Impact of APEC Trade Liberalisation on Sino–Australian Bilateral Trade

This paper uses the global trade analysis project (GTAP) model to simulate the effect of APEC trade liberalisation on Sino-Australian bilateral trade. By comparing the development of Sino-Australian bilateral trade in the short run and the long run, the analysis depicts a whole set of bilateral trade determination mechanisms. The results indicate that, as economic cooperation within APEC increases, trade between Australia and China will increase, especially in agriculture and textiles. The bilateral trade pattern may follow the principle of comparative advantage and the terms of trade may improve for both countries. The results for the short term are very different from those for the long term, indicating that bilateral trade in open economies is more than just an 'external sector' affair.

Introduction

In the past 20 years, the Asia Pacific economies have grown rapidly. This growth has been associated with an increasing level of economic interdependence and market integration resulting from international trade liberalisation in the region. In particular, intra-regional trade is now at the highest level in history: by the end of 1999, it already accounted for more than 76 per cent of APEC's total trade.

With increasing trade flow, bilateral trade has become more and more important. Appendix Table A1 shows APEC's intra-regional trade for 1999. The data indicate a concentration of trade in a few countries. For example, APEC's total intra-regional trade (153 trade flows) amounted to about US$365.109 billion; however, 22 per cent of the total (US$81 billion) came from 10 bilateral trade flows among five countries (Appendix Table A1).[1] This suggests that bilateral trade is a crucial issue for trade liberalisation in the APEC region.

There are three main determinants of bilateral trade. The first is the geographical distribution of trade, which determines the direction of the future trade flow between the two countries. The second is the terms of trade. The third is the impact from domestic production and other trade partners: whether the trading country could obtain the commodity from other sources or not. The interaction of the three factors determines the future development of bilateral trade. Predictions of potential changes in these factors are important for policymakers.

This paper focuses on the trade relationship between China and Australia. A computable general equilibrium (CGE) model based on the global trade analysis project (GTAP) is used to estimate the results of tariff cuts in APEC's early voluntary sector liberalisation (EVSL). I compare traditional trade theory (partial equilibrium analysis) with the general equilibrium analysis method and describe adaptations to the model. Then I discuss data collection and model closure, and outline the procedure for simulation. Next I analyse the results of trade liberalisation in the APEC region and the effect on Sino-Australian bilateral trade, explaining the future composition of bilateral trade from a number of perspectives, including trade flows, trade structure and trade terms. Finally, I discuss policy implications and present some conclusions.

Theories and modelling

Partial equilibrium theory

Theories about regional integration can be traced back to Viner (1963), who introduced the concepts of trade creation and trade diversion. Viner used traditional comparative advantage theory to analyse the effect of European Economic Community tariff cuts on trade flow among major Western European countries. Critics suggested that his theory placed too much emphasis on static welfare, and the theory was subsequently revised by many people. The index of trade intensity model and the gravity model are the most popular revised models.

The index of trade intensity is one of the standard analytical tools in empirical trade analysis. It was originally discussed by Drysdale and Garnaut (1982) in the context of the dependency of bilateral trade. Young (1992) used it to analyse trade in APEC, followed by a related study by Anderson and Norheim (1993). By eliminating the effect of the size of partner regions from the actual bilateral trade relationships, Young worked out a new index, which reflected changes in the intra- and extra-regional trade of different countries during the previous three decades. He concluded that bilateral trade had developed quickly when the Asia Pacific region was growing into a well-integrated region – a similar situation to Western Europe. This conclusion was supported by Petri (1992), who reported a higher intra-regional trade intensity index for East Asia than for other regional integrations.

Saxonhouse (1989) used the gravity model to explain bilateral trade flows by analysing the interaction between the factor endowments of exporters and importers, based on the estimated coefficients of gravity equation. He computed the 1985 data for 43 countries – each with 29 manufacturing sectors – and found that, out of 2,088 trade flows, only 325 were outside the tolerance interval. His results indicated that intra-regional bilateral trade in APEC had increased strikingly, consistent with the predictions of traditional trade theory.

The theories surveyed above explain several issues about bilateral trade before and after regional trade liberalisation. In particular, they predict the relationship between bilateral trade and regionalism. However, they have some shortcomings for detailed trade determination. Most start from the perspective of partial equilibrium analysis, but the structure embodied in this analysis requires too many strict assumptions. For example, when the gravity model is used to explain bilateral trade flows, it is assumed that production, consumption and all other transaction sectors except trade will keep constant. The obvious problem is whether the discussion will be convincing without taking account of changes in the rest of the economy. A CGE model is the best way to address such an issue.

