Foot-and-mouth disease and trade restrictions: Latin American access to Pacific Rim beef markets[†]

Allan N. Rae, Chris Nixon and Peter Gardiner*

Owing to their eradication of foot-and-mouth disease Argentina and Uruguay have recently been granted access to the fresh beef markets of the United States and Canada. This raises the prospect of Latin American suppliers gaining access to other Pacific Rim markets, and of increasing the integration of the Pacific and non-Pacific beef markets. A two-commodity spatial equilibrium model is constructed for the base year 1995. Projections are then made for the year 2001 under various policy and other scenarios. In some instances, major changes in trade patterns may result.

1. Introduction

Recent years have seen significant changes in protection levels and instruments within the Pacific Rim beef market. Japan's import quota system was phased out over the period 1988–90 and replaced by tariff-only protection from 1991. The GATT/Uruguay Round negotiations led to agreements to move from quota to tariff protection in the Republic of Korea, to replace the US Meat Import Act with a tariff-rate quota and a reducing out-of-quota tariff, and to further reduce Japan's tariff on beef imports. Other barriers to trade in fresh beef within Pacific Rim markets have been the bans imposed by some countries on beef imports from regions where foot-and-mouth disease is endemic. But some such barriers have also been removed recently, opening the way for new exporters to compete with those from Australia and New Zealand in Pacific Rim fresh beef markets.

[†]We gratefully acknowledge the financial support of the Agricultural and Marketing Research and Development Trust (AGMARDT) of New Zealand.

^{*}Allan Rae, Department of Applied and International Economics, Massey University, Palmerston North, New Zealand; Chris Nixon, New Zealand Institute of Economic Research, Wellington, New Zealand; Peter Gardiner, The Treasury, Wellington, New Zealand.

[©] Australian Agricultural and Resource Economics Society Inc. and Blackwell Publishers Ltd 1999, 108 Cowley Road, Oxford OX4 1JF, UK or 350 Main Street, Malden, MA 02148, USA.

Foot-and-mouth disease (FMD) exists in many parts of the world, and affects cloven-footed animals. The symptoms typically are blistering of the mouth, feet or udder. It is highly contagious owing to its short incubation period, its ability to survive for lengthy periods in the environment, multiple ways of transmission and the large amounts of virus produced from infected animals. It is the prospect of disease transmission by the international movement of livestock or livestock products that has led some countries to ban the import of these commodities from infected regions. Such bans constitute technical barriers to trade (Hillman 1991).

Infected animal products can contain large quantities of the FMD virus, although some further processing activities can prevent the spread of the disease. FMD has been present in Latin America for many years, and has prevented regions infected with FMD accessing the major Pacific Rim beef markets. Thus their fresh beef has been directed to regions that have not imposed trade bans for FMD-related reasons, for example, Europe and the Middle East, or to products exported in a further-processed form and with perhaps lower returns.

The process of FMD clearance starts with eradication and vaccination, followed by a period of FMD-free status, certification by an international agency and finally clearance by individual importing countries. The Sanitary and Phtyosanitary Agreement (SPS) of the Uruguay Round of multilateral trade negotiations has assisted this process. Under this Agreement, countries may ban selected goods if they endanger human, animal and plant health, but should not discriminate among sources of supply if similar conditions exist in these supplying countries. Trade bans should be made on accepted international standards and scientific principles. The Agreement also recognises disease-free areas within a country as: 'An area, whether all of a country, part of a country, or all or parts of several countries, as identified by the competent authorities, in which a specific pest or disease does not occur' (Agreement on the Application of Sanitary and Phytosanitary Measures, Annex A, paragraph 6, GATT 1993). Thus regions of Latin American countries could obtain clearance to export to the Pacific Rim market prior to the disease being eradicated from the entire country.

Authorities in the United States and Canada opened their borders to imports of fresh, frozen or chilled imports of beef from Uruguay (in 1996) and Argentina (in 1997). US and Canadian tariff-rate quotas currently include only small allocations to Uruguay and Argentina, which raises the question as to how these allocations might be modified in the new WTO negotiations due to commence during 1999. Northeast Asian markets might also permit imports of fresh beef from South America, providing the potential for new competition for traditional suppliers to those markets also. Finally, future expansion of the North American Free Trade Area

(NAFTA), perhaps into an integrated North–South American market, could also have profound impacts on the Pacific Rim beef trade.

The following section provides a brief overview of the Pacific Rim beef market, followed by discussion of methodology and data. This includes definition of regions and products, base period data, demand and supply estimates and trade policies. Results from various experiments are next discussed, and some concluding remarks complete the article. The Appendix includes additional data.

2. The Pacific Rim beef market

We define this market as those Pacific Rim countries that are recognised as free of foot-and-mouth disease. Within this market, major exporting countries are Australia, United States, New Zealand and Canada, while major importers are Japan and the United States. The predominant trade flows are from the United States and Australia to Japan and the Republic of Korea, from Australia and New Zealand to the United States, and between Canada and the United States (table 1). All these countries impose bans on the import of fresh, chilled and frozen beef from regions where FMD is endemic, which separates this market from other beef markets within the Pacific Rim or elsewhere. Table 1 also shows trade flows among the above Pacific Rim such as Southeast Asian nations, which include others within the Pacific Rim such as Southeast Asian nations, and those elsewhere in the world. These trade flows will not be modelled here, and they have been netted out of the base year data (see the notes to Appendix table 1).

The FMD-free Pacific Rim beef market comprises (at least) two integrated markets, differentiated by product type. Australia and New Zealand produce grassfed beef reflecting the climatic conditions that exist in these two countries. In contrast, the North American and Northeast Asian cattle

To From	US	Canada	Japan	Korea	Other	Total Exports	Total excl. 'other'
United States Canada Australia NZ Other	250 316 271 72	137 47 62 2	469 9 462 40	130 3 86 42	95 152 102	831 262 1063 517	736 262 911 415
Total imports Total excl. 'other'	909 837	248 246	980 980	261 261			

 Table 1
 Structure of beef trade in 1995 ('000 tonnes cwe, fresh, chilled or frozen)

Sources: WTO and national trade statistics.

industries are geared to grain feeding. The latter production system is also being adopted in Australia. Both types of beef are important in consumption in Japan, Korea and the United States. Since Argentina and Uruguay are producers of grassfed beef, analysis of their entry to the Pacific Rim beef market should consider the strength of the substitution relationship between both types of beef in consumption.

