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CHANGING STRUCTURE OF CHINA'S MEAT IMPORTS

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In press in JIA

Abstract

This paper discusses the determinants of meat imports of China. Results indicate that import demand is mostly determined by import price and real GDP. Imported price has a negative effect and real GDP has a positive influence on import quantity. Tariff does not have a significant effect. As GDP and consumption capacity increases, China has a large potential demand for meat imports. Some countries may gain if China's economy continues expanding, while others, like the United States, are the most sensitive to the trade policy of China.

Keywords: meat import demand, China, price elasticity, income elasticity, pork, beef, poultry

1. Introduction

China has enjoyed rapid economic growth over the last three decades. Per-capita disposable income and consumption capacity have increased along with the price of commodities. One of the significant changes in the Chinese food consumption structure has been the sustained growth in meat consumption. Table 1 shows per-capita meat consumption in China was 16.18 kilograms in 1995 and increased to 28.20 kilograms in 2010. The internal structure of meat consumption also has undergone significant changes. According to the data from the China National Statistics Bureau (CNSB), in 1995, pork accounted for 77.4% of the total meat consumption, followed by poultry (15.2%), and beef and mutton combined (7.5%). In 2010, although pork still dominated meat consumption, its share decreased to 64.2% while the poultry share increased to 26.3% and beef and mutton combined share slightly increased to 9.5%.

Table 1. Per capita meat consumption share in China (kilograms), selected years

Year	Per capita meat consumption	Pork		Beef and mutton		Poultry	
		quantity	%	quantity	%	quantity	%
1995	16.18	12.51	77.4	1.21	7.5	2.45	15.2
2000	20.22	14.53	71.9	1.93	9.5	3.76	18.6
2005	25.95	17.57	67.7	2.43	9.4	5.95	22.9
2006	25.67	17.47	68.1	2.55	9.9	5.65	22.0
2007	24.73	15.59	63.0	2.62	10.6	6.52	26.4
2008	24.13	15.76	65.3	2.30	9.50	6.07	25.2
2009	26.87	17.12	63.7	2.50	9.30	7.26	27.0
2010	27.35	17.56	64.2	2.60	9.50	7.19	26.3

Source: China Statistical Yearbook, CNSB (1995–2010)

Because of the rapid growth in meat demand in China, the total import value[1] of meat increased dramatically during the last several years. As shown in Figure 1, China's meat imports increased by 725% in terms of total value with imports exceeding exports twice between 1995 and 2010. The deficit in meat trade was 4.19 billion in 2008 and 4.18 billion in 2011. China's share of total world meat imports by value was 8.69% in 2011 (calculated by UNCTAD STAT).

[1] Import values are based on Cost Insurance and Freight (CIF)

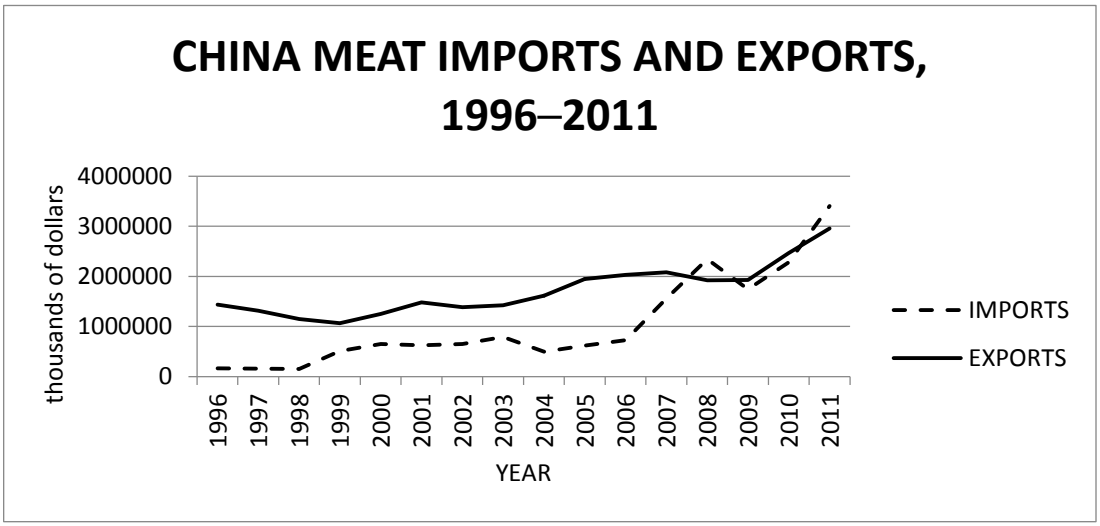

Figure 1. China: Meat imports and exports, 1996 to 2011
Source: UNCTAD STAT (1996–2011)

Even though the United States' share of the total Chinese meat import reduced from 82.5% in 1996 to 40% in 2011, it remains the largest meat exporter to China. Since 2008, South American countries, such as Brazil and Argentina, have become major sources of imported meat to China.

From the perspective of import structure, poultry, pork, beef, and mutton are the major groups of imported meat to China. Poultry showed a continued growth until the bird flu outbreak in 2009. Pork imports grew steadily in the 1990s before dropping sharply to 1.36 billion in 2006 due to the swine flu outbreak. Beef and mutton shares had similar trends like pork. In 2011, beef and mutton import values increased by 193 times of the values in 1996. Due to the fast growth in meat demand in China, strong market competition has developed among countries worldwide. Most recent statistics show that Brazil is the largest poultry exporter to China. When combining Brazil with Argentina, Chile, and the United States, these countries account for 99% of total poultry imports of China by value. The United States, Germany, Canada, Spain, Denmark, and France are the major pork exporters to China, accounting for more than 91% of total import value. Australia and New Zealand account for more than 60% of the total beef and mutton imports of China by value.

Although there are many studies on domestic and import demand, most research related to the meat trade of China mainly focuses on exports. There are few studies on China's import demand for meat. With increasing domestic demand for meat in China, it is important for the world's major meat importers to have a better understanding of China's import demand for meat and the changing structure of the Chinese meat import market. The objective of this paper is to fill this gap by

estimating the demand elasticity of China's meat imports by meat type, as well as by analyzing the changing patterns of importing different meats by country.

2. Literature Review

The commonly used demand systems include the Rotterdam system model (Theil 1965), the Almost Ideal Demand System (AIDS) model (Deaton and Muellbauer 1980), the Central Bureau of Statistics (CBS) system model (Keller and van Driel 1985), and the National Bureau of Research (NBR) system model (Neves 1987). Rotterdam and AIDS are the most popular models in agricultural economics research in China (Luo and Jiang 2013; Gao et al. 2012; Zhang and Tian 2012). For example, Gao et al. (2012) analyzed the import demand of soybeans in China between 1999 and 2011 using the Rotterdam model. Their results showed that when multinational food companies increased their share of soybeans in the Chinese market, the import demand for soybean oil decreased while the import demand for soybeans strongly increased. Zhang and Tian (2012) estimated the demand of imported red wine in China from 1996 to 2008 using the AIDS model. Their results showed that income had a positive effect on demand of red wine imports, and domestic red wine price and tariff had a negative effect on import demand. In addition, the price of imported red wine and exchange rate had little influence on red wine import demand.

Few researchers have estimated the import demand for meat. Yang and Koo (1994) estimated Japanese meat imports using a source differentiated AIDS model. Combining this model with source differentiation provided more reliable and detailed information about Japan's meat import demand behavior. Their results showed that the United States was the largest beef exporter to Japan. Taiwan had the largest expenditure elasticity along with insignificant own-price elasticity in the pork market, while Thailand had the largest expenditure elasticity in the poultry market.