The GTAP model

The CGE model has proved to be a powerful tool for policy analysis. The initial neoclassical version of the model has been modified considerably to incorporate institutional features with different assumptions; the modified versions include ORANI, IC95 and GTAP, used in different fields. All have the same basic idea: to associate all sectors in the economy on the basis of general equilibrium theory, discussing the synthetic result of a shock and mutual relationships across sectors. In this study, GTAP version 4.0 of 1995, a multi-region, multi-sector model (Hertel and Tsigas 1997) is adopted. Appendix 1 describes the structure of a standard CGE model.

Four new features of the basic GTAP model are considered here.

First, a comparative static extension that allows capital stocks to be endogenous is incorporated. This is used when considering the simulation results in the long run. As a comparative static model, GTAP initially assumes that capital is determined exogenously, so it emphasises effects in the short run. The model has been modified by Arndt et al. (1997), Francois et al. (1996) and McDougall and Levesque (1996), but the long run estimations are still to be improved. Walmsley (1998) compared all the methods previously used for long run estimation conditions, and developed a new macroeconomy closure based on Horridge and Powell (1984) and Francois et al. (1997). With the assumption of perfect capital mobility across time and the definition of a comparative steady state, Walmsley re-split the exogenous and endogenous variables (or closure) to infer the time frame over which the effect of a shock was simulated, so as to reconsider the effect of capital accumulation in the long run. This solves the problem that the fixed capital in production will change continually across time and improves the accuracy of estimation under the GTAP model for the long run. I used this idea as the basis for analysis of the dynamic effect of regional integration on bilateral trade. Appendix 2 describes the modifications I made.

Second, government investment is separated out from total investment. Government investment policies are very important in most countries, especially those with large public sectors. For example, in 1995 Chinese government investment accounted for 30.5 per cent of total investment, and most government investments were a key to production and trade. In order to simplify investment decision processes, the GTAP model does not separate out government investment. Instead, it selects total investment variables, and uses a uniform market price for a capital good to balance the gross national saving. As a result, government action in the capital market is omitted. In the following discussion, I try to separate this part by assuming that the government is an independent 'sector' in the capital market, when making the simulation in both the short run and the long run. By identifying the shadow price of government investment determined by social welfare, discount rate and real private rate of return,[2] I use the constant elasticity of substitution function to separate total investment into two parts – private and public investment (Equation 1) – while supposing that the amount of saving is constant. Furthermore, I add 'govinvest' to express the preferred government investment policy – a shock variable used to simulate impact from government.[3] However, I could not split the investment further by sector because there are not enough data about government investments in different industries. The equation is:

$$QCGDS(r) = CES[QGCGDS(r), QPCGDS(r)] \tag{1}$$

where QCGDS(r) is total demand for commodity in economy r, which is divided into government demand, QGCGDS(r), and private demand, QPCGDS(r), following the CES function. The prices used here are shadow prices and private market prices. This modification is described in Appendix 2.

Third, the effects of subregion liberalisation are simulated. Subregions are important components of APEC. Since APEC has adopted the principles of tariff cutting, most countries have pursued trade liberalisation within their own subregions. For example, for countries under the North American Free Trade Agreement (NAFTA), there was free movement of trade commodities, factor endowments and most services by 2000. If we are to realistically illustrate the results of APEC liberalisation, we must take into account the activities of the subregions before we carry out the simulation for the whole region. I defined the data for the period before subregional liberalisation as the base term and simulated tariff cuts[4] at the subregional level.[5] I then simulated further shocks from liberalisation in APEC so as to incorporate the impact of subregional liberalisation.

Fourth, the final change in bilateral terms of trade into different effects is decomposed and the process of variation in the complex simulation process is illustrated. According to McDougall (1997), terms of trade effects resulting from the GTAP simulation can be split into three parts. The first is the world price effect (caused by the change in the world price). The other two are the export price effect and the import price effect, both of which denote the impact from the export country or import country. As shown in Equations 2–5, we can use this method to decompose the changes in terms of trade in bilateral trade flow caused by intra-regional free trade into three sources. This helps to explain the determinants behind the formation of bilateral terms of trade. Consistent with Arndt and Pearson (1996), the left side of Equation 2 is the bilateral terms of trade in sector *i*; the right side is the three parts decomposed – the world price effect, the export price effect and the import price effect. These are explained in Equations 2–5.

