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SOUTH KOREAN BEEF INDUSTRY: POTENTIAL IMPACT FROM LIBERALISATION

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In the past South Korea has heavily protected its beef industry with quantitative import controls. However, the stop-start nature of its import policy has adversely affected the development of the South Korean beef industry. As a result, beef production has not kept pace with rising consumer demand. Following a GATT ruling in April 1989, Australia and other major beef suppliers are likely to have increased permanent access to the South Korean beef market in the future. A structural model of South Korean beef demand and supply was developed to obtain estimates of beef demand and supply elasticities. The Korean beef model was incorporated into ABARE's Econometric Model of Australian Broadacre Agriculture (EMABA), which contains a detailed representation of the Pacific Basin beef trade. A series of simulation experiments was performed to analyse the impact of alternative access levels on the Australian and South Korean beef industries. Australian beef producers look set to gain increased sales in the future, but substantially more under full liberalisation of trade than under a 10 kt quota expansion. Gains to South Korean beef consumers would far outweigh the losses to local producers who would be required to adjust to a smaller industry.

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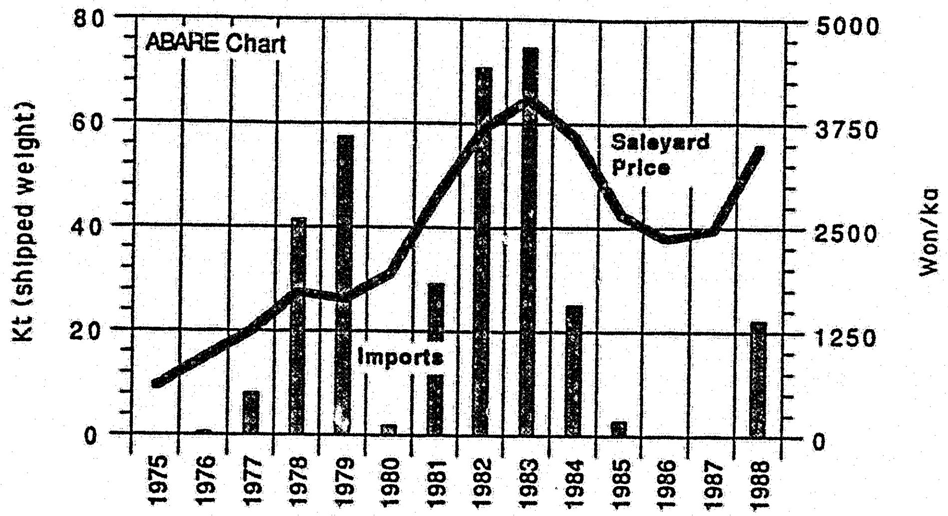
<u>Introduction</u>

The South Korean beef market has a history of sudden changes to access levels for beef imports. Prior to the reopening of the South Korean market to imports in mid-1988 there were two periods of large imports to South Korea, 1976-79 and 1981-84. Strong growth in beef demand and a limited capacity for short term expansion of supplies caused beef prices to rise sharply prior to the relaxations of import bans during these two periods (Figure 1). Increased domestic production and the rapid growth in imports of beef and live cattle eventually led to price reductions and the re-imposition of import bans in an attempt to support prices.

Figure 1 - Saleyard Price of Beef and Quantity of Imports



Recent developments suggest the South Korean imported beef trade is likely to be less volatile in the future. In April 1989 a specially convened panel of the General Agreement on Tariffs and Trade (GATT) found that South Korea's import arrangements were not consistent with its obligations under the GATT and directed that they be made GATT consistent. It seems likely that consultations with major supplying countries will provide for increased permanent access to the South Korean beef market.

The objective of this paper is to analyse the impact of alternative access levels on the South Korean and Australian beef industries. A model of South Korean beef demand and supply was developed; from this, elasticities of beef demand and supply were estimated. The Korean model was incorporated into a model of the Pacific Basin beef trade, which is part of ABARE's Econometric Model of Australian Broadacre Agriculture (EMABA). A series of simulation experiments on alternative South Korean beef import levels was performed and the results are presented.

South Korean Beef Market

South Korean beef production

In the early 1960s in South Korea (termed 'Korea' in the remainder of this paper), each cattle-owning household held only 1.0 head on average and total beef production was less than 40 kt (carcass weight equivalent).

Korean nati e cattle were used mainly for draft purposes on farms, and beef supplies came from culled draft animals. Consequently, the responsiveness of native cattle numbers and beef supplies to price changes was very limited (Shin 1982). Increased mechanisation of rice farming and the strong demand for beef by urban-based consumers ensured that beef production quickly became the primary purpose of raising cattle. This trend toward beef production began during the 1960s and developed rapidly (Huh and Lee 1989). Traditionally, native cattle are fed a combination of grain refuse and forage. However, an increase in the quantity of compound feed consumed by beef cattle in recent years (Table 1) suggests a trend towards grain fed beef production.

