The Australian Journal of Agricultural and Resource Economics

Journal of the Australian Agricultural and Resource Economics Society

Australian Journal of Agricultural and Resource Economics, 57, pp. 601–619

The welfare cost of Japanese rice policy with home-good preference and an endogenous import price

James Fell and Donald MacLaren†

The welfare cost of Japanese rice policy is estimated in the context of a large importing country, treating domestically produced rice and imported rice as heterogeneous goods and where there is home-good preference. Not accounting for this preference will cause the gains from liberalisation to be overestimated. The period that is analysed is 2004–2007, departing from that in previous studies, which do not cover this period of greater deregulation. Rather than use border trade flow data as is customary, we acknowledge the actions of a state trading enterprise and construct and use a unique data set which should better gauge import penetration in the Japanese market for rice. Econometric estimation fails to reject the hypothesis that the Ministry of Agriculture, Forestry and Fisheries prevents imports from affecting the price of domestically produced rice. In the absence of precisely estimated parameter values, simulations of liberalisation are conducted under a range of parameter values and the effects on social welfare calculated. The tariff equivalents of the government's support to rice producers are also estimated with values for the period in excess of 100 per cent.

Key words: home-good preference, Japan, rice, welfare cost.

Japanese consumers pay a very high price for rice relative to world market prices. During 2004 and 2005, the consumer tax equivalent at the first point of sale post-farm-gate averaged 533 per cent, before falling to an average of 272 per cent during 2006 and 2007 (Anderson and Valenzuela 2008). These values may overstate the consumer tax equivalent at retail if the markups along the distribution chain are not entirely ad valorem. Nevertheless, they give some indication of the implicit tax being imposed on final consumers of rice by domestic and border rice policies. This high level of support for rice producers has its origins in post-war Japanese development when the government attempted to reduce the disparity between rural and rapidly rising urban incomes. After widespread crop failure in 1993, a temporary change of government and the completion of the Uruguay Round, Japanese rice policy was partially deregulated, and a limited volume of imports was permitted. Since then rice has been sold in a market system with government support being in the form of subsidies, stockpiling, acreage reduction (and later, acreage stipulation), an income stabilisation program and a tariff quota.

† James Fell (email: james.fell@alumni.unimelb.edu.au) and Donald MacLaren are at University of Melbourne, Parkville, Victoria, Australia.

doi: 10.1111/1467-8489.12013

Studies of Japanese rice trade liberalisation can be distinguished by their treatment of (i) Japan as either a 'small' or a 'large' importer; (ii) import and home-good heterogeneity/homogeneity; and (iii) the construction of data linking consumption to production, imports and stock changes. First, there are the studies that make the unrealistic assumption that Japan is a small country importer of rice (e.g. Otsuka and Hayami 1985 and Godo 1993). It is recognised that the international market for rice is 'thin'. The Harmonised System does not distinguish between rice varieties, but on an assumption that most of Japan's rice imports are japonica rice, Japan imports around 20 per cent of world exports of japonica rice.[1] Therefore, it is very likely that a unilateral liberalisation of Japan's rice policy would result in a significant rise in the price of imported rice, at least in the short run.

In contrast, Adachi and Suzuki (2005), Durand-Morat and Wailes (2010), and Wailes and Chavez (2011) and those using general equilibrium models, for example Fujiki (2000), do not employ the assumption of a small importing country. Adachi and Suzuki estimated the own-price elasticity for supply of domestic rice to be 0.048 but with little regard to the major changes in policy that occurred over the period of analysis. In contrast, the estimates in Fujiki range from 0.374 to 0.543. Other estimates of price elasticities of supply are 0.29 (FAPRI 2009), 0.292 (for area harvested) (Wailes and Chavez 2011), 0.30 (Cramer *et al.* 1993), 0.08 (Cramer *et al.* 1999) and 0.316–0.728 (MAFF 2009a).

Second, it is assumed in much research that imports and domestically produced rice are homogeneous. This is the case in Otsuka and Hayami (1985), Fujiki (2000), Kako *et al.* (1997), Cramer *et al.* (1993, 1999). In contrast, Adachi and Suzuki (2005) and the RICEFLOW model of Durand-Morat and Wailes (2010) introduce imperfect import substitution into the analysis. However, Adachi and Suzuki consider only a tariff of ¥402/kg, which is inappropriate because this was not the most-favoured nation tariff faced by exporting countries (OECD 2009; Japan Customs n.d.).

As well as treating domestically produced and imported rice as being heterogeneous, it is also possible that, in addition, consumers have a preference for the domestically produced good. Yue *et al.* (2006) introduce preferences over domestically produced goods ('home goods') and imports into the estimation of a tariff equivalent for imported goods. This is done by placing, in a representative consumer's utility function, preferences over two otherwise identical goods which are differentiated by place of production. Demand functions for the home good and imported good can then be derived. The authors demonstrate that when consumer preferences favouring the domestic product are considered, the estimate of welfare changes is significantly different from that when these preferences are ignored. If a

[1] This figure is only approximate and was calculated from Japan's import data and world trade data for japonica rice in FAO (2010).

home-good preference raises the price of the domestically produced good relative to the price of imported substitutes, then the gains from liberalisation will be overestimated if homogeneity is assumed.

Third, all the research of which the authors are aware use Japanese trade data to measure quantities of imports consumed. However, it is inappropriate to use trade data for rice for such a purpose. In the presence of a state trading enterprise that impedes the flow of these imports and which manipulates stock levels, the imported rice can be consumed in a time period different to that when it crossed the border, if indeed, it is ever consumed at all. Thus, alternative data are required to those that are commonly used.

