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An Error Correction Almost Ideal Demand System for Import Meat in China

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***Abstract*—The purpose of this study is to determine the relationship between the price and the demand for imported meat products and suggest the marketing strategies for imported meat in China. This study presented a dynamic specification of the Almost Ideal Demand System (AIDS) based on co-integration techniques and error correction models. Results indicate that import of meat products in China was dictated by the relationship between the price and the import budget. Chilled or frozen pig meat (PC), chicken meat (CM) and chilled or frozen cattle meat (CC) are price sensitive imported products, and will face competition with domestic meat products. Keeping price low is the most important strategy for increasing market share for imported PC, CM and CC in China. This study is the first one to quantify the demand of imported meat in China by using the Error Correction Almost Ideal Demand System. Findings of this study have imperative implications that help Chinese government make policies for meat import, and provide agribusiness firms robust suggestions of marketing strategies for imported meat products.**

***Keywords* - Error Correction Almost Ideal Demand System, Imported meat products, China**

I. INTRODUCTION

China is the largest country in both animal production and meat consumption in the world. Since 2001, meat demand has been increased dramatically and so have meat prices. To meet the increased meat demand, the Chinese government has opened import markets for fresh meat and meat products gradually with cautions. When China opens its meat market fully, it will provide business opportunities for not only importers to share the market but also agribusiness firms to distribute imported meat in China. Both importers and agribusiness need to understand marketing strategies for imported meat. The objectives of this study were to quantify the relationship between the price and the demand for imported meat products in China, and identify the marketing strategies for expansion of meat imported to China.

Meat market

China's total population climbed from 996 million in 1981 to 1347 million in 2011 [1][2][3][4]. During the same period, total meat consumption of urban households increased from 14 kg per capita to 57 kg [1][2][3][4]. Although total meat production rose from 14 million tons in 1981 to 77 million tons in 2011, meat production still cannot meet the demand [5][1)]. As a result, meat price has increased dramatically to the point that the pork price was 68% higher in China than in the U.S. in 2012 [6]. Although the government intervention to stabilize domestic production could partially attribute to the high meat price, the increase in both meat consumption and production cost was the major contributor to the high meat price in China. In 2012, the production cost of pork in China was 3350.24 USD/ton, which was higher than the production cost of 1992.96 USD/ton in the U.S. [6]. In addition, the rapid increase of income level has changed patterns of meat consumption in China [7][8]. While demand for poultry, beef, and mutton is increased accordingly, pork is still the most consumed meat in China.

Food safety has been a major issue in Chinese meat markets. Since the animal disease and food poisoning problems are documented in China [9], consumers are increasingly concerned about food safety and quality of the meat they buy. Chinese consumers generally believe that imported meat and meat products are safer than those produced domestically [10] [11].

Meat production

The meat production sector in China has developed rapidly, with the total meat production being increased by five times over the last thirty years [6]. In 2013, livestock production accounted for 29.3% of the total value of agricultural production in China [4]. The rapid development of livestock production is associated with changes in livestock production structure. The intensification of livestock production in China started in the late 1980s. Since then, the intensification process has been stimulated vigorously by the rapid increase in demand for meat products and advances in the modern feed industry and other technologies. In addition, the government policy is also an important factor for the intensification.

Due to the planned economy, the meat market in China was controlled by the central government until 1985. During that period, both the market distribution and meat prices were controlled by the central government [12]. In 1985 when the Ten Policies for Rural Economy Activation [13] was released, the meat market was shifted to market economy. This government policy was also an important contributor to the intensification of livestock production in China.

Instead of the intensification of livestock production is in progress, there are still a large number of small-scale farms in China [14]. On these small-scale farms, it is difficult to practice biosecurity and standard production protocols. So, hygiene and animal health management is a sever challenge to animal production. To control diseases, some farmers tend off-label use antibiotics, chemical synthetic drugs or feed additives [15], which may cause food safety issues [9].

China's trade development of meat products

China maintained self-sufficiency in meat supply until the beginning of the 21st century. Since 2007, China has

gradually turned into a net importer of meats [16]. Between 2008 and 2013, meat import to China increased rapidly, which was partially triggered by the high price of domestic meat products. According to FAO [6], China became net importer of pork from 2008 (Table 1). From 2009 to 2012, the pork import was increased, and the pork export was decreased. The quantity of pork import is significantly higher than the quantity of pork export.

Table 1. Pork import and export in China

	Import		Export	
Year	Quantity	Value	Quantity	Value
1993	29	34	38,007	39,250
1994	140	165	83,263	105,243
1995	678	712	118,132	188,106
1996	521	433	74,455	125,105
1997	58	16	73,977	139,656
1998	871	548	75,804	134,413
1999	58,421	24,349	43,641	54,924
2000	136,140	58,439	46,286	59,339
2001	94,274	41,590	96,310	126,359
2002	144,905	81,684	141,982	183,471
2003	149,122	90,889	192,262	239,242
2004	70,557	54,460	276,301	432,091
2005	31,046	28,788	232,342	370,381
2006	23,843	21,303	249,303	367,327
2007	85,412	123,024	121,708	254,777
2008	373,124	523,009	74,057	240,505
2009	134,972	136,312	78,311	231,905
2010	176,425	171,789	99,920	296,783
2011	316,775	492,413	71,647	283,435
2012	154,290	343,596	13,227	54,918

Note: Units for quantity- metric tons
Units for value- 1000 U.S. dollars
Source: FAOSTAT (2015)

With strong economic growth during the last two decades, China has urbanized at a fast pace. Urbanization and rising purchasing power have led to a dietary change from traditional food grain products to animal protein. So, meat import is necessary and will continue to grow in order to meet the increased demand in the future.

Research gaps

After joining the WTO in 2001, China has become the fast-growing market for imported meat in the world. However, consumers' demand for imported meat may change rapidly depending on the price of the product in China. To support policy making for meat import, it is important to understand the relationship between the price and the demand for import meat products in this country. Previous studies on Chinese household food demand usually focused on the broader segment of food demand, without considering the demand for imported products[17][18][19]. To the best of our knowledge there is no research published to date about Chinese consumers' demand for imported meat. Therefore, an originality of this study was to assess Chinese consumers' demand for imported meat using an advanced Error Correction Almost Ideal Demand System (EC-AIDS).

Since 2001, the import of agricultural products has increased constantly and had significant impact on China's economy [20]. Although meat production is an important agricultural sector in China, little research has been done to analyze the meat demand in this country, especially for imported meat demands. To the best of our knowledge, this is the first study which applies modified AIDS model to evaluate the demand of imported meat in China.