Terms of trade: $\Delta T_i = \Delta T_{1i} + \Delta T_{2i} + \Delta T_{3i}$ (2)

World price effect: $\Delta T_{1i} = (p_{wi} + 1)/(p_w + 1) - 1$ (3)

Export price effect: $\Delta T_{2i} = (p_{ei} + 1)/(p_{wi} + 1) - 1$ (4)

Import price effect: $\Delta T_{3i} = (p_{wi} + 1)/(p_{mi} + 1) - 1$ (5)

Data and simulation

Data

GTAP version 4.0 includes data from 37 countries and 50 sectors. I aggregated the database to a smaller group, with 7 country groups and 10 sectors,[6] because my discussion focuses on trade liberalisation in APEC countries.

Table 1 shows the re-set of the database used in the calculations. The seven ‘regions’ are six APEC members and the group defined as the rest of the world. Countries with similar characteristics are grouped; for example, ASEAN 5 countries are grouped into one ‘region’ (AS5). Such aggregation will have no effect on the simulation for subregional issues, because I only

Table 1 Regions, sectors and endowments used in the calculations

Region	
CHN	China (mainland)
AUS	Australia
JPN	Japan
AS5	ASEAN 5 countries
NOA	North American Free Trade Area
AIC	Other Asian newly industrialised countries
ROW	Rest of world
Sector	
Page	Crops
Oage	Non-crop agriculture
Mine	Mining, energy and non-metallic products
Texe	Textiles and clothing
Wppe	Wood and wood products
Chme	Chemicals
Trne	Transport
Mcee	Machinery and electronics
Ompe	Metallic products and other manufactures[a]
Svce	Services
Endowments	
Nat	Sluggish land and other endowments
Lab	Mobile unskilled labour
Slab	Mobile skilled labour
Capital	Mobile capital

Note: a For simplicity, I have added the metallic sector into the other manufactures sector in data aggregation.
Source: GTAP version 4 database and author's own calculation.

consider the whole effect in subregions. This simplification does not affect the accuracy of the model because my analysis deals only with the determinants of bilateral trade between China and Australia. The sectors include two agriculture sectors, seven manufacturing sectors (including mining) and one service sector. For manufacturing, this simple division seems too aggregated, but it is sufficient to reflect the differences among major manufacturing sectors. The model uses four kinds of factor endowments: natural resources, labour, capital and human capital. All except natural resources are assumed to be mobile. The government investment and risk-free return rate data come from International Financial Statistics (IMF 1997).

Trade liberalisation in APEC[7] was simulated mainly using the proposed EVSL tariff cut figures.[8] First, I simulated tariff cuts in the APEC subregions and used the results to construct a new database. The second simulation concerned trade liberalisation in APEC as a whole. For this, I used the model to provide a snapshot view of the impact of the whole APEC liberalisation process. Instead of considering each step sequentially, I condensed the process (from 1996 to 2000) to one static state in order to expose differences. Many changes other than tariffs may be included in APEC trade liberalisation, but they are omitted in the simulation, for brevity. Therefore, the results should be treated with caution.

When dealing with the structural indexes between the short run and the long run, I adapted the method of merging sector divisions in order to make the results comparable at different time points. For example, to match the shocks from real most favoured nation (MFN) tariff cuts and the GTAP base data, the electronics sector is combined with machinery as machinery and electronics. Some information may be omitted by such approximation, but the final results are not affected.

Sino-Australian bilateral trade and EVSL

Bilateral trade between China and Australia has grown since 1965. Table 2 shows Sino-Australian trade flows from 1979 to 1999. Bilateral trade grew throughout the period, but most of the increase occurred after the foundation of APEC. Therefore, my analysis simulated the effect of further development of APEC, especially the recent EVSL, on Sino-Australian bilateral trade flow.

At their Subic Bay meeting in November 1996, APEC leaders gave ministers the following instructions:

> To identify sectors where early voluntary liberalisation would have a positive impact on trade, investment and economic growth in the individual economies as well as in the region, and to submit recommendations on how this could be achieved ...

