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Time-varying Armington elasticity and country-of-origin bias: from the dynamic perspective of the Japanese demand for beef imports

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Elasticities of substitution, often called Armington elasticities, reflect incomplete substitutability because of perceived product characteristics. This study divides the determinants of the Japanese demand for beef imports into two factors: (i) substitution elasticity and (ii) country-of-origin bias, and demonstrate how these measurements are associated with trade policy and food scare events. The Japanese beef industry serves as a case study to evaluate the multifold impact of import liberalisation and a series of bovine spongiform encephalopathy (BSE) outbreaks. A time-varying parameter model is used to shed light on the dynamic effects of the import liberalisation and BSE outbreaks on the measurements. The estimation results reveal that the estimated substitutability and country-of-origin bias are very sensitive to the BSE cases, but not to the process of trade liberalisation. The results also confirm that as a result of the BSE outbreaks, the major factor of the Japanese demand for beef imports has changed from relative prices to the country-of-origin effect, thereby emphasising the importance of a traceability system and promotional activities, which would help in the formation of the country-of-origin effect.

Key words: Armington elasticity, beef import market, country-of-origin bias.

1. Introduction

Consumers are becoming increasingly concerned about food health and safety. Information regarding food safety, nutrition, and traceability affects consumers' decisions at the point of sale and also affects international food trade (Caswell 2000). Country-of-origin labelling for beef is considered to be one of the important production attributes valued by Japanese consumers (Erikson *et al.* 1998). Awareness about the country-of-origin of agricultural products is prominent in Japan and is also growing in many parts of the world.[1] In fact,

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[1] While the country-of-origin labelling program is implemented in many parts of the world, it becomes critical issue when implementing the preferential trade through differentiated tariff rates. The preferential trade area (PTA) requires some evidence of the origin of the products, the so-called 'rules of origin'. The rules of origin become extremely complicated as the number of PTAs increases, possibly becoming stumbling blocks of free trade (Bhagwati *et al.* 1999).

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mandatory country-of-origin labelling has already been implemented in the EU and Japan and is also planned to take effect in the US. Even the consumers in these countries support the mandatory country-of-origin labelling program; for instance, consumers in France and Germany give the highest priority to the product characteristic of country-of-origin from among other product characteristics such as brand, price, and marbling (Roosen *et al*. 2003). The use of country-of-origin labelling in Japan was widespread on a voluntary basis even before the onset of the mandatory labelling program in July 2000; this allowed Japanese consumers to select their preferences from among major beef suppliers.

The sources of the country-of-origin bias (also referred to as home or foreign product bias) stems from various demand and/or supply factors. Several previous studies have investigated the determinants of the country-of-origin bias prevailing across industrial sectors. For example, Blonigen and Wilson (1999) demonstrated that the formation of the home product bias in the US manufacturing sector is associated with industry characteristics such as entry barriers, foreign-owned facilities, and the proportion of union workers. In addition to such supply-side factors, Lopez *et al*. (2006) showed that demand-side factors are more influential in the formation of such biases in the case of the US. processed food industry. They demonstrated that the home product bias with regard to processed food is formed in the cases of greater domestic agricultural content and more value-added products while controlling other supply-side factors. These approaches are useful to identify the product and/or industrial characteristics that explain the wide variation of home product biases across industries. However, little is known about how the degree of the country-of-origin bias fluctuates over time. It is highly possible that such measurements are strongly linked to food safety issues such as bovine spongiform encephalopathy (BSE) outbreaks as well as trade policies. Therefore, using time series data, we estimate time-varying parameters for the country-of-origin bias and for the substitution elasticity, and demonstrate how these measurements are associated with policy reforms and food scare events.

The Japanese beef industry serves as a good case study to analyse the changes in consumers' preferences over time. As shown in Table 1, the beef import liberalisation policy implemented in April 1991 increased competition between imports and the domestic market, possibly altering consumers' preferences. Moreover, a series of BSE outbreaks occurred in the domestic market, and foreign beef suppliers entailed considerable adjustments in beef supply between domestic and imported markets as well as among foreign beef suppliers, thereby shedding light on the dynamic adjustment process with regard to the country-of-origin among major beef suppliers.