In general, econometric studies of demand include both single equation (*e.g.* Working-Leser model; [21][22], and systems analysis (*e.g.* Almost Ideal Demand System (AIDS); [23]. Compared to these traditional methods, we assessed the Chinese consumers' demand for meat product using an advanced AIDS model in this study. The advanced AIDS model has been chosen because of its theoretical and practical considerations, and population in demand analysis [24][25]. The AIDS model was developed by Angus Deaton and John Meulbauer in the late 1970s. This model is the most popular demand analysis tool in the field of agricultural economics [26], and also well applied for food demand analysis in China [27][28]. However, until recently, the AIDS has been estimated with conventional economic techniques (*i.e.* OLS), without paying any attention to either the statistical properties of the data or the dynamic specification arising from time series analysis [29].

Another originality of the current study is to increase the accuracy of the assessment. We modified the AIDS model for demand analysis using time series data. Previous researchers [27][28] normally used time series data in the AIDS model without justifying the properties of time series. In this study, we improved the AIDS model by using justified time series data. Karagiannis and Velentzas[30]attempted to incorporate the dynamic element into the AIDS model by relying on the statistical properties of the time series data, and outlined the potential use of an error correction model of the AIDS (EC-AIDS). For annual time series data used in this study, the EC-AIDS approach seems more appropriate than the traditional AIDS model. However, the EC-AIDS model has not been used to evaluate the demand of imported meat in China yet. Therefore, we developed the EC-AIDS model based on the work by Karagiannis and Velentzas [30]. For more details regarding the theoretical framework of AIDS and EC-AIDS, please refer to the studies of Deaton, and Muellbauer [23], and Karagiannis and Velentzas [30].

II. MATERIALS AND METHODS

Data for this study were extracted from the trade statistics section of the website maintained by the Food and Agricultural Organization of the United Nations [6]. Annual imports (metric tons) and expenditures on imports (US$1000) between 1986 and 2011 were obtained. For consistency with the original source of the data, we adopted the FAO's definition of meat products (pig meat, cattle meat, and chicken meat) in this study. The values of imports are on a cost, insurance and freight (CIF) basis. All values are expressed in US dollars. Since prices for individual imported meats are not publicly available, the proxy prices were obtained by dividing import values by import quantities, and imported meat prices were deflated

to remove the effects of inflation, following Feleke and Kilmer [24][2]. To adjust the effect of inflation, we used the price index of meat consumption provided by the National Bureau of Statistics of the People's Republic of China. The descriptive statistics of expenditure shares and meat prices are represented in Table 2.

Table 2:Descriptive statistics of expenditure shares and meat prices

Symbol	Variables	Mean	SD	Sample size
Expenditure shares (Total share=1)				
wpb	Bacon and ham	0.0028	0.0046	26
wpc	Chilled or frozen pig meat	0.0886	0.1194	26
wpd	Dried or smoked pig meat	0.0018	0.0019	26
wps	Pig meat sausages	0.0020	0.0019	26
wcm	Chicken meat	0.8385	0.1232	26
wcc	Chilled or frozen cattle meat	0.0616	0.0787	26
wcd	Dried or smoked cattle meat	0.0047	0.0041	26
Prices (Unit: U.S. dollar per kg)				
ppb	Bacon and ham	3.3619	1.4404	26
ppc	Chilled or frozen pig meat	0.9215	1.3243	26
ppd	Dried or smoked pig meat	1.1065	0.4677	26
pps	Pig meat sausages	1.2800	1.8246	26
pcm	Chicken meat	0.2900	0.1538	26
pcc	Chilled or frozen cattle meat	1.9250	2.2738	26
pcd	Dried or smoked cattle meat	2.5708	1.8123	26

As in studies by Feleke and Kilmer [24], and Singh *et al.*[25], data for this study came from the Food and Agricultural Organization (FAO). In the FAO data set, some meat items (*e.g.* meat cattle) include both fresh meat and edible offal (or bones). Although China imports large quantity of edible offal of pig and cattle every year, the demand of edible offal is beyond the scope of this study. Therefore, in this study we attempted to use the meat items of 'chilled and frozen pig meat' and 'chilled and frozen cattle meat' and excluded edible offal and bones for demand analysis. Unfortunately, the separated meat items of 'chilled meat' and 'frozen meat' do not exist in the data set. Therefore, we consider chilled and frozen meat as fresh meat products, but consider dried or smoked meat, bacon and ham as processed (or cooked) meat products in demand analysis. On the other hand, the quality between meat products produced domestically and imported could be different. This study focused on the demand for imported meat products. The analysis of the relationship between demand for domestic produced meat and imported meat is beyond the scope of the current study.

Error Correction of AIDS model

Using the AIDS model developed by Deaton, and Muellbauer[23] and applied in import demand study Feleke and Kilmer [24], the demand for meat imported into China can be estimated as:

$$\boldsymbol{w_{i,t} = \alpha_i + \sum_{j=1}^{n} \gamma_{ij}\, lnp_{j,t} + \beta_i ln\left(E_t / P_t^*\right)} \quad \textbf{(1)}$$

Where α, β, and γ are parameters estimated in the AIDS model, the subscripts i and j denote meat products (i,j= 1,…,N), the $\boldsymbol{w_{i,t}}$ is the average import expenditure share (Calculated from: the value of each import meat product divided by total value of import meat product) of meat product $i$in time t, $\boldsymbol{E_t}$ is total expenditures on imported meat in time t, $\boldsymbol{p_{j,t}}$ is the price of imported meat products j in time t, and $\boldsymbol{lnP_t^*}$ is the Translog price index of meat product in the time t.

$$\boldsymbol{ln(P_t^*) = \alpha_0 + \sum_i \alpha_i\, lnp_{i,t} + \frac{1}{2}\sum_i \sum_j \gamma_{ij}^*\, l\, n(p_{i,t}) ln(p_{j,t})} \quad \textbf{(2)}$$

Equation 2 is non-linear in its parameters and entails a non-linear estimation. To avoid the complication with non-linear estimation, Deaton, and Muellbauer [23] suggested a substitute Stone's geometric price index defined as:[3]

$$\boldsymbol{ln(P_t) = \sum_i w_{i,t} lnp_{i,t}}$$

However, Moschini [31] suggested that the Stone index typically used in estimating linear approximate almost ideal demand system is not invariant to changes in units of measurement, which may seriously affect the approximation properties of the model. Pashardes (1993) also stated that Stone index approximation for linear estimation of the AIDS model can result in understated (in absolute value) own price elasticities and cross-price elasticities of goods. Moschini [31] further proposed three alternative indices where are more appropriate for linear approximate almost ideal demand system.