By November 1997, cuts in 41 out of 62 nominated sectors were agreed on. Of these, 15 proposals had the greatest support among member economies, and at the Vancouver meeting these areas were selected for early liberalisation. In brief, the proposal consisted of two tiers, which cover almost all sectors except the metallic products sector. Most proposals were expected to be implemented between 1997 and 2000. In the following simulation, I consider the total or overall change of trade barriers during this period. It is hard to measure variation in non-tariff measures and other measures, so the proposals I examine in this paper are limited to tariff cuts. Sectoral details were revised to adapt the figures for the GTAP model.

Table 2 Sino-Australian bilateral trade 1979–99 (US$ million)

Year	Exports	Imports	Total
1979	759.72	184.35	944.07
1980	769.08	239.31	1008.39
1981	640.80	277.86	918.66
1982	766.26	296.25	1062.51
1983	404.67	226.14	630.81
1984	745.39	306.12	1051.51
1985	846.52	285.73	1132.25
1986	957.64	329.07	1286.70
1987	1322.42	501.11	1823.53
1988	1100.26	695.12	1795.37
1989	1462.75	949.00	2411.75
1990	1353.49	1056.62	2410.11
1991	1557.63	1367.06	2924.69
1992	1671.17	1703.52	3374.68
1993	1949.49	1957.48	3906.97
1994	2451.81	2441.09	4892.91
1995	2584.51	2823.91	5408.42
1996	3433.76	3191.27	6625.03
1997	3247.56	3475.57	6723.13
1998	2681.28	3626.06	6307.34
1999	3607.16	4238.78	7845.93

Source: NAPES database, Australian National University.

Simulation scenarios

I use three simulation scenarios. First, I use the 1995 subregion shock data as a basis for simulating the 1995 APEC shock in the short run. This is the basic simulation for the revised GTAP 4.0 database. The results show the effect of trade liberalisation on bilateral trade in the short run. The shocks are from real tariff cuts.

Second, I use the 1995 subregion shock data as the basis for simulating the 1995 APEC shock in the long run. By endogenising the capital accumulation, the simulation detects the effects of the APEC EVSL proposal in the long run. The results reveal many differences between the short run and the long run.

Third, I use the shock from production factor input variables to simulate the possible sector structure adjustment in both the short run and the long run.

The closure for the model in the short run was the GTAP standard closure, with the addition of the government investment variable. For the closure in the long run, I used the Walmsley (1998) closure method. The exogenous variables are listed in Appendix Table A2.

Results and policy implications

Results from the simulation capture the effects of APEC regional trade liberalisation on Sino-Australian bilateral trade, in both the short run and the long run.

Key economic indicators

The first result concerns the key economic indicators resulting from the shock of trade liberalisation in the short run (static) and in the long run (dynamic) (see Table 3). The results imply that in the short run China will experience a modest growth in GDP (by 0.82 per cent) and Australia a decrease (by 0.38 per cent) if other conditions are kept constant. In the long run the relationship will be reversed: in China, GDP will decrease by 1.87 per cent; in Australia GDP will increase by 1.31 per cent. In the short run, the shocks will cause China to increase her output in almost all sectors except metallic products and other manufactures (where there was a 2.14 per cent decrease) and machinery and electronics (a 3.13 per cent decrease), while Australia will increase only in the agricultural sectors (by 6.48 per cent for crops and 0.90 per cent for non-crop agriculture) and metallic products and other manufactures (by 0.002 per cent). However, in the long run, the increased output in China may be mainly from sectors such as textiles and clothing (15.80 per cent), wood and wood products (by 1.36 per cent), transport (by 4.30 per cent) and machinery and electronics (by 1.44 per cent), while Australia will increase its output in almost all sectors except crops (a decrease of 10.94 per cent) and services (a decrease of 0.29 per cent). Francois et al. (1997) found similar results for Korea.

What is the explanation for these results? One possibility is that the trade effect and the production effect (the two effects of trade liberalisation) have the reverse impact on the two economies. In general equilibrium, the trade effect denotes the production improvement from imported cheap raw materials, services and so on; the production effect denotes a change in production resulting from changes in production structure and the reorganisation of production factors (such as capital and labour) in the long run. Here, because the market was relatively closed before liberalisation, trade liberalisation in the short run may free the 'surplus produc-

Table 3 Output levels: simulation results (percentage change following liberalisation)