The responsiveness of Korean beef production to changes in beef prices may have changed over time. For example, it seems likely that Korean beef supplies are now more responsive to price movements than they were in the early 1960s when cattle were raised essentially for draft purposes.

Demand for beef in South Korea

During the 1970s and 1980s, rapidly rising incomes contributed to a gradual change in Korea's food consumption patterns. Consumption of livestock products has risen, while consumption of cereal and vegetable products has fallen (Huh 1986). Between 1975 and 1988, consumption of meats and seafood increased by around 63 per cent to an estimated 41 kg per person. Seafood continues to be the major source of non-vegetable protein, with 26 kg per person consumed in 1988 (Figure 2). Despite periods of substantial rises in beef prices and bans on beef imports, beef consumption almost doubled over the period 1975-1988 (Table 1). Consumption of poultry meat has remained lower than that of beef, while pork consumption has risen to 8.4 kg a person in 1988, more than twice the level of beef consumption (Figure 2).

Figure 2 - Consumption of Meat and Seafood per Person

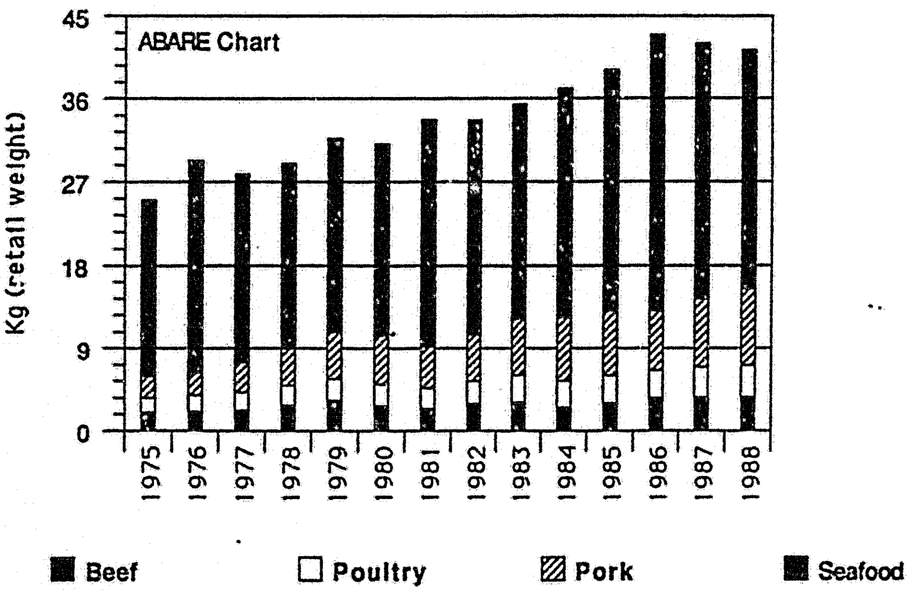


TABLE 1

Korean Beef Industry Indicators

Calendar years	Beef production(a)	Beef imports(b)	Beef consumption(c) Total	Beef consumption(c) Per person	Saleyard price(d)	Cattle numbers	Compound feed consumption
	kt	kt	kt	kg	won/kg	'000 head	kt
1965	41	-	28	1.00	116	1 356	-
1970	56	-	39	1.21	303	1225	19
1975	105	-	72	2.04	582	1 858	184
1980	139	2	104	2.76	1 934	1 762	820
1985	174	3	126	3.07	2 644	2 652	2 203
1988	189	17	141	3.71	3 464	2 386	3 120
1989(e)	120	70	130	3.00	4 600	2 039	3 180

(a) Carcass weight equivalent. (b) Shipped weight. (c) Retail weight equivalent. (d) Liveweight. (e) Estimate based on Jan.-Mar. 1989.
Sources: NLCF (1989a,b); Office of Customs Administration (1988).

Harris, Corra and Shaw (1989) estimated the response of Korean consumers to changes in income and the retail prices of meat and seafood. The uncompensated demand elasticities for meat and seafood estimated in that study are presented in Table 2. Their results indicate that beef consumption is highly responsive to changes in income, with a 1 per cent growth in income generating a 1.1 per cent increase in beef consumption. Further, changes in beef prices also have a significant effect on decisions to buy beef, with a 1 per cent rise in retail prices causing a 0.72 per cent fall in beef consumption. These estimates of demand elasticities have been used to represent the demand component of the South Korean beef model developed in this paper.

<u>South Korean beef imports</u>

Over the period 1976-84, Australia dominated the Korean beef trade, supplying around 95 per cent of imports during the years when import bans were relaxed (Office of Customs Administration 1988). Australia's dominance was achieved largely because most tenders related to grass fed beef for general consumption, and New Zealand had limited supplies of carcass beef that matched tender specifications. Other potential suppliers such as Uruguay and Argentina were excluded from the trade because of the presence of foot-and-mouth disease in their cattle herds. Since the reopening of the market to beef imports in mid-1988, Australia has succeeded in capturing around 75 per cent of tenders. Increased demand for grain fed beef has led to stronger competition from US beef and a decline in Australia's share.