The first one is Tornqvist index $\boldsymbol{P^T}$

$$\boldsymbol{ln(P_t^T) = \frac{1}{2}\sum_i (w_{i,t} + w_i^0) ln(p_{i,t}/p_i^0)}$$

The second one is Paasche price index $\boldsymbol{P^S}$

$$\boldsymbol{ln(P_t^S) = \sum_i w_{i,t} ln(p_{i,t}/p_i^0)}$$

The third one is logarithmic Laspeyres index $\boldsymbol{P^C}$

$$\boldsymbol{ln(P_t^C) = \sum_i w_i^0 lnp_{i,t}}$$

According to Moschini [31], the mean values were used for the base of those three indices, so that $\boldsymbol{p_i^0}$ represents the mean of $\boldsymbol{p_{i,t}}$ and $\boldsymbol{w_i^0}$ is the mean of $w_{i,t}$. Previous study Singh *et al.* [25] accepted Moschini [31]' suggestion and applied Paasche price index in AIDS estimation.

However, Tornqvist index $\boldsymbol{P^T}$and Paasche price index $\boldsymbol{P^S}$ also cause a simultaneity problem, because the expenditure share in the index '$\boldsymbol{w_{i,t}}$' is also the dependent variable. Therefore, the logarithmic Laspeyres index $\boldsymbol{P^C}$ is suitable solution to this problem.

Following Feleke and Kilmer [24]; Singh *et al.* [25] and on the basis of model specification tests (reported in Results and Discussion), this study have derived an EC-AIDS model from equation (1). The data used in this study are time series. If some of the variables were non-stationary time series in Equation (1), this equation would be "spurious". To fit the model, the value of $\boldsymbol{w_{i,t}}$ has to be changed to an optimal value of $\boldsymbol{w_{i,t}^d}$. The value between $\boldsymbol{w_{i,t}}$ and $\boldsymbol{w_{i,t}^d}$ can be expressed by equation (3) [4]

$$\boldsymbol{w_{i,t} - w_{i,t-1} = \delta\left[w_{i,t}^d - w_{i,t-1}\right], 0 < \delta \leq 1} \quad \textbf{(3)}$$

Then the demand equation is reformulated by equation (4)

$$\boldsymbol{w_{i,t}^d = \alpha_i + \sum_j \gamma_{ij}\, lnp_{j,t} + \beta_i\left(lnE_t - \sum_i w_i^0 lnp_{i,t}\right)} \quad \textbf{(4)}$$

Using equation (3) and (4) to obtain

$$\boldsymbol{w_{i,t} - w_{i,t-1} = \delta\left[\alpha_i + \sum_j \gamma_{ij}\, lnp_{j,t} + \beta_i\left(lnE_t - \sum_i w_i^0 lnp_{i,t}\right) - w_{ih,t-1}\right]} \quad \textbf{(5)}$$

Define $\boldsymbol{M_t^* = lnE_t - \sum_i w_i^0 lnp_{i,t}}$

And add item below:

$\boldsymbol{+\sum_j \gamma_{ij}\, lnp_{j,t-1} + \beta_i M_{t-1}^* - \left(\sum_j \gamma_{ij}\, lnp_{j,t-1} + \beta_i M_{t-1}^*\right)}$

Then obtain

$\boldsymbol{w_{i,t} - w_{i,t-1} = \delta \sum_j \gamma_{ij} [lnp_{i,t} - lnp_{i,t-1}] + \delta \beta_i [M_t^* - M_{t-1}^*] + \delta [\alpha_i + \sum_j \gamma_{ij}\, lnp_{j,t-1} + \beta_i M_{t-1}^* - w_{i,t-1}]}$

Define that:

$\boldsymbol{w_{i,t} - w_{i,t-1} = \Delta w_{i,t}}$; $\boldsymbol{lnp_{i,t} - lnp_{i,t-1} = \Delta lnp_{i,t}}$; $\boldsymbol{M_t^* - M_{t-1}^* = \Delta M_t^*}$

$$\boldsymbol{\alpha_i + \sum_j \gamma_{ij}\, lnp_{j,t-1} + \beta_i M_{t-1}^* - w_{i,t-1} = \eta_i} \quad (6)$$

Then, equation (5) can be generated by

$$\Delta \boldsymbol{w_{i,t}} = \boldsymbol{\sum_j \gamma_{ij}^S \Delta lnP_{j,t} + \beta_i^S \Delta M_t^* + \lambda_i \eta_i} \quad (7)$$

Adding the lagged dependent variable ($\Delta \boldsymbol{w_{i,t-1}}$) to capture habit effects, the explicit Error Corrected AIDS model can be written as:

$$\Delta \boldsymbol{w_{i,t}} = \boldsymbol{\psi_i} \Delta \boldsymbol{w_{i,t-1}} + \boldsymbol{\sum_j \gamma_{ij}^S \Delta lnP_{j,t} + \beta_i^S \Delta M_t^* + \lambda_i \eta_i + \mu_i} \quad (8)$$

where $\boldsymbol{\psi_{ih}}$ is a parameter measuring the effect of habit persistence, which is also called "Short memory", indicating that changes of consumption over last period ($\Delta \boldsymbol{w_{i,t-1}}$) affects current changes of consumption ($\Delta \boldsymbol{w_{i,t}}$) [29].

$\boldsymbol{\alpha_i + \sum_j \gamma_{ij}\, lnp_{j,t-1} + \beta_i M_{t-1}^* - w_{i,t-1} = \eta_i}$ is the error correction term (ECT); $\boldsymbol{\lambda_{ih}}$ is the adjustment coefficient of the ih^{th} equation. This coefficient is interpreted as the speed of adjustment [32]. This coefficient was well applied in current EC-AIDS studies (*e.g.* Feleke and Kilmer [24]; Singh *et al.* [25]). In previous studies Feleke and Kilmer [24] and Karagiannis *et al.*[29], equation (8) was called as short-run equilibrium, but the equation (6) was called long-run equilibrium, and $\boldsymbol{\eta_i}$ is the disturbances in the long-run equilibrium caused by shocks (*e.g.* the shocks such as the WTO trade agreement, that might cause the change of imported meat demand). This study applied and modified the Feleke and Kilmer [24]'s suggestion of $\boldsymbol{\lambda_{ih}}$. If the absolute value of $\boldsymbol{\lambda_{ih}}$was closer to one, that is, the disturbance (shocks, such as WTO agreement) in long-run quickly disappears (*i.e.* the shock is quickly adjusted by short-run equilibrium). If it was closer to zero, then it takes a longer time for the disturbance to disappear.