Item/sector	Static (short run) simulation		Dynamic (long run) simulation	
	CHN	AUS	CHN	AUS
Crops	0.344	6.477	–9.244	–10.943
Non-crop agriculture	0.302	0.903	–0.260	7.206
Mining, energy and non-metallic products	0.429	–9.182	–18.195	8.410
Textiles and clothing	0.853	–3.034	15.796	7.522
Wood and wood products	0.322	–0.557	1.364	1.187
Chemicals	0.355	–0.545	–2.277	8.534
Transport	1.738	–0.642	4.300	7.358
Machinery and electronics	–3.130	–1.168	1.443	6.789
Metallic products and other manufactures	–2.138	0.002	1.735	18.114
Services	0.025	–0.041	–2.419	–0.288
Capital goods	0.783	0.738	–7.273	–3.547
Total	0.821	–0.377	–1.871	1.310

Note: CHN=China; AUS=Australia
Source: model simulation.

tivity' (surplus labour) in most sectors in China. However, in the long run, the division of production between countries will gradually change according to individual endowments. As China's exports increase, the revenue it gets from exports may decrease, leading to reduced economic growth.[9] For Australia, the process is reversed: manufacturing sectors will suffer the shock from developing countries in the short run, but Australia may earn back its advantage in these sectors because of its abundant resources.

Trade flow

Another result relates to trade flow and the fact that, both in the short run and in the long run, bilateral trade will improve considerably after regional free trade shocks. Table 4 shows the results of my simulation. In the short run, there will be a significant increase in China's exports to Australia in all sectors, especially textiles and clothing (16.39 per cent), crops (19.40 per cent) and machinery and electronics (8.36 per cent). At the same time, Australia will export more to China, mainly in textiles and clothing (an increase of 36.63 per cent)[10] non-crop agriculture (an

Table 4 Sino-Australian bilateral trade: changes in exports (per cent)

Item	Short run simulation		Long run simulation	
	AUS-CHN	CHN-AUS	AUS-CHN	CHN-AUS
Crops	19.417	19.404	19.297	–126.389
Non-crop agriculture	30.862	9.010	49.913	–23.295
Mining, energy and non-metallic products	–15.690	14.084	76.292	–166.739
Textiles and clothing	36.627	16.385	58.339	28.224
Wood and wood products	7.617	18.577	4.549	30.137
Chemicals	–2.755	2.553	13.451	–9.890
Transport	14.503	12.757	31.609	26.257
Machinery and electronics	32.738	8.361	37.435	20.951
Metallic products and other manufactures	26.726	5.782	57.619	9.876
Services	–1.749	1.543	–4.888	12.973

Note: CHN=China; AUS=Australia
Source: GTAP model simulation.

increase of 19.42 per cent), metallic products and other manufactures (an increase of 26.73 per cent) and wood and wood products (an increase of 7.62 per cent). However, in the long run, Australia will continue to improve export performance in metallic products and other manufactures (by 57.62 per cent), non-crop agriculture (by 49.91 per cent), mining, energy and non-metallic products (by 76.29 per cent) and chemicals (by 13.45 per cent),[11] while China will increase exports in textiles and clothing (by 28.22 per cent), wood and wood products (by 30.14 per cent) and machinery and electronics (by 20.95 per cent), although the rate of improvement will decrease.

Trade potential in the short run

The rapid growth of Sino-Australian bilateral trade as a result of APEC trade liberalisation suggests that there is great potential for trade between China and Australia. Trade theory distinguishes two sorts of trade: inter-industry trade and intra-industry trade. Sino-Australian bilateral trade combines the two sorts of trade. The inter-industry trade between Australian resource-intensive industries and Chinese labour-intensive industries is increasing; in most sectors the intra-industry trade is also developing quickly. For example, as shown in Table 4, in the short run Australia will increase its exports to China by 30.86 per cent in non-crop agriculture and 36.63 per cent in textiles and clothing, while in these sectors China will increase her exports to Australia by 9.01 per cent and 16.39 per cent respectively. We can conclude that the potential for trade between China and Australia not only is large but also is taking multiple directions, which will provide bilateral trade with continuing impetus. As Findlay and Chen (2000) have argued, the exchange of food for food products and wool for woollen products may become the trend for Sino-Australian bilateral trade in the next several years.

