_{beef}^{Unconditional} = \varepsilon_{beef}^{Conditional} * \varepsilon_{X_{beef}},$$

where $\varepsilon_{beef}^{Unconditional}$ represents the unconditional price elasticities for beef, and $\varepsilon_{beef}^{Conditional}$ represents the conditional elasticities which are obtained before. $\varepsilon_{X_{beef}}$ represents the elasticity of beef expenditure within the meat group

SOYBEAN IMPORT DEMAND

CHAPTER I

INTRODUCTION

1.1 Problem Statement

As an important protein crop, soybean occupies an important place in food and grain system. Rapid growth in soybean demand has driven China's increasing reliance on soybean imports. Growing population, increasing income and urbanization in China raise demand for animal protein products and vegetable oils. The increasing edible oil consumption leads to a higher demand for soybean oil even though it increased slowly due to the developed crushing industry in recent years. With the increase of meat consumption, the feed for the livestock increases. The country's great appetite for pork has made it heavily dependent on imports of soybeans, a necessary feed for China's swine.

However, restricted by the growing environment, domestic soybean production cannot meet the large demand for consumption. The limited domestic production cannot satisfy the huge demand for soybeans. That is why China is heavily dependent on the global soybean market. The United States and Brazil are two major soybean suppliers of China. If the soybean trade between China and these two suppliers fluctuates, the fluctuations in prices will spread to domestic soybean market and then it will influence the domestic consumers in China and producers in the U.S. and Brazil.

Since 2018, the trade friction between China and the United States and African swine fever have made profound influence in agricultural commodity markets in China. In February 2019, China's soybean oil imports fell to their lowest monthly level in four years, which adds a big uncertainty to the futures markets. The developing futures markets of soybean needs a reliable estimate to avoid risks and uncertainty. "The domestic soybean and oilseeds futures price is not as fluctuant as the future market in the United States. Since the tariff on Ag Commodities is still 25%, which is not a surprise for Chinese traders, but they did hit to a very low point in the U.S. future market due to the greater uncertainty. Farmers in Kansas are worrying about their stockpile," said Guanzhong Xu, a soybean meal and gold trader in Dalian Commodity Exchange. Soybean producers, agribusinesses, and exporters needs enough information to make marketing decisions to enhance their competitiveness of the soybean industry in the world market. Policy evaluations and welfare analysis require reliable estimates of soybean import behavior responsiveness to source differentiated prices and expenditure.

1.2 Objectives:

The primary objective of this study is to increase the precision of policy analyses regarding China's soybean import demand. The specific objective is to determine the estimates of China's soybean oil import demand by source.

1.3 Literature Review

There are several published studies on soybean import in recent years.

Song and Merchant (2006) tested the market power and conducted a competitive analysis of China's soybean import by means of Two-Country Partial Equilibrium Model. They indicated that Chinese soybean importers have stronger market power relative to U.S. soybean exporters. They also found that the U.S. and South America are seasonal complementary soybean suppliers for China. Possible reasons include: 1) seasonal difference--the U.S. and South America have opposing growing seasons, i.e., different time periods to supply soybeans to markets; and 2) stronger market power of Chinese soybean importers. China's strategic choice, diversifying their soybean suppliers and reducing price increase risk, made the U.S. and South America complementary soybean suppliers to China.

Ningrum and Irianto (2018) analyzed the factors that impact soybean imports in Indonesia by Two Stage Least Squares. They indicated that consumption has a positive effect on soybean imports while production has a negative effect. The exchange rates and international soybean prices have no influence on soybean import.

Zhu and Seale (2015) estimated China's soybeans import allocation by country-of-origin using the input allocation model for the multiproduct firm under input-output separability.