Since 1976 access for imported beef has been controlled through the combination of import quotas and an <u>ad valorem</u> tariff of 20 per cent (Harris and Dickson 1989). The objective of Korean import policy is to 'stabilise both producer and consumer prices and to ensure producers continue to receive a reasonable price' for their beef (Pacific Consultants 1989). As in Japan, control of beef imports has been the most important tool used by the Korean government to achieve this objective.

On the two previous occasions of significant beef imports, increased beef supplies eventually contributed to a weakening of beef prices and the re-introduction of import bans. The possibility that this latest expansion

TABLE 2

Estimated Responsiveness of Korean Demand for Non-vegetable Proteins to Price Changes

	Consumption change per 1 per cent change in				
Commodity	Beef price(a)	Pork price(a)	Chicken price(a)	Seafood price(a)	Income
	%	%	%	%	%
Beef	-0.72	0.06	0.03	0.25	1.10
Pork	0.14	-1.11	0.07	0.62	1.10
Chicken	0.07	0.06	-0.55	0.29	0.41
Seafood	-0.03	0.26	0.00	-0.64	1.16

(a) Retail price.
Source: Harris, Corra and Shaw (1989, p.23).

in imports may be followed by a sudden market closure is less likely than before, following the GATT ruling in April 1989 that South Korea make its import arrangements GATT consistent. Initial indications suggest that, in the short term, permanent import quotas may be established with annual increments negotiated with foreign suppliers.

A further possibility is that the establishment of a permanant import quota could form part of an agreement similar to the phased opening of the Japanese imported beef market. In 1988 Japan agreed to increase its import quota by 60 kt annually from Japanese fiscal year (JFY) 1988 to JFY 1990. In JFY 1991 quotas will be replaced by ad valorem tariffs initially set at 70 per cent and decreasing to 50 per cent by 1993. In the South Korean market ad valorem tariffs levied on imported beef are bound under the GATT. As a result, future access arrangements involving the removal of quotas would require either the re-negotiation of this tariff binding or the incorporation of a system of import surcharges to complement the existing tariff.

A Model of Beef Supply Response in South Korea

In this paper, a structural approach was chosen to model the South Korean beef industry. Huh and Lee (1989) have also modelled beef supply in South Korea within a structural framework similar to that adopted here. In their study equations were explicitly modelled for calves reared, cattle slaughtered and average slaughter weight. This approach allows cattle inventories to be determined residually via a system of stock flow identities. Beef production was derived from the product of cattle slaughterings and average slaughter weights. Unfortunately, Huh and Lee did not present estimates of supply response or data sources.

A structural approach was preferred in modelling Korean beef supply because of its greater 'generality' compared with the 'reduced' form method, such as that adopted by Tyers and Anderson (1985) in their study of agricultural protection in East Asia. A similar structural approach is used for ABARE's EMABA which models beef supply response in other major beef producing countries of the Pacific Basin (Corra, Dickson and Teal 1989; Shaw 1986; Dewbre, Shaw, Corra, and Harris 1985). Harris, Corra and Shaw (1989) used a single equation, partial adjustment approach to model South Korean beef supply in their study on the effects of policy changes on Pacific Basin beef trade; they estimated the long run beef supply response to be 1.8.

The method chosen to estimate producers' response in this analysis was to model changes in cow inventories, the most important factor affecting future levels of cattle slaughter and beef production. This approach is based on the theoretical framework of livestock supply response developed by Jarvis (1974). Korean livestock statistics did not allow estimation of a detailed structural representation of inventory dynamics in the beef industry. There are insufficient time series on slaughter by age or breed, the number of calves born and the number of females that calved. There are also insufficient time series on the slaughter of dairy and native breed animals to allow development of a separate model of the dairy sector.

Because slaughter data were aggregated we could not determine female calf and heifer slaughter. Therefore, it was assumed that over the chosen sample period, all females slaughtered were cows more than two years old and that all female calves are eventually promoted into the cow herd. This assumption is not unreasonable, given the structure of the Korean beef industry. During the 1970s very few heifers or female calves were slaughtered. The small scale of operations (average herd size 1 to 1.5 head) encouraged producers to retain females for breeding purposes while males were gradually fattened and sold at between one-and-a-half and three years of age. In addition, the Korean government imposed a ban on the slaughter of females less than six years of age for most of the 1980s in order to encourage an expansion of the national herd.

Cow inventory and heifer promotion equations are specified so that the slaughter of females can be determined explicitly in the model from the following stock flow identity (in all equations j refers to the current period) :

(1) $$K_j = K_{j-1} + FP_j + QLBI_j - SL_j - D_j$$

where K is closing inventory of female cattle greater than two years old; FP is heifer promotions to the cow inventory; QLBI is number of live breeding cattle imports; SL is slaughter of females; and D is deaths of cows.