Comparative advantages

Comparative advantages will be reflected in Sino-Australia bilateral trade in the long run. The simulation shows (Table 4) that Australia will considerably increase exports in sectors such as mining, energy and non-metallic products (by 76.29 per cent), textiles and clothing (by 58.34 per cent), wood and wood products (by 4.55 per cent), metallic products and other manufactures (by 57.62 per cent) and non-crop agriculture (by 49.91 per cent); China will expand her exports to Australia in textiles and clothing (by 28.22 per cent), wood and wood products (by 30.14 per cent), machinery and electronics (by 20.95 per cent) and metallic products and other manufactures (by 9.87 per cent). The results are consistent with the principle of comparative advantage. For Australia, bilateral trade growth in mining, textiles and clothing and non-crop agriculture is even higher than that of Australian total exports, which implies a biased trend towards China. In the long term, it is obvious that Sino-Australian bilateral trade will be a kind of complementary trade.

Terms of trade

The simulation shows that the terms of trade between China and Australia will change greatly following the shocks from trade liberalisation in APEC. Table 5 shows these changes. In the short run, to some extent, the growth of bilateral trade leads to increases in the relative prices for imports in China and exports in Australia, but in most sectors in China the terms of trade are worsened, while for Australia they are improved. In the long run, as the relative price comes down slowly, terms of trade in different sectors of different countries will take different directions. Specifically, China will improve its terms of trade in crops (by 27.43 per cent), mining, energy and non-metallic products (by 44.40 per cent) and chemicals (by 5.06 per cent), while Australia

Table 5 Changes in the terms of trade: short run and long run (per cent)

	Australia to China		China to Australia		Term	Term
	FOB	CIF	FOB	CIF	AUS	CHN
Short run						
Crops	5.354	5.104	1.496	1.413	3.886	–3.432
Non-crop agriculture	2.693	2.597	1.200	1.1465	1.529	–1.363
Mining, energy and non-metallic products	5.281	4.684	0.220	0.219	5.051	–4.264
Textiles and clothing	0.562	0.541	–2.182	–2.057	2.674	–2.708
Wood and wood products	0.345	0.340	–0.821	–0.771	1.125	–1.157
Chemicals	1.269	1.154	–0.226	–0.194	1.465	–1.364
Transport	0.437	0.430	–0.986	–0.959	1.409	–1.410
Machinery and electronics	0.454	0.446	–1.550	–1.492	1.975	–1.987
Metallic products and other manufactures	1.101	1.064	–0.850	–0.800	1.916	–1.893
Services	0.480	0.480	–0.097	–0.097	0.578	–0.574
Long run						
Crops	–33.184	–31.540	–12.758	–11.893	–24.166	27.435
Non-crop agriculture	–16.288	–15.636	–10.202	–9.620	–7.378	6.441
Mining, energy and non-metallic products	–41.492	–36.530	–8.348	–7.615	–36.669	44.401
Textiles and clothing	–5.414	–5.061	–7.538	–7.110	1.827	–2.609
Wood and wood products	–2.016	–1.903	–4.964	–4.689	2.804	–3.120
Chemicals	–11.323	–10.027	–5.473	–5.021	–6.636	5.061
Transport	–2.419	–2.329	–3.220	–3.134	0.738	–0.912
Machinery and electronics	–1.703	–1.630	–4.104	–3.945	2.334	–2.515
Metallic products and other manufactures	–7.082	–6.761	–4.651	–4.401	–2.804	2.263
Services	–0.600	–0.600	–3.234	–3.234	2.722	–2.650

Note: CHN=China; AUS=Australia; FOB= free on board; CIF= cost, insurance and freight.
Source: GTAP model simulation.

will worsen its terms of trade in wood and wood products (by 2.80 per cent), services (by 2.72 per cent) and so on (see Table 5). When this is combined with simulation results for trade volume, both countries will obtain trade surpluses from total trade in the long run, although Australia may have a trade deficit in the short run.

Furthermore, the decomposition results of the bilateral terms of trade effects according to Equations 2–5 indicate that after trade liberalisation export relative prices in different sectors change for different reasons. For example, in the short run, the worsening of bilateral terms of trade in the Chinese textiles and clothing sector (by 2.71 per cent) is mainly caused by the export terms of trade effect.[12] In the long run, the terms of trade worsened by about the same amount (2.61 per cent) but in this case it was due to terms of trade effects for both exports and imports – competition from other countries and the 'Rybcyznski effect' as well as the rapid increase in domestic demand. Another example concerns Australian exports to China in wood and wood products and chemicals in the short run. In both cases, the export relative price is more than 1 per cent (chemicals, 1.47 per cent; wood and wood products, 1.12 per cent), but the increase in the former results from the world price effect[13] while the latter results from technological progress.[14] We cannot judge the impact of regionalism on bilateral terms of trade only by changes in the import–export relative price, but must take the specific situation into account.