Fewer studies have focused on China's import demand for meat. Song et al. (2012) analyzed the trends of meat production and imports. They demonstrated that beginning in 2011, the demand for imports had strongly increased due to the decreasing supply and the high price of domestic meat. This study only analyzed the basic trend of meat imports without estimating import demand models to determine the elasticity of meat demand or the country-of-origin effect.

3. Model

According to Khan (1974), the import demand function is specified as:

$$\ln M^{d}{}_{it} = a_0 + a_1 \ln(PM_i / PD_i)_t + a_2 \ln Y_t + U_t \qquad (1)$$

where M_i is the quantity of imports of country i, PM_i is the unit value of imports in country i, PD_i is the domestic price level of country i, Y_i is the real gross domestic product (GDP), and U_t is the error term. Warner and Kreinin (1983) used a different approach to estimate import demand. They used the volume of imports as the independent variable and separated the time period into two distinct investigation periods. Bahmani-Oskooee (1986) applied a dynamic import demand model by introducing a distributed lag structure on the relative price and on the effective exchange rate. The model is described as

$$\ln M^d{}_{it} = a + b \ln Y_t + \sum_{j=0}^{n1} c_j (PM_i / PD_i)_{t-j} + \sum_{j=0}^{n2} h_j \ln E_{t-j} + U_t \qquad (2)$$

where Y_t is real GDP, and E_{t-j} is an export weighted effective exchange rate after introducing lags to the equation. Although the Bahmani-Oskooee model may be more theoretically ideal, we chose to apply the Warner and Kreinin (1983) model because of the data's very short time period. In addition, introducing lags into the model would result in very small degrees of freedom. The final econometrics model in this paper for Chinese meat import demand is

$$\ln q_i = \alpha + \beta_1 \ln p_i + \beta_2 \ln rgdp + \beta_3 \ln dp_i + \beta_4 \ln t_i + \varepsilon \qquad (3)$$

where q_i represents the total import quantity of commodity i; p_i is the import price of commodity i; $rgdp$ is Gross Domestic Product based on purchasing-power-parity (PPP) per capita GDP, representing the income of the importing country; dp_i is the domestic price of commodity i; and t_i is the tariff rate for commodity i. Except for tariff rate, all other variables are normalized by the consumer price index (CPI) with 2005 as the base year. In the model, β_1 is the price elasticity of import demand that is expected to be negative; β_2 is the import income elasticity that is expected to be positive; β_3 is the cross price elasticity of domestic price on import demand that is expected to be positive, implying a substitute relationship between domestic and imported meats; and β_4 is import tariff elasticity which is expected to be negative. Seven demand equations are estimated for major meat products based on the HS-4 classification standard using annual data from 1995 to 2012.

4. Data

Meat import data of 1995 to 2012 were obtained from the World Trade Atlas (2014). The import data contained the import volume and quantity of different types of meats by HS4 codes. Average prices were computed by dividing the import value by import quantities. Because some product categories have zero values and some products have a very small share of the total meat import, we combined these together. This reduced the ten products based on HS4 codes to seven. They are "0201: Beef, Fresh/Chilled" (Beef, Fresh/Chilled); "0202: Beef, Frozen" (Beef,

Frozen); “0203: Pork, Fresh/Chilled/Frozen” (Pork); “0204: Sheep & Goat Meat, Fresh/Chilled/Frozen” (Sheep & Goat); “0206: Edible offal of bovine animals, swine, sheep, goats, horses, asses, mules or hinnies, Fresh/Chilled/Frozen” (Offal); “0207: Meat and edible offal, of the poultry of heading 01.05, Fresh/Chilled/Frozen” (Poultry); and Others, which includes “0205: Meat of horses, asses, mules or hinnies, Fresh/Chilled/Frozen”; “0208: Other meat and edible meat offal, Fresh/Chilled/Frozen”; “0209: Pig fat, free of lean meat, and poultry fat, not rendered or otherwise extracted, fresh, chilled, frozen, salted, in brine, dried or smoked”; and “0210: Meat and edible meat offal, salted, in brine, dried or smoked ; edible flours and meals of meat or meat offal”. Gross Domestic Products based on purchasing-power-parity (PPP) per capita GDP of 1995 to 2012 were obtained from the International Monetary Fund, World Economic Outlook Database (IMF 2013); Producer Price Indices of different types of meat used as domestic commodity[2] prices were obtained from FAO statistics for the years of 1995 to 2012 (FAO 2014), and the tariff rates of 1995 to 2012 based on HS-4 classification were obtained from WTO Tariff Analysis Online (WTO 2014). Import prices and per capita GDP were measured in US dollars and were converted to national currency RMB using exchange rate. Producer Price Indices used 2004–2006 as the base period and were only available for the meat of cattle, ass, chicken, duck, goat, goose and guinea fowl, pig, and sheep. Therefore the Producer Price Index of a meat that was most close to the product in HS-4 classification was used as the domestic price of that product. For example, the Producer Price Index of cattle was used as the domestic price of both “0201: Beef, Fresh/Chilled” and “0202: Beef, Frozen”. In addition, because Producer Price Indices used 2004–2006 as the base period, import prices and per capita GDP were normalized by CPI that used 2005 as the base period.

Table 2 shows the basic summary statistics (import quantity and average price) of the seven meat groups for China from 1995 to 2012. Offal had the largest import quality, followed by Pork and Poultry. Beef, Fresh/Chilled had the smallest imported quantity. However, Pork, Poultry, and Offal had the lowest, second, and third lowest average import prices, respectively. Beef, Fresh/Chilled and Beef, Frozen had the highest and second highest average import prices, respectively. From 1995 to 2012, the import quality of all the major meat products demonstrated an increasing trend, with poultry having the highest volatility. For instance, poultry import quantity increased significantly in 1998 and 1999, and reached the highest level in 2000. But the import decreased sharply after 2000 and only reversed the decreasing trend after 2004. Poultry import quantity started a three-year decreasing

[2] There are two main reasons for us to use Producer Price Indices as the domestic commodity price: 1) historical retail prices of all meat products were not available in China and 2) producer prices could better reflect the supply conditions of different meat products, which should have a significant impact on meat imports.

trend again in 2008. Although other meat products did not experience the volatility as high as that of poultry, the special case of poultry demonstrated the complication of studying meat imports of China. Meat imports of China are not only affected by the import price, domestic price, income, and tariff, but are also affected by other factors that seem unpredictable such as foodborne diseases and trade policies associated with foodborne diseases or even social and political events. Overall, the import prices of all meat products increased significantly between 1995 and 2012, with the exception of Others which started a decreasing trend in 2005 before increasing again in 2007. The prices of pork and poultry were under US$1 per kilogram before 2006 and kept stable at US$1 and above after 2006. There was a dramatic increase in the import price of beef. Between 2002 and 2005, the price of Beef, Frozen increased from US$1.09 to US$6.31. The Beef, Fresh/Chilled price increased from US$6.81 per kilogram in 2002 to US$20.87 in 2011.