In this article, we provide estimates of the welfare cost of Japanese rice policy as defined by the gains from a liberalisation of the Japanese market for rice. Liberalisation is defined here as the removal of trade barriers, the state trading enterprise and domestic support for rice producers. Unlike the papers cited above, we consider the current set of policy instruments and take into account consumer preference for domestically produced rice. Furthermore, we use a unique data set that has been compiled by the authors, which better gauges import penetration in the Japanese market and which takes into account the actions of the state trading enterprise through data on government stockpiles and data from auctions on imports. A partial equilibrium approach is used, as in Otsuka and Hayami (1985), but using the method developed in Yue *et al.* (2006) to account for consumers' preference towards the domestically produced rice. By relaxing their small country assumption, we allow for the estimation of welfare changes and tariff equivalents for a large importing country.

We begin with a brief review of the most salient features of Japan's rice policy since 2004. We then present the theoretical model that incorporates home-good preference and an endogenous import price. Thereafter, we discuss in detail the construction of the data set that we believe is an improvement on the data sets used previously, present the results and discuss their significance.

1. Policy review

This brief review of Japan's rice policy begins with the situation from FY2004.[2] In that year, the rice market underwent substantial deregulation. The net effect of Japan's border and domestic policies over the period of analysis can be summarised by a tariff equivalent, such as the market price differential of OECD (2010). This approach suggests that the tariff equivalent averaged around 235 per cent.

Prior to the changes made in 2004, the principal domestic instruments had been centralised price setting (which ceased in 1995), an acreage

[2] FY refers to the Japanese fiscal year, which runs from April to March, so FY2004 refers to April 2004–March 2005. All years are calendar years unless otherwise stated.

reduction program, government stockpiling, producer and consumer subsidies and an income stabilisation program, whilst the principal trade instruments were exclusive import rights for the state (until 1995), a quota (until 1998) and a tariff quota (from 1999).[3,4] From 1995, and with the introduction of the WTO Agreement on Agriculture, imports were subject to a target level of 4 per cent of the level of domestic consumption during the base period 1986–88 (i.e. 379,000 tonnes, milled basis). For each subsequent year, the target was to be increased by 0.8 percentage points until it reached 8 per cent by FY2000 (758,000 tonnes, milled basis). However, for FY1999, the instrument was changed to a tariff quota which, in the year FY2000, would have represented 7.2 per cent of base-period consumption. Today, this quantity remains the minimum access (MA) tariff quota.

1.1. Domestic measures

Over the period of analysis (FY2004–FY2008), the Ministry of Agriculture, Forestry and Fisheries (MAFF) operated the production stipulation (formerly acreage reduction) program; it ran a rice-farming income stabilisation program and maintained stockpiles of rice (MAFF 2009b; MAFF 2006). These stockpiles are targeted at around 1 million tonnes of domestically produced rice (United States Department of Agriculture (USDA 2009)). MAFF also maintains stockpiles of MA imported rice. Since FY2004, the combined total of domestic rice and MA rice in stockpiles has fluctuated, averaging just over 2 million tonnes (USDA 2009).

1.2. Border measures – imports

The current border measure is a tariff quota of 682,000 tonnes (milled basis) per year, which has been unchanged since FY2000 and is the minimum access quantity (MA). There is no in-quota tariff; however, the government can charge a markup of up to ¥292/kg (MAFF 2009b).[5] The out-of-quota tariff is ¥341/kg, which the Organisation for Economic Co-operation and Development (OECD) (2009) claims is prohibitive.

All MA rice is purchased by the government and is sold by the government. These sales from stocks can occur several years after importation. The MA volume is separated into two portions, which are known as ordinary market access (OMA) and simultaneous buy and sell (SBS): the proportions in MA imports being around 87 per cent and 13 per cent, respectively. Since 2002,

[3] The reader is referred to Honma and Hayami (2007) for an overview of the evolution of Japanese rice policy.

[4] The reader is referred to Fukuda *et al.* (2003) for details on rice policies prior to the 2004 deregulation.

[5] The state trading enterprise is permitted to sell the rice at a price up to ¥292/kg above the price at the border.

the auctions for the purchase of OMA rice by MAFF have been conducted throughout the year from May to March.

Ministry of Agriculture, Forestry and Fisheries periodically also holds auctions for the sale of OMA rice in its possession. These auctions are conducted approximately monthly throughout the year, and they are altogether different auctions from those in which MAFF buys rice from importers. Rice that becomes part of Japan's international food aid is not sold in these auctions (MAFF 2009b).

Under the SBS system, importing parties nominate a price at which to sell to the government and a price at which to buy from the government (leading to a self-nominated markup). SBS rice does not pass into the physical possession of the state. These auctions have been conducted around four to eight times per year, at the discretion of MAFF. Since FY2001, annual SBS contract volumes have been 100,000 tonnes each year.

Minimum access rice is ultimately destined for table rice, manufacturing purposes, aid (foreign and domestic), fodder and stockpiling. The government determines the destination of OMA rice; however, the destination of SBS rice is determined by the private sector (MAFF 2009b). Between April 1st 1995 and March 31st 2008, 11 per cent of the volume of MA rice went to table consumption, 37 per cent went to manufacturing uses, 26 per cent was used for aid purposes, 12 per cent went to fodder, and 15 per cent was recorded as remaining in stocks (MAFF 2008).

2. Model

The liberalisation of Japan's rice policy that we simulate assumes the total removal of border and domestic instruments. This allows us to avoid modelling the instruments outlined above. We measure the change in social welfare in going from the status quo to total liberalisation, as well as the tariff equivalent, as a summary variable, of the existing set of instruments.

2.1. Demand functions

The consumer's optimisation problem (as in Yue *et al.*) is:

$$\max_{D_h,\, D_m} U = (\alpha D_h^{\rho} + (1-\alpha) D_m^{\rho})^{\frac{1}{\rho}} + Z \quad \text{s.t. } p_h D_h + p_m D_m + Z \leq M \qquad (1)$$

where: $\sigma \equiv 1/(1-\rho)$ is the elasticity of substitution between home-good rice and imported rice; α is the home-good preference parameter ($\alpha > 0.5$ indicating a greater preference for domestically produced than imported rice); D_h is quantity demanded of the home good; D_m is quantity demanded of imported rice; Z is the aggregate numéraire good; p_h is the wholesale price of the home good (*wholesale* prices are used because a full set of retail price data for both the home good and imported good is not available; this approach is consistent with that of Otsuka and Hayami, and Yue *et al.*); p_m is the

wholesale-equivalent price of imported rice in Japan; and M is expenditure on all goods.