Producers' demand for cow inventories was specified as an unconditional factor demand relationship as shown below:

(2) $$K_j = f(E_j, K_{j-1})$$

where E_j is discounted expected real returns to cow beef production.

Expected real returns to cow beef production were specified as a three-year moving average of the salvage value of cows and the beef price in the current period deflated by the Korean consumer price index as a proxy for production costs. This variable was converted into present value terms by dividing through current period interest rates.

Heifer promotions was specified as a lagged relationship of cow inventories, time and the expected returns to cow beef production.

(3) $$FP_j = f(\Sigma(i = j\text{-}3, j\text{-}2)K_i, E_{j-1}, T)$$

where T is time.

This set of behavioural equations (1)-(3) allows cow slaughter to be determined explicitly by the stock flow identity.

Total beef production was obtained from two sources, cow beef production and 'other' beef production. Although there are some short run trade-offs between future and current production sourced from the male population, for the most part this relationship is fixed. Consequently, short run variations in beef supplies are mainly determined by changes in female slaughter. Changes in long run beef supplies are largely a consequence of variations in breeding cattle numbers.

Importantly, the response of beef supplies to price changes differs between the short term and the long term. In the short term, a negative relationship may exist between female slaughter (and cow beef supplies) and changes in beef prices as beef producers trade off current returns against expected future returns (Jarvis 1974). In the long term, a positive relationship between beef supplies and price changes would be expected.

Attempts to model 'cow' beef and 'other' beef production directly proved inadequate in forecasting exercises. Consequently, total beef production and 'other' beef production were modelled with 'cow' beef production determined residually. Both total beef production and 'other' beef production were estimated as functions of lagged cow inventories and the current price of beef deflated by the consumer price index.

(4) $QSB_j = f(\Sigma(i = j\text{-}3 \text{ to } j\text{-}1)K_i, SPMB_j/CPI_j)$

where QSB is the quantity of total beef production; SPMB is the saleyard price of male cattle; and CPI is the consumer price index.

(5) $QSOB_j = f(\Sigma(i = j\text{-}3 \text{ to } j\text{-}1)K_i, SPMB_j/CPI_j)$

where QSOB is the quantity of 'other' beef production.

(6) $QSCB_j = QSB_j - QSOB_j$

where QSCB is the quantity of 'cow' beef production.

Price Responsiveness of South Korean Beef Supplies

Ordinary least squares regression techniques were used to estimate the above equations in log-linear functional forms. The relevant equation coefficient estimates and diagnostic statistics for the full supply model and market clearing identity are presented in Appendix A. All coefficient estimates are of the correct sign. The standard error of regression (SER) statistics confirm that the equations display a satisfactory level of explanatory power.

To assess model performance, two kinds of validation experiments were performed. The first compared historical static and dynamic simulations of the full South Korean demand and supply model over the period 1975 to 1987. A static simulation uses actual values of lagged endogenous variables while a dynamic simulation uses prior period model solutions for those variables. The means of actual and simulated data and root mean square (RMS) errors for the major model variables are presented in Table 3. Although the model produces high errors for some variables it replicates variations in total beef production and cow inventories satisfactorily with static simulation errors of less than 8 per cent.

The second type of validation experiment concerned the stability and dynamic behavioural characteristics of the model. All exogenous variables were set at, for example, 1988 values for all future periods; the model was then simulated a sufficient number of periods forward to determine whether model solutions converge to a stable equilibrium. This procedure is analogous to the determination of the properties of the characteristic roots of a linear model. Although they do not constitute a formal mathematical proof of global model stability, the results of these simulations do provide empirical evidence of local stability.

Supply elasticities for total beef production, 'cow' beef production and 'other' beef production were calculated with respect to saleyard prices (Table 4). The elasticities were estimated from experimental runs of the system of supply and demand equations; an outline of this procedure can be found in Dewbre et al. (1985). Such elasticities are explicitly time-

TABLE 3

Static and Dynamic Simulation Performance 1975 to 1987

Variable	Unit	Actual mean	Dynamic Mean	Dynamic RMS error	Static Mean	Static RMS error
				%		%
'Total' beef production	kt	135.6	134.1	14.63	134.0	7.88
'Cow' beef production	kt	49.0	48.4	121.35	49.7	57.36
'Other' beef production	kt	86.6	85.7	14.39	84.3	12.93
Inventory of cows	head	904.3	900.9	12.43	912.8	7.18
Heifer promotions	head	239.9	216.0	36.59	243.7	26.29
Cow slaughter	head	196.8	170.4	203.55	192.1	98.68
Farm level price	won/kg	2205.3	2118.7	38.00	2084.1	21.30

TABLE 4

Beef Supply Response(a)

Variable	Change in production per 1% change in saleyard price			
	After 1 year	After 5 years	After 10 years	Long run
	%	%	%	%
'Cow' beef production	-0.618	-0.052	0.317	0.343
'Other' beef production	0.629	0.936	1.132	1.146
'Total' beef production	0.140	0.548	0.812	0.831

(a) Production effects from an immediate and sustained 1 per cent rise in farm-level beef price.

dimensional, that is, giving response after one year, after two years, etc. The elasticity estimates may also be sensitive to the starting values of the exogenous variables. Consequently, the experimental simulations were performed using both 1975 and 1986 values of the exogenous variables. As the two sets of estimates were not significantly different, those calculated from the 1986 data set have been reported here.