Generally, the effect of the import price is greater in the short run; that of the export price is greater in the long run. In addition, the world price effect is dominant in the primary sectors, while the border price effect is dominant in advanced sectors.

Structural adjustment indexes

Table 6 shows that there are differences in measurements of sector structural adjustment indexes. The results of the simulation show that for China, before the shock of trade liberalisation, production structure in manufactures would change positively with an increasing supply of endowments, but that the reverse is the case for agriculture and mining.[15] For Australia, the indexes would change positively in most sectors and would be much higher. However, after regional trade liberalisation, the changes in the structural indexes represent a new trend. For example, before tariff cuts the structural adjustment index of human capital in manufacturing in China was quite low; after trade liberalisation, it increased considerably. This implies that trade liberalisation in the APEC region has helped to improve the distribution of human capital in manufacturing.

Public investment

Public investment in China has an important effect on production and trade (Table 7). In particular, for sectoral production, the positive effects of Chinese public investment are now mainly in manufactures: transport (0.48 per cent), machinery and electronics (0.42 per cent) and textiles and clothing (0.23 per cent). For agriculture and other sectors, the impact of public investment is almost negligible, or even negative, reflecting policy orientation.

Table 6 Sector structural adjustment index

	CHN Labour	CHN Capital	CHN Slab	AUS Labour	AUS Capital	AUS Slab
Before trade liberalisation						
Crops	–1.968	–0.179	–0.031	0.264	1.415	0.135
Non-crop agriculture	–1.046	–0.090	–0.018	0.712	1.051	0.446
Mining, energy and non-metallic products	–1.716	0.320	0.047	–0.498	1.928	–0.145
Textiles and clothing	0.646	0.672	0.136	1.969	1.533	1.260
Wood and wood products	0.727	0.486	0.827	0.641	0.522	0.414
Chemicals	0.284	0.483	0.077	0.846	1.096	0.620
Transport	2.082	1.132	0.157	1.726	1.071	1.086
Machinery and electronics	1.133	0.921	0.148	1.781	1.353	1.265
Metallic products and other manufactures	0.781	0.866	0.141	1.849	1.783	1.269
Services	0.861	0.369	0.054	0.146	0.120	0.113
After trade liberalisation						
Crops	–0.123	–2.739	–0.464	0.040	2.352	–0.043
Non-crop agriculture	–0.040	–1.979	–0.333	2.095	2.877	1.352
Mining, energy and non-metallic products	0.036	–0.953	–0.170	–1.603	2.951	–0.739
Textiles and clothing	0.625	0.655	0.170	4.885	3.787	3.195
Wood and wood products	0.316	0.873	0.169	3.521	2.643	2.324
Chemicals	0.251	0.685	0.109	1.812	1.981	1.358
Transport	0.606	3.314	0.526	7.459	5.526	4.950
Machinery and electronics	0.568	1.577	0.288	4.123	3.246	2.951
Metallic products and other manufactures	0.503	1.298	0.219	3.889	3.763	2.687
Services	0.171	1.204	0.312	3.710	2.980	2.790

Note: CHN=China; AUS=Australia; see Table 1 for other terms.
The sector structural adjustment index is defined as the change in production of a 1 per cent change in endowment.
Source: GTAP simulation results.

Conclusions

Sino-Australian bilateral trade has experienced rapid growth and is an important component of intra-regional trade in APEC. As trade cooperation among APEC members continues, China and Australia will have even more trade potential. The analysis described in this paper shows that Sino-Australian bilateral trade is likely to increase greatly under regional trade liberalisation. By taking advantage of the current conditions and by using individual comparative advantage, China and Australia can promote the development of both economies.

Table 7 The effect of public investment in China (per cent)

	QO	QXW	QIM	QXS(CHN–AUS)
Crops	–1.007	–5.417	2.055	–5.454
Non-crop agriculture	–0.964	–3.885	1.436	–3.957
Mining, energy and non-metallic products	–0.565	–0.334	1.657	–0.343
Textiles and clothing	0.229	0.515	–0.347	0.436
Wood and wood products	–0.161	0.767	–0.699	0.758
Chemicals	–0.222	0.324	–0.479	0.317
Transport	0.482	3.348	–1.502	3.340
Machinery and electronics	0.418	1.696	–0.924	1.669
Metallic products and other manufactures	0.298	1.122	–0.524	1.082
Services	–0.303	1.083	–1.017	1.257

Note: The shock variable is indirectly used.
QO=total output; QXW=exports; QIM=imports; QXS (CHN–AUS)=exports from China to Australia.