Persaud and Dohlman (2006) developed alternate policy scenarios to examine the impacts of soybean trade liberalization on crushing efficiency and oil imports. They used an open economy structural representation of the Indian soybean sector, including equations for soybean acres planted, the domestic usage of soy oil and soymeal, and the cost of crushing. Simulation results indicate that India could lower its barriers to soybean imports without adversely affecting farmers, since imports are economically attractive to crushers even when subject to modest tariffs which sustain pre-liberalization farm and wholesale prices. In summary, those studies provide abundant research methods for defining the variables for soybean import. Most of the studies adopted residual demand method to measure the degree of competition in segmented export markets. They focused on the exporting price and supply side. But few studies estimate price and expenditure elasticities on soybean import. China's soybean import market is different from India's because it has a developed crushing industry to process soybean into soybean oil and soybean meal. As a result, it imports more soybean instead of importing soybean oil and soybean meal directly. This study fills a gap in soybean import demand of China by not only estimating the price and income elasticities but also adding domestic inputs into consideration.

CHAPTER II

METHODOLOGY

2.1 Conceptual Framework

Assume that China is a multiproduct firm that faces a competitive soybean exporting market as its input market and jointly produces two products which are soybean meal and soybean oil. In this paper, the three inputs are the source differentiated soybeans imported from the U.S., Brazil and ROW. Respectively, the two outputs are soybean meal and soybean oil. Therefore, as a profit-maximizing-multiproduct firm, it will first minimize importing cost when the source differentiated input prices and products prices change.

2.2 Modeling

In the past studies, imports are considered to be final goods that enter directly into the consumer's utility function and the resulting demand equations for imports are derived from utility maximization theory. However, given the nature of international trade, where traded goods are either used in other production processes or go through a number of domestic channels before reaching the consumer. It is more appropriate to view imported goods as intermediate products than as final consumption goods. (Davis 1994)

Following the methodology of Laitinen and Theil (1980), the differential production model will be used to estimate soybean import demand. The differential production model is derived from the differential approach to the theory of the firm where firms maximize profit in a two–stage procedure. In the first stage, firms determine the profit-maximizing level of output to produce, and in the second stage, firms minimize the cost of producing the profit-maximizing level of output. In the first stage, the output supply equation is obtained, and the conditional factor demand system is obtained in the second stage. Combining the results of both stages, a system of unconditional derived-demand equations is derived.

In the first stage, a competitive firm seeks to identify the profit-maximizing level of output by equating marginal cost with marginal revenue. This procedure yields the differential output supply equation:

(1) $$d\left(\log Q_{output}\right) = \alpha * d\left(\log p_{output}\right) + \sum_{m=1}^{n} \beta_m \, d\left(log p_{input}\right),$$

where:

Q_{output}: quantity of output (The quantity of soybean meal and soybean oil)

p_{output}: price of output (The price of soybean meal and soybean oil)

p_{input}: price of input. (Import price and domestic price of soybean, labor wages)

α: price elasticity of output supply

β: price elasticity of input

n: total number of inputs used in production

In the second stage, the differential factor demand model is derived, which will be used to estimate the system of source-specific derived-demand equations. The Differential Production Approach can be expressed as:

(2) $$w_{i_h} d\log(q_{i_h}) = \gamma_{i_h} d\log(X) + C_{i_{hk}} d\log(p_{ih}) + \sum_{m=1}^{12} \rho_{im} D_m,$$

Where:

i : the imported goods, which is soybean import

h and k: imported sources such as the U.S.

w_{i_h}: budget share of imported good i from country *h*

q_{i_h}: quantity imported of good i from country *h* (quantity of soybean imported from the U.S.)

$d\log(X)$: Divisia volume input index as well as "expenditure" on imported soybean.

γ_{i_h}: $\gamma_{i_h} = w_{i_h} \times \eta_{i_h}$ (where η_{i_h} stands for the Divisia elasticity)

$C_{i_{hk}}$: $w_{i_h} \times {\varepsilon^*}_{i_{hk}}$ (where ${\varepsilon^*}_{i_{hk}}$ is the compensated cross-price elasticity)

ρ_{im}: coefficient for monthly dummies.

D_m: monthly dummies

The general demand restrictions of Adding-up, Homogeneity, and Symmetry conditions are imposed on these elasticities.

(3) Adding-up: $\sum_h \gamma_{i_h} = 1$, $\sum_h \beta_{i_h} = 0$, and $\sum_h \rho_{i_h} = 0$;

(4) Homogeneity: $\sum_h C_{i_{hk}} = 0$;

(5) Symmetry: $C_{i_{hk}} = C_{i_{kh}}$.