The first year effects are an indication of the short-run response of beef supplies to price changes. The negative elasticity of -0.618 for cow beef supplies is indicative of the 'retain or slaughter' option faced by producers. It indicates that, when faced with rising prices, producers will suspend or reduce the slaughter of cows, and forego a certain return in the expectation of higher future returns. As expected, the supply response of 'cow' beef production to beef price changes becomes positive in the long run. The supply of 'other' beef is positively related to changes in beef prices, rising from 0.629 in the short run to 1.146 in the long run.

The elasticity of total beef supply is 0.140 in the short run, 0.548 after five years, 0.812 after ten years and 0.831 in the long run. The estimated long run elasticity compares favourably with that of Harris, Corra and Shaw (1989), the only other published estimate of the long run beef supply response in South Korea. They estimated that a sustained 1 per cent rise in beef prices would generate a 1.8 per cent rise in total beef production. The long run estimate of supply response presented here also compares with estimates of 3 per cent for Australia, 0.5 per cent for the United States (Dewbre et al. 1985) and 0.5 per cent for the Japanese dairy beef sector (Corra, Dickson and Teal 1989).

In the future, the trend towards a grain-based feedlot industry may reduce the overall responsiveness of beef production to price changes. The relatively high capital intensity of a feedlot production system limits the responsiveness of beef supplies to price changes in the short run. Once the initial investment is made in the larger, more specialised feedlots, it is economically viable to continue producing beef at times of short term price reductions as long as direct operating costs are covered. Though a sustained price decline would generate a larger supply response, the magnitude of the response is likely to be significantly lower than the response generated in a grass fed beef production system such as Australia's.

A further rise in the importance of dairy cattle as a source of beef supply could also reduce the level of price responsiveness, as the supply of these animals depends primarily on returns to milk production (Coyle 1983). Consequently, the usefulness of supply response estimates derived from historical data in assessing future changes in South Korean beef supplies will depend on the pace at which these developments occur. To the extent that these trends continue, the supply response estimate based on a sample period over the 1970s and 1980s will provide an upper bound on producer's response to price changes.

Effects on Beef Imports of Changes in Korean Access Levels

As mentioned earlier, the GATT panel ruling is likely to result in the negotiation of some form of permanent access arrangement for South Korean beef imports. To assess the implications of alternative import access scenarios on both the South Korean and Australian beef industries, the South Korean beef model was integrated with the Bureau's EMABA model. EMABA is a spatial equilibrium model which incorporates 21 countries for which demand and/or supply of up to seven commodities is represented (Harris, Corra and Shaw 1989). Specifically for beef, EMABA models market price determination in six Pacific Basin countries: the United States, Canada, Australia, New Zealand, Japan and Korea. The model also includes endogenous beef demands in Taiwan and other South-East Asian markets, as well as the necessary differentiated product trade equations to link these markets. Recently the model has been revised to endogenise the pig and poultry industries of these same six countries and Taiwan.

The analysis consisted in comparing a baseline forecast simulation for the 1990-95 period with two alternative simulations. For all the baseline simulations the values assumed for the model's exogenous economic variables were based on the most recent set of ABARE projections prepared for the 1990 National Agricultural and Resources Outlook Conference (ABARE 1989). In the baseline simulation, quota access for Korean beef imports was assumed to rise by 10 kt annually from 80 kt in 1990 to 130 kt by 1995. Data constraints did not allow the estimation of price determined trade share equations. For the purposes of this study it was assumed Australia, the United States and New Zealand would receive fixed trade shares of 75, 15 and 10 per cent respectively. These trade shares approximate the most recent information on country import shares over the 1988-89 period. Results of the baseline forecast simulation for some of the major model components are presented in Appendix B. The baseline results indicate that South Korean farm level prices will continue to rise over the medium term to 6830 won/kg. Beef consumption is forecast to rise to around 300 kt by 1995, while domestic production is projected to decline slightly in the short term before rising to 117 kt by 1995.

Two alternative policy simulations were considered. As South Korea has a history of sudden changes to access levels for beef imports, the first alternative simulation involved the immediate reimposition of a ban on beef imports. To assess the implications of greater market liberalisation, a second simulation scenario involved the complete removal of quota constraints from the Korean beef market. For this simulation the South Korean domestic beef price was assumed to adjust downward to a level equivalent to the landed Australian grass beef price, adjusted for exchange rates, insurance, freight, handling charges and the existing 20 per cent tariff. This particular experiment implies that South Korean and Australian grass fed beef are perfect substitutes. As these two products will be close but not perfect substitutes the simulated effects will tend to overestimate the likely effects of a non-quota trading environment. Results comparing the baseline and alternative policy simulations are presented in Table 5.