Source: Model simulation.

Appendix 1 The structure of a standard computable general equilibrium model

Generally, the specification of the general model is divided into nine components: final demand behaviour, production technology, factor supplies and demands, treatment of traded goods, domestic prices, domestic market equilibrium, income and government revenue, foreign sector closure, and macro closure. Here, I just list the basic equations.

Final demand behaviour

The basic model considers domestic final demand using a linear expenditure system (LES), which includes household consumption, government demand, and investment demand.

$$P_i^Q C_i = P_i^Q \mu_i + s_i \left[(1 - mps)Y - \sum_h P_h^Q \mu_h \right] \qquad \forall i \qquad \text{(A1.1)}$$

where C_i represents household demand for composite consumption good i, P_i^Q denotes the domestic purchaser price of the composite consumption good I, s_i is the marginal budget share for composite good i, mps is the marginal propensity to save, Y is domestic income, and μ_i is the subsistence minimum for composite consumption good i. The function form is

$$I_i = is_i I \qquad \forall i \qquad \text{(A1.2)}$$

$$G_i = gs_i G \qquad \forall i \qquad \text{(A1.3)}$$

where I and G are total investment and government demand, respectively, and is_i and gs_i are the share of the total investment and government demand each sector receives.

Production technology

Production technology is modelled by using a constant elasticity of substitution (CES) value-added function specified as:

$$X_i = a_i (b_i L_i^{(\phi_i - 1)/\phi_i} + (1 - b_i) K_i^{(\phi_i - 1)/\phi})^{\phi_i/(\phi_i - 1)} \qquad \forall i \qquad \text{(A1.4)}$$

where X_i denotes gross domestic output for sector I, L_i is labour used in sector i, K_i is capital used in sector i and f_i is the elasticity of substitution between labour and capital for sector i. The parameter f_i is exogenous and is estimated outside the model. The parameters a_i and b_i are the respective intercept and share parameters that allow the CES production function to be calibrated for each sector i.

A Leontief function is assumed for intermediate products:

$$D_i = \sum_h io_{ih} X_h \qquad \forall i \tag{A1.5}$$

where D_i is the intermediate demand for composite consumption good i, X_h is the gross domestic output of sector h, and io_{ih} is the input–output coefficient between sectors I and h.

Factor supplies and demands

Factor demands are derived from the CES production:

$$L_i = a_i^{(\phi_i - 1)} X_i (\frac{b_i P_i^V}{w})^{\phi_i} \qquad \forall i \tag{A1.6}$$

$$K_i = a_i^{(\phi_i - 1)} X_i [\frac{(1-b)_i P_i^V}{r}]^{\phi_i} \qquad \forall i \tag{A1.7}$$

where P_i^V is the value added price in sector i, w is the economy-wide wage rate, and r is the economy-wide rental rate on capital.

Treatment of traded goods

The import composition of domestic demand is influenced by the ratio of domestic and import prices, as well as by any administrative quantity restrictions. The model aggregates imports and their domestic counterparts into an aggregate good for each sector, Q_i, using a CES function

$$Q_i = \alpha_i [\beta_i M_i^{(\sigma_i - 1)/\sigma_i} + (1-\beta_i) S_i^{(\sigma_i - 1)/\sigma_i}]^{(\sigma_i - 1)/\sigma_i} \qquad \forall i \tag{A1.8}$$

$$(\frac{M_i}{S_i}) = [(\frac{\beta_i}{(\beta_i - 1)})(\frac{P_i^S}{P_i^M})]^{\sigma_i} \qquad \forall i \tag{A1.9}$$

where Q_i denotes the composite good for domestic consumption in sector i, M_i is imports of sector i and S_i is the domestic supply in sector i.

Domestic prices

In this sector, the equations are as follows:

$$P_i^X X_i = P_i^S S_i + P_i^E E_i \qquad \forall i \tag{A1.10}$$

$$P_i^Q Q_i = P_i^S S_i + P_i^M M_i \qquad \forall i \tag{A1.11}$$

$$P_i^V = P_i^X - \sum_h io_{hi} P_h^Q \qquad \forall i \tag{A1.12}$$

$$P_i^M = (1+t_i)(1+\rho_i) erPW_i^M \