The Marshallian demand functions for the home good (D_h) and the imported good (D_m) are obtained from the constrained maximisation of Equation (1). They are:[6]

$$D_h(p_h, p_m, M) = \left(\frac{\alpha}{p_h}\right)^{\sigma}\left(\frac{M - Z}{\alpha^{\sigma} p_h^{1-\sigma} + (1-\alpha)^{\sigma} p_m^{1-\sigma}}\right) \tag{2}$$

$$D_m(p_h, p_m, M) = \left(\frac{1-\alpha}{p_m}\right)^{\sigma}\left(\frac{M - Z}{\alpha^{\sigma} p_h^{1-\sigma} + (1-\alpha)^{\sigma} p_m^{1-\sigma}}\right) \tag{3}$$

The first-order conditions also provide an expression for the marginal rate of substitution, which forms the basis of estimating the preference parameters, α and σ:

$$\text{MRS} = \frac{p_m}{p_h} = \frac{1-\alpha}{\alpha}\left(\frac{D_h}{D_m}\right)^{\frac{1}{\sigma}} \tag{4}$$

The associated indirect utility function and expenditure function are, respectively:

$$V(p_h, p_m, M) = (M - Z^*)(\alpha^{\sigma} p_h^{1-\sigma} + (1-\alpha)^{\sigma} p_m^{1-\sigma})^{\frac{1}{\sigma-1}} \tag{5}$$

$$e(p_h, p_m, u) = (u - Z^*)(\alpha^{\sigma} p_h^{1-\sigma} + (1-\alpha)^{\sigma} p_m^{1-\sigma})^{\frac{1}{1-\sigma}} \tag{6}$$

where Z^* is optimal expenditure on the aggregate numéraire good.

2.2 Domestic supply function

As in Yue *et al.* and Otsuka and Hayami, a constant elasticity function is used for the supply of rice by domestic producers. Then, supplies available from domestic sources for consumption are supplies from production ($\lambda p_h^{\varepsilon}$) plus net releases from the government's stockpile (ΔG_h):

$$S_h = \lambda p_h^{\varepsilon} + \Delta G_h \tag{7}$$

where: S_h is the quantity of rice that suppliers bring to market, which does not include rice which is placed into private stockpiling[7]; and ε is the price elasticity of supply. Prior to liberalisation, domestic production is augmented to account for the change in government stockpiles of domestically produced rice. After liberalisation, it is assumed that there is no government-held stockpile and, therefore, that S_h defines the quantity available to consumers from domestic producers only (i.e. $S_h = \lambda p_h^{\varepsilon}$, referred to later as Eqn 7′).

[6] The derivation is given in Silberberg and Suen (2001, p. 359).
[7] One of the reasons for this is inadequate data on private stocks.

2.3. Import supply function

The post-liberalisation import supply function is specified as the constant elasticity function:

$$S_m = \beta p_m^{\zeta} \tag{8}$$

where S_m is the supply of imports at the border (in contrast to the supply of imports through the border); p_m is the wholesale-equivalent price of imported rice; and ζ is the price elasticity of import supply.

Because the liberalisation of Japan's rice policy that we simulate assumes the total removal of border and domestic instruments, it is unnecessary to model instruments such as the tariff quota. Changes in welfare are estimated using different quantity/price pairs on the consumers' demand curve and the domestic producers' supply curve (see below).

2.4. Tariff equivalents

The tariff equivalent of the government's support to rice producers is specified using pre-liberalisation prices and the tariff wedge approach of Yue *et al.* and the identity:

$$T = p_m - (1 + \tau)p_{\mathrm{CAL}} \tag{9}$$

where: T is the tariff equivalent; τ is domestic and international transport costs and other expenses associated with bringing the good to the buyer; and p_{CAL} is the Californian price of medium-grain rice. It is assumed that τ does not change with the liberalisation. Unfortunately, a data-based approach to estimating tariff equivalents is not feasible. It requires the tracking of each month's imports to find out which later month they appear in consumption (each shipment cannot be tracked through the government's stockpiling).

In the event that alpha and/or sigma need to be surmised (for example, sigma may be unrecoverable if MAFF successfully prevents external markets affecting the internal market), then a theoretical import price that is consistent with the system's parameter values can be expressed, using Equation (4) as $p_m = p_h\left(\frac{1-\alpha}{\alpha}\right)\left(\frac{D_h}{D_m}\right)^{\frac{1}{\sigma}}$, which allows the hypothetical tariff equivalent to be expressed as:

$$T = p_h\left(\frac{1-\alpha}{\alpha}\right)\left(\frac{D_h}{D_m}\right)^{\frac{1}{\sigma}} - (1 + \tau)p_{\mathrm{CAL}} \tag{10}$$

For consistency, Equation (10) will be used for estimation of tariff equivalents of existing policy.[8]

[8] Yue *et al.* decompose tariff equivalents into the official tariff and a tariff equivalent of non-tariff barriers to trade. It is possible to calculate a tariff equivalent of non-tariff barriers separately, but this requires breaking up the tariff equivalent into components. However, here it is difficult to do this accurately because it requires calculation of the OMA markup, which is not possible from MAFF data.