This study has two specific objectives. First, we investigate whether and to what extent the country-of-origin bias is likely to affect the Japanese demand for beef imports. In other words, this study compares the extent of the country-of-origin bias with the substitution elasticity and identifies the circumstances under which the country-of-origin bias becomes a dominant

Table 1 Japanese beef import index, market share, and unit price: 1991–2007

Year	Beef import index	Tariff	Market share (%, volume)			Unit price (¥/kg)		
	(1992 = 100)	rate	US	Australia	ROW	US	Australia	ROW
1991	85.8	0.700	43.8	52.5	3.6	852.2	557.1	603.4
1992	100.0	0.600	45.0	52.3	2.7	817.2	496.4	569.8
1993	124.3	0.500	42.3	54.2	3.4	699.1	408.6	429.7
1994	143.0	0.500	42.5	53.2	4.3	620.9	404.5	395.8
1995	157.6	0.481	46.0	48.6	5.4	590.2	367.8	361.7
1996	153.0	0.462	49.0	45.4	5.7	586.0	358.5	348.2
1997	157.3	0.443	47.3	47.2	5.5	606.1	381.0	392.4
1998	161.9	0.423	48.0	46.8	5.2	557.7	363.6	401.0
1999	164.6	0.404	48.4	46.5	5.2	487.9	334.9	380.9
2000	174.8	0.385	48.4	45.9	5.6	465.7	310.9	352.1
2001	164.0	0.385	46.1	48.0	5.9	485.8	350.3	362.4
2002	118.3	0.385	46.5	47.4	6.1	417.4	368.6	339.7
2003	140.0	0.385	46.4	49.2	4.4	479.9	387.0	362.8
2004	104.9	0.385	n/a	91.3	8.4	n/a	461.3	423.5
2005	111.8	0.385	n/a	89.4	10.5	n/a	483.3	464.6
2006	111.9	0.385	n/a	88.1	10.3	n/a	486.9	487.7
2007	115.1	0.385	7.2	83.1	9.6	643.1	497.4	501.3

factor in the demand for beef imports. Umberger *et al*. (2003) point out that the factor of the country-of-origin for beef became increasingly important worldwide, particularly after the BSE outbreaks. This observation has been empirically investigated. Second, as a result of major structural changes led by trade liberalisation and the BSE outbreaks in the last decade, it is of interest to understand how such changes are associated with the measurements of the country-of-origin bias and substitutability. To achieve this result, we illustrate the dynamic trend in the measurements of the country-of-origin effect and of the substitution elasticity. Conventional regression analyses suggest that the parameters do not vary according to time; however, it would often be more reasonable to assume that the parameters do vary over time.

The remainder of this article is organised as follows. Section 2 provides the background and reviews the literature related to the Japanese beef import market. Then, section 3 describes Armington import demand model that distinguishes the products by the place of production, and its estimation method. Section 4 addresses the estimation results, trend of the country-of-origin bias and substitution elasticity. Finally, Section 5 summarises the main findings and suggests directions for future research.

2. Japanese beef imports: an overview

Table 1 presents the Japanese beef import index (1992 = 100), market shares, and unit prices for the US, Australia, and the rest of the world (ROW). It shows that Japanese beef imports grew steadily under the trade liberalisation policy. Japanese beef imports had increased by 74.8 per cent

from 1992 to 2000 as the applied tariff rate gradually reduced from 70 per cent to 38.5 per cent. The corresponding unit price of imported beef decreases for the US and is fairly constant for Australia and the ROW, thereby diminishing the price differentials between countries. It is also clear that in terms of beef imports, Japan is an important market for the US and Australia, dominating 95 per cent of the market in terms of volume. On the contrary, the market share of the ROW, mainly New Zealand and Canada, remains barely 5–10 per cent.

The impact of a series of BSE outbreaks on Japanese beef imports is clearly evident in Table 1. The first BSE case in Japan, which occurred in September 2001, decreased the beef import index from 164.0 to 118.3, which is equivalent to a 27.9 per cent loss in beef imports. It is interesting to note that the beef import market did not serve as a substitute for the domestic beef market when the first BSE outbreak occurred in Japan. The BSE case in Canada, which occurred in May 2003, reduced the market share of the ROW from 6.1 per cent to 4.4 per cent. Likewise, the BSE case in the US, which occurred in December 2003, further decreased the import index in the subsequent year to 104.9, which is close to the index at the pre-trade liberalisation level.