Following an immediate reimposition of a South Korean ban on beef imports, Korean farm level prices were estimated to be 66 per cent higher than baseline levels in 1995. The higher beef prices result in substantially higher levels of domestic beef production and domestic consumption levels around 18 per cent lower than 1995 baseline levels. Under the assumption of free trade, farm level prices are 68 per cent lower than baseline levels. Korean beef imports and consumption levels are substantially higher, while domestic beef production is estimated to be around 71 per cent lower than 1995 base levels.

Under the assumptions of both alternative simulations, the developments in the South Korean beef market have a significant impact on the Australian beef industry. With no quota constraints, the higher levels of Korean beef imports result in increased export demand for Australian beef. Consequently, Australian saleyard beef prices are more than 11 per cent higher by 1995. There is also a lower level of domestic beef consumption and an expansion of the Australian cattle herd to yield a 1995 production level around 1.5 per cent higher than the base level. The reimposition of the import ban has the opposite effects, with Australian beef prices around 9 per cent lower than base levels by 1995. The lower prices encourage higher domestic beef consumption, and a smaller cattle herd means a lower level of beef production by 1995.

TABLE 5

Simulation Results for the Reimposition of a South Korean Import Ban and the Removal of Import Quotas(a)

Country and variables	1990	1991	1992	1993	1994	1995
			Reimposition of Import Ban			
South Korea						
Production	21.7	31.7	49.6	75.7	98.1	110.0
Imports	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0
Consumption	-40.4	-41.0	-35.9	-26.9	-19.9	-18.0
Farm level price	285.0	293.5	216.7	124.5	76.8	66.3
Australia						
Production	0.1	0.9	0.8	0.1	-0.4	-0.7
Exports	-2.3	0.3	-0.2	-1.0	-2.1	-3.4
Consumption	2.9	1.6	2.2	1.5	2.0	3.7
Farm level price	-7.7	-3.7	-5.2	-3.7	-5.0	-9.1
			Removal of Import Quotas			
South Korea						
Production	-13.1	-23.5	-37.7	-53.4	-62.5	-67.9
Imports	175.6	187.5	191.5	197.7	198.0	209.7
Consumption	83.2	92.9	93.3	93.5	92.7	101.3
Farm level price	-62.0	-61.0	-67.0	-67.6	-68.8	-70.7
Australia						
Production	-0.2	-1.6	-1.5	-0.1	0.7	1.4
Exports	3.9	-0.4	0.5	2.1	3.9	4.7
Consumption	-5.3	-3.3	-4.2	-3.2	-3.9	-4.0
Farm level price	16.1	8.2	11.0	8.5	10.6	11.1

(a) All figures are percentage changes from baseline simulation results (Appendix B).

Table 6 contains estimates of the gains (and losses) in these alternative policy simulations, based on changes in producer and consumer surplus. These welfare effects have been calculated as the summation of each year's effect for the 1990-95 period and discounted to 1990 net present value terms. Under the partial equilibrium framework chosen for this analysis, beef producers in South Korea would gain from a reimposition of the ban on beef imports. However, the net result for the economy is a substantial loss of around US $9074m due to the relatively larger losses in consumer surplus. Conversely, the removal of import quotas would result in large gains for South Korean consumers and substantial losses for beef producers, with a net gain of around US$16 640m for the South Korean economy.

A ban in South Korean beef imports over the 1990-95 period would result in substantial losses for Australian beef producers and gains for domestic beef consumers. The net result is an estimated loss of around US$422m for the Australian economy. Removing quantitative import controls would yield large gains for Australian beef producers, losses for domestic consumers and a net gain of around US$828m.

TABLE 6

Estimated Cumulative Changes in Producer and Consumer Surplus: 1989 to 1995

Country and variables	Simulated impact of Import ban	Simulated impact of No quota
	US$m	US$m
South Korea		
Change in consumer surplus	-26 937	21 693
Change in producer surplus	17 863	-5 052
Net gain to economy	-9 074	16 640
Australia		
Change in consumer surplus	294	-560
Change in producer surplus	-716	1 388
Net gain to economy	-422	828

Conclusions

While the South Korean beef industry has been heavily protected in the past, the market has been adversely affected by the stop-start nature of South Korean import policy. As a result the production of beef has not kept pace with strongly rising consumer demand. The reopening of the market to beef imports and the favourable findings of the GATT panel suggest Australian beef producers could gain significantly higher sales in future years. South Korean beef consumers would also gain, while beef producers would be required to adjust to a smaller industry.

The immediate and complete removal of Korean import quotas would result in large gains for Korean beef consumers and a significant net gain for their economy, despite the estimated losses for beef producers. Australian beef producers would also gain substantial benefits if the assumed 75 per cent market share were maintained over the 1990-95 period. If Korea banned beef imports over this period, Australian beef producers would experience significant welfare losses. Although Korean beef producers would gain from the import ban, the welfare losses experienced by Korean beef consumers would result in a large net loss for the Korean economy.