2.5. Post-liberalisation prices

Post-liberalisation equilibrium prices are determined by solving simultaneously Equations (2), (3), (7′) and (8) when each has been expressed in logarithms. To simplify the analysis, it is assumed that post-liberalisation, Japan does not export rice, and there is no government or private stockpiling. Therefore, the relevant equilibrium (market-clearing) conditions become:

$$\log_e \lambda + \varepsilon \log_e p_h = \log_e \left[\left(\frac{\alpha}{p_h} \right)^{\sigma} \left(\frac{M - Z}{\alpha^{\sigma} p_h^{1-\sigma} + (1-\alpha)^{\sigma} p_m^{1-\sigma}} \right) \right] \tag{11}$$

$$\beta + \zeta \log_e p_m = \log_e \left[\left(\frac{1-\alpha}{p_m} \right)^{\sigma} \left(\frac{M - Z}{\alpha^{\sigma} p_h^{1-\sigma} + (1-\alpha)^{\sigma} p_m^{1-\sigma}} \right) \right] \tag{12}$$

2.6. Welfare changes

Welfare changes are defined as the unweighted sum of changes in consumer welfare, changes in producer surplus and changes in government expenditure. For simplicity, any positive or negative externalities associated with rice production, consumption or importation are not considered, and any welfare changes experienced by rice exporting nations are not considered either.

The change in consumer welfare is measured by equivalent variation (EV), where

$$\mathrm{EV} = e(\mathbf{p}_0, u_1) - e(\mathbf{p}_0, u_0) \tag{13}$$

where: $\mathbf{p} = (p_h,\ p_m)$ with subscripts 0 and 1 representing pre- and post-liberalisation prices, respectively; e is the expenditure function (Eqn 6); and u is measured using the indirect utility function (Eqn 5). The change in producer welfare is measured using producer surplus as:

$$\Delta\mathrm{PS} = \int_{p_{h1}}^{p_{h0}} \lambda p_h^{\varepsilon} \mathrm{d}p_h \tag{14}$$

The change in government spending, ΔGovt, is the change in government expenditure on rice programs plus the forgone out-of-quota tariff revenue.

Therefore, the change in social welfare is measured by:

$$\Delta\mathrm{SW} = \mathrm{EV} + \Delta\mathrm{PS} - \Delta\mathrm{Govt} \tag{15}$$

which represents the opportunity cost to Japan of its rice policy.

3. Data

The use of data in this paper demonstrates the importance of understanding the policy structure when analysing Japanese rice policy. It is inappropriate to use trade data when analysing national welfare, as is customary. To retrieve points on the consumers' demand function, the actual quantities consumed must be retrieved. Most of the rice that is imported is placed in government

stockpiles. Consumers then consume imported rice that emerges from government stockpiles.

Monthly import consumption data (post-border) were taken from MAFF sales auction results for ordinary MA rice leaving MAFF stockpiles (MAFF variousab), MAFF auction results for SBS rice (MAFF various) and Japan Customs data (Japan Customs various) for out-of-quota imports. Likewise, monthly post-border prices for imports are taken from the above sources and calculated as a weighted average. The data do not track individual shipments though the stockpiling system. Consequently, this prevents pairing of prices of rice on entry and exit from the government stockpiles and inhibits a data-driven estimation approach to tariff equivalents.

In contrast, it is necessary to retrieve a point on the import supply function (at the border) for the calibration of β in the import supply function. Volumes and prices at the border are taken from MAFF's ordinary MA procurement auction results (MAFF variousaa), SBS auction results and Japan Customs data (for out-of-quota imports). Prices are taken as a weighted average.

Monthly consumption of the home good is taken as apparent consumption, using sales (wholesale quantities at wholesale prices; from MAFF's Survey of producers' rice inventories and other items (MAFF variousa) less the change in government stockpiles (from MAFF's domestic stockpile procurement and sales results (MAFF variousba) and the Rice Stable Supply and Support Organization's stocks data (RSSSO various) less exports (from Japan Customs). Monthly home-good prices are taken from the RSSSO (RSSSO various). No adjustments are made to prices for deflation (or inflation) because changes to the price level over the period of analysis, as measured by the CPI, were negligible.

For econometric estimation of α and σ, additional monthly data are required. These are agricultural input prices and dates of OMA and SBS sales auctions, which are taken from MAFF's agricultural commodity indices (MAFF variousb) and OMA/SBS sales data.

As is the case in Sumner and Lee (2000), the California medium-grain #1 price (FOB truck), as reported monthly in the USDA's Rice Outlook (USDA various), is taken as a representative world japonica price.

The change in expenditure is taken from the Rice Account in the annual Special Accounts (as reported by the Parliament of Japan) and is MAFF's expenditure (net of revenue) on rice programs and includes MA markup revenues. Change in tariff revenue is calculated from Japan Customs data. Annual aggregates for FY2004-FY2007 are given in Table 1.

4. Results

4.1. Econometric estimation of the preference parameters

In order to calculate the social welfare effects of liberalising the import regime for rice and simultaneously removing the domestic support program, we need

Table 1 Data summary

FY	Pre-liberalisation*,†,‡						Calibrated parameter values		
	p_h	p_{CAL}	D_h	S_h	D_m	S_m	λ	β (ζ = 0.3)	β (ζ = 1.0)
2004	385,674	48,766	6,300,504	6,476,732	271,618	671,395	155,365	10.14	2.48
2005	345,396	50,521	6,341,754	6,659,917	185,941	678,240	164,952	10.14	2.46
2006	341,166	61,295	6,384,618	6,506,112	241,680	678,523	161,719	10.08	2.26
2007	337,225	64,686	6,310,991	6,471,799	213,072	630,139	161,409	9.99	2.14

Note: *Prices are in ¥/tonne, and quantities are in tonnes.
†S_m substantially differs from D_m because S_m, a quantity on the import supply curve, also includes rice that is re-exported, rice that goes to fodder and rice that is disposed of in any other way that MAFF chooses, whereas D_m just includes table rice and manufacturing rice.
‡$D_h = S_h - \Delta G_h -$exports.
Source: The source for each data series is explained in Section 3.

to obtain estimates of the parameters in Equations (2) and (3). We chose to econometrically estimate the preference parameters in the demand functions (from Eqn 4) because we wanted to test the hypothesis that there existed home-good preference. We used values from the literature for the domestic and import supply elasticities. These allow us to calibrate the domestic and import supply functions using a single data point for each of the years FY2004–FY2007.