Note that the market share is somewhat stable, whereas both the beef import index and unit prices fluctuate over time before the occurrence of the BSE outbreaks. Because of the rigidity in the trade shares, it can be argued that the Japanese beef import market is not subject to price competition. In other words, the trade share in Japanese beef imports might be determined independently of price levels. Weatherspoon and Seale (1995) investigated this hypothesis when Australia began losing its market share from 1970s to 1980s. The estimation results show that the trade share of beef exported to Japan would not have changed in the absence of relative price changes, thereby rejecting the null hypothesis. Reed and Saghaian (2004) empirically investigated the price margin in relation to market power. Their analysis shows that the degree of market power in the Japanese beef import market depends on the beef cut (e.g., loin, chuck, ribs) and the form (e.g., frozen vs. chilled) and is not related to the size of the market share. Whether or not the Japanese demand for beef imports is discriminatory depends on the substitutability between the different sources of beef supply; that is, the market would be judged to be discriminatory when the country-of-origin bias rather than the substitution elasticity is the principal determinant of the demand for beef imports. Between 2003 and 2007, since the import index has declined (see Table 1), US share has declined and Australia's share has increased; the presence of country-of-origin bias is very much apparent. However, because the US price increased in 2007 and Australian price decreased, the price effect needs to be isolated. Thus, it is more desirable to take into account the influence of the country-of-origin when analysing source-specific import demands.

3. Method and procedure

This study utilises a framework of the Armington demand model to distinguish beef products by place of production.[2] The Armington demand model assumes that the budgeting procedure for beef consumption involves two stages. In the first stage, consumers divide beef expenditure into expenditure on domestic and imported beef, allowing for substitution between the two. In the second stage, the expenditure allocated to imported beef is further allocated into source-specific imports (e.g., the US, Australia and the ROW). The Armington demand model is derived from the following utility function:

$$U = \left[\delta \cdot D^{\frac{\sigma-1}{\sigma}} + (1-\delta) \cdot M^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \quad \text{where} \quad M = \left[\sum \phi_i \cdot M_i^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \tag{1}$$

U is the total utility from the consumption of domestic beef (D) and imported beef (M). σ and θ are the elasticities of substitution between domestic and imported beef and among various sources of imported beef, respectively. δ and ϕ are the distribution parameters that reflect the relative preference between different sources; for example, if there is no preference bias between domestic and imported beef, δ takes the value of 0.5. On the contrary, the value of δ becomes >0.5 when consumers prefer domestic beef over imported beef. Similarly, ϕ_i indicates the weight of preference on the ith beef exporting country among the alternatives. To maximise the total utility subject to the budget constraints, the following optimal conditions need to be satisfied:

$$\frac{D}{M} = \left(\frac{\delta}{1-\delta}\right)^{\sigma} \left(\frac{P^M}{P^D}\right)^{\sigma}, \quad \text{and} \tag{2}$$

$$\frac{M_j}{M_i} = \left(\frac{\phi_j}{\phi_i}\right)^{\theta} \left(\frac{P^i}{P^j}\right)^{\theta}, \tag{3}$$

where P^M and P^D are the prices for imported and domestic beef respectively. M_i and P^i indicate the beef import volume and unit price, respectively, from the ith country. Equation (2) implies that the domestic to import ratio should be determined by a fraction of the prices multiplied by a fraction of the

[2] The Armington model assumes that, within a market, trade patterns change only with relative price changes, and elasticities of substitution between the pairs of competing products are identical and *constant*. While the Armington model has been widely used in agricultural trade analysis, recent evidence indicates that the underlying assumptions is not always valid (Alston *et al*. 1990). The aim of this paper is not to investigate the validity of Armington assumption. Rather, the aim is to prove empirical evidence that Armington elasticity is not constant over time. Dynamic perspective of Armington elasticities is also discussed in Welsch (2006).

distribution parameters. Similarly, Equation (3) indicates that the ratio of beef imports from two different countries (i and j) depends on their relative price and a fraction of the distribution parameters. The optimality conditions provide the conceptual basis for the empirical analysis. Taking the natural logarithm on both sides of Equation (2) yields

$$\log\left(\frac{D}{M}\right) = \sigma \cdot \log\left(\frac{\delta}{1-\delta}\right) + \sigma \cdot \log\left(\frac{P^M}{P^D}\right), \tag{4}$$

Adding an error term and seasonal dummy variables (D_j) yields Equation (5), which can be estimated by a standard econometric tool.

$$q_t = \beta_0 + \beta_1 \cdot p_t + \sum_{k=1}^{11} m_k D_k + \varepsilon_t, \tag{5}$$

where $q_t = \log\left(\frac{D}{M}\right)$, $\beta_0 = \sigma \cdot \log\left(\frac{\delta}{1-\delta}\right)$, $\beta_1 = \sigma$, $p_t = \log\left(\frac{P^M}{P^D}\right)$.