In adding up condition, Mutondo and Henneberry (2007) estimate the demand system for meat in the U.S. with BSE and seasonal dummies. For each seasonal dummy variable, the parameters of seasonal dummies for all countries adds up to 0, which can be stated as: $\sum_h \rho_{i_h} = 0$.

The second stage procedure results in the conditional own/cross price elasticity:

(6) Conditional price elasticity: $\varepsilon_{cp} = \frac{d\log(q_{i_h})}{d\log(p_{ih})} = \frac{C_{i_{hk}}}{w_{i_h}} = \varepsilon^*{}_{i_{hk}}$

(7) *Conditional Divisia elasticity:* $\varepsilon_{cx} = \frac{d\log(q_{i_h})}{d\log(X)} = \frac{\gamma_{i_h}}{w_{i_h}} = \eta_{i_h}$

Laitinen (1978) defined the relationship between Divisia index (input volume) and output:

(8) $$d\log(X) = \delta\, d\left(\log Q_{output}\right),$$

where δ stands for the elasticity of cost with respect to a proportionate output increase. According to Laitinen, δ is also the ratio of revenue to cost.

Equation (1) can be substituted into equation (2) to yield the unconditional derived-demand system (Washington and Kilmer 2002):

(9) $$w_{i_h} d\log(q_{i_h}) = \gamma_{i_h}\delta\left[\alpha d\left(\log p_{output}\right) + \sum_{m=1}^{n}\beta_m\, d(\log p_{input})\right] + C_{i_{hk}}\, d \log(p_{ih}) + \sum_{m=1}^{12}\rho_{im}\, D_m$$

So the unconditional derived-demand elasticities can be obtained

(*10) Unconditional output elasticity:* $\varepsilon_{ui} = \frac{d\log(q_{i_h})}{d(\log p_{output})} = \delta\alpha\varepsilon_{cx}$;

(11) Unconditional price elasticity of imported soybean: $\varepsilon_{ui} = \frac{d\log(q_{i_h})}{d\log(p_{ih})} = \delta\varepsilon_{cx}C_{i_{hk}}$;

(12) Unconditional input elasticity: $\varepsilon_{ui} = \frac{d\log(q_{i_h})}{d\log(p_{input})} = \delta\varepsilon_{cx}\beta_m$.

2.3 Estimation Procedures

The endogenous variable is the quantity of soybean imported from different sources. The exogenous variables are the import price and expenditure from different sources, the domestic soybean meal price and soybean oil price, and labor price (wages), and seasonality. The system as defined by equation (1) and (2) were estimated by using seemingly unrelated regression and PROC Model in SAS 9.4. Theil (1980) showed if the parameters between equation (1) and (2) are constant and normally distributed, then the covariance between the error terms of both equation should be 0. A Durbin-Watson AutoReg test (Table 2.1) and a Shapiro-Wilk test cannot reject that the error terms are well behaved, i.e. serially uncorrelated and normally distributed. The soybean equation for rest of the world (ROW) is dropped for adding up constrained, and it is recovered by adding up property. The joint F test is done to test if monthly dummies affect the soybean demand system. The null hypothesis is all 12 monthly coefficients for four countries are equal. The results in Table 2.2 showed that the P value for all the 4 cases are smaller than 0.01. Thus, it can be concluded that soybean import demand in China is affected by seasons.

Table 2.1. Durbin Watson and Shapiro-Wilk Tests

Null Hypothesis: The residuals for soybean demand equation are normally distributed

	W statistics	DF	P-Value	Critical Value	Result
P_Soybean Meal	0.923	64	0.054	0.05	Fail to reject
P_Soybean Oil	0.651	64	0.11	0.05	Fail to reject
P_Domestic Soybean	0.598	64	0.094	0.05	Fail to reject
P_Labor wages	0.604	64	0.131	0.05	Fail to reject
Soybean_U.S.	0.724	64	0.145	0.05	Fail to reject
Soybean_Brazil	0.613	64	0.192	0.05	Fail to reject
Soybean_Argentina	0.601	64	0.113	0.05	Fail to reject
Soybean_ROW	0.924	64	0.098	0.05	Fail to reject
Dependent Variable:	Q_Import Soybean				
R-Squared:	0.752		Durbin-Watson: 1.998 (close to 2)		
Adjusted R-Squared:	0.657				