The estimation of the demand parameters was conducted using monthly data from April 2005 to October 2008.[9] This sample period provides 43 observations. The estimating equation is obtained from Equation (4) by taking logarithms of both sides to get:

$$\log_e\left(\frac{p_{m_t}}{p_{h_t}}\right) = \log_e\left(\frac{1-\alpha}{\alpha}\right) + \frac{1}{\sigma}\log_e\left(\frac{D_{h_t}}{D_{m_t}}\right) + u_t \tag{16}$$

where: u_t is a disturbance term, which can include autoregressive terms. Because of the seemingly inherent simultaneity of the price ratio and quantity ratio, a Hausman test was conducted using the equation:

$$\log_e\left(\frac{p_{m_t}}{p_{h_t}}\right) = \log_e\left(\frac{1-\alpha}{\alpha}\right) + \frac{1}{\sigma}\log_e\left(\frac{D_{h_t}}{D_{m_t}}\right) + v\hat{h_t} + \mu e_{t-1} + e_t \tag{17}$$

where $\hat{h_t}$ represents the residuals from the reduced form equation in Table 2, and μe_{t-1} is an autoregressive term. The null hypothesis of no endogeneity ($v = 0$) was rejected (prob. = 0.0302). Consequently, a 2SLS regression was conducted.

First-stage regression results (Table 2) show that most instruments are individually significant at the 1 per cent level, and, when combined, the instruments are jointly significant at the 1 per cent level. The results of the second-stage regression are provided in Table 3, but, because of the small sample size, they should be treated with caution.

4.2. Hypothesis tests

The first test is one for home-good preference. If $\alpha > 0.5$, this implies that the alternative hypothesis is $\log_e[(1-\alpha)/\alpha] < 0$, the null hypothesis being $\alpha = 0.5$, that is no home-good preference and $\log_e[(1-\alpha)/\alpha] = 0$. With $\log_e[(1-\alpha)/\alpha] = -1.131$ and a standard error of 0.084, the null hypothesis is rejected.

From $\log_e[(1-\alpha)/\alpha] = -1.131$, the estimate of the home-good preference parameter is $\hat{\alpha} = 0.756$. Using the delta method, the standard error of $\hat{\alpha}$ is calculated to be 0.015, giving a 95 per cent confidence interval for α of $0.725 \leq \alpha \leq 0.787$.

[9] The estimation was conducted using EViews.

Table 2 First-stage regression results

Instrument	Parameter estimate	SE	Prob.
Constant	−6.676	10.831	0.542
Input prices	0.085	0.108	0.443
SBS	−1.784	0.403	0.000
August	3.069	0.986	0.004
September	2.777	0.442	0.000
October	3.132	0.462	0.000
November	3.169	0.419	0.000
December	2.371	0.417	0.000
Crop Year '06	−0.056	0.458	0.902
Crop Year '07	−0.579	0.664	0.390
Crop Year '08	−0.556	1.202	0.647
Dependent variable is $\log_e(d_h/d_m)$			
F-stat = 15.2629, Prob. = 0.000		$R^2 = 0.827$	

Table 3 Second-stage regression results

Parameter	Parameter estimate	SE	Prob.
$\log_e\left(\frac{1-\alpha}{\alpha}\right)$	−1.131	0.084	0.000
$1/\sigma$	0.017	0.032	0.608
MA(1)	−0.633	0.130	0.000
F-Stat = 0.267, Prob. = 0.608		$R^2 = 0.010$	

The second test involves the elasticity of substitution. In particular, we test for perfect substitution between imports and the home good (i.e. $\rho \to 1 \Rightarrow \sigma \to \infty \Rightarrow \sigma^{-1} \to 0$). If the term σ^{-1} (in Equation 16) is zero, then this suggests either that there is perfect substitution between imports and the home good, the indifference curves are linear, and there is a corner solution, or that there is no observed relationship between the log of the price ratio and the log of the ratio of home-good consumption to import consumption.

The first explanation is plausible, given the very small proportion of imported rice in total food use (i.e. direct food consumption plus manufacturing), because the tangency point of the indifference curve with the budget constraint will then be very close to the home-good axis. However, there may still be some curvature in the indifference curves, that is $\rho < 1$, but there are insufficient data to show it. Again, the delta method can be used to compute a standard error for $\hat{\rho}$ and given that convexity requires $\rho < 1$, we calculate a one-sided confidence interval. The resulting calculations give a standard error of 0.032 for ρ and $\rho \geq 0.929$. Hence, values for ρ in the interval $0.929 \leq \rho < 1$ are acceptable hypotheses.

The second explanation is also plausible and could, amongst other possible reasons, suggest that MAFF prevented the domestic price from being affected by the quantity of imports. The state trading enterprise does not necessarily pursue an objective of maximising profit, but may pursue objectives such as

preventing imports from affecting home-good prices or increasing producer welfare.

Accepting the first explanation would be inconsistent with the reality that consumption comprises both domestically produced and imported rice, and, therefore, the indifference curves cannot be perfectly linear. Therefore, our preferred interpretation is the second one. The explanation for the lack of association between relative prices and relative quantities may be, amongst other possible explanations, that the state trading enterprise does not pursue a policy of profit maximisation, as commercial importers would be assumed to do, but it has other objectives imposed on it by government.