The estimation of the parameters in Equation (5) reveals Japanese consumers' underlying preference for beef imports in Equation (1). β_1 indicates the substitution elasticity that measures the percentage increase in the ratio of domestic to foreign purchase of beef in the face of a 1 per cent increase in the ratio of foreign and domestic prices. The effect of this substitution translates the fluctuation in price ratio into the relative import demand. On the contrary, the country-of-origin bias is defined as a natural logarithm of the ratio of the distribution parameters, particularly $\log((1-\delta)/\delta)$. It can be obtained by dividing β_0 by β_1. Note that the estimate of the country-of-origin bias becomes zero if the value of δ is 0.5. The value of the country-of-origin bias becomes positive if domestic beef is more favoured than imported beef ($\delta > 0.5$). Hence, estimating the country-of-origin bias (β_0/β_1) demonstrates the underlying relative preference of domestic beef over imported beef.

In this manner, we can divide the determinants of the Japanese demand for beef imports into two factors: (i) substitution elasticity and (ii) country-of-origin bias. The former represents how the ratio of prices changes the relative share of the import demand, and the latter absorbs other non-price factors such as inherent preferences.[3]

Using the same procedure, Equation (3) generates the following equation describing the relative demand share between country i and j:

[3] Trade and distribution policies such as traceability system, country-of-origin of product, and food safety standard (e.g. Sanitary and Phyto-Sanitary parlance of the WTO), often considered as non-tariff barrier, are likely to reduce Armington elasticity. Note that these policies also have potential impact on the formulation of country-of-origin effect through the change in distribution parameters.

$$q_t^{ij} = \beta_0^{ij} + \beta_1^{ij} \cdot p_t^{ji} + \sum_{k=1}^{11} m_k D_k + \varepsilon_t \tag{6}$$

where

$$q_t^{ij} = \log\left(\frac{M_i}{M_j}\right), \beta_0 = \theta \cdot \log\left(\frac{\phi_i}{\phi_j}\right), \beta_1 = \theta p_t^{ji} = \log\left(\frac{P^j}{P^i}\right).$$

The parameter's value, β_1^{ij}, is the substitution elasticity between country i and j. The ratio of β_0^{ij} to β_1^{ij} reflects j's country-of-origin bias relative to that of i. We consider the US, Australia, and the ROW to be major beef exporters to Japan, and estimate two equations: Australia to the US and Australia to the ROW. Since Australia is a major and continuous beef exporter to Japan without having any cases of BSE, the country-of-origin biases are calculated by benchmarking the beef imports from Australia.

The appropriate econometric procedure for estimating the above equations depends on the data series properties (Gallaway *et al*. 2003). Since the error tem (ε_t) is likely to have serial autocorrelation, we use the first- and second-order serial autocorrecting (AR) method and the Kalman filtering method. The estimates obtained by using the AR model provide the benchmark parameters of interest, whereas the estimate of the Kalman filter model sheds light on the dynamic movements. The AR is estimated by the maximum likelihood method, inclusive of three dummy variables representing the first BSE cases that occurred in Japan, Canada, and the US On the contrary, the Kalman filter model allows for recursively updating the estimate of coefficients, using every point of observation; hence, the Kalman filter model can be used for examining how parameter estimates have evolved over a sample period. Various economic applications of Kalman filter model are discussed in Pasricha (2006). The time-varying parameter model is given by

$$q_t = \beta_t Z_t' + \varepsilon_t \text{ where } \beta = (\beta_0 \quad \beta_1 \quad m_k), \; z = (1 \quad p_t \quad D_k), \tag{7}$$

and

$$\beta_t = \beta_{t-1} + \eta_t \text{ where } \eta_t \sim N(0, \sigma^2 \cdot Q). \tag{8}$$

Equation (7) is the import demand equation with time-varying parameters, and Equation (8) defines the evolution of the parameter values. Only the parameters of β_0 and β_1 are allowed to vary over time so that the element of monthly dummy variables in the variance of transition equation (Q) is set as zero. The details of the updating formula and the underlying theory can be found in Harvey (1989). The results provide both the state vectors and smoothed state vectors of the parameter estimate. The former represents the

actual estimates of the coefficient for each time period, and smoothed coefficients are calculated beginning with the final Kalman filter estimate and then working backwards. We rely on the smoothed time-varying parameters because the smoothed coefficients are more stable since they are based on all the information up to and including the final observation (Harvey 1989).