$\boldsymbol{\mu_{ih}}$ is the ih^{th} disturbance term assumed to have independent identical distribution over time. Finally, China's accession to the WTO in 2001 led to fundamental changes in the scheme of agricultural trade. It is likely that the removal of quantitative controls and reduction of tariffs may alter patterns of meat import to China, leading to structural breaks in the empirical models. On the other hand, the occurrence of bovine spongiform encephalopathy (BSE) may cause import prohibition for beef, resulting in fundamental changes in the scheme of agricultural trade. Therefore, to account for possible structural changes associated with the WTO agreement of 2001 and BSE outbreak in 2004, this study introduced a dummy variable D and E, and rewrites Equation 8 as :

$$\Delta \boldsymbol{w_{i,t}} = \boldsymbol{\alpha_i D_i + \theta_i E_i + \psi_i} \Delta \boldsymbol{w_{i,t-1}} + \boldsymbol{\sum_j \gamma_{ij}^S \Delta lnP_{j,t} + \beta_i^S \Delta M_t^* + \lambda_i \eta_i + \mu_i} \quad (9)$$

where $\boldsymbol{D_i = 0}$ is dummy variable representing the time period from 1986~2000 and $\boldsymbol{D_i = 1}$ represents the time period 2001~2011; $\boldsymbol{E_i = 0}$ is dummy variable representing the time period from 1986~2003 and $\boldsymbol{D_i = 1}$ represents the time period 2004~2011 [5].

On the basis of parameter estimation in equation (9), this study estimated uncompensated and compensated price elasticity and expenditure elasticity. Elasticity calculation was originally developed from the long-run equilibrium (Equation 6) by Deaton, and Muellbauer [23]. To calculate elasticities in Error Corrected AIDS model, based on suggestion of Feleke and Kilmer [24], there is no difference between a consumer's short-run and long-run behavior. In other words, it is implicitly assumed that a consumer's behavior is always in equilibrium. Therefore this study can use the parameters in equation (9) to calculate the uncompensated and compensated own and cross price elasticities.

Co-integration analysis

Integration analysis was used for identify the long-run equilibrium relationship between the price and the expenditure of meat products in China. First, this study investigates the stationarity of the data to be used in this analysis. The reason why stationarity investigation is needed is that there is a danger of obtaining apparently significant regression results from unrelated data when non-stationary series are used in regression analysis. In other word, if those variables are non-stationary, this study cannot use regression analysis such as OLS to check the long-run equilibrium relationship between them.

There are several statistical tests for stationarity of time series data (*e.g.* Dickey-Fuller (DF) test, Augmented Dickey-Fuller (ADF) test, *etc.*). However, a rough and ready method of testing for stationarity is to plot the time series. Chatfield [33];Hill *et al.*[34]; and Gujarati [35] also recommended that such an intuitive feel is the starting point of more formal tests of stationarity.

Visual inspections of series were checked for design the variants (intercept excluded or trend included) in unit root tests, such as DF or ADF tests [34][35]. On the other hand, previous studies [36][37][38]also stated that the DF and ADF tests have relative low power for testing time series. For those reasons, this study applied alternative unit root tests for testing the time series.

Following Hill *et al.*[34], and Gujarati [35], this study considered three different forms for performing unit root tests. ① the time series fluctuates around a sample average zero (*e.g.*pcc), it is called a random walk without drift (*i.e.* no intercept); ② the time series fluctuates around a sample average that is nonzero (*e.g.*pcm), it is called a random walk with drift (*i.e.* with an intercept); ③ the time series fluctuates around a linear trend (*e.g.*mt), it is called a random walk with drift and deterministic trend (*i.e.* with an intercept and trend term). Based on the visual inspection[6], this study chose one of above three forms of unit root tests performing for testing each time series

For data 'pcc', this study use form ①;

For data 'pcm', 'ppb' and 'wcd', this study use form ②;

For the rest of data, this study use form ③;

For the differenced data, this study use form ①.

Furthermore, only one time lag was considered in our analysis for time series data (Equation 6), therefore this study considered the time lag length as one (Bandwidth=1

in Phillips-Perron test) for unit root tests. This study applied ADF and Phillips-Perron tests [7]. Table 3 shows the results of unit root tests, and most variables in Equation (1) are non-stationary. Therefore the original AIDS model [23] is not suitable in our study.

On the other hand, the initial analysis (Table 3) indicates the difference form (*e.g.* $\boldsymbol{w_{i,t} - w_{i,t-1} = \Delta w_{i,t}}$) of the variables is stationary. Differencing procedure is used for analyzing non-stationary data in equation (8), but one drawback of the procedure of differencing is that it results in a loss of valuable "Long-run information" in the data [38]. Recently, the concept of co-integrated series has been suggested as one solution to this problem [39]. In other word, co-integrated systems are better method than just differencing procedure for analyzing time series. In defining different forms for co-integrated systems, there are several estimation procedures (*e.g.* Johansen [40]; Johansen [41]; Johansen and Juselius[42]; Engle and Granger[39]). Most convenient is the error correction form [39].

Based on Engle and Granger [39]; Maddala[38], suppose there are two time series $\boldsymbol{y_t}$ and $\boldsymbol{x_t}$, both $\boldsymbol{y_t}$ and $\boldsymbol{x_t}$ are I(1) (*i.e.* integrated of order one); then if there is a nonzero β such that $\boldsymbol{y_t - \beta x_t}$ is I(0) then $\boldsymbol{y_t}$ and $\boldsymbol{x_t}$ are said to be co-integrated. The regression $\boldsymbol{y_t - \beta x_t = \mu_t}$ is called co-integration regression. Engle and Granger [39] suggest estimating $\boldsymbol{y_t - \beta x_t = \mu_t}$ by ordinary least squares, getting the residual $\boldsymbol{\hat{\mu}_t}$(Error Correction Term) and then applying unit root test based on $\boldsymbol{\hat{\mu}_t}$.Due to the small sample size, following the suggestion of Karagiannis *et al*. [29], the Engle and Granger's two-step method is applied in this study [8].Therefore, the co-integration of the data series in EC-AIDS model will be assessed by testing the Error Correction Term (ECT;$\boldsymbol{\eta_i}$) from Equation 6 for stationarity using the unit root test.