The United States is both a major exporter and importer of beef, and exports have recently increased rapidly; those for 1997 are forecast to be 43 per cent above the 1991–95 average (OECD 1997). Beef imports into the United States and Canada are predominantly grassfed product from Australia and New Zealand, with smaller quantities now admitted from Argentina and Uruguay.

The two largest import markets in Northeast Asia are Japan and Korea. While production in Japan has stabilised, it increased in Korea by 72 per cent between 1989 and 1995. Self-sufficiency has continued to fall in both countries in response to reduced levels of protection from tariffs or non-tariff barriers and continued demand growth. Per head consumption of beef is relatively low in both countries, providing scope for further growth as the trend towards increased consumption of high-protein products continues and imported beef prices fall owing to reforms of import policies.

Beef production in Australia and New Zealand has been affected during the 1990s by droughts and falling prices, although both countries have shown some recent recovery. While production in both countries is predominantly grassfed, grainfed production is becoming more important in Australia in response to Asian demand. The share of grainfed beef in Australia's exports to Japan has been forecast to increase from 40 per cent in 1994 to 58 per cent by 2000 (Doyle *et al.* 1995).

Although drought reduced the size of the Uruguay cattle herd in 1989, cattle numbers have been increasing. They were expected to reach 11 million head in 1997 (table 2) and to continue to expand in recognition of positive export prospects. Export volumes increased 32 per cent from 1995 to 1996, and major destinations included the EU, Israel and other parts of South America. In Argentina, beef production reached over 2.5 million tonnes (carcass weight equivalent) in 1996, which was almost as great as the combined production of Australia, New Zealand and Uruguay. While cattle numbers are the lowest since 1971, higher future production could see export volumes by 2000 at 56 per cent above the level forecast for 1997 (WTO 1997). The European Union (EU) has been Argentina's major export market, taking over 105000 tonnes in 1996 including a quota for 28 000 tonnes of high-quality beef. For the first time in over 60 years, Argentina was able to export fresh (i.e. uncooked) beef to the United States in 1997. Uruguay benefited from the same measure the previous year, and in each

	Unit	1995	1996	1997	1995/6 (per cent change)	1996/7 (per cent change)
Uruguay						
Cattle numbers	'000 head	10451	10630	10 790	2	1.5
Beef and Veal Production	'000 tonnes	350	419	423	16	1
Consumption	'000 tonnes	204	205	213	0.5	4
Per capita	kgs/capita	65	65	67	0	3
Exports	'000 tonnes	143	210	210	32	0
Argentina						
Cattle Numbers	'000 head	54 207	53 569	51 821	-1	-3.5
Beef and Veal Production	'000 tonnes	2 600	2 5 5 0	2 500	-2	-2
Consumption	'000 tonnes	2 0 8 0	2110	2 0 2 0	1.5	-4.5
Per capita	kgs/capita	60.7	60.9	57.6	0.5	-5.5
Exports	'000 tonnes	520	460	480	-11.5	4.5

Table 2 The bovine meat sector in Argentina and Uruguay (1996 estimates and 1997 forecasts)

Source: WTO (1997).

case a quota of 20 000 tonnes (product weight) was allocated. Uruguay and Argentina were granted access to the Canadian market in the same year that US access was granted.

3. Methodology and data

3.1 The quadratic programming model

A commonly used spatial equilibrium trade model is the quadratic programming formulation of Takayama and Judge (1971), based on linear demand and supply functions. In our two-commodity application, the matrices of slope coefficients in the demand functions were not always symmetric, and an alternative formulation of Martin (1981) was used. In this, the function to be maximised is specified as a net revenue problem, that is gross revenue from sales in all regions net of the cost of procuring product in all producing regions and associated transfer costs. The value of this objective function in competitive equilibrium will be zero. The maximisation is subject to a set of linear constraints that impose all of the necessary conditions for a competitive equilibrium.

The entire set of demand and supply equations for all regions and commodities can be written as: $P_y = \lambda - \Omega y$ and $P_x = v + Hx$, respectively, and the model can be expressed as:

maximise
$$(\lambda - \Omega^* y)' y - (v + H^* x)' x - T' X - 0' \rho_v - 0' \rho_x$$
 (1)

subject to:

$$G_{y}X - y \ge 0 \tag{2}$$

$$G_x X + x \ge 0 \tag{3}$$

$$\rho_{y} - (\lambda - \Omega y) \ge 0 \tag{4}$$

$$-\rho_x + v + Hx \ge 0 \tag{5}$$

$$T - G'_y \rho_y - G'_x \rho_x \ge 0 \tag{6}$$

$$y, x, X, \rho_y, \rho_x \ge 0 \tag{7}$$

where:

y and x are vectors of quantities demanded and supplied respectively; λ and v are vectors of intercepts of the demand and supply functions; Ω and H are matrices of slope coefficients of the demand and supply functions; Ω^* and H^* are symmetric slope coefficient matrices; T is transfer costs;

 G_{v} and G_{x} are matrices consisting of zeroes and ones;

 \vec{X} denotes the trade flows between all pairs of regions; and

 ρ_{y} and ρ_{x} are vectors of demand and supply prices.

Solutions from such a model are equilibria in the sense that:

- they require each region's consumption to be equal to its imports plus that portion of its production that is consumed domestically (constraint (2));
- they require each region's production to be equal to its exports plus that portion of its production that is consumed domestically (constraint (3));
- they specify a set of regional prices that determine the levels of production and consumption in each region (constraints (4) and (5));
- they require that if trade occurs between two regions, the price in the exporter will equal that in the importer less the relevant transport costs, tariff charges and quota rents; and
- they require that if no trade exists between two regions, then the price in the importer must be less than that in the exporter plus the relevant transport costs and tariff charges (constraint (6)).