Table 2.2. Joint F Test of Seasonal Dummies

Null Hypothesis: all 12 *monthly coefficients are equal*

Country	F stat	P value	Significance at 1%
U.S.	8.91	0.001	rejected
Brazil	8.15	0.001	rejected
Argentina	9.24	0.002	rejected
ROW	8.31	0.001	rejected

2.4 Data Collection

The study applies time series monthly data from 2013 to 2018. Part of 2018 data will be released at the end of February 2019. The soybean and corn import value and prices from the U.S., Brazil and ROW were obtained from Trade Map and Foreign Agricultural Services Database (2019 March). The domestic soybean oil and meal prices are available at the Agricultural Yearbook in China. Labor wages, income per capita and tariffs can be obtained from the National Bureau of Statistics. To make a common format, all the quantities are in a million ton and all the prices are in US dollar.

CHAPTER III

RESULTS

3.1 Results for Import Demand Coefficient Estimates

Table 2.3 shows the coefficients for conditional demand equation (2). From table 2, the marginal factor shares for the 4 sources are positive and statistically significant, which means China will import the soybean from each sources as total expenditure on soybean increases. Among these shares, the U.S. has the largest coefficient (0.402), which indicates China's soybean expenditure relies on more on U.S. than other sources.

Table 2.3 Coefficient Estimates for Soybean Import in China

		Price Coefficients			
Exporting Countries	Marginal Factor Shares	U.S	Brazil	Argentina	ROW
The U.S.	0.402 (0.039)***	-0.314 (-0.089)***	0.105 (0.096)***	0.113	0.096
Brazil	0.229 (0.034)***		-0.105 -0.049	-0.056	0.043
Argentina	0.209 (0.050)***			-0.085	0.028
ROW	0.16 (0.023)**				-0.025

Note: Significant at: * for 10% level, ** for 5% level, *** for 1% level

3.2 Conditional Price Elasticities

Conditional derived demand estimates for China's soybean imports are reported in Table 2.4. Divisia elasticities are measuring the percentage change in soybean import from a source with respect to a percentage change in the total soybean imports. Argentina has the highest Divisia elasticity (1.462) which means Argentina is the most responsive country when China increases its total soybean imports. The U.S. is the least responsive country to the expenditure change in total imports (0.728). The own-price elasticities are all negative as expected which indicates that if the import price increases by 1 percent, China will decrease the imports from the U.S. by 0.543%, Brazil by 0.091%, Argentina by 0.491% and ROW by 1.101%. From the own price elasticities, ROW (-1.101) and the U.S. (-0.543) are the most responsive sources to the price changes. From the cross price elasticities, the U.S. is competing with all other countries since the cross price elasticities between the U.S. and other sources are all positive. Argentina and Brazil have a complementary relation in the soybean imports beacause of the negative cross price elasticity.

Table 2.4. Conditional own and price elasticities

Country	Divisia index	Conditional Price Elasticities			
		U.S.	Brazil	Argentina	ROW
U.S.	0.728	-0.543	0.029	0.201	0.141
	(11.54)***	(-1.136)*	(1.166)**	(2.13)**	-1.17
Brazil	1.031	0.023	-0.091	-0.088	0.361
	(1.409)**	(1.512)*	(-1.431)**	(-1.28)*	(1.13)*
Argentina	1.462	0.362	-0.068	-0.491	0.123
	(1.671)**	(2.462)***	(-1.345)**	(-1.131)*	(1.141)**
ROW	0.913	0.012	0.125	0.123	-1.101
	(6.568)***	(5.787)***	(3.028)***	(3.048)*	(3.739)*

Note: Significant at: * for 10% level, ** for 5% level, *** for 1% level

3.3 Unconditional Input and Output Elasticities

The unconditional input and output elasticities are given in Table 2.5, which combines all the determinants in two-stage budgeting. The output price elasticities are all positive, which indicates, if the prices of domestic soybean meal and soybean oil increases, China will increase their soybean imports. U.S. soybean (0.713) is the least responsive to the price changes of soybean meal while Argentina is the most responsive (1.126). Brazilian soybeans are the most responsive to the price changes of soybean oil prices.