The estimation period is from April 1991 to November 2007. Monthly data on volumes and total import values from Australia, the US, and the ROW are sourced from Trade Statistics of Japan, the Japanese Ministry of Finance, whereas data on beef production and price are sourced from the Statistics Department, Minister's Secretariat, the Japanese Ministry of Agriculture, Fisheries and Forests.[4]

4. Estimation results

4.1. Fixed parameters

The Armington demand model was used to estimate the parameters of beef demand between imported and domestic beef and across various sources of supply. Table 2 presents the estimation results for the case of fixed parameters with dummy variables, which is estimated by the Cochrane-Orcutt iterative procedure. β_1 is the estimated substitution elasticity, and the country-of-origin bias effect is evaluated by dividing β_0 by β_1. Dummy variables D_{jp}, D_{ca}, and D_{us} represent the first BSE cases in Japan, Canada, and the US, respectively.[5] The seasonal effects of beef imports are captured with monthly dummies from M_1 to M_{11}, while ρ_1 and ρ_2 indicate the first- and second-order adjusted serial correlation parameters.

Table 2 shows that all the elasticities of substitution are estimated to be positive and significant as expected and range between 0.817 and 1.137. The substitution elasticity between the US and Australia is estimated to be about 1.0, reinforcing the conclusion that price competition is present between the largest beef exporters (Weatherspoon and Seale 1995). The estimated Armington elasticities are also consistent with the previous estimates for meat and the meat processing industry. For example, Lopez and Pagoulatos (2002) use four-digit SIC data to find that the Armington elasticities for US meat packing plants and poultry slaughtering plants are 0.803 and 0.706, respectively. Moreover, the substitution elasticity for meat products between the EU and its future member countries is estimated to be around 1.0 on an average (Chevassus-Lozza and Unguru 2001).

[4] Trade Statistics of Japan is available at http://www.customs.go.jp/toukei/info/index_e.htm. Please visit http://www.maff.go.jp/toukei/geppo/geppo-e.html for information about Monthly Statistics of Japanese Agriculture. All data used in this analysis is available upon request.

[5] Although a series of BSE cases occurred at each country, dummy variable is used for only the first BSE case. That is, $D_{jp} = 1$ after September 2001, $D_{ca} = 1$ after May 2003, $D_{us} = 1$ after December 2003, and otherwise 0.

Table 2 Estimation results of the fixed parameters model

Dependent Variable	$\ln(D/M)$		$\ln(M_{au}/M_{us})$		$\ln(M_{au}/M_{row})$	
Period	1991.04–2007.11		1991.04–2003.12		1991.04–2007.11	
Sample	200		153		200	
β_0	0.463***	[0.000]	−0.328***	[0.000]	2.193***	[0.000]
β_1	0.817***	[0.000]	1.005***	[0.000]	1.137***	[0.000]
D_{jp}	0.015	[0.827]	0.295***	[0.000]	−0.022	[0.865]
D_{us}	0.254**	[0.018]			−0.461***	[0.002]
D_{ca}	0.023	[0.844]	−0.048	[0.538]	0.443***	[0.004]
M_1	−0.244***	[0.000]	−0.279	[0.000]	−0.246***	[0.000]
M_2	−0.180***	[0.003]	−0.195***	[0.000]	−0.207***	[0.000]
M_3	−0.154**	[0.020]	−0.089*	[0.077]	−0.232***	[0.000]
M_4	−0.124*	[0.073]	−0.116**	[0.025]	−0.219***	[0.001]
M_5	−0.083	[0.229]	−0.134**	[0.011]	−0.085	[0.213]
M_6	−0.232	[0.737]	−0.119***	[0.027]	0.039	[0.573]
M_7	−0.035	[0.610]	−0.127**	[0.016]	0.113	[0.101]
M_8	0.102	[0.141]	−0.102**	[0.049]	0.182***	[0.007]
M_9	0.233***	[0.001]	−0.105**	[0.038]	0.076	[0.230]
M_{10}	0.041	[0.504]	−0.134***	[0.006]	−0.014**	[0.014]
M_{11}	0.002	[0.997]	−0.006	[0.882]	−0.081	[0.102]
β_0/β_1	0.566***	[0.000]	−0.326***	[0.000]	1.928***	[0.000]
ρ_{t-1}	0.184**	[0.015]	0.417***	[0.000]	0.588***	[0.000]
ρ_{t-2}	0.218***	[0.004]			0.190**	[0.014]
R^2	0.538		0.407		0.679	
logL	62.650		119.551		74.073	
DW	2.065		2.056		2.074	