The model is constructed on the assumption that the Pacific Rim beef market is perfectly competitive. This assumption may appear questionable in Northeast Asia where state trading enterprises have been involved in the importation of beef. However, the Japanese market is now relatively liberalised compared with the situation that existed when quotas were in place. In Korea the volume of imports has, in recent times, exceeded the annual quotas (Doyle *et al.* 1995) and by 2001, the Korean state trading

[©] Australian Agricultural and Resource Economics Society Inc. and Blackwell Publishers Ltd 1999

enterprise will no longer be involved in beef importation. The model was initially constructed to simulate prices, quantities and trade flows in the base period of 1995. All ensuing scenario analyses involve projections to the year 2001, when implementation of the GATT/WTO Agreement on Agriculture is to be completed.

3.2 Regions and products

Seven Pacific Rim beef markets were modelled: North America (i.e. United States plus Canada), Japan, South Korea, Australia, New Zealand, Argentina and Uruguay. While the bulk of beef exports from North America, Australia and New Zealand were consigned to Pacific Rim markets (table 1) in the 1995 base year, Argentina and Uruguay exported no fresh beef to the above Pacific Rim markets. A linkage was specified in the model between prices in the Pacific Rim market and those faced by Argentina and Uruguay exporters elsewhere so that the allocation of their future exports between Pacific and non-Pacific markets could be properly determined. This was simulated through the addition of two further 'regions', to represent the non-Pacific markets for Argentina and Uruguay, respectively. Note that for all regions other than those in Latin America, exports to countries other than those explicitly modelled are assumed to be exogenous.

Beef was modelled as two differentiated products, named grainfed and grassfed beef. Table 3 indicates the types of beef that were assumed to be produced, consumed and traded in each region. Both grainfed and grassfed beef are produced and consumed in North America, but we assume all their exports are grainfed and all imports are of grassfed beef. In Japan and Korea we assume only grainfed beef is produced but both types of beef are consumed and imported. For Australia, the assumption is that both types of beef are produced (although grassfed beef predominates) and exported, but only grassfed beef is consumed domestically. In New Zealand and the two Latin American countries production, consumption and exports are assumed to involve only grassfed beef.

Country/region	Production	Consumption	Exports	Imports
North America	both	both	gn	gs
Japan, Korea	gn	both	_	both
Australia	both	gs	both	-
New Zealand	gs	gs	gs	-
Argentina, Uruguay	gs	gs	gs	_

Table 3 Modelled beef differentiation across regions

Note: gn = grainfed beef

gs = grassfed beef.

The trade flows permitted in the model are, for grainfed beef, those from North America to Japan and Korea, and that from Australia to Japan. Grassfed beef trade flows modelled are those from Australia and New Zealand to North America, Japan and Korea. In some scenarios, the grassfed beef trade flows represented in the model include those from Argentina and Uruguay to North America, Japan, Korea and their non-Pacific destinations.

3.3 Base period (1995) quantities and prices

Data on beef production, consumption, trade and stocks were taken from national sources and from the WTO (1996, 1997) and were converted, where necessary, to a carcass weight equivalent (cwe) basis.¹ These data then required adjustment for a number of reasons — inconsistencies between national and WTO data, the absence of stocks in our model, and the 'netting out' of exports to and imports from countries not included in our model. The adjusted base data are given in Appendix table 1. Total 1995 exports and imports for North America are net of the trade flows between Canada and the United States.

Beef exports from Argentina and Uruguay include substantial quantities of manufactured beef products, and in some scenarios the implications were examined of some of this beef being diverted to the chilled/frozen beef Pacific Rim trade. Their exports also include sales of fresh beef to the EU which provide returns above those that might be expected from Pacific Rim markets, and we do not permit this beef to be diverted to Pacific Rim markets. Relevant data are found in Appendix table 2.

In some countries, the production or consumption data required disaggregation to grassfed and grainfed categories. For US production, the data presented by Brester and Wohlgenant (1991) along with the assumption that all beef imported into the United States is grassfed and all that exported is grainfed, implied that 65 per cent of total US beef production was classified as grainfed. The same proportion was applied in the case of Canada. It was assumed that 15 per cent of Australian beef production was grainfed in 1995, based on an estimate of Australian grainfed exports to Japan.² Consumption data for North America, Japan and Korea were disaggregated into the two types of beef, given the definitions of the types of beef produced by and imported into those countries.

486

¹ A conversion factor of 0.7 was used in all instances.

² Personal communication, Australian Meat and Livestock Corporation.

[©] Australian Agricultural and Resource Economics Society Inc. and Blackwell Publishers Ltd 1999

Border prices were estimated from national trade data as unit values (cif or fob), and converted to US\$ at 1995 exchange rates. Domestic prices of both types of beef in Japan and Korea, and for grassfed beef in North America, were set equal to the border price plus tariffs or tariff equivalents. Otherwise, domestic prices and border prices were identical. Beef prices in Argentina and Uruguay will be discussed in later sections, as the appropriate scenario is introduced. International freight costs for Australian and New Zealand beef shipments to Japan, Korea and the United States were obtained from industry sources, and from these the relationship between cost per tonne and distance was estimated and then used to estimate freight costs for all other routes.

3.4 Domestic demand and supply relationships

Beef production was assumed to be influenced by the prices of both grainfed and grassfed beef, the price of maize (for grainfed beef production only) and productivity growth. Maize prices were included since changes in feedgrain costs could affect the relative competitiveness of grainfed and grassfed supplies. Most price elasticities were taken from Sullivan *et al.* (1992). Price elasticities of fed and non-fed cattle supply in the United States were taken from Brester and Wohlgenant (1997) and assumed to apply to grainfed and grassfed beef supplies, respectively. The same elasticities were used for Canada. In the case of Australia, where both beef types are produced, lack of data required the assumption of identical supply elasticities for grainfed and grassfed production (Appendix table 3.)