Table 2. Average price and quantity for imported meats in China, 1995–2012

Year	Import quantity (million kg)							Average price ($/kg)						
	0201 (Beef, Fresh/Chilled)	0202 (Beef, Frozen)	0203 (Pork)	0204 (Sheep & Goat)	0206 (Offal)	0207 (Poultry)	Others	0201 (Beef, Fresh/Chilled)	0202 (Beef, Frozen)	0203 (Pork)	0204 (Sheep & Goat)	0206 (Offal)	0207 (Poultry)	Others
1995	0.05	3.0	2.7	1.6	7.3	257.8	3.78	5.11	1.31	0.35	0.45	0.85	0.31	0.48
1996	0.20	2.8	1.7	3.3	8.8	310.8	1.04	1.78	1.30	0.60	0.48	1.01	0.45	1.21
1997	0.17	2.4	2.6	4.0	6.6	208.6	0.72	1.45	1.23	0.65	0.59	1.67	0.62	0.73
1998	0.08	3.5	18.7	9.3	18.2	192.7	1.76	2.64	1.40	0.42	0.53	0.87	0.56	0.67
1999	0.26	4.3	58.0	10.4	93.7	803.7	3.19	2.22	1.34	0.42	0.77	0.51	0.51	0.72
2000	0.21	6.1	135.9	17.7	134.2	843.3	1.05	2.39	1.05	0.43	0.79	0.56	0.57	1.45
2001	0.28	3.6	94.5	25.3	142.9	703.2	0.60	2.43	1.44	0.44	0.78	0.60	0.63	1.59
2002	0.11	10.9	145.3	34.7	114.9	575.3	0.45	6.81	1.09	0.56	0.78	0.68	0.74	1.55
2003	0.11	8.1	148.6	34.2	211.3	641.4	0.12	9.89	1.35	0.61	1.13	0.73	0.72	1.93
2004	0.20	3.2	70.7	33.0	246.5	184.8	0.09	13.95	2.20	0.77	1.29	0.87	0.83	2.09
2005	0.25	0.9	31.1	41.4	175.3	384.8	0.10	12.43	6.31	0.93	1.32	0.91	0.87	2.20
2006	0.26	0.9	23.9	36.9	201.7	585.7	0.07	14.38	5.32	0.89	1.36	0.71	0.79	1.79
2007	0.41	3.2	85.5	46.7	394.7	800.7	3.66	15.29	2.44	1.44	1.68	0.90	1.18	0.83
2008	0.53	3.7	373.8	55.4	546.8	829.9	17.89	15.12	2.69	1.40	1.91	1.04	1.31	0.91
2009	0.56	13.6	134.7	66.5	399.0	750.8	1.42	13.55	2.68	1.01	2.09	0.99	1.31	1.00
2010	0.38	23.3	199.9	56.9	712.3	540.8	6.32	17.86	3.32	1.04	2.75	1.13	1.78	0.91
2011	0.43	19.7	467.3	82.8	890.5	421.3	21.97	20.87	4.36	1.81	3.31	1.45	2.07	1.18
2012	0.86	60.5	521.7	123.9	848.1	522.2	6.09	13.28	4.02	1.88	3.40	1.75	1.83	1.32
Average	0.30	9.65	139.82	38.00	286.27	530.98	3.91	9.53	2.49	0.87	1.41	0.96	0.95	1.25

Source: World Trade Atlas (2014)

Table 3 shows China's imports of the six major meat products by country of origin in 2012. We selected the top largest exporting countries to China for each type of meat, such that these countries accounted for more than 80% of total meat imports of China in quantity or value. We then combined the imports from all the other countries as meat imports from the rest of the world (ROW). In 2012, Australia was the single largest exporter of Beef, Fresh/Chilled to China, accounting for about 98% of China's meat imports in both quantity and value. Australia, Uruguay, New Zealand, and Brazil were the top four largest exporters of Beef, Frozen. The Pork exporting countries were less concentrated, with the United States, Germany, Canada, Spain, and Denmark accounting for about 85% of total Chinese pork imports in value. Australia and New Zealand were the two largest exporters of Sheep & Goat, accounting for 98% of these Chinese imports in both quantity and value. The United States was the largest exporter of Offal, accounting for about 50% of total Chinese Offal imports, followed by Germany, Canada, and Denmark. Brazil accounted for about 57% of the total Poultry imports of China, followed by the United States and Argentina. These statistics show that China's imports of Beef, Fresh/Chilled, Beef, Frozen, Sheep & Goat, and Poultry were more concentrated than that of Pork and Offal.

Table 3. Import quantity, value, average price, quantity share, and value share, by country of origin for major meat products, 2012

Country	Quantity (million kg)	Value (million dollars)	Average price ($/kg)	Quantity share	Value share
			0201 (Beef, Fresh/Chilled)		
Australia	0.85	11.24	13.27	98%	98%
ROW	0.01	0.20	13.86	2%	2%
			0202 (Beef, Frozen)		
Australia	26.46	118.55	4.48	44%	49%
Uruguay	14.49	49.40	3.41	24%	20%
New Zealand	7.46	26.05	3.49	12%	11%
Brazil	8.71	37.21	4.27	14%	15%
ROW	3.36	11.96	3.56	6%	5%
			0203 (Pork)		
United States	186.82	323.20	1.73	36%	33%
Germany	95.16	192.22	2.02	18%	20%
Canada	52.82	101.42	1.92	10%	10%
Spain	67.16	118.87	1.77	13%	12%
Denmark	51.32	101.62	1.98	10%	10%
ROW	68.40	143.43	2.10	13%	15%
			0204 (Sheep & Goat)		
Australia	50.97	153.92	3.02	41%	37%
New Zealand	70.70	260.90	3.69	57%	62%
ROW	2.22	6.43	2.89	2%	2%

			0206 (Offal)		
United States	402.78	745.14	1.85	47%	50%
Germany	60.94	95.07	1.56	7%	6%
Canada	82.14	136.36	1.66	10%	9%
Denmark	169.10	262.10	1.55	20%	18%
ROW	133.16	245.54	1.84	16%	17%
			0207 (Poultry)		
United States	220.60	271.34	1.23	42%	28%
Brazil	230.41	548.37	2.38	44%	57%
Argentina	48.15	82.82	1.72	9%	9%
ROW	23.00	53.03	2.31	4%	6%

Source: World Trade Atlas (2014).

5. Results

5.1 Import Demand for Beef, Pork, and Poultry in China

We used the Seemingly Unrelated Regression (SUR)[3] method to estimate the empirical models. This method accounts for the correlation in the error terms across the equations of the seven meat products, therefore resulting in more efficient estimates than the Ordinary Least Square (OLS) method (Greene 2003). Table 4 presents the results of both the OLS and SUR methods, which demonstrates that the SUR method resulted in parameter estimates with smaller standard errors and more significant parameter estimates. The following discussion will focus on the results from the SUR method.