***1%, **5% and *10% level of significance.

The degree of the country-of-origin bias for domestic beef as compared with imported beef (β_0/β_1) is calculated to be 0.566, reflecting Japanese consumers' preference for domestic beef. On the contrary, the country-of-origin bias for Australian beef as compared with US beef is estimated to be negative (–0.326). This result is consistent with the fact that the price of beef from the US was constantly higher than that from Australia (see Table 1). The largest country-of-origin bias is found for Australia relative to the ROW (= 1.928), indicating Japanese consumers' preference for Australian beef. It should be noted that supply limitation on account of volume from Canada and New Zealand contribute to increasing the country-of-origin bias for Australia relative to the ROW.

The impact of the BSE cases on the relative import demand depends on the countries where the BSE cases occurred. The coefficients on the Japanese BSE dummy (D_{jp}) show that the BSE outbreak in Japan is positively related to the demand for Australian beef and negatively to that for US beef. The impact on the relative demand for domestic beef is inconclusive because the estimated coefficient is small and statistically less meaningful. The share of domestic beef volume increased from 47 per cent to 55 per cent next year after the BSE discovery in Japan. However, the increased market share of domestic

beef was not persistent enough to have significant positive results because it is in part induced by the increase in imported beef price, mostly, Australian beef. When the first BSE case was confirmed in the US, it greatly affected the perception of domestic beef, which is understood by the high estimate of D_{us} (0.254). While most parameter estimates in the fixed parameter model are significant with a high degree of confidence, the values of R^2 are relatively small. This discrepancy suggests that the form of estimated equations is valid but there are numerous other factors that the fixed parameters cannot account for. This result further validates the application of the Kalman filter model, as is done below.

4.2. Time-varying parameters

Here, we focus on the dynamic trend of the country-of-origin bias effect (β_0/β_1) and the substitution elasticity (β_1). The time paths of the time-varying parameters trace the effects of the import liberalisation and the series of BSE outbreaks. Both estimates are smoothed state vectors obtained from the Kalman filter model. Table 3 presents the estimation results. R^2 is improved by using the Kalman filter model. Note that only β_0 and β_1 are allowed to evolve over time.

Figure 1 clearly illustrates that the trend and volatility in both series prior to and after the series of BSE outbreaks are different. While both series exhibit steady paths prior to the BSE cases, large fluctuations and some drifts are observed thereafter. The steady path of the country-of-origin parameter before the BSE outbreaks, ranging between 0.65 and 1.0, indicates that

Table 3 Estimation results of the time-varying parameter model

Dependent variable	$\ln(D/M)$		$\ln(M_{au}/M_{us})$		$\ln(M_{au}/M_{row})$	
Period	1991.04–2007.11		1991.04–2003.12		1991.04–2007.11	
Sample	187		140		187	
β_0	1.330***	[0.000]	−0.199**	[0.020]	1.480***	[0.000]
β_1	1.406**	[0.011]	1.507***	[0.000]	1.417**	[0.016]
M_1	−0.215***	[0.000]	−0.010	[0.797]	−0.240***	[0.000]
M_2	−0.271***	[0.000]	0.125***	[0.003]	−0.182***	[0.001]
M_3	−0.289***	[0.000]	0.121***	[0.007]	−0.108*	[0.054]
M_4	−0.476***	[0.000]	−0.152***	[0.000]	−0.366***	[0.000]
M_5	−0.425***	[0.000]	−0.066	[0.140]	−0.336***	[0.000]
M_6	−0.396***	[0.000]	0.039	[0.395]	−0.352***	[0.000]
M_7	−0.329***	[0.000]	0.004	[0.926]	−0.336***	[0.000]
M_8	−0.325***	[0.000]	−0.028	[0.521]	−0.199	[0.000]
M_9	−0.272***	[0.000]	−0.019	[0.652]	−0.071	[0.198]
M_{10}	−0.303***	[0.000]	−0.019	[0.628]	0.007	[0.895]
M_{11}	−0.146***	[0.006]	0.006	[0.865]	0.105**	[0.040]
R^2	0.898		0.865		0.927	
logL	11.882		76.175		36.062	