FAO data on beef production and slaughterings over the period 1985-95 were used to estimate the average annual growth in production per animal (Appendix table 3). With the exception of Argentina and Uruguay, these growth rates were used in the projections to 2001. However, the productivity growth rates were negative for the two Latin American countries. Cap (1995) reported a study of the growth potential of Argentina's agricultural sector, under various assumptions about the future adoption of currently available technologies. A number of factors that constrained the rate of adoption of productivity-enhancing innovations in the past were said to be easing, and the study examined the implications of new technology adoption on several beef production systems under a number of adoption scenarios. That considered by Cap to be 'most likely' implied a future productivity growth rate of 4.75 per cent per year. However, this would appear a rather optimistic estimate of productivity growth in Argentina for our projection period of 1995-2001, given the static output per animal since 1995 (table 2). Therefore we apply zero productivity growth in the Latin American countries, which still assumes an improvement on their performance over the 1985–95 period.

[©] Australian Agricultural and Resource Economics Society Inc. and Blackwell Publishers Ltd 1999

A.N. Rae, C. Nixon and P. Gardiner

Beef consumption was modelled as a function of the prices of grainfed and/or grassfed beef, incomes per capita and growth in the total population. For those countries where both grainfed and grassfed beef was consumed, demand relationships were specified for each beef type. Estimates of the various income, own-price and cross-price demand elasticities were taken from Brester and Wohlgenant (1991) for the United States, from Hayes *et al.* (1990) for Japan, from Doyle *et al.* (1995) for Korea,³ and from Sullivan *et al.* (1992) for remaining countries. The Brester and Wohlgenant study was based on improved estimates of 'ground' and 'table-cut' beef consumption in the United States, and their definition of ground beef was assumed to be identical to ours of grassfed beef. The Japanese results of Hayes *et al.* were estimated for Wagyu beef and 'import quality' beef, the latter defined as either Japanese dairy beef or imported beef. While this does not match our own product definitions, it can be noted that the cross-elasticities from the Japanese study are within the 0.1 to 0.4 range of the US cross-elasticities.

The US estimates were assumed to apply to North America (i.e. including Canada) while the cross-elasticities for Japan were also assumed to apply in Korea. The Japanese income elasticities of Hayes *et al.* were specified in terms of changes in meat (rather than total) expenditures, so were replaced by the estimate found in Rae (1995) which was assumed to apply to both types of beef.⁴ All demand elasticity data are presented in Appendix table 4.

Both Argentina and Uruguay export substantial quantities of manufactured ('cooked') beef, which in 1995 amounted to 245 000 and 22 000 tonnes (cwe), respectively. In addition, they exported in that year 92 000 and 22 000 tonnes (cwe) of fresh beef respectively to the EU (Appendix table 2). All beef used for manufactured products, plus all fresh beef exports to the rest of the world with the exception of that to the high-priced EU market, was assumed available for diversion by Argentina and Uruguay as fresh product exports to the Pacific Rim.⁵ Two rest-of-the-world demand functions were constructed, namely those facing Argentina and Uruguay for non-Pacific sales. These functions were

³ Doyle *et al.* quote Korean own-price and income elasticities for 'beef' as a homogeneous product. Their data are applied here to both grassfed and grainfed beef.

⁴ Hayes *et al.* found that the income elasticities for both types of beef, with respect to total expenditures on meat, were almost identical.

⁵ In 1995, average fob returns for Argentina were US\$1 393 per tonne for manufactured beef products, US\$1 347 per tonne for non-EU sales of fresh product and US\$4 543 per tonne for fresh beef sales to the EU. It is conceivable that returns from North American or Asian markets could encourage at least a portion of these exports to be diverted as fresh sales to the Pacific Rim. Our 1995 estimate of the United States price less duty and freight from Argentina, for example, was US\$1 508 per tonne.

[©] Australian Agricultural and Resource Economics Society Inc. and Blackwell Publishers Ltd 1999

calibrated to the weighted average returns from non-EU chilled and frozen sales plus all manufactured beef sales, and the appropriate (cwe) quantities from 1995 trade data. The export demand elasticities were taken from Goddard (1988). They provide a mechanism to allow an equilibrium to be reached between sales from Latin America to the Pacific Rim markets and to non-Pacific markets.

Projections of beef demand required projections of future population and income growth in each region. Future growth rates of GDP were based on the projections of the OECD (1997) for the United States, Canada, Australia, Japan and Korea,⁶ on IMF data for Argentina and Uruguay, and on NZIER (1997) projections for New Zealand. Population projections were based on past growth rates from national data for Argentina and Uruguay, and from the same sources as above for remaining countries.

The linear demand and supply relationships were initially calibrated by estimating the constant terms so that the functions simulated the 1995 data and exhibited the assumed elasticities. Given the generalised linear function q = a + bp, the slope parameter can be estimated given base period values of q and p, and given that the known elasticity equals bp/q. The constant term can then be computed. For the projections to 2001, the demand relationships were determined by first projecting 2001 consumption given data on base period consumption, population and income growth and income elasticities. The same procedure as described above was then used to recalibrate the functions so that they predicted that projected level of consumption at base period prices. Similarly the supply relationships, the 2001 production projections were made by first applying the productivity growth rates to 1995 base data.⁷ These supply functions were then recalibrated so that they predicted the projected supplies at base period beef prices, and given the projected 22 per cent increase in maize prices.⁸

3.5 Trade policies

Whether specified for the base year of 1995 or for projections in the year 2001, the model replicated the trade policies as set out in the Uruguay

⁶We halved the published growth rate for Korea, given the economic situation that developed in that country in late 1997.

⁷Zero productivity growth was assumed for Argentina and Uruguay, rather than the negative historic rates of Appendix table 3.

 $^{^{8}}$ The OECD (1996) projected a US export price of US\$133 per tonne fob for the 1997–99 period, compared with an actual average price of \$109 per tonne for the 1991–93 period.