APPENDIX A

The Model and Estimation Results

Equation A1: Cow bef production

$$QSCB_j = QSB_j - QSOB_j$$

'Cow' Beef Production (QSCB) - Dynamic and Static Simulation Results

		Dynamic			Static		
Measure	Actual	Simulation	Error	Percent -age error	Simulation	Error	Percent -age error
Mean	49.0	48.4	-0.6	40.2	49.7	0.7	16.2
RMS	57.4	51.9	28.36	121.3	58.4	14.2	57.4
Std dev.	31.1	19.7	29.4	119.1	32.0	14.8	57.3

Equation A2: Expected real beef returns

$$E_j = \Sigma_i((0.2\ SPFB_i\ 250 + SPMB_i\ 500)/CPI_i)/3 \qquad (i=j-2,j-1,j)$$

Equation A3: Cow inventory

$$K_j = K_{j-1} + FP_j + QLBI_j - SL_j - D_j$$

Cow Slaughter (SL) - Dynamic and Static Simulation Results

		Dynamic			Static		
Measure	Actual	Simulation	Error	Percent -age error	Simulation	Error	Percent -age error
Mean	196.8	170.4	-26.4	50.1	192.1	-4.7	10.3
RMS	249.2	196.5	171.0	203.6	237.9	79.2	198.7
Std dev.	159.1	101.8	175.9	205.3	146.1	82.3	102.1

Equation A4: Total beef and veal production

$$\log(QSB_j) = \underset{(-8.53)}{-7.83} + \underset{(13.81)}{1.82} \log \Sigma_i(K_i/3)$$

$$+ \underset{(1.47)}{0.15} \log(SPMB_j/CPi_j) \qquad (i=j-3,j-2,j-1)$$

Range 1972 to 1987; NOB = 16; NOVAR = 3

R^2 = 0.94; CR^2 = 0.93; F(2/13) = 97.21

SER = 0.10; SSR = 0.13; DW = 1.21

Total Beef and Veal Production (QSB) - Dynamic and Static Simulation Results

		Dynamic			Static		
Measure	Actual	Simulation	Error	Percent -age error	Simulation	Error	Percent -age error
Mean	135.6	134.1	-1.5	1.0	134.0	-1.6	-1.6
RMS	142.2	139.0	19.2	14.6	142.2	10.9	17.9
Std dev.	44.7	37.9	19.9	15.2	49.5	11.3	8.0

Equation A5: Other beef production

$$\log(QSOB_j) = \underset{(-18.25)}{-6.30} + \underset{(11.94)}{1.31} \log \Sigma_i (K_i/3)$$

$$+ \underset{(7.73)}{0.64} \log (SPMB_j/CPI_j) \qquad (i=j-3, j-2, j-1)$$

Range 1972 to 1987; NOB = 16; NOVAR = 3

R^2 = 0.94; CR^2 = 0.93; F(2/13) = 104.403

SER = 0.08; SSR = 0.09; DW = 1.72

Other Beef Production (QSOB) - Dynamic and Static Simulation Results

		Dynamic			Static		
Measure	Actual	Simulation	Error	Percent -age error	Simulation	Error	Percent -age error
Mean	86.6	85.6	-0.9	-1.7	84.3	-2.3	-2.8
RMS	88.4	89.3	12.8	14.4	87.0	10.9	12.9
Std dev.	18.3	25.8	12.7	13.3	22.4	11.1	13.1

Equation A6: Heifer promotions

$$\log(FP_j) = \underset{(-2.03)}{-8.60} + \underset{(2.38)}{1.62} \log \Sigma_i(K_i/2) + \underset{(4.19)}{1.04} \log(E_{j-1})$$

$$\underset{(-2.47)}{-\ 0.12}\ T \qquad (i=j-3,j-2)$$

Range 1972 to 1987; NOB = 16; NOVAR = 4

$R^2 = 0.74$; $CR^2 = 0.68$; $F(3/12) = 11.432$

SER = 0.29; SSR = 1.00; DW = 2.32

Heifer Promotions (FP) - Dynamic and Static Simulation Results

		Dynamic			Static		
Measure	Actual	Simulation	Error	Percent -age error	Simulation	Error	Percent -age error
Mean	239.92	216.0	-23.9	3.3	243.7	3.8	8.2
RMS	272.1	229.8	102.9	36.6	270.3	52.0	26.3
Std dev.	133.7	81.9	104.2	37.9	121.6	54.0	26.0

Equation A7: Cow inventories

$$\log(K_j) = \underset{(2.89)}{1.82} + \underset{(4.31)}{0.16} \log(E_j) + \underset{(5.45)}{0.58} \log(K_{j-1})$$