Therefore, with the second hypothesis test suggesting that the indifference curves may be linear and the first hypothesis test suggesting that a home-good preference exists, there is an apparent inconsistency. We have chosen to retain the CES functional form on the demand side, but to use a selected value of the elasticity of substitution in calculating the welfare effects and the tariff equivalents of the policy.[10]

4.3. Simulations

The post-liberalisation prices are obtained from Equations (11) and (12) with the home-good preference parameter, α, taking the previously estimated value of 0.756. The elasticity of substitution was arbitrarily fixed at $\sigma = 10$. The value of the domestic supply elasticity, ε, is taken from the estimate given by FAPRI of 0.29, and the values of the import supply elasticity, ζ, are taken from Fujiki who used a short-run value of 0.3 and a long-run value of 1.0. The parameters λ and β from the domestic and import supply functions (Eqns 7 and 8), respectively, were obtained by calibrating these supply functions to the data in Table 2 using ε and ζ. Solving Equations (11) and (12) give the post-liberalisation prices which, from Equations (2) and (3), give the equilibrium quantities. With these prices and quantities, use was then made of Equation (15) to calculate the change in social welfare from the liberalisation of rice policy (Tables 4–6). Making use of Equation (10) allows the tariff equivalent of the policy to be calculated (Table 7).

The results for the change in social welfare range from ¥136 billion to ¥1.079 trillion (approximately ¥1062 to ¥8448 per person per year) depending on the specified parameter values (Tables 4–6). In general, the higher the import supply elasticity, the greater is the gain in consumer welfare from liberalisation. This makes intuitive sense, because the greater the import supply elasticity, the smaller is the increase in post-liberalisation prices faced by consumers. Since imports are an imperfect substitute for the home good, the increase in the home-good price is also smaller. Intuition would suggest

[10] Elasticities of supply are not estimated owing to the difficulties associated with obtaining unbiased estimates. For a discussion of selected issues regarding the measurement of trade elasticities, see Ahmadi-Esfahani (2009).

Table 4 Simulation results for small country assumption (¥ trillion)

Year	EV	ΔPS	−ΔGovt	ΔSW
2004	2.680	−1.093	0.058	1.645
2005	1.848	−0.888	0.120	1.079
2006	1.174	−0.658	0.107	0.623
2007	0.977	−0.585	0.125	0.518

Table 5 Simulation results for $\zeta = 0.3$ (¥ trillion)

Year	EV	ΔPS	−ΔGovt	ΔSW
2004	0.133	−0.118	0.058	0.073
2005	0.163	−0.147	0.120	0.136
2006	0.098	−0.086	0.107	0.119
2007	0.103	−0.091	0.125	0.137

Table 6 Simulation results for $\zeta = 1.0$ (¥ trillion)

Year	EV	ΔPS	−ΔGovt	ΔSW
2004	0.217	−0.181	0.058	0.093
2005	0.221	−0.191	0.120	0.150
2006	0.138	−0.117	0.107	0.128
2007	0.135	−0.117	0.125	0.144

Table 7 Tariff equivalents

FY	Per cent
2004	204
2005	173
2006	117
2007	105

Note: $\alpha = 0.756$, $\sigma = 10$, $\tau = 0.15$.

that when ζ is greater, then in general, the absolute change in producer surplus would be greater. This is true in the results.

Under the small country assumption, as the pre-liberalisation home-good price falls from FY2004 to FY2007 (see Table 1), as intuition suggests, the total change in SW tends to become smaller (over this period, the exogenous import price rose) (Table 4). However, this pattern is not observed for the upward sloping import supply curves because, in these cases, the price of the imported good endogenously rises (Tables 5 and 6).

In Otsuka and Hayami, the change in consumer welfare and the change in producer surplus often effectively cancelled each other out, and the change to SW was caused by the change in taxpayer expenditure. The same effect occurs

in this analysis. For both $\zeta = 0.3$ and $\zeta = 1.0$, there does appear to be evidence of EV (change in consumer welfare) being approximately equal to $|\Delta PS|$ (the absolute value of the change in producer welfare).

4.4. Tariff equivalents

The estimated tariff equivalents are shown in Table 7. These are calculated according to Equation (10), to ensure that the pre-liberalisation import prices are consistent with the values of α and σ, and a value of $\tau = 0.15$ taken from Otsuka and Hayami. As expected, the tariff equivalents are lower in FY2006 and FY2007 when higher border prices for imported rice prevailed (see Table 1). The tariff equivalents range from 105 per cent to 204 per cent.

These tariff equivalents are compared with those implied by the OECD's market price differential (OECD 2010). The specific tariff equivalents estimated in this analysis average around 40 per cent lower than those implied by the OECD because of the recognition of a home-good preference (i.e. heterogeneous products) and the consequent lower post-border price of the imported good. The OECD uses a domestic farm-gate price and external reference price (CIF unit value, adjusted for quality and farm-gate equivalency) in calculating its market price differential (Organisation for Economic Co-operation and Development (OECD) 2010), in contrast to a post-border wholesale-equivalent market price of imported rice and an adjusted world price.

4.5. Sensitivity analysis

A limited, further sensitivity analysis was conducted on σ and ε. The effects on the change in social welfare of changes to the substitution elasticity (σ) and the price elasticity of domestic supply, ε, are evaluated using an arbitrary base case of FY2005 with $\alpha = 0.756$ and $\zeta = 0.3$.[11] For each value of ε, the value of the associated parameter λ is recalibrated.

The effect on social welfare of changes to the domestic supply elasticity is given in Table 8. The results show that as ε varies from the more inelastic value of 0.145 to the more elastic value of 2.03 (a range of 0.29–50 per cent to 0.29 + 500 per cent), the change to social welfare is barely altered. The corresponding percentage changes in ΔSW range from 1.045 to −3.249. From this result, we conclude that the change in social welfare is not sensitive to the value of the elasticity of domestic supply.

The sensitivity of ΔSW with respect to σ is explored in Table 9. As σ increases for each value of the import supply elasticity, the price of the home-good falls more under the small country assumption than it does for an upward sloping import supply function. The intuition behind this result is

[11] The tariff equivalent does not depend on ε, so its sensitivity with respect to ε was not evaluated (see Equation 10).