***1%, **5% and *10% level of significance.

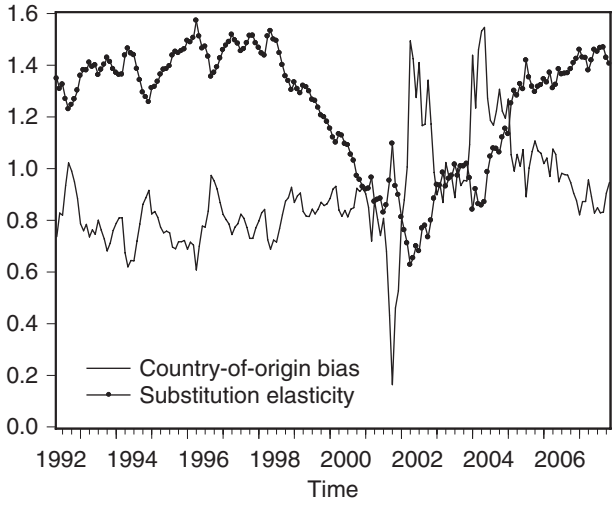

Figure 1 Time paths of the country-of-origin and substitution elasticity between domestic and imported beef.

Japanese consumers normally prefer domestic beef over imported beef, which is consistent with the previous notion about Japanese consumers' preferences. More importantly, the stability of the country-of-origin bias suggests that the underlying preference for Japanese beef remains unchanged during the process of import liberalisation. Therefore, the rapid expansion of Japanese beef imports, as seen in Table 1, is caused by import substitution in the course of relative price changes rather than by the shift in preference toward imported beef.

The time path of the substitution elasticity shows a declining trend since 1999. As the beef import market in Japan is saturated, the substitution elasticity between domestic and imported beef tends to decrease. Furthermore, there is no doubt that the increased concern about the safety of beef products worldwide because of the BSE outbreaks contributed to making the price level more irrelevant as a factor for the demand of beef imports, resulting in lower substitutability.

The impacts of the BSE cases become very prominent on the path of the country-of-origin bias parameters. With regard to the BSE case in Japan, the country-of-origin parameter in favour of domestic beef drops to near zero, resulting in a no preference bias at that moment. However, the country-of-origin parameter shortly shifts back to a normal level and even rises above the pre-BSE level. It can be argued that stringent government polices such as a mandatory BSE screening test for all cattle and the removal of special risk materials (SRM) implemented after the first announcement of the BSE case might have helped restore consumers' confidence in the safety of domestic beef. Such arguments can be supported by Japanese consumers' high willingness to pay for BSE-tested beef (McCluskey *et al.* 2005). The BSE case in the US further increases the country-of-origin bias against imported beef. Thus,

the major factors of demand for Japanese beef imports have changed from the price ratio to other non-price factors such as the consequences of the BSE outbreaks.

Figure 2 exhibits the time paths of the substitution elasticity and country-of-origin bias between Australia and the US, before the imposition of the import restriction on US beef. A distinctive effect that was not captured in the fixed parameters model is that the level of substitutability between two countries constantly increases with the onset of trade liberalisation. Although the trade liberalisation did not enhance the substitutability between domestic and imported beef (Fig. 1), it certainly induced high substitutability between major beef exporters. The estimated substitution elasticity becomes sufficiently high, suggesting that a small change in the price ratio results in a large difference in the market share. It is evident that the trade shares between Australia and the US are mostly determined by their relative prices. The path of the country-of-origin parameter indicates that Japanese consumers prefer US beef to Australian beef. However, the incident of the BSE case in Japan increased the source preference toward Australian beef. It also altered the trend of the substitution elasticity from positive to negative, making the price level less important as a demand factor.

Figure 3 exhibits the evolution of the country-of-origin bias and the substitution elasticity for Australia in relation to the ROW. Consistent with the fixed parameters model, there is a strong preference bias for Australian beef as compared with the ROW. In addition, the country-of-origin bias highly fluctuates with the BSE incidents. The bias started increasing when the BSE case in Canada was confirmed in May 2003. It is worth noting that Canada and New Zealand are the major beef exporters in the category of the ROW. The country-of-origin bias shifted back from Australia to the ROW when the