A.N. Rae, C. Nixon and P. Gardiner

Round Agreement on Agriculture. No quotas applied in Japan and tariff rates were 49.4 per cent in 1995 reducing to 38.5 per cent in 2001. Import quotas and other impediments to Korean imports have increased their domestic beef prices well above international prices. Doyle *et al.* (1995) estimated the tariff equivalent of these non-tariff trade barriers as 89.7 per cent in 1995. By the year 2001, Korea must remove its quantitative restrictions on beef imports and can apply a tariff of 41.2 per cent.

Canada and the United States have a system of tariff rate quotas. Quotas have been allocated to specific countries (Appendix table 5). Within-quota tariffs are US\$44 per tonne (product weight) for the United States, and zero for Canada. Over-quota tariffs in each country were 30.3 per cent in 1995, reducing to 26.4 per cent in the year 2001.

4. Results

We first compare a 2001 projection with the base situation in 1995. This scenario assumes that Argentina and Uruguay can access North America under existing tariff rate quotas, but not other Pacific Rim markets. We next allow Latin American access to Japan and Korea, under similar policies as would be experienced in 2001 by other exporters and explore solution sensitivity to changes in transport costs from Latin America. The final scenario assumed an integration of NAFTA and MERCOSUR that would include free trade in beef between the countries of North and South America.⁹

Results for the first scenario are summarised¹⁰ in the first two data columns of table 4, and the equilibrium prices for the various scenarios are given in table 6. Consumption of grainfed and grassfed beef in North America is projected to increase by 10 per cent and 7 per cent, respectively, despite the projected 6 per cent increase in grainfed beef prices. The price of grassfed beef is projected to decline by about 1 per cent compared with 1995. The income elasticities employed ensure that per person consumption of 'grainfed' beef increases, but that of grassfed beef decreases, with increases in incomes (Appendix table 4). North American production¹¹ of grainfed beef increases at a faster rate than production of grassfed beef, as a result of

⁹ All solutions were obtained with GAMS/MINOS.

¹⁰ All quantities are measured in carcass weight equivalents. To save space in the table, results for Japan and Korea have been aggregated.

¹¹Our analyses recognise longer-term trends in productivity but do not attempt to replicate the United States beef cycle, which may be in a down-swing over the period covered by the projection.

[©] Australian Agricultural and Resource Economics Society Inc. and Blackwell Publishers Ltd 1999

		Projections to 2001				
		LA access to NA only	LA a	access to NA	+ JK	
				10	20	
LA transport cost reduction	1995	nil	nil	per cent	per cent	
North America						
Grainfed production	8119	9087	9084	9084	9078	
Consumption	7507	8277	8275	8274	8270	
Exports	612	810	809	810	808	
Grassfed production	4307	4598	4560	4556	4492	
Consumption	5003	5355	5385	5388	5440	
Imports:	696	757	825	832	948	
from Australia	363	346	506	513	537	
New Zealand	333	347	255	255	347	
Argentina	0	29	29	29	29	
Uruguay	0	35	35	35	35	
Japan and Korea						
Grainfed production	756	793	793	793	792	
Consumption	1526	1785	1784	1784	1782	
Imports	770	992	991	991	990	
<i>Grassfed</i> consumption/imports:	472	569	570	570	572	
from Australia	390	487	317	308	268	
New Zealand	82	82	172	172	76	
Argentina	0	0	0	0	134	
Uruguay	0	0	81	89	94	
Australia						
Grainfed production/exports	158	182	182	182	182	
Grassfed production	1309	1442	1435	1434	1423	
Exports	753	833	823	822	805	
New Zealand						
Grassfed production	533	556	554	554	551	
Exports	415	430	427	427	423	

Table 4	Some impacts of	f Argentina and	Uruguay access to	o Pacific Rim	beef markets ^{a,b}
---------	-----------------	-----------------	-------------------	---------------	-----------------------------

Notes: ^a All volumes are in '000 MT (cwe). LA refers to Argentina and Uruguay, NA to North America and JK to Japan and Korea.

^b Production (consumption) is net of exports to (imports from) non-model countries, and exports and imports are those only involving modelled countries.

the price changes for both beef types and the elastic supply of grassfed beef, and modest productivity growth. While imports of grassfed beef are projected to show some growth, exports of grainfed beef from North America may increase by over 30 per cent owing to continued export demand growth and improving access to those markets by the end of the projection period, making this region a net exporter of beef. For New

	Existing TRQ's	NAFTA-	NAFTA-MERCOSUR Integration			
LA transport cost reduction	nil	nil	10 per cent	20 per cent		
North America						
Grainfed production	9084	9073	9071	9069		
Consumption	8275	8266	8265	8264		
Exports	809	807	806	805		
Grassfed production	4560	4428	4410	4391		
Consumption	5385	5492	5506	5521		
Imports:	825	1064	1096	1130		
from Australia	506	286	279	273		
New Zealand	255	347	347	347		
Argentina	29	282	317	351		
Uruguay	35	149	154	158		
Japan and Korea						
Grainfed production	793	791	792	791		
Consumption	1784	1780	1780	1779		
Imports	991	989	988	988		
<i>Grassfed</i> consumption/imports:	570	574	575	575		
from Australia	317	502	504	505		
New Zealand	172	72	71	70		
Argentina	0	0	0	0		
Uruguay	81	0	0	0		
Australia						
Grainfed production/exports	182	182	182	182		
Grassfed production	1435	1411	1408	1405		
Exports	823	788	783	779		
New Zealand						
Grassfed production	554	548	547	546		
Exports	427	419	418	416		

Table 5 Impacts of North-South American integration on Pacific Rim beef markets: 2001 a,b

Notes: ^a All volumes are in '000 MT (cwe). LA refers to Argentina and Uruguay. ^b Production (consumption) is net of exports to (imports from) non-model countries, and exports and imports are those only involving modelled countries.

Zealand, Argentina and Uruguay, their quotas are restrictive in the 2001 projection, but the price differences between those countries and North America were insufficient to attract additional exports at the out-of-quota tariff of 26.4 per cent. Australia did not fill its quota to North America.