Results in Table 4 show that all the own import price elasticities are negative as expected. Except for the elasticities of Beef, Fresh/Chilled, and Sheep & Goat, the absolute value of elasticities of all other meat products are larger than one, with Others having the largest elasticity (–2.22). These elasticities indicate that if the own import price increases by 1%, total import quantity Beef, Fresh/Chilled, Beef, Frozen, Pork, Sheep & Goat, Offal, Poultry and Others will decrease by 0.97%, 1.58%, 1.77%, 0.59%, 1.11%, 1.15%, and 2.22%, respectively. Regarding the domestic price, only the price elasticities of Beef, Frozen, Poultry, and Others are significantly different from zero. The positive domestic price elasticities of Beef, Frozen and Others indicate that domestic products are substitutes of imported products: a 1% increase in the domestic prices of Beef, Frozen and Others will result in about a 2.93% and 2.58%, respectively, increase in the imports of these meats. Rather than being a substitute, domestic Poultry is a complement of imported poultry. A 1% increase in the price of domestic Poultry is associated with a 1.11% decrease in Poultry imports. Except for

[3] Because SUR is a widely used standard method in estimating system equations, we do not provide details of the method. Interested readers can find more details in most econometric textbooks.

the income elasticity of meat Others, all the income elasticities are positive as expected. The income elasticities, from the largest to the smallest are 4.45 for Pork, 3.89 for Sheep & Goat, 3.54 for Offal, 2.78 for Beef, Fresh/Chilled, 2.20 for Poultry, and 1.57 for Beef, Frozen. It is not surprising that Pork has the largest income elasticity, as pork is the most widely consumed meat in the traditional Chinese diet. These results also indicate that Beef, Fresh/Chilled may have better market opportunities than Beef, Frozen with the increasing income of Chinese consumers. The parameters of tariffs are all insignificant no matter which method is used, indicating that tariffs do not have much influence on meat import demand in China.

Table 4. Parameter estimates of meat import demand in China by OLS and SUR

Coefficient	OLS						
	0201 (Beef, Fresh/Chilled)	0202 (Beef, Frozen)	0203 (Pork)	0204 (Sheep & Goat)	0206 (Offal)	0207 (Poultry)	Other
Intercept	–12.73***	–13.56***	–22.85***	–10.82*	–11.98***	0.28	1.11
	(2.83)	(3.78)	(5.81)	(5.22)	(2.05)	(2.69)	(4.95)
Ln(Import Price)	–0.78***	–1.82***	–3.02*	0.24	–1.63***	–1.04	–2.84***
	(0.19)	(0.38)	(1.51)	(1.12)	(0.51)	(0.81)	(0.69)
Ln(Domestic Price)	0.20	2.95**	0.50	–0.59	-0.29	–1.08**	0.55
	(0.55)	(1.00)	(1.63)	(0.88)	(0.70)	(0.44)	(1.61)
Ln(GDP)	2.25***	2.04**	4.96***	2.84**	3.46***	2.15**	0.08
	(0.57)	(0.77)	(1.10)	(1.24)	(0.62)	(0.75)	(1.31)
Ln(Tariff)	0.25	-1.62	0.69	0.08	0.66	0.22	0.71
	(0.52)	(0.99)	(1.61)	(0.77)	(0.64)	(0.60)	(1.74)
Adjusted R^2	0.83	0.72	0.63	0.86	0.93	0.34	0.67
	SUR						
Intercept	–14.83***	–12.46***	–19.24***	–14.06***	–13.07***	0.002	2.01
	(2.56)	(3.45)	(4.30)	(3.37)	(1.72)	(2.32)	(4.59)
Ln(Import Price)	–0.97***	–1.58***	–1.77**	–0.59	–1.11***	–1.15*	–2.22***
	(0.16)	(0.31)	(0.69)	(0.67)	(0.31)	(0.59)	(0.37)
Ln(Domestic Price)	0.38	2.93***	0.12	–0.75	0.01	–1.04**	2.58**
	(0.51)	(0.88)	(0.88)	(0.58)	(0.49)	(0.41)	(1.07)
Ln(GDP)	2.78***	1.57**	4.45***	3.89***	3.54***	2.20***	–1.17
	(0.51)	(0.71)	(0.87)	(0.79)	(0.47)	(0.61)	(1.01)
Ln(Tariff)	–0.05	–1.31	0.27	0.05	0.05	0.22	–0.74
	(0.47)	(0.87)	(1.37)	(0.67)	(0.58)	(0.59)	(1.61)
No. of Obs				18			
System Weighted R^2				0.94			

[a] Numbers in parentheses are standard errors.

[b] *** indicates this number is statistically different from zero at the 0.01 level.

[c] ** indicates the number is statistically different from zero at the 0.05 level.

[d] * indicates the number is statistically different from zero at the 0.1 level.

5.2 Import Demand for Meat by Country of Origin

Between 1996 and 2012, Australia was a dominant exporter of Beef, Fresh/Chilled to China, accounting for more than 95% of these Chinese imports in most years. These exports kept increasing and reached 0.98 million kg in 2012 (Figure 2).

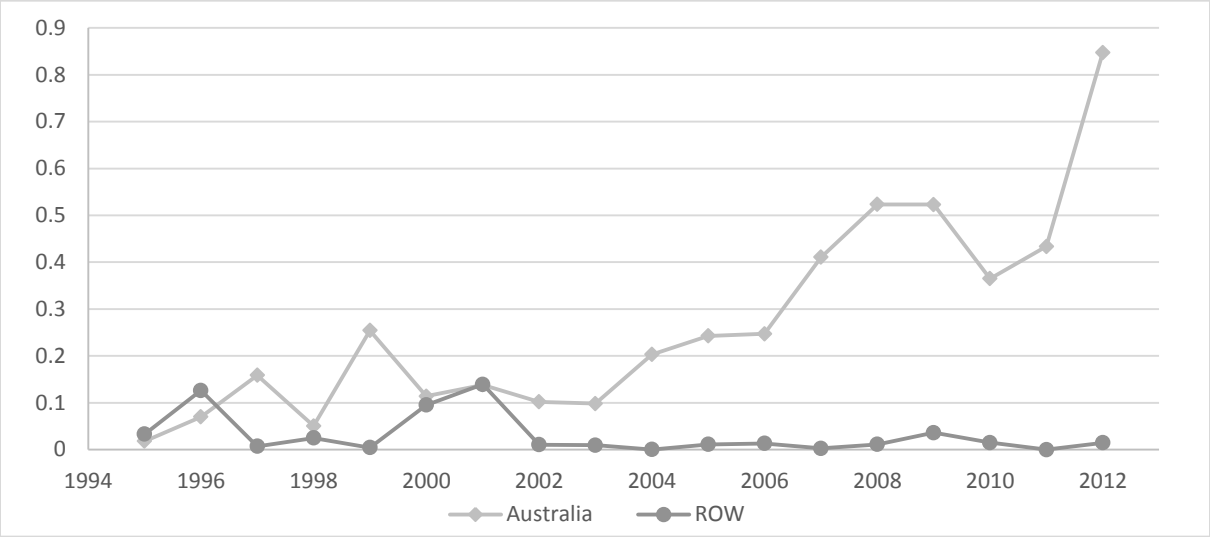

Figure 2. Total quantity of imported Beef, Fresh/Chilled from Australia and ROW, 1995 to 2012 (million kg)

Source: World Trade Atlas (2014)

Between 1995 and 2012, the exporting countries of Beef, Frozen to China were diverse, and changed over the years. From 1995 to 2012, Australia and New Zealand continuously exported Beef, Frozen to China, while exports to China from the other major exporting countries changed during this period for various reasons. For instance, the United States was the largest, or the second largest exporter of Beef, Frozen to China from 1995 to 2003. These exports dropped significantly to 0.04 million kg in 2004, and to zero after 2004 due to the US beef Bovine spongiform encephalopathy (BSE) outbreak in 2003 (Seng 2013). After the ban on US beef, Uruguay and Brazil gradually became the second and the third largest exporters, respectively (Figure 3). Other than the United States, the exports of all the major countries increased, implying the increased total imports of Beef, Frozen associated with the fast growing Chinese economy.