Brazil (0.329) is the most responsive to the domestic soybean price changes. As for the labor wages, the soybeans from Brazil, and Argentina are both negatively affected. It indicates that if labor wages increases, soybean imports from Brazil and Argentina will decrease. As for the unconditional cross and own price elasticities, similar to conditional elasticities, all the own-price elasticities are negative as expected. The U.S. is competing with other countries. Brazil and Argentina are considered as complementary sources. ROW (-1.469) and the U.S. (-0.724) are most responsive to the price changes.

Table 2.5. Unconditional Elasticities of the Derived-Demand Model

			Input Price					
	Output Price				Import Price Elasticities			
Country	P_Soybean Meal	P_Soybean Oil	Domestic P_Soybean	Labor Wages	U.S.	Brazil	Argentina	ROW
U.S.	0.713	0.891	0.231	-0.013	-0.724	0.038	0.268	0.188
	(1.433)*	(2.157)**	(1.254) **	(-2.01) **	(2.123)**	(1.914)**	(3.25)***	(1.356)
Brazil	0.919	1.045	0.329	-0.014	0.031	-0.121	-0.117	0.481
	(2.651)**	(2.164)**	(1.147) *	(-10.22) ***	(1.934)**	(0.012)***	(-2.631)**	(1.379)**
Argentina	1.126	0.887	0.114	-0.098	0.48327	-0.091	-0.655	0.164
	(2.136)**	(0.62)	(0.239) ***	(-1.11) *	(2. 23)**	(0.002)***	(-1.64)**	(0.156)
ROW	0.702	0.33	0.045	0.111	0.016	0.166	0.164	-1.469
	(1.364)*	(1.25) **	(2.216) **	(1.145) ***	(12.312)***	(1.253)**	(0.165)	(-1.329)*

Note: Significant at: * for 10% level, ** for 5% level, *** for 1% level

3.4 Seasonality Estimates

Seasonal impacts for China's soybean import are shown in Table 2.6. The U.S and the South American Countries (Brazil and Argentina) are located in different hemispheres. The harvest season for U.S. soybeans is from late September to early November while the harvest season is from early March to late May in Brazil. Argentina's soybean harvest season is from early April to late June. From the results, during most months (Feb, March, April, May, Sept, Oct, Nov, Dec), the U.S soybean is positively (negatively) affected by seasonal factors while Brazilian and Argentinean soybeans are negatively (positively) affected. This result is as expected which indicates that seasonality is an important determinant of China's soybean imports.

Table 2.6. Seasonality Estimates for China's Soybean Imports

Month	U.S.	Brazil	Argentina	ROW
January	0.041**	-0.007*	0.044**	0.012
February	-0.048	0.035	0.214	0.065
March	0.198***	-0.145**	-0.164*	0.031**
April	-0.254	0.268	0.126	-0.135
May	-0.283**	0.198**	0.236**	-0.151*
June	-0.215	-0.015	-0.037	-0.214
July	0.035**	0.019***	0.026**	-0.016**
August	-0.076**	0.036*	-0.007*	0.234
September	0.028	-0.086	-0.095*	0.014*
October	0.094**	-0.065**	-0.195**	0.036**
November	0.203	-0.069	-0.015	-0.065*
December	0.516	-0.169	-0.133	0.189

Note: Significant at: * for 10% level, ** for 5% level, *** for 1% level

3.5 Conclusions

A differential production approach is used to estimate China's soybean import demand from different sources. By assuming two stage budgeting, a derived demand model is developed for the multiproduct firm. From the estimating results, U.S. competes with Brazil and Argentina as well as ROW in exporting soybeans. Brazil and Argentina are complementary to each other in China's soybean import demands. Seasonal factors have a great impact on China's soybean imports. Seasonality is shown to have a reverse effect on the soybean import from the U.S. and South American countries. This study did not address how the tariff rates affect the import price of the soybean. It could be a good start to estimate and forecast the price reflection with different tariff rates for further studies.

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