Beef production in Japan and Korea together is projected to grow by 5 per cent between 1995 and 2001, outpaced by the 18 per cent increase in consumption. Income growth was assumed to have a relatively strong impact on the demand for grainfed and grassfed beef in both these countries. Consumption will be further encouraged by price reductions as Japan's tariff

reduces over the projection period, and as Korea's import quota system is replaced with tariff-only protection in 2001. Grassfed beef prices in Japan are projected to decline proportionately more than those of grainfed beef, since prices of the former product were assumed to be more sensitive to changes in supply than were those of grainfed beef. Korean prices of grainfed and grassfed beef are projected to fall by around 22 per cent and 27 per cent, respectively, by 2001 when protection levels will be reduced substantially, and total Korean consumption could increase by over 30 per cent despite the assumed moderated growth in incomes. Thus, growth in grainfed and grassfed beef import volumes is projected at 29 per cent and 21 per cent, respectively, supplied by increased shipments from North America and Australia.

In Australia and New Zealand, beef production is projected to increase by 11 per cent and 4 per cent, respectively, due to productivity improvements, as prices of grassfed beef are projected to decline slightly in both countries. Exports expand at similar rates.¹² Given the limited entry of the two Latin American suppliers to the North American market, Australian export growth is directed at Northeast Asia.

Next we retain the same assumptions as above, with the exception that Japan and Korea offer access to beef from Argentina and Uruguay under the same conditions as those offered to North American and Australasian suppliers. Tariff rate quotas are still assumed to apply in the United States and Canada. South American exports to Northeast Asia have the opportunity to expand under this projection scenario (table 4, third data column) until their marginal return equals that obtained from export sales outside the Pacific Rim arena (but excluding the higher-price EU sales). At the new equilibrium, these exports are projected at 81000 MT from Uruguay to Japan, in addition to the 64000 MT exported in total from both suppliers under quota to North America. Compared with the previous scenario where Pacific Rim sales from South America were limited to the United States and Canada, the South American expansion into Northeast Asia displaces grassfed sales from Australia which in turn increases exports to North America. Some New Zealand exports are projected to be diverted from North America to Japan and Korea. Neither Australia nor New Zealand fill their North American quotas under this scenario. No beef trade occurs from Argentina to Northeast Asia: adding the import tariffs to the landed cost of beef from Argentina makes beef from that source uncompetitive at the originally estimated freight costs.

¹²Note that grainfed exports as a proportion of total Australian exports have been restricted to the 1995 proportion (about 18 per cent).

[©] Australian Agricultural and Resource Economics Society Inc. and Blackwell Publishers Ltd 1999

A.N. Rae, C. Nixon and P. Gardiner

South American access to Asia has little impact on prices. Those of grassfed beef in Australasia, North America, Japan and Korea are projected to be about 1 per cent lower than they would have been had South American Pacific exports been restricted to the North American market, while those of grainfed beef remain almost unchanged. At these prices, out-of-quota exports from South to North America would not occur. Average Argentina fob returns are unchanged, but those for Uruguay are estimated to rise by 10 per cent which produces a positive supply response. However, the projected income and population growth in these Latin countries give rise to increases in domestic consumption so that the combined export surplus of beef (excluding fresh exports to the EU but including manufactured beef exports) falls from 544 000 in 1995 (Appendix table 2) to 256 000 tonnes. Further, medium-term demand expansion in the EU and other non-Asia/Pacific markets (ignored in this analysis) could further reduce the available supplies for Pacific Rim markets.

We next examined the sensitivity of the projections to reductions in the estimated freight costs from Latin America to Pacific Rim markets - all transport costs per tonne out of Argentina and Uruguay were reduced by 10 per cent and then by 20 per cent. The former reduction implied that Latin American freight costs per tonne to North America would be about 10 per cent less, and to Northeast Asia would be about 45 per cent greater, than those from Australasia. A 20 per cent freight cost reduction meant these costs were, to North America and Northeast Asia, respectively, 20 per cent below and 30 per cent above those from Australasia (table 4, final two columns). Substantial quantities of Argentinian beef are diverted from non-Pacific markets to Northeast Asia once their transport costs have been reduced by at least 20 per cent from the original estimates. As these freight rates are successively reduced, total imports of grassfed beef into Japan and Korea are little changed, with increased sales from Latin America to Northeast Asia displacing grassfed sales from Australia and New Zealand. The latter countries respond, through increased sales to North America -Australasian suppliers have excess quota in North America that can be utilised, whereas exports to that region from Latin America are constrained by their quotas — and through adjustments within their domestic markets. Only minor adjustments to prices occur — a 20 per cent reduction in Latin American freight costs and the ensuing trade flow changes would have the effect of reducing prices of grassfed beef in North America, Japan, Korea and Australasia by only 1 per cent.

North American beef import policies could undergo further change over the medium term. Should the tariff rate quota system be retained, individual supplier allocations might change. The existing allocations to Argentina and Uruguay are relatively small, and could result in quantities of beef from

those sources being shipped to Northeast Asia and causing a redirection of Australasian sales from the latter markets to North America. One development that could change the quota allocations would be the integration of the MERCOSUR¹³ free trade area with NAFTA.¹⁴ The Summit of the Americas initiated a plan to create a free trade area of the Americas by the year 2005. This was seen as integrating all countries of North, Central and South America. Provided this free trade agreement was to cover beef, then the trade between South and North America would be duty free. This is of importance to Australia and New Zealand since it could have a considerable trade diversion effect.

To illustrate what such a diversion of trade might be with regard to beef, the final scenario assumes that North American tariff rate quotas currently applied to Argentina and Uruguay are eliminated and the beef trade between those countries is duty free. The North American tariff rate quotas that potentially restrict imports of beef from Australia and New Zealand remain in place. Otherwise, this scenario is similar to the previous ones.

Exports of grassfed beef from Latin America to Northeast Asia that might have resulted under earlier scenarios are redirected to North America where entry is free (table 5, first two columns of data), and their total beef exports to North America would reach 431 000 tonnes compared with the current combined quota of 64 000 tonnes (cwe). Consequently, Australian exports to North America are displaced and redirected to Northeast Asia. This diversion of trade, however, may be thought of as a correction of the trade diversion caused in earlier scenarios by the quota restrictions on South American beef into North America that encouraged their trade with Northeast Asia. Total exports of grassfed beef from Australia and New Zealand to the modelled Asia-Pacific markets would fall by 4 per cent and 2 per cent, respectively.