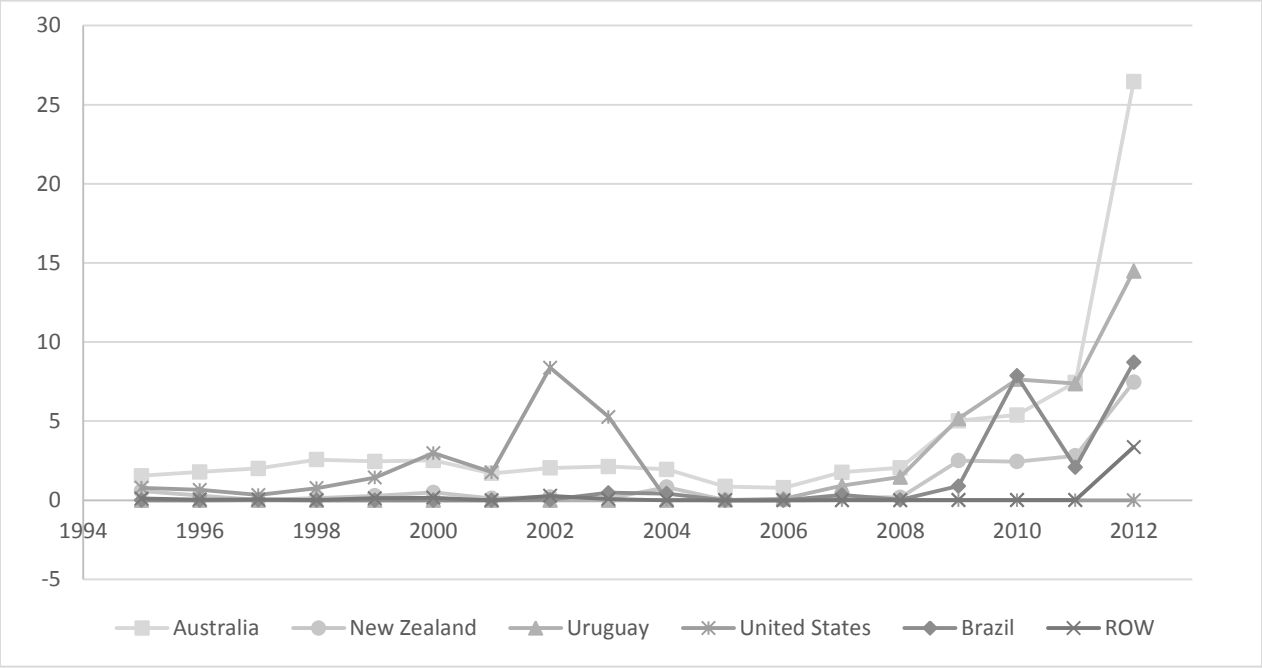

Figure 3. Total quantity of imported Beef, Frozen from Australia, New Zealand, Uruguay, the United States, Brazil, and ROW, 1995 to 2012 (million kg)

Source: World Trade Atlas (2014)

Pork imports of China increased significantly in the last 10 years, again implying the increased total Pork imports associated with the fast growing Chinese economy. Between 1995 and 2012, the major exporting countries of Pork included the United States, Canada, Spain, Germany, and Demark (Figure 4). Germany and Spain significantly expanded their Pork exports to China. For example, in 2012, Germany and Spain became the second and third largest Pork exporters, respectively, to China. The fluctuation of US Pork exports to China were particularly high, which indicated that factors such as foodborne diseases and trade policies may have a stronger impact than price on US Pork exports to China.

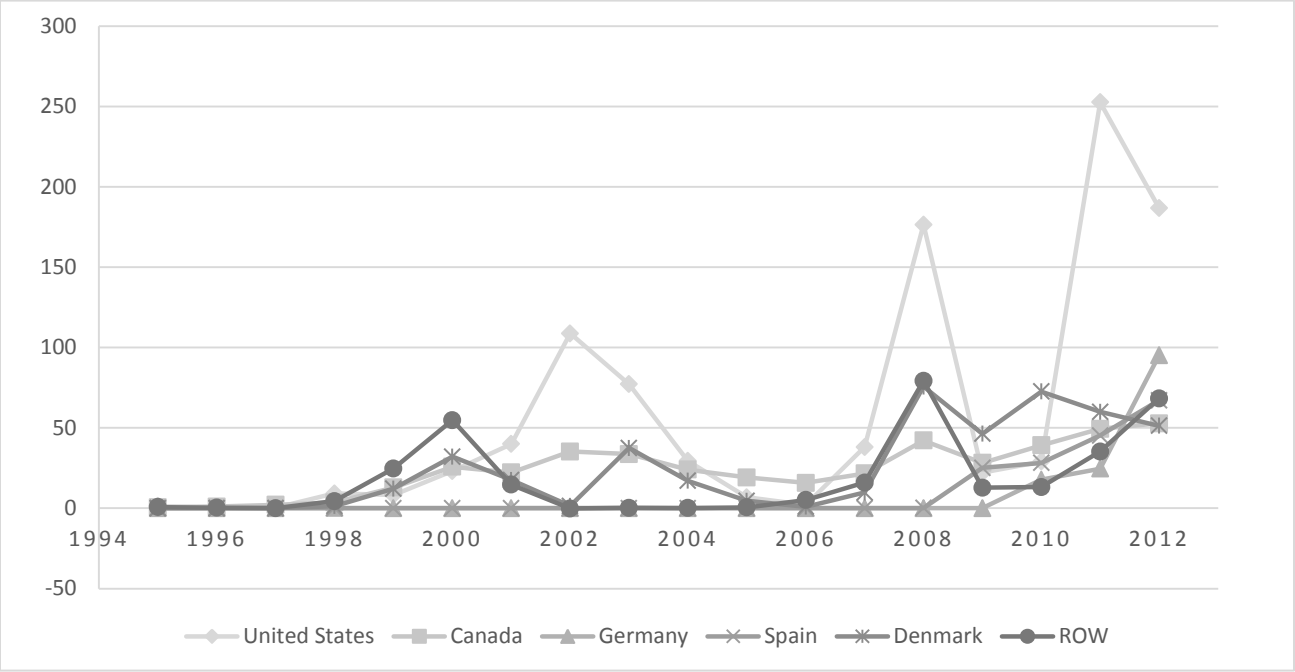

Figure 4. Total quantity of imported Pork from the United States, Canada, Germany, Spain, Demark, and ROW, 1995 to 2012 (million kg)

Source: World Trade Atlas (2014)

Australia and New Zealand were the two dominant countries of Sheep & Goat meat to China from 1995 to 2012 (Figure 5). Exports from New Zealand were sometimes 700% more than those from Australia. In recent years, the gap in exports between the two countries decreased, with exports from New Zealand being only about 16% to 38% greater than those from Australia. The significant larger exports of Sheep & Goat meat from New Zealand before 2001 might be attributed to the lower price of New Zealand meat, normally about 8% to 85% lower than the Australia meat. After 2001, the price of Australia Sheep & Goat meat was equal to, or lower than, that of New Zealand. The still larger exports of New Zealand may reflect Chinese consumer preference for New Zealand Sheep & Goat.