Estimation of elasticities

Following Karagiannis *et al*. [29], Feleke and Kilmer [24], and Taljaard *et al.*[26], the (Marshallian, Uncompensated) expenditure elasticity of meat product *i* can be expressed as:

$$\boldsymbol{\varepsilon_i = 1 + \frac{\beta_i^s}{\bar{w}_i}} \quad \textbf{(10)}$$

where $\boldsymbol{\bar{w}_i}$ is an average expenditure share of meat product *i* and $\boldsymbol{\beta_i^s}$ is the expenditure coefficient in equation (9).

The uncompensated own price and cross price elasticities of meat can be expressed as:

$$\boldsymbol{\varepsilon_{ij}^u = -\delta_{ij} + \frac{\gamma_{ij}^s}{\bar{w}_i} - \beta_i^s\left(\frac{\bar{w}_j}{\bar{w}_i}\right)} \quad \textbf{(11)}$$

Where $\boldsymbol{\delta_{ij} = 1}$ for *i=j* and $\boldsymbol{\delta_{ij} = 0}$ otherwise.

The compensated (Hicksian) own price and cross elasticities of meat can be expressed as:

$$\boldsymbol{\varepsilon_{ij}^c = -\delta_{ij} + \frac{\gamma_{ij}^s}{\bar{w}_i} + \bar{w}_j} \quad \textbf{(12)}$$

where$\boldsymbol{\delta_{ij} = 1}$ for *i=j* and $\boldsymbol{\delta_{ij} = 0}$ otherwise.

III. RESULTS AND DISCUSSION

Model appropriateness

Augmented Dickey Fuller tests show all variables in equation (1) are non-stationary at 5% level (Table 3). Phillips-Perron tests also show that most variables are non-stationary at 5% level, except for 'wps', 'wcc', 'pcc' and 'pcd'. Both ADF and Phillips-Perron tests show that all time-series data used in this study were integrated into order one (*i.e.* all-time series become stationary after differencing it once; denoted as I(1))[9]. In this study, after checked unit root test of ECT which were stationary (*i.e.* integrated into order zero), all the variables in equation (8) were stationary (*i.e.* integrated to the same degree I(0)). Gujarati [35] suggested that regression analysis involving time series may lead to the phenomenon of non-sense repression if there were two or more non-stationary time series, and the normal AIDS model is not suitable for such analysis. Since all variables were non-stationary for the ADF tests, the EC-AIDS modified in this study (Equation 8) was suitable for the time series data in the current study.

Table 3: Tests for non-stationarity

Augmented Dickey Fuller Test		*=5%; **=1%	
Variable	Symbol	Level	Difference
①Expenditure share			
Bacon and ham	*wpb*	-2.62	-3.26**
Chilled or Frozen Pig meat	*wpc*	-3.47	-5.48**
Dried or smoked pig meat	*wpd*	-2.12	-4.27**
Pig meat sausages	*wps*	-2.53	-5.37**
Chicken meat	*wcm*	-2.31	-3.73**
Chilled or frozen Cattle meat	*wcc*	-2.96	-4.52**
Dried or smoked cattle meat	*wcd*	-2.39	-5.19**
②Log of price index	*Mt*	-2.78	-3.18**
③Log of meat prices			
Bacon and ham	*ppb*	-1.96	-4.56**
Chilled or Frozen Pig meat	*ppc*	-0.65	-2.99**
Dried or smoked pig meat	*ppd*	-2.69	-4.54**
Pig meat sausages	*pps*	-2.60	-3.55**
Chicken meat	*pcm*	-2.60	-3.48**
Chilled or frozen Cattle meat	*pcc*	-0.39	-2.99**
Dried or smoked cattle meat	*pcd*	-3.26	-5.00***
Phillips-Perron tests		*=5%; **=1%	
Variable	Symbol	Level	Difference
①Expenditure share			
Bacon and ham	*wpb*	-2.41	-4.65**
Chilled or Frozen Pig meat	*wpc*	-3.31	-4.66**
Dried or smoked pig meat	*wpd*	-2.71	-6.61**
Pig meat sausages	*wps*	-7.11**	-11.71**
Chicken meat	*wcm*	-3.58	-5.26**
Chilled or frozen Cattle meat	*wcc*	-10.03**	-11.59**
Dried or smoked cattle meat	*wcd*	-2.73	-5.90**
②Log of price index	*Mt*	-2.91	-4.42**
③Log of meat prices			
Bacon and ham	*ppb*	-2.71	-6.91**
Chilled or Frozen Pig meat	*ppc*	-1.25	-7.59**
Dried or smoked pig meat	*ppd*	-2.73	-5.43**
Pig meat sausages	*pps*	-2.42	-4.50**
Chicken meat	*pcm*	-1.64	-4.57**
Chilled or frozen Cattle meat	*pcc*	-2.02*	-2.93**
Dried or smoked cattle meat	*pcd*	-3.01*	-5.09**

Based on the visual inspection of the plot in figure 1, we chose forms ① of unit root tests performing for testing ECT in this study. At this stage, the purpose of the unit root test was to make sure that the ECT was stationary (or I(0)). If the stationary of ECT could be identified, the variables in equation (1) would be co-integrated, and there

would be a long-run equilibrium relationship among the variables in equation (1).

Table 4 shows all ECTs in our analysis were stationary. This demonstrates that meats imported into China have a long-run equilibrium relationship between the price and the expenditure of meat products. These results further demonstrate that applying EC-AIDS was appropriate for this study.

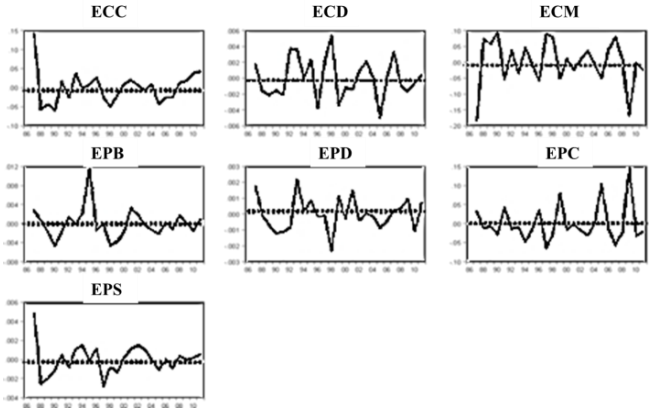

Figure 1: Plot of ECT

EC-AIDS

The demand restrictions homogeneity and symmetry are expressed in terms of the model's coefficients:

$\sum_j \gamma_{ij}^S = \mathbf{0}$ (**homogeneity**); $\gamma_{ij}^S = \gamma_{ji}^S$ (**symmetry**)

Following Karagiannies *et al*. [29], based on a Wald test, the maintenance of both homogeneity, and symmetry and homogeneity, can be rejected at a 1% significance level. On the other hand, Taljaard *et al.*[26] tested homogeneity by each expenditure share equations, and tested symmetry by each pair of price parameters. Following Taljaard *et al.*[26], the Table 5 reports the Wald test statistics for homogeneity and symmetry tests.