While the total quantities of grassfed beef imported into Japan and Korea show little change (only the sources are different), quantities of grassfed beef imported into North America increase by around 29 per cent. Projected imports of grassfed beef into North America in 2001 amount to more than 1 million tonnes compared with the projection of 825 000 tonnes under the TRQ system, exerting downward pressure on beef prices in North America, especially of grassfed beef. Grassfed beef prices in Argentina rise, however, by about 6 per cent in comparison with the previous scenario (table 6).

¹³ Argentina and Uruguay joined with Brazil and Paraguay in the common market called MERCOSUR in 1995. It is the third-largest free trade area after NAFTA and the EU, and has eliminated most internal tariffs between the member countries. As a result, trade amongst the member countries increased fourfold between 1990 and 1996.

¹⁴ The North American Free Trade Agreement, involving the United States, Canada and Mexico.

[©] Australian Agricultural and Resource Economics Society Inc. and Blackwell Publishers Ltd 1999

			Projec	ctions to 20	001		
	LA access to NA only]	LA access t NA + JK	.0	NAF	TA-MERC Integration	OSUR n
LA transport cost reduction	nil	nil	10 per cent	20 per cent	nil	10 per cent	20 per cent
North America Grainfed Grassfed	106.4 98.9	106.4 98.3	106.3 98.2	106.2 97.1	106.1 96.1	106.1 95.8	106.0 95.5
Japan Grainfed Grassfed	98.1 91.6	98.0 91.0	98.0 90.9	97.9 89.9	97.8 88.9	97.8 88.6	97.7 88.4
Korea Grainfed Grassfed	78.1 72.9	78.0 72.4	78.0 72.4	77.9 71.6	77.8 70.8	77.8 70.5	77.8 70.3
Aust + NZ Grassfed	98.7	97.9	97.9	96.6	95.3	95.0	94.6
Argentina Grassfed	102.7	102.7	102.7	103.8	109.0	110.5	112.1

Table 6 Estimates of beef prices (1995 = 100)

Market shares change substantially — that of Australasian exporters could fall from over 90 per cent in the previous scenario to 60 per cent of total North American imports.

Should the South American freight costs used in the model be reduced by up to 20 per cent, Latin American sales to North America could exceed 500 000 tonnes and would provide them with a 45 per cent share of the North American import market (table 5, final two columns). North American grassfed imports would rise from 1.06 million to 1.13 million tonnes, due largely to increased imports from Argentina. Little change occurs in Japan and Korea, and the Australasian grassfed industries adjust through a reduction in total production and exports. Beef prices in Australasia could be reduced by about 3 per cent from the level that would have applied had the tariff rate quotas been maintained, and could be 5 per cent below 1995 prices. In contrast, prices in Argentina could be 9 per cent to 12 per cent above their 1995 levels.

5. Conclusion

If South American entry to the Pacific Rim beef market was limited to existing quotas in North America, results suggest that impacts on Pacific Rim markets would be minimal. However, importing countries such as

Japan and South Korea may have opened their markets to beef from FMD-free regions of South America before the year 2001. This presents the potential for more substantial impacts on regional markets.

South American export supplies of fresh beef might be expanded through the diversion of product from use in 'manufactured' beef to fresh uses and considerable exportable surpluses are likely to result that could find their way to Asian markets given competitive freight costs. Whether or not South American suppliers would choose to export to Asian markets depends critically on their freight costs and their conditions of access to North America. Under some circumstances, our results show that South American suppliers could win substantial market share in Northeast Asia should their freight costs per tonne be no more than 20-30 per cent above rates from Australasia, given no change in North American trade policy.

North American beef import policies could undergo further change over the medium term. For example, the tariff-rate-quota allocations could be adjusted should the MERCOSUR free trade area be integrated with NAFTA. In this case, exports of grassfed beef from Argentina and Uruguay to North America could reach over 500 000 tonnes compared with today's quota allocations that allow a maximum of 64 000 tonnes (cwe). This would produce major changes in the Pacific Rim beef market.

Our analyses have attempted to differentiate beef products depending upon whether they derived from grainfed or grassfed animals. This required estimates of the relevant cross-elasticities of demand. The estimates used for North America were derived from product classifications that fitted rather closely those adopted in this study. However, further work is required on the degree of substitution in Japan. It is possible that the actual strength of the substitution relationship for our beef aggregates could be somewhat higher than that employed here. The implications for our results are that we may have over-estimated the degree of independence of the two beef markets in Japan, and hence over-estimated the impacts of Latin American entry on the grassfed beef market.

Both Australia and Argentina are major producers of grain. Australia has already begun producing grain-finished beef for the Japanese market, and is expected to increase that product's share of total exports to Japan. In this way the beef sector can to some extent be separated from the implications of South American entry into grassfed beef markets. Although our analyses assumed that South American producers do not adopt grain feeding, a move in this direction would lessen the impacts on grassfed beef markets of their entry to Pacific Rim markets.

Integration of the North American Free Trade Agreement with the Latin American free trade area MERCOSUR is already under discussion. Our results indicate that should this occur, South America would win a large

[©] Australian Agricultural and Resource Economics Society Inc. and Blackwell Publishers Ltd 1999

A.N. Rae, C. Nixon and P. Gardiner

share of the North American market at the expense of Australian suppliers. Should the beef industries of Australasia wish to maintain a substantial presence in the US market, work will be required to improve access conditions. One approach would be to push forward the idea for closer relations between Australasia and NAFTA. Unless something like this occurs, Australasian suppliers are likely to lose important North American market share in the advent of a North American–South American free trade area becoming a reality.