Range 1972 to 1987; NOB = 16; NOVAR = 3

$R^2 = 0.88$; $CR^2 = 0.86$; $F(2/13) = 47.668$

SER = 0.08; SSR = 0.08; DW = 1.18

Cow Inventories (K) - Dynamic and Static Simulation Results

		Dynamic			Static		
Measure	Actual	Simulation	Error	Percent -age error	Simulation	Error	Percent -age error
Mean	904.3	900.9	-3.3	1.5	912.8	8.6	1.7
RMS	926.2	911.9	100.3	12.4	930.1	54.6	7.2
Std dev.	208.6	147.2	114.7	12.8	185.5	56.2	7.3

Equation A8: Farm level price for female cattle

$$\log(SPFB_j) = 0.43 + 0.95 \log(SPMB_j)$$
$$(1.44)(23.52)$$

Range 1972 to 1987; NOB = 16; NOVAR = 2

$R^2 = 0.98$; $CR^2 = 0.97$; $F(1/14) = 553.292$

SER = 0.12; SSR = 0.22; DW = 1.29

Farm Level Price for Female Cattle (SPFB) - Dynamic and Static Simulation Results

Measure	Actual	Dynamic			Static		
		Simulation	Error	Percent -age error	Simulation	Error	Percent -age error
Mean	2311.2	2183.6	-127.5	6.5	2152.3	-158.9	0.4
RMS	2598.3	2424.4	1322.5	47.8	2345.5	857.3	26.9
Std dev.	1235.7	1096.3	1370.1	49.3	970.3	876.9	28.0

Equation 9: Market clearing identity for beef

$$QDB_j = QSB_j + QBI_j \; KBI - QBX_j/0.67 - BST_j/0.67$$

Farm Level Price for Male Cattle (SPMB) - Dynamic and Static Simulation Results

Measure	Actual	Dynamic			Static		
		Simulation	Error	Percent -age error	Simulation	Error	Percent -age error
Mean	2205.3	2118.7	-86.6	1.9	2084.1	-121.3	-2.2
RMS	2419.3	2372.6	1059.7	38.0	2287.7	662.0	22.3
Std dev.	1035.4	1111.5	1099.3	39.5	982.1	677.4	23.1

TABLE A1

Data Listing

Variable	Definition	Unit
SPMB	Price received by farmers, male cattle 400 kg	won/kg (liveweight)
SPFB	Price received by farmers, female cattle	won/kg (liveweight)
E	Returns to cow beef producers	won/head
QDB	Domestic beef and veal consumption	kg (cwe)
QSB	'Total' beef and veal production	kt (cwe)
QSCB	Production of 'cow' beef	kt (cwe)
QSOB	Production of 'other' beef	kt (cwe)
K	Inventory of cows	head
FP	Heifer promotions	head
SL	Slaughter of cows	head
D	Deaths	head
BST	Change in beef stocks	kt (product weight)
QBI	Imports of beef	kt (shipped weight)
QBX	Exports of beef	kt (shipped weight)
QLBI	Live breeder cattle imports	head
KBI	Conversion factor for cwe beef imports	per cent
CPI	Consumer price index	1980=100
I	Interest rate	per cent
T	Time	years

A copy of data and their sources is available from the authors upon request.

APPENDIX B

Summary of Forecast Baseline Simulation Results for Pacific Basin Beef Market(a)

	Unit	1989(b)	1991	1993	1995
<u>Australia</u>					
Production	kt	1 471	1 456	1 470	1 718
Consumption	kt	663	617	602	609
Exports	kt	574	589	613	790
Farm level price (c)	Ac/kg	210	239	250	237
<u>New Zealand</u>					
Production	kt	566	550	684	786
Consumption	kt	141	131	130	153
Exports	kt	280	270	356	402
Farm level price (c)	NZc/kg	200	212	212	194
<u>United States</u>					
Production	kt	10 516	10 706	10 972	11 053
Consumption	kt	11 170	11 311	11 579	11 821
Exports (d)	kt	288	274	279	284
Imports (d)	kt	526	509	517	606
Farm level price (e)	USc/kg	161	169	176	191
<u>Canada</u>					
Production	kt	1 043	1 098	1 142	1 168
Consumption	kt	1 094	1 140	1 181	1 223
Imports (d)	kt	84	66	59	64
Farm level price (e)	Can c/kg	189	190	199	219
<u>Japan</u>					
Production	kt	522	555	569	561
Consumption	kt	1 160	1 332	1 491	1 678
Imports (f)	kt	333	487	627	775
Farm level price (c)	yen/kg	1 256	650	604	548
<u>South Korea</u>					
Production	kt	120	102	110	117
Consumption	kt	218	228	264	299
Imports	kt	70	90	110	130
Farm level price (e)	won/kg	4 324	5 880	6 181	6 834

(a) Production and consumption figures are in carcass weight equivalent. Imports and export figures are in shipped weight. (b) ABARE estimate. (c) Dressed weight. (d) Excludes beef trade between Canada and the United States. (e) Liveweight. (f) Includes diaphragm beef.

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