Table 5 shows that results of symmetry and homogeneity do not match. The failure of matching symmetry with homogeneity was also reported by other researchers [43][44][45]. It might be due to overlooking rapid changes in consumer behavior [23]. For example, when severe BSE outbreaks occurred in February 1st 2003, the expenditure for beef was differed sharply between January and February of 2003, but the expenditure difference between 2002 and 2003 was not as sharply as the difference between January and February. So, studies on developing appropriate tests for symmetry and homogeneity in the EC-AIDS model are needed[46]. In this study, the restricted parameter estimations (with symmetry and homogeneity) were not included in analyzing expenditure change with the prices of imported meat products.

After confirming the existence of a long-run equilibrium (co-integration relationship), we proceeded to estimate the short-run demand for imported meat in China. A Restricted Seemingly Unrelated Regression was used to estimate the parameters in equation (9). The parameter estimation results are represented in Table 6.

Table 5: Wald test statistics for testing homogeneity and symmetry restrictions

Restriction	Wald test statistic	P-Value
Homogeneity in:		
(pb) share equation	0.98	0.32
(pc) share equation	3.18	0.07
(pd) share equation	0.59	0.44
(ps) share equation	4.97	0.03
(cm) share equation	0.15	0.70
(cc) share equation	0.00	0.95
(cd) share equation	4.27	0.04
Symmetry for:		
pb-pc price parameters	5.10	0.02
pb-pd price parameters	0.40	0.53
pb-ps price parameters	2.58	0.11
pb-cm price parameters	1.77	0.18
pb-cc price parameters	0.16	0.69
pb-cd price parameters	0.57	0.45
pc-pd price parameters	32.18	0.00
pc-ps price parameters	0.75	0.39
pc-cm price parameters	0.00	1.00
pc-cc price parameters	10.72	0.00
pc-cd price parameters	3.51	0.06
pd-ps price parameters	5.11	0.02
pd-cm price parameters	16.95	0.00
pd-cc price parameters	0.82	0.37
pd-cd price parameters	0.45	0.50
ps-cm price parameters	0.53	0.47
ps-cc price parameters	0.03	0.87
ps-cd price parameters	17.34	0.00
cm-cc price parameters	1.49	0.22
cm-cd price parameters	4.46	0.03
cc-cd price parameters	1.23	0.27

The parameters of Structural change (α_i) are not statistical significance, except for 'wpc'. It appears that after China entry into the WTO in 2001, the expenditure

Table 6: Parameter estimates of the Short-Run Demand for Imported Meat in China

		Dependent variables						
		wpb	*wpc*	*wpd*	*wps*	*Wcm*	*wcc*	*wcd*
Structural change (α_i)		0.0008	-0.0811***	-0.0006	0.0009	0.0516	0.0026	0.0003
Structural change (θ_i)		-0.0005	0.1500***	0.0010*	-0.0008	-0.1321	0.0051	-0.0010
Habit effects (ψ_i)		0.3739**	0.6008***	0.0442	0.3796***	0.3438***	0.0244	0.3110***
Income coefficients (β_i^S)		-0.0027	0.0278	-0.0017***	-0.0017**	0.0796**	-0.0438***	0.0001
Speed of adjustment (λ_i)		-1.1034***	-2.1280***	-1.3091***	-1.1437***	-1.5250***	-1.2328***	-1.6968***
Price coefficients (γ_{ij}^S)	*ppb*	0,0014	0.0433**	0.0009***	-0.0001	-0.0454	-0.0009	-0.0010
	ppc	0.0009	-0.0299*	0.0004	-0.0011**	0.0673**	-0.0149	0.0013*
	ppd	-0.0001	-0.1365***	0.0014***	0.0011*	0.1716***	-0.0116	-0.0010
	pps	0.0022	0.0163	0.0006	0.0001	-0.0238	0.0008	0.0043***
	pcm	-0.0039	0.0673	-0.0014	-0.0001	-0.1184*	0.0361**	-0.0045**
	pcc	-0.0039**	0.0856***	-0.0024***	-0.0005	-0.0232	-0.0108	-0.0045***
	pcd	-0.0000	0.0307*	-0.0002	0.0004	-0.0557**	0.0025	0.0016**
Adjusted R-squared		-0.1087	0.6701	0.6380	-0.5578	0.1911	0.0618	0.6158

share of imported chilled or frozen pig meat was decreased. Between 2001 and 2014, the import of meat product was increased. But, due to the continuing occurrence of Avian influenza from 2003 and Foot-and-mouth disease from 2001 in China, demand for imported chicken and cattle meat was increased from 2001. On the other hand, the parameter of Structural change (θ_i) indicates that the BSE outbreaks in the U.S.A. affected China's demand for imported pig meat positively and for imported cattle meat negatively. Compare with studies in other countries, Japanese consumers' meat consumption pattern had changed after BSE outbreaks [47][48]. Although Japan stopped beef import from the U.S.A. immediately just after BSE occurrence in the U.S.A. and increased the beef import from Australia and New Zealand, the Japanese beef import quantity between 2003 and 2011 was lowered to the half of the 2003 level [6]. Similar to what happened in Japan, the quantity of imported beef in China also was decreased sharply after 2003 when China stopped beef import from the U.S.A and increased the beef import from Uruguay. As a result, Chinese beef import decreased sharply between 2004 and 2008, and recovered after 2008 [6]. The information suggests that both domestic and oversea animal disease outbreaks affect demand for imported meat significantly in China.

The parameter of habit effects (ψ_i) represents how last period's changes of import quantity ($\Delta w_{i,t-1}$) affects current changes ($\Delta w_{i,t}$) [29]. This means that the quantity of import this year may increase if the quantity of imported meat product increased last year. Except for 'wpd' and 'wcc', the changes of imported quantity last year had significant influence on the changes this year. The Speed of adjustment (λ_i) was the coefficients of the ECT. All the parameters (λ_i) were statistically significant, which further confirm that the EC-AIDS model was better for this study than the AIDS model. In addition, all parameters λ_i in the current study were greater than one in absolute values, which suggests that the estimation bias caused by the AIDS model was quickly adjusted by the error correction process in EC-AIDS model. So we are confident that the EC-AIDS model used in this study was appropriate for analyzing the demand of imported meant in China.