Table 8 Sensitivity of ΔSW with respect to ε

ε	Per cent Δ (ΔSW)*
0.145	1.001
0.261	0.175
0.290	0.000
0.319	−0.164
0.435	−0.728
0.580	−1.276
0.870	−2.032
1.160	−2.519
1.450	−2.852
1.740	−3.092
2.030	−3.270

Note: *The percentage change in ΔSW is measured relative to the case where $\varepsilon = 0.29$.

that as the price of the imported good rises (induced by increased demand), the greater the upward feedback effect on the price of the home good the more substitutable the two goods are. Accordingly, the change in social welfare is lower the higher σ is. The change in social welfare tends to decrease in σ, but this is not a general result (e.g. it does not hold for FY2004) and depends on the relative changes in both EV and ΔPS. It may be concluded that the size of the percentage change in ΔSW is sensitive to the value of the elasticity of substitution.

5. Discussion and conclusion

In conducting this analysis of Japan's rice policy, we have departed from previous analyses in four important respects. First, we have constructed a unique data set in which we recognise that the data on imports demanded per time period must be calculated from the actual volumes flowing to consumers and not, as in previous studies, the data on price and quantity pairs being obtained from trade data on border flows. This is important because a state trading enterprise largely controls the volumes of imports available to consumers and because imported rice is placed in government stocks prior to release at some future date. Thus, this article represents a significant departure from previous analyses of this policy in terms of the data used. Second, we treat Japan as a large country in the international market for medium-grain rice. Third, the time period over which the analysis is conducted follows the most recent set of major reforms of Japan's rice policy, FY2004 to FY2007. And fourth, we have allowed for a home-good bias on the part of Japanese consumers for domestically produced rice and have found that one exists.

With liberalisation, it was assumed that there is no other government intervention in the market and that market equilibrium occurs at a price such that supply of each good equals demand for each good. It would be appropriate to extend the analysis beyond an assumption of a competitive

Table 9 Sensitivity analysis for the elasticity of substitution (σ)

ζ	σ	Per cent Δ (ΔSW)*
∞	5	1.079
	10	n/a
	15	1.034
0.3	5	15.027
	10	n/a
	15	−3.487
1.0	5	25.611
	10	n/a
	15	−5.950

Note: *Per cent Δ (ΔSW) is measured relative to the case of $\sigma = 10$.

domestic market, by introducing imperfect competition, particularly given the strength of the political lobby and marketing group, Japan Agriculture. In addition, we have not incorporated explicitly the activities of the state trading enterprise. Instead, we have merely summarised its activities through the tariff equivalent. Further insight could also be gained by supplementing the results on full liberalisation in this paper with some on partial liberalisation, but this is a topic for further research.

In conducting sensitivity analysis on the change in social welfare in totally removing both border and domestic instruments, it was found that the change was not sensitive to the value of the elasticity of domestic supply, whereas it was sensitive to the elasticity of the import supply function.

The interpretation of α as a home-good preference parameter may be open to criticism when government or another organisation influences consumption decisions. However, this is not a difficulty in this analysis because the data that are used record the actual volumes of imports purchased by consumers, rather than those purchased by an organisation such as a state trading enterprise.

Japanese consumers pay an exorbitantly high price for rice relative to the world price. This comes at a significant cost to domestic welfare. Our estimate of this cost is of the order of one hundred billion yen per year with a tariff equivalent in the range 100 per cent to around 200 per cent. These estimates of the welfare cost of Japanese rice policy (and its tariff equivalent) are sensitive to the elasticity of substitution and to the elasticity of supply of imports. Consequently, we conclude that in studies of the welfare cost of Japanese rice policy, it is important to incorporate these characteristics, including home-good preference, and we have shown one potential way of doing so.

References

All translations and transliterations are those of the first-named author, except where an individual or organisation provides an alternative for its own name.

Adachi, H. and Suzuki, N. (2005). Nihon no Nousambutsu Boueki Jiyuuka no Kousei Kouka - 'Shoukoku' no Katei no Mondai (Welfare effects of Japanese agricultural trade liberalisation - the problem of the 'small country' assumption), *Kyuushuu Daigaku Nougakubu Gakugei Zasshi* 60(1), 93–101.

Ahmadi-Esfahani, F. (2009). Estimation of trade elasticities in the presence of trade barriers, multinationals and imperfect competition, *The Australian Journal of Agricultural and Resource Economics* 53, 385–392.

Anderson, K. and Valenzuela, E. (2008). Estimates of Global Distortions to Agricultural Incentives, 1955 to 2007. World Bank, Washington, DC. Available from URL: http://www.worldbank.org/agdistortions [accessed October 2009].

Cramer, G., Wailes, E. and Shui, S. (1993). Impacts of liberalizing trade in the world rice market, *American Journal of Agricultural Economics* 75(1), 219–226.

Cramer, G., Hansen, J. and Wailes, E. (1999). Impact of rice tariffication on Japan and the world rice market, *American Journal of Agricultural Economics* 81(5), 1149–1156.

Durand-Morat, A. and Wailes, E. (2010). Riceflow: a multi-region, multi-product, spatial partial equilibrium model of the world rice economy. University of Arkansas Department of Agricultural Economics and Agribusiness SP 03-2010.

FAO (2010). International Trade in Rice, Recent Developments and Prospects. FAO, Rome. Available from URL: http://www.fao.org/es/esc/en/15/70/81/highlight_79.html [accessed June 2010].

FAPRI (Food and Agriculture Policy Research Institute) (2009). FAPRI Elasticity Database. Department of Economics, Iowa State University. Available at http://www.fapri.iastate.edu/tools/elasticity.aspx [accessed July 2009].

Fujiki, H. (2000). Japanese rice market liberalization: a competitive equilibrium approach, *The Japanese Economic Review* 51(4), 492–518.