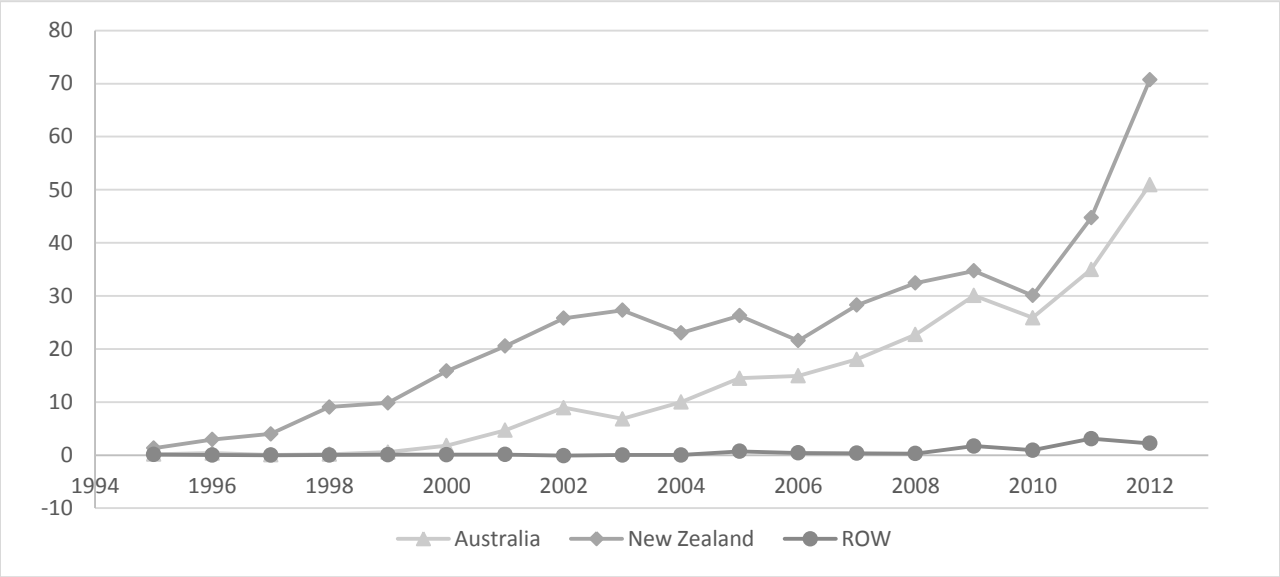

Figure 5. Total quantity of imported Sheep and Goat from Australia, New Zealand, and ROW, 1995 to 2012 (million kg)

Source: World Trade Atlas (2014)

Between 1995 and 2012, the major Offal exporters included the United States, Germany, Canada, and Denmark, with the United States and Denmark dominating the market after 2007 (Figure 6). On average, these four countries accounted for more than 85% of the total Chinese Offal import, although sometimes the percentage was below 50%, which indicated that other countries were supplying Offal products to China. Exports of Offal to China increased from all the countries, particularly from the United States. US exports increased from 154 million kg in 2010 to 548 million kg in 2011 and 403 million kg in 2012.

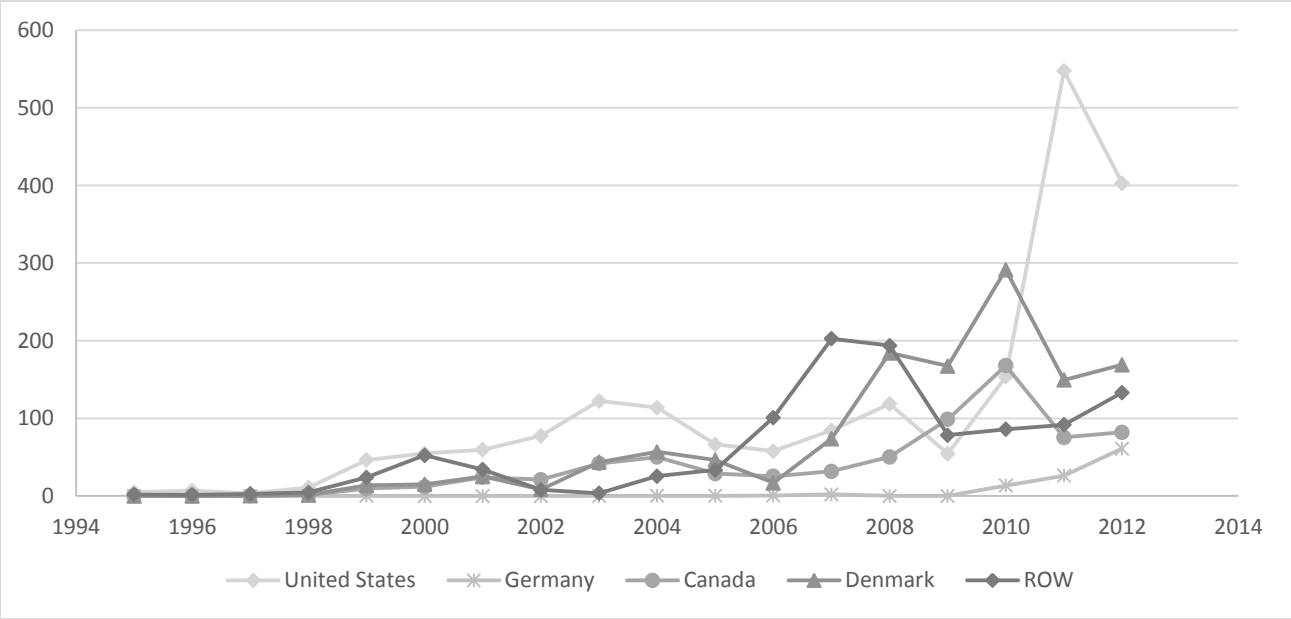

Figure 6. Total quantity of imported Offal from United States, Germany, Canada, Denmark and ROW, 1995 to 2012 (million kg), Source: World Trade Atlas (2014)

The United States, Brazil, and Argentina were the three largest Poultry exporters to China from 1995 to 2012. The United States dominated the Poultry imports of China until 2010, accounting for more than 90% of the total Chinese Poultry imports in 2002 and 2003 (Figure 7). However, Brazil surpassed the United States in 2010, becoming the largest Poultry exporter to China. Although the exports from these three countries all increased from 1995 to 2012, the quantity of Poultry exports to China fluctuated dramatically in some years. This is especially true for US Poultry exports. For instance, US exports dropped significantly from 620 million kg in 2003 to 80 million kg in 2004, and decreased from 640 million kg in 2009 to 108 million kg in 2010. These dramatic changes in US poultry exports to China indicated the substantial impact of foodborne diseases and trade policies on international trade. It was believed that the significant decrease in US poultry exports was due to bird flu outbreaks and China's trade policy bans on U.S. poultry imports.