Table 7: Expenditure elasticities of the expenditure for imported meat in China

Items	Symbol	Estimates	Standard Error
Bacon and ham	PB	0.050	0.603
Chilled or Frozen Pig meat	PC	1.313***	0.274
Dried or smoked pig meat	PD	0.101	0.249
Pig meat sausages	PS	0.182	0.348
Chicken meat	CM	1.095***	0.046
Chilled or frozen Cattle meat	CC	0.289	0.171
Dried or smoked cattle meat	CD	1.013***	0.253

Note: ***, **, * denote statistical significance at 1%, 5% and 10% levels.

Expenditure elasticities

Estimates of elasticities were calculated from parameter estimates in Equation 9. The expenditure elasticities represent relationships between the budget (Expenditure) of imported meat product and the quantity demand for each imported meat. The estimates of expenditure elasticities of demand for meat product in China are positive (Table 7). The demands for imported chilled or frozen pig meat (PC) and chicken meat (CM) are expenditure elastic. Dried or smoked cattle meat (CD) was found to have an almost unitary elasticity.

These results suggest that assuming China increased budget (expenditure) for all import meat products by one (or 100%) and there is no change in prices of meat products, the quantity of imported PC, CM and CD will increase by 1.31 unit (or 131%), 1.10 (or 110%), and 1.01 (or 101%) respectively[10]. In other words, if China increased the quantity of imported meat products, the proportional increase in imported pig meat would be larger than the proportional increase in other imported meat products. Consequently, pig meat importers would benefit from the expansion of imported market in China. However, this will present great challenges to Chinese pork producers who will face more severe competition for pork market in the country. Comparing with major pork exporting countries (*e.g.* U.S.A. and Canada), China has more small-scale pig farmers. These small-scale pork producers may not be able to survive if China opens its market for imported meat, due to their poor production performance and financial vulnerability.

Price elasticities

The price elasticities represent the relationship between the prices and the quantity of demand for imported meat product. Uncompensated price elasticities contain both the income and price effect. The uncompensated price elasticity means quantity changes of each product with its price when holding import budget and all other prices (of import meat products) constant. Compensated price elasticity contains only price effect. It assumes the utility is unchanged when the price is changed.

Table 8: Own price elasticities of the expenditure for imported meat in China

Items	Uncompensated		Compensated	
	Estimates	Stan. Er.	Estimates	Stan. Er.
Bacon and ham	-0.511	0.440	-0.671	0.380
Chilled or Frozen Pig meat	-1.365***	0.182	-0.907***	0.003
Dried or smoked pig meat	-0.235	0.238	-0.232	0.238
Pig meat sausages	-0.942***	0.224	-0.939***	0.224
Chicken meat	-1.221***	0.096	-0.119***	0.020
Chilled or frozen Cattle meat	-1.131***	0.165	-1.113***	0.168
Dried or smoked cattle meat	-0.660***	0.139	-0.655***	0.139

Note: ***, **, * denote statistical significance at 1%, 5% and 10% levels.

Both uncompensated and compensated own price elasticities were negative (Table 8). Except PB and PD, all elasticities were significantly different from zero. This suggests that the quantity of imported meat product will decrease if the price was increased. PC, CM and chilled or frozen cattle meat (CC) are price sensitive imported meat products. If their price was increased by one unit (or 100%), the quantity of imported meat will decrease by more than one unit.

Compared with dried or smoked cattle meat, PC, CM and CC are less processed meat products, and are

relatively cheap. These meats would present major competition with domestic meat products. So, the most important strategy to maintain and increase market share for PC, CM and CC in China is to keep the price low. For imported pork sausages (PS) and CD, on the other hand, the marketing strategy of low price may be relatively less important and enhancing the food safety and quality would be more important for increasing market share in China.

Implications of the research

The result indicates that demand for imported fresh pig meat is expenditure elastic. Along with the rapid economic development and urbanization, the demand for meat is increasing, and the quantity of total meat import is also increasing [6]. In agreement with findings by [49], the result of the current study suggests that demand for imported fresh pig meat product will increase in the near future. Pork is a traditional meat in China. Due to the large Chinese population, a small increase in demand for imported pork will result in huge business opportunities for fresh pig meat importers. In addition, because Chinese consumers generally believe that imported meat and meat products are safer than those produced domestically [10][11], pig meat importers will have opportunities to develop their brand of country-of-origin labeling in China.

Results of own price elasticities indicate that imported fresh pig meat is price sensitive. China is also the biggest pork production country in the world, pig meat importers have to face a severe competition from a large number of domestic pig meat producers. Therefore keeping the relatively low price of their products is an important marketing strategy for pig meat importers.

Limitation of this study and suggestion for further research

There is an implicit assumption that the EC-AIDS model does not differentiate products by source (*i.e.* origin country imported from). This assumption seems too strong in international agricultural trade, because demand should be different between Canada imported pork and U.S.A. imported pork. This is one of the reasons that test results of symmetry and homogeneity is not perfect in this study. To improve this, detailed agricultural trade data collection is required. In addition, more advanced EC-AIDS model development for analyzing demand for imported meat product from different countries is also necessary.

Based on the results of this study, further research related to the linkage between domestic and world meat market seems essential [50][51]. Moreover, market prices of meat in China are vulnerable to factors such as cost of labor, prices of feed grains, and governmental policies addressing environmental protection. Further research to clarify the economic impacts of labor cost, feed price, and policy change on pig production and pork price is needed.

IV. CONCLUSION

Meat consumption (demand) in China has been increased so dramatically that the domestic meat supply cannot meet the demand. Consequently, imported meat market has been developed rapidly. In this study we used EC-AIDS models to evaluate relationships between the price, and the quantity demand for imported meat product. The results indicate that each kind of imported meat product will have potential market extensions in China, and each kind of product will need different pricing strategies for market expansion in this country.

This study provides necessary information for policy makers to manage imported meat. The results suggest that the quantity of imported pork will increase more rapidly than other imported meat products if China increases its expenditure on imported meat. Opening pork markets will challenge or even damage Chinese pork producers, especially small-scale producers. So, government supports to increase competitiveness of domestic pig farmers are needed to maintain stable domestic production.