Fukuda, H., Dyck, J. and Stout, S. (2003). Rice Sector Policies in Japan. Economic Research Service, United States Department of Agriculture, Tokyo.

Godo, Y. (1993). Beika Seisaku to Gentan Seisaku no Porishii Mikkusu (The policy mix of rice price policy and acreage reduction policy), *Keizai Kenkyuu* 44(1), 32–40.

Honma, M. and Hayami, Y. (2007). Distortions to agricultural incentives in Japan, Korea and Taiwan. World Bank Agricultural Distortions Working Paper 35.

Japan Customs (n.d.) *Japan's Tariff Schedule*. Available from URL: http://www.customs.go.jp/english/tariff/index.htm [accessed October 2009].

Japan Customs (Various). *Trade Statistics of Japan*. Available from URL: http://www.customs.go.jp/index_e.htm [accessed May 2009].

Kako, T., Gemma, M. and Ito, S. (1997). Implications of the minimum access rice import on supply and demand balance of rice in Japan *[sic]*, *Agricultural Economics* 16, 193–204.

MAFF (Ministry of Agriculture, Forestry and Fisheries) (2006). *Kome Seisaku Kaikaku Kihon Youkou* (Basic Principles of the Rice Policy Reform).

MAFF (2008). *Kome Ryuutsuu wo Meguru Joukyou* (Circumstances Pertaining to Rice Distribution). Kome Ryuutsuu Shisutemu Kentoukai, Dai 1 kai Kentoukai, Shiryou 8 (Rice Distribution System Investigative Committee, Meeting 1, Resource Document 8).

MAFF (2009a). *Kome Seisaku ni Kansuru Shimyureeshon Kekka ni Tsuite* (Results of Rice Policy Simulations). Nousei Kaikaku Kankei Kakuryou Kaigou, Nousei Kaikaku Tokumei Chiimu, Dai 11 kai Kaigou, Hairyou Shiryou 3 (Distributed Document #3, Meeting 11, Agricultural Policy Reform Special Team, Agricultural Policy Reform Cabinet Ministers' Group)

MAFF (2009b). *Minimamu Akusesu Mai ni Kansuru Houkokusho* (Report into Minimum Access Rice).

MAFF (Various). Yunyuu Mai ni Kakaru SBS no Kekka no Gaiyou (Summary of Imported Rice SBS Results).

MAFF (Variousa) Seisansha no Beikoku Genzaidaka nado Chousa (Survey of Producers' Rice Inventories and Other Items).

MAFF (Variousaa). Kakou Genzairyouyou ni Kakaru Seifu Shoyuu Minimamu Akusesu Mai no Teirei Hambai no Kekka ni Tsuite (Gaiyou) (Results of Regular Sales of Government Minimum Access Rice, Relating to the Use of Manufacturing Ingredients (Summary)).

MAFF (Variousab). MA Ippan Yunyuu Mai Nyuusatsu Kekka no Gaiyou (Summary of Ordinary MA Imported Rice Tender Results).

MAFF (Variousb). Toukei Jouhou Sougou Deetabeesu (Statistical Information Comprehensive Database). Available from URL: http://www.tdb.maff.go.jp/toukei/toukei [accessed July 2009].

MAFF (Variousba). Kokunaisan Beikoku no Seifu Kaiire ni Kakaru Ippan Kyousou Nyuusatsu no Kekka ni Tsuite (Results of Open Tender Government Procurement of Domestically Produced Rice).

MAFF (Variousbb) Seifu Kokunaisan Beikoku no Ippan Kyousou Nyuusatsu ni Yoru Uriwatashi no Kekka (Results of Open Tender Sales of Domestically Produced Government Rice).

OECD (Organisation for Economic Co-operation and Development) (2009). Evaluation of Agricultural Policy Reforms in Japan. OECD, Paris.

OECD (2010). OECD's Producer Support Estimate and Related Indicators of Agricultural Support – Concepts, Calculations, Interpretation and Use (The PSE Manual). OECD, Paris.

Otsuka, K. and Hayami, Y. (1985). Goals and consequences of rice policy in Japan, 1965–80, *American Journal of Agricultural Economics* 67(3), 529–538.

Parliament of Japan (Various). Tokubetsu Kaikei Sainyuu Saishutsu Kessan (Special Accounts Annual Revenue and Expenditure Balance Sheet). Parliament of Japan, Tokyo

RSSSO (Rice Stable Supply Support Organisation) (Various). Kome no Oroshi Uri Kakaku no Suii (Movement in the Wholesale Price of Rice). Available from URL: http://www.komenet.jp/komedata/ [accessed September 2009].

RSSSO (Variousa). Seifu Bichiku Mai no Tsuki betsu Hambai Doukou (Government Reserve Rice Monthly Sales Variation). Available from URL: http://www.komenet.jp/komedata/ [accessed July 2009].

Silberberg, E. and Suen, W. (2001). The Structure of Economics: A Mathematical Analysis (International Edition). Irwin McGraw-Hill, Singapore.

Sumner, D. and Lee, H. (2000). Assessing the effects of the WTO agreement on rice markets: what can we learn from the first five years?, *American Journal of Agricultural Economics* 82 (3), 709–717.

USDA (United States Department of Agriculture) (2009). Japan – Grain and Feed – Grain and Feed Annual Report – 2009. GAIN Report #JA9022. USDA, Washington, DC.

USDA (Various). California medium-grain #1 price. *Rice Outlook Monthly Tables*. Available from URL: http://www.ers.usda.gov/Briefing/Rice/data.htm [accessed July 2009].

Wailes, E. and Chavez, E. (2011). 2011 Updated Arkansas Global Rice Model. University of Arkansas Department of Agricultural Economics and Agribusiness SP 01-2011.

Yue, C., Beghin, J. and Jensen, H. (2006). Tariff equivalent of technical barriers to trade with imperfect substitution and trade costs, *American Journal of Agricultural Economics* 88(4), 947–960.