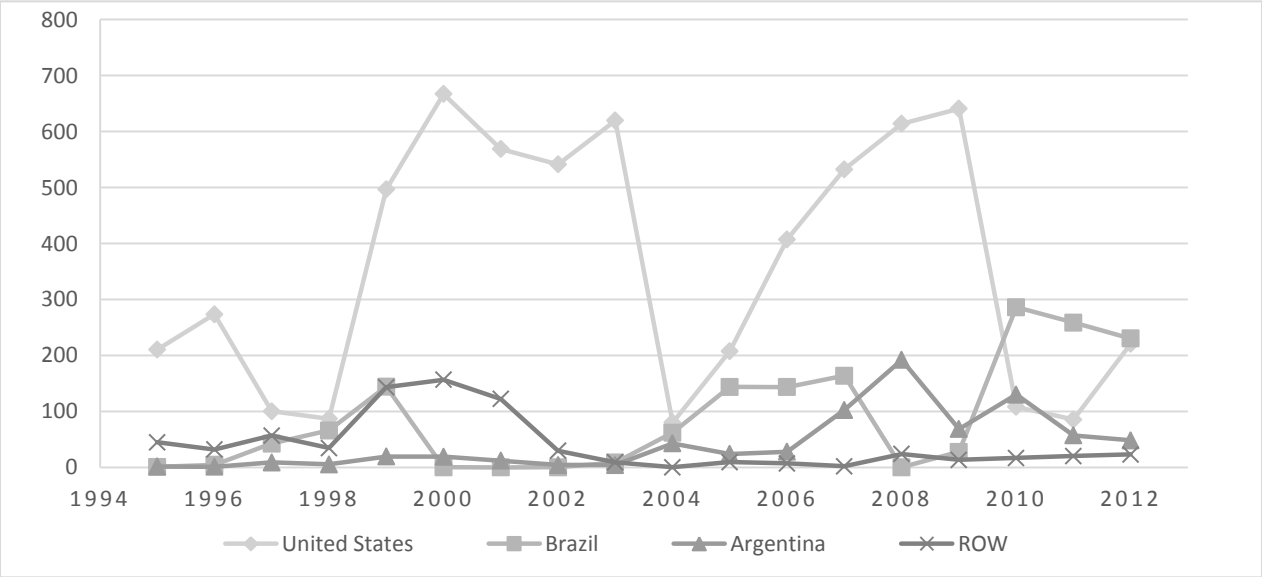

Figure 7. Total quantity of imported Poultry from United States, Brazil, Argentina, and ROW, 1995 to 2012 (million kg), Source: World Trade Atlas (2014)

These statistics also indicate that when estimating the import demand model of China by country, prices may sometimes demonstrate a theoretically incorrect effect on import demand (e.g., significant positive price coefficients). These types of price effect may be expected for meat products that experienced substantial changes due to outbreaks of foodborne diseases and trade policy bans.

5.3 Regression Results of Import Demand of Meat by Country of Origin

System import demand equations were estimated for the six major meat products (except Others category) by country. Because the major meat exporters to China differed by meat product, the countries included in each system of demand equations vary. The demand equations included imports from Australia and ROW for Beef, Fresh/Chilled; imports from Australia, New Zealand, and ROW for Beef, Frozen and Sheep & Goat; imports from the United States, Canada, Denmark, and ROW for Pork; imports from the United States, Canada, Denmark, and ROW for Offal, and imports from the United States, Brazil, Argentina, and ROW for Poultry. For each product, the demand equation was first estimated by including all the cross country price effects. The *F* test was then conducted to determine whether or not all the cross country price effects were significant. The final model was selected such that the null hypothesis that the coefficients of the cross country prices included in the model equaled zero was rejected. For instance, the import demand equations of Beef, Frozen were first specified as:

$$Import\ from\ AU = \alpha_0 + \alpha_1 lnrgdp + \alpha_2 lndp + \alpha_3 lnt + \alpha_4 lnp_{AU} + \alpha_5 lnp_{NZ} + \alpha_6 lnp_{ROW} + e_1 \quad (4)$$

$$Import\ from\ NZ = \beta_0 + \beta_1 lnrgdp + \beta_2 lndp + \beta_3 lnt + \beta_4 lnp_{AU} + \beta_5 lnp_{NZ} + \beta_6 lnp_{ROW} + e_2 \quad (5)$$

$$Import\ from\ ROW = \gamma_0 + \gamma_1 lnrgdp + \gamma_2 lndp + \gamma_3 lnt + \gamma_4 lnp_{AU} + \gamma_5 lnp_{NZ} + \gamma_6 lnp_{ROW} + e_3 \quad (6)$$

where $lnrgdp, lndp, lnt$ are the same as defined in equation (3), and $p_{AU}, p_{NZ}, and\ p_{ROW}$ are prices of imported Beef, Frozen from Australian, New Zealand, and ROW, respectively. Then the null hypothesis that all the cross price effects were not significant such that α_5=$\alpha_6 = \beta_4 = \beta_6 = \gamma_4 = \gamma_5 = 0$ was tested. If the null hypothesis cannot be rejected, then all the cross country prices were removed from the model. If the null hypothesis was rejected, then actions were taken to determine the cross price effects that were significant, and only the cross country prices that had significant effects were included in the final model.

Results in Tables 5, 6, and 7 indicate that the all the cross country price effects are not significant for the models of Beef, Fresh/Chilled; Sheep & Goat; and Offal. For Beef, Frozen, the import price of Australia has a significant cross country price effect on the import from ROW (Table 6, column 6). For Pork, the import prices of Canada, Demark, and ROW have significant cross country price effects on the imports from the United States. The import price of Canada also has a significant cross country price effect on the imports from Demark and ROW. For Poultry, the import price of ROW has a significant cross country price effect on the imports from the United States.

Results in Table 5 show that for Beef, Fresh/Chilled, the own price elasticities of both Australia and ROW are significant. However, ROW has a larger own price elasticity than Australia. Domestic Beef, Fresh/Chilled is a substitute of imports from ROW but not from Australia. However, Chinese income only has a significant positive impact on the imports from Australia. Tariff only has a significant negative impact on the imports from ROW. Regarding imports of

Beef, Frozen, all the own price elasticities of the imports from Australia, New Zealand, and ROW are not significant. Domestic Beef, Frozen is a substitute of the imports of all the three countries/regions, with New Zealand having the largest domestic price elasticity (6.9), followed by ROW (4.01) and Australia (2.15). Chinese income only has a significant positive impact on the imports from ROW. For Sheep & Goat, only Australia and ROW have significant own price elasticities. In addition, only Australia has significant income elasticity. Imports from New Zealand are not significantly affected by any of the variables specified in the models (Table 5).

Results in Table 6 demonstrate that for Pork, all the income elasticities of the United States, Canada, Demark, and ROW are significant, with Demark having the largest income elasticity (8.07), followed by ROW, Canada, and the United States. Domestic price only has a significant impact on the imports from the United States and ROW. The most striking result is that ROW has a positive own price elasticity, which is not consistent with economics theory. However, this may be because the imports from Canada dominate the Pork imports from other countries/regions due to the cross price elasticity between Canada and the United States, Demark, and ROW. All the cross price elasticities are significantly negative and very elastic. This is particularly true for the imports from ROW that has a cross price elasticity of –11.65, which indicates that if the price of Pork from Canada decreases by 1%, Chinese imports from ROW would increase by 11.65%. Under this condition, even if the Pork price of ROW increases, the imports from ROW would continue to increase as long as the Canadian price decreases. Results in Table 6 also demonstrate that income has a significant impact on the Offal imports from all four countries/regions. Denmark has the largest income elasticity, followed by Canada, the United States, and ROW. Regarding the own price elasticities, only Canada and ROW have significant own price elasticities, which indicates that increased prices of imported Offal from the United States and Demark might not reduce the imports from these two countries.

Results in Table 7 demonstrated that the United States and Argentina have significant income elasticities for Poultry imports of China. Only the United States and ROW have significant own price elasticities. In addition, domestic Poultry and imported Poultry from ROW are complements of imported Poultry from the United State—increased prices of domestic Poultry and Poultry from ROW would significantly reduce the poultry imports from the United States.