The results also offer valuable information for food and agribusiness firms. The results demonstrated that due to the limited domestic meat production, Chinese meat imports will increase in the future, which will present great opportunities for meat importers. Less processed meat, such as chilled or frozen meat are price sensitive and will face competition with other domestic meat products. The processed meat (such as pig meat sausages, and dried or smoked cattle meat) meat importers, on the other hand, are relatively less price sensitive, so enhancing the quality and safety of these products would be essential for increasing their market share in China.

Notes:

1) Although the quantity of total pork production is similar to the quantity of total pork consumption in China[6], some pork products were used as raw materials for animal feed, fertilizer production, or wasted in the process stage. Therefore, production cannot meet demand, and pork import is needed in China. Based on the recent database of Food and Agriculture Organization of the United Nations [6] the quantity of fresh and frozen pig meat and edible pig offal imported to China were increased constantly from 2009 to 2011. Meanwhile, the export quantity of fresh and frozen pig meat and edible pig offal were decreased constantly. The data of FAOSTAT also indicate the increased demand for imported pork in China.

2) Data for this study were extracted from the FAOSTAT. Although data of China's meat consumption from other sources are also available, but data from different sources in China are not comparable [52]. Therefore, all data used in this study came from the FAOSTAT, which were used for the demand analysis in previous studies [24][25]. The latest meat trade data released from FAOSTAT are the data of 2011 (accessed in April 19, 2015). Since China used a double-track exchange rate scheme until 1994, it would be desirable to delete the data collected before 1994. However, since the payment of imported meat was settled in U.S. dollars, the double-track exchange rate scheme before 1994 likely had limited effect on imported meat price (in U.S. dollars). Furthermore, by deleting the data collected before 1994, we might suffer from a degree-of-freedom problem in the model estimation. Therefore, for the ease of computation and interpretation of the results, we decided to use the data collected before 1994 in the model estimation. On the other hand, the exchange rate scheme would affect the ratio of domestic price and import/export price, leading to changes in demand for imported products (and supply of exported products). However, the relationship between the exchange rate and meat import/export quantity is beyond the scope of this study. Further research to elucidate the linkage between exchange rate and international trade of meat products is needed.

Not all the imported meat items are included due to discontinued import (*e.g.* prepared chicken) in this study. For instance, the import of prepared chicken in 1987 was zero. In this case, it is technically impossible to explain how price changes affected the import of prepared chicken in 1987 by EC-AIDS. In addition, since prices for individual imported meats are not publicly available, in this study the proxy prices were obtained by dividing import values by import quantities according to Feleke and Kilmer [24]. Furthermore, although the EC-AIDS model is more flexible than the previous AIDS model, it may suffer from a degrees-of-freedom problem in empirical applications. To reduce the number of parameters, in this study we focused on the major imported meat items, such as pig meat, cattle meat, chicken meat, and their meat products. In addition, using unit value as a proxy of the price may be subject to the problem of quality variation. For example, the model predicted the price of imported beef from the U.S.A. is much lower than imported beef from Germany. More advanced Source Differentiated Error Correction AIDS model (*e.g.*Yang and Koo [53]) may be more appropriate for meat import demand analysis. However, the large amount of data extraction from huge database is required for this kind of advanced analysis. Due to the limitation of data sources, this study used the proxy prices for analysis based on Feleke and Kilmer [24]. This study paved a path to apply the advanced Source Differentiated Error Correction AIDS to study imported meat economy in China in the further research.

3) Applying Stone's index in equation (1) may cause a simultaneity problem since the expenditure share in the index $w_{i,t}$, is also the dependent variable in equation (1). Therefore, many studies have lagged the expenditure share in Stone's index by one period (*e.g.* Eales and Unnevehr [54]; Yang and Koo [53]; Feleke and Kilmer [24]).

4) Following Engle and Granger [39], an example of a time series that can be described as:

$$y_1 = y_0 + \omega_1$$
$$y_2 = y_1 + \omega_2 = (y_0 + \omega_1) + \omega_2$$
……
$$y_t = y_{t-1} + \omega_t = y_0 + \sum \omega$$
$$y_t - y_{t-1} = \omega_t \quad \text{(N1)}$$

where y_0 often set to zero because it is so far in the past that its contribution to y_t is negligible. The term ω_t can be separated into two parts μ_t and δ_t . The term μ_t is the error term and independent, with zero mean and constant variance σ_μ^2, and the term δ_t is the shocks because it causes the time series to trend in unpredictable directions, and causes the spurious regression. This assumption can be described as:

$\omega = (\mu \ , \delta)$ and
$$y_t - y_{t-1} = \delta\mu_t \quad \text{(N2)}$$

We assume an optimal value of y_t^d and the value between y_t and y_t^d can be expressed by equation (N3)

$y_i^d = y_{t-1} + \mu_t$and
$$y_i^d - y_{t-1} = \mu_t \quad \text{(N3)}$$

Using equation (3) and (4) to obtain

$$y_t - y_{t-1} = \delta\left[y_i^d - y_{t-1}\right] \quad \text{(N4)}$$

This is the explanation of equation (3) in the text. The co-integration in this study is also called Engle and Granger two-step method. The similar model description is also represented in De Boef [55].

5) In the error correction model, dummy variables were often used to assess the impact of animal disease. For example, Abao *et al.* [56] applied this methodology to analyze the impact of FMD on meat market in Central Luzon, Philippines; Park *et al.* [57] used similar methodology to assess the impact of BSE occurrence in the U.S.A. and on Korean meat markets. Similar methodology was used in this study.

6)Visual inspection of each time series data and the original data in this are available at:

http://wenku.baidu.com/view/c4d8e8a57f1922791788e845

7)Although Johansen test is also an effective tool for investigating the time series properties of data, this test is not recommended for EC-AIDS [29].

8)Besides the two-step estimation, other methods are also available [58][59]. However, due to the limited number of observations, we used the two-step estimation in this study, which provided reliable estimates with a small sample size.

9)When specifying regression models in time series, it is important to make sure that the different variables are integrated to the same degree [35]. Therefore, two types of unit root tests were applied in this study.

10)Same meat product (*e.g.* Chilled or frozen pig meat) is imported from several different countries (*e.g.* U.S.A. Denmark, or Germany). In the situation of analyzing demand of importing meat product, it is difficult to say that if the price of imported sausages from Japan increased, the demand for imported chilled or frozen pork from U.S.A. will decrease (or increase). Therefore, in this study we deleted the results of cross price elasticities. Calculation results and the original data in this study can be found at: http://wenku.baidu.com/view/c4d8e8a57f1922791788e845

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