This study has various limitations that could be usefully addressed in future work. Further beef product differentiation would appear to be useful, given the range of beef types available in various markets such as Japan. This calls for further econometric research to estimate the various elasticities, and often improved data as well. Even given the level of product differentiation assumed in this study, elasticity estimates could be improved, for example the grainfed beef supply elasticities for Australia and the crosselasticities of demand for Korea. Further investigation of transport costs for potential routes such as from South American ports to Northeast Asia is also an urgent requirement. Finally, our approach has not permitted substitution between beef and other meats and did not attempt to model beef market shocks transmitted via markets for other meat types.

	Production ^a	Consumption ^b	Exports ^c	Imports ^d
United States	11462	11563	736	837
Canada	967	951	262	246
Japan	601	1582	0	980
Korea	155	416	0	261
Australia	1468	556	911	0
New Zealand	533	118	415	0

Appendix

Appendix Table 1 Model base data for 1995 ('000 tonnes cwe)

Notes: ^a Production is net of exports to non-model countries.

^b Consumption is net of imports from non-model countries.

^c Exports are those only to the modelled countries.

^d Imports are those only from the modelled countries.

	Ex ₁ (chilled	Exports (chilled/frozen)		T 1	T - 1
	To EU	To others	Manufactured exports	l otal exports	l otal consumption
Argentina Uruguay	92 22	179 98	245 22	516 142	1937 204

Appendix Table 2 Model base data for Latin America: 1995 ('000 tonnes cwe)

	Supply	elasticity with res		
	grainfed beef price	grassfed beef price	corn price	Productivity growth (per cent per year)
North America	0.6	1.4	-0.05	1.49
Japan	0.4	-	-0.01	0.99
Korea	0.5	_	-0.13	2.84
Australia	0.7	0.7	_	1.77
New Zealand	_	0.45	—	0.80
Argentina	_	0.5	_	-1.53
Uruguay	_	0.45	_	-0.95

Appendix Table 3 Parameter estimates for supply relationships

Note: North American elasticities are those for the United States. See text for data sources.

		Demand elasticity with respect to					
	Beef type	grainfed price	grassfed price	Income			
North America	Gn	-0.81	0.14	0.81			
	Gs	0.41	-1.02	-0.20			
Japan	Gn	-1.79	0.28	0.80			
•	Gs	0.25	-0.37	0.80			
Korea	Gn	-0.69	0.25	1.09			
	Gs	0.25	-0.69	1.09			
Australia	Gs	-	-0.78	0.18			
Argentina	Gs	-	-0.65	0.14			
New Zealand	Gs	-	-0.59	0.27			
Uruguay	Gs	_	-0.62	0.54			

Appendix Table 4 Elasticity estimates for demand relationships

Note: See text for data sources.

Appendix Table 5	US and	Canadian b	beef quotas	('000 tor	nnes product	weight)
------------------	--------	------------	-------------	-----------	--------------	---------

Allocated to:	United States	Canada
Australia	378.2	42.0
New Zealand	213.4	29.6
Argentina	20	
Uruguay	20	
Open to all suppliers		4.8

Note: These were converted to a cwe basis in the model, dividing by a conversion factor of 0.7.

References

- Brester, G.W. and Wohlgenant, M.K. 1991, 'Estimating interrelated demands for meats using new measures for ground and table cut beef', *American Journal of Agricultural Economics*, vol. 73, pp. 1182–94.
- Brester, G.W. and Wohlgenant, M.K. 1997, 'Impacts of the GATT/Uruguay Round trade negotiations on U.S. beef and cattle prices', *Journal of Agricultural and Resource Economics*, vol. 22, pp. 145–56.
- Cap, E.J. 1995, Argentina: The Sustainable Growth Potential of the Production Possibilities Frontier in the Agricultural Sector: An Outlook, National Institute of Agricultural Technology, Buenos Aires, November.
- Doyle, S., Bui-Lan, A., Rodriguez, A., Benard, A. and Whish-Wilson, P. 1995, 'Pacific Basin beef trade: the influence of South Korea', *Australian Commodities*, vol. 2, no. 3, pp. 326–39.
- GATT 1993, *The Final Act, Multilateral Trade Negotiations, The Uruguay Round.* Trade Negotiations Committee. GATT Secretariat, Geneva, 15 December 1993.
- Goddard, E.W. 1988, 'Export demand elasticities in the world market for beef', in Carter, C.A. and Gardiner, W.H. (eds), *Elasticities in International Agricultural Trade*, Westview Press, Boulder, CO.
- Hayes, D.J., Wahl, T.I. and Williams, G.W. 1990, 'Testing restrictions on a model of Japanese meat demand', *American Journal of Agricultural Economics*, vol. 72, pp. 556–66.
- Hillman, J.S. 1991, Technical Barriers to Agricultural Trade, Westview Press, Boulder, CO.
- Martin, L.J. 1981, 'Quadratic single and multi commodity models of spatial equilibrium: a simplified exposition', *Canadian Journal of Agricultural Economics*, vol. 29, no. 1, pp. 21–48.
- NZIER, *Quarterly Predictions* (various issues), New Zealand Institute of Economic Research, Wellington.
- OECD 1996, The Agricultural Commodities Outlook Database, 1970-2000, OECD, Paris.
- OECD 1997, The Agricultural Outlook 1997-2001, OECD, Paris.
- Rae, A.N. 1995, East Asian Food Consumption Patterns: Projections for Animal Products, Agricultural Policy Paper No. 18, Centre for Applied Economics and Policy Studies, Massey University, New Zealand, November.
- Sullivan, J., Roningen, V., Leetma, S. and Gray, D. 1992, A 1989 Global Database for the Static World Policy Simulation (SWOPSIM) Modeling Framework, Economic Research Service, United States Department of Agriculture, Washington, DC.
- Takayama, T. and Judge, G.G. 1971, Spatial and Temporal Price and Allocation Models, North-Holland, Amsterdam.
- World Trade Organisation 1996, *International Bovine Meat Agreement*, Second Annual Report, The International Markets for Meat, 1995/96, Geneva, November .
- World Trade Organisation 1997, International Bovine Meat Agreement, Third Annual Report, The International Markets for Meat, 1996/97, Geneva, August.