Table 5. Parameter estimates of meat import demand for Beef, Fresh/Chilled, Beef, Frozen, and Sheep & Goat by country

	0201 (Beef, Fresh/Chilled)		0202 (Beef, Frozen)			0204 (Sheep & Goat)		
Variables	Australia	ROW	Australia	New Zealand	ROW	Australia	New Zealand	ROW
Intercept	–14.95***	–12.83**	–8.33**	–22.70**	–21.97***	–25.53***	–5.42	–24.01***
	(3.86)	(4.56)	(3.73)	(9.56)	(6.20)	(1.53)	(5.02)	(4.00)
Ln(Domestic Price)	–0.73	3.99***	2.15**	6.90**	4.01**	0.02	–0.57	3.26
	(0.76)	(1.08)	(0.96)	(2.57)	(1.66)	(0.82)	(1.04)	(2.18)
Ln(GDP)	3.26***	0.49	0.55	–0.02	3.96**	5.53***	1.55	0.79
	(0.81)	(0.76)	(0.81)	(1.75)	(1.42)	(0.48)	(1.21)	(1.38)
Ln(Tariff)	0.54	–2.52**	–0.65	–2.38	–2.38	0.02	0.16	1.34
	(0.71)	(0.97)	(0.96)	(2.53)	(1.59)	(0.65)	(0.87)	(1.74)
Lnp(Australia)	**–0.83*** **		**–0.65**		–3.12***	**–1.79*** **		
	(0.26)		(0.39)		(0.88)	(0.38)		
Lnp(New Zealand)				**–1.45**			**0.76**	
				(1.07)			(0.88)	
Lnp(ROW)		**–1.37*** **			**–0.82**			**–0.67** **
		(0.12)			(0.63)			(0.29)
System Weighted R^2	0.91			0.64			0.95	

Note: a: Values in bold are own price elasticities.

b: Values in parentheses are standard errors.

c: *** indicates this number is statistically different from zero at the 0.01 level.

d ** indicates the number is statistically different from zero at the 0.05 level.

e* indicates the number is statistically different from zero at the 0.1 level.

Table 6. Parameter estimates of meat import demand for Pork and Offal by country

	0203 Pork				0206 Offal			
Variables	United States	Canada	Denmark	ROW	United States	Canada	Denmark	ROW
Intercept	–25.78***	–13.30***	–42.21***	–38.29***	–11.96***	–18.84***	–27.84***	–9.25***
	(7.16)	(3.83)	(9.45)	(10.30)	(3.04)	(2.84)	(4.61)	(2.60)
Ln(Domestic Price)	4.94**	0.28	4.23	4.52*	–1.39	–1.57	–2.41	0.93
	(1.66)	(0.99)	(2.41)	(2.34)	(1.09)	(0.96)	(1.64)	(0.86)
Ln(GDP)	3.28**	3.23***	8.07***	5.71**	3.59***	5.41***	7.10***	1.84**
	(1.29)	(0.75)	(1.86)	(1.77)	(0.94)	(0.89)	(1.51)	(0.76)
Ln(Tariff)	–1.65	–0.02	–1.92	0.87	1.27	0.24	0.19	0.69
	(1.40)	(0.86)	(2.13)	(1.85)	(1.05)	(0.87)	(1.68)	(0.85)
Lnp(United States)	**1.78**			1.96	**–0.73**			
	(0.96)			(1.59)	**(0.74)**			
Lnp(Canada)	–9.00***	**–1.82***	–9.06***	–11.65***		**–1.21****		
	(1.81)	**(1.01)**	(2.63)	(2.24)		**(0.54)**		
Lnp(Denmark)	3.68**		**0.72**				**0.85**	
	(1.26)		**(1.49)**				**(0.52)**	
Lnp(ROW)	–0.54*			**1.60*****				**–1.98*****
	(0.27)			**(0.45)**				**(0.40)**
System Weighted R^2		0.83				0.87		

Note: a: Values in bold are own price elasticities.

b: Values in parentheses are standard errors.

c: *** indicates this number is statistically different from zero at the 0.01 level.

d ** indicates the number is statistically different from zero at the 0.05 level.

e* indicates the number is statistically different from zero at the 0.1 level.

Table 7. Parameter estimates of meat import demand for Poultry by country

	0207 Poultry			
Variables	United States	Brazil	Argentina	ROW
Intercept	1.80	–12.30	–15.35**	0.67
	(2.82)	(18.90)	(6.05)	(4.37)
Ln(Domestic Price)	–1.96**	2.98	–0.85	–1.16
	(0.65)	(3.46)	(1.05)	(1.01)
Ln(GDP)	3.19***	–0.33	4.41**	1.29
	(0.80)	(4.48)	(1.81)	(1.01)
Ln(Tariff)	–0.28	0.35	–0.52	1.69
	(0.91)	(4.73)	(1.30)	(1.38)
lnp_United_States	**–1.70*** **			
	(0.70)			
lnp_ Brazil		**1.10**		
		(2.96)		
lnp_ Argentina			**–0.57**	
			(1.20)	
lnp_ROW	–0.61**			**–2.33*** **
	(0.25)			**(0.38)**
System Weighted R^2		0.80		

Note: a: Values in bold are own price elasticities.

b: Values in parentheses are standard errors.

c: *** indicates this number is statistically different from zero at the 0.01 level.

d ** indicates the number is statistically different from zero at the 0.05 level.

e* indicates the number is statistically different from zero at the 0.1 level.

6. Conclusions

With increasing household income and continuing economic growth in China, Chinese consumers are demanding more high protein products such as meat. Accordingly, it is important for the major world meat producers to have a better understanding of the meat import demand in China. Using annual data from 1995 to 2012 to estimate the import demands for major meat products such as Beef, Fresh/Chilled, Beef, Frozen, Pork, Sheep &Goat, Offal, and Poultry, our results indicate that import demands for meat products are mostly determined by import price and real GDP. Other factors such as prices of domestic meat and tariffs in general do not have significant impacts on meat imports of China. For all the major meat products in our analysis, the absolute values of income elasticity are larger than the own-price elasticities, indicating that when both income and price increase at the same rate, China will continue importing more meat. In addition, Beef, Fresh/Chilled and Sheep & Goat have smaller own-price elasticities than other meat products, which means that increasing the prices of Beef, Fresh/Chilled and Sheep & Goat will have less impact on the import demand for Beef, Fresh/Chilled and Sheep & Goat than on the demand for other meat products. Pork and Beef, Frozen have the largest and smallest income

elasticities, respectively. This implies that the continuing income growth of China may benefit pork exporters the most and the Beef, Frozen exporters the least.

The analysis of meat demand by country demonstrates that Australia is the dominant exporter of Beef, Fresh/Chilled and Beef, Frozen, and Australia and New Zealand are the dominant exporters of Sheep & Goat. The United States was one of the largest exporters of Beef, Frozen until the BSE outbreak in the United States in 2003; since then its position has been replaced by other countries such as Uruguay and Brazil. Between the two largest pork exporters to China, the United States and Canada, U.S. pork exports to China are more susceptible to trade policies and foodborne disease outbreaks. Overall, all the exporters of Pork and Offal are enjoying the fast growing income and meat demand from China. The impact of income on import demands for meat differs significantly by country.

Further research should extend the current paper in several dimensions. First, when estimating import demand by country, some important exporters are combined because of the lack of data for certain years. For instance, although the United States was one of the most important Beef, Frozen exporters, it completely stopped its exports to China after 2004. In the meanwhile, Uruguay and Brazil exported about 24% and 14%, respectively, of total Chinese imports of Beef, Frozen in 2013. However, because data for these two countries are unavailable before 2005 and 2007, respectively, it is also impossible to estimate import demand for Beef, Frozen for these countries individually. In addition, it is also obvious that trade policy and foodborne disease events would significantly affect meat imports; because of the short time period, it is hard to incorporate this information when estimating the demand models. When more data are available, the impact of trade policies and foodborne diseases should be incorporated into the model estimation.

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