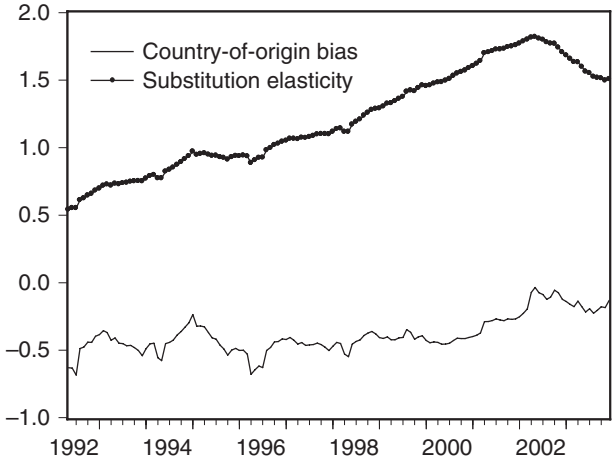

Figure 2 Time paths of the country-of-origin and substitution elasticity between Australia and the US beef.

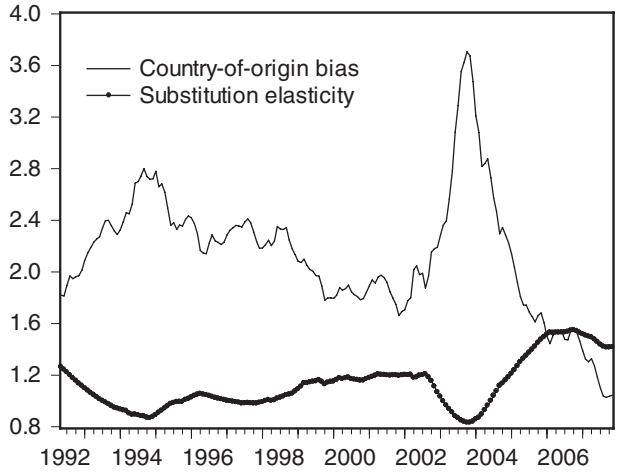

Figure 3 Time paths of the country-of-origin and substitution elasticity between Australia and the ROW beef.

BSE case occurred in the US. This trend is consistent with the fact that the market share of the ROW increased to more than that of Australia after the BSE case occurred in the US (see Table 1).

5. Concluding remarks

Japanese beef imports have undergone a series of changes led by policy reform and the BSE outbreaks. This article aimed at estimating the extent of the country-of-origin bias and substitution elasticity by focusing on the possible impact of the beef import liberalisation and BSE outbreaks on each of the estimations. The main findings are summarised below.

The estimated country-of-origin bias remains almost constant during the course of trade liberalisation. The rapid growth of Japanese beef imports in the 1990s was therefore considered to be induced by relative price change. A shift in consumers' preference from domestic to imported beef was not observed under the process of import liberalisation. The degree of the country-of-origin bias of domestic to imported beef ranges between 0.6 and 1.4. It gives the US and Australia the potential to increase exports by lowering their export prices. In other words, reducing the customs duty also has the potential to increase beef imports.

A series of BSE outbreaks have had a negative influence on beef exporting countries. The BSE outbreaks are likely to decrease the substitution elasticity among major beef suppliers and to increase the country-of-origin bias toward BSE countries that did not experience BSE outbreaks, such as Australia and New Zealand. The measurements of substitutability and country-of-origin bias are found to be very sensitive to the BSE cases. Strict government

interventions during the BSE outbreak seem to have contributed to restoring Japanese consumers' confidence in the safety of domestic beef. In addition, we also argue that the safeguard policy might have increased the country-of-origin bias. Under the current rule of the safeguard policy, the tariff rate is to be increased from 38.5 per cent to 50 per cent when the growth rate of beef import volume is over 17 per cent. This precludes that the beef import industry from expanding its imports in response to demand, thereby lowering the market resiliency with regard to beef imports. When beef importing industries act in cooperation, for example, when they avoid the onset of safeguard policies during the BSE outbreaks, such actions might delay the recovery of beef imports, possibly increasing the home product bias.

Future research is needed to gain insight into political as well as other economic aspects. In particular, this study did not consider quality differentials including the traceability system, food safety standard, promotional activities that also contribute to the formation of the country-of-origin bias (e.g., the Aussie Beef campaign). Thus, the country-of-origin effect could be viewed in a more positive prospective than considering as non-tariff barriers. Furthermore, the development of traceability and the country-of-origin rules would be important agenda for multilateral and regional/bilateral trade, especially where the negotiations for preferential trade and free trade area (FTA) needed to be taking place (Bhagwati *et al*. 1999). The extension of this research in the above directions would provide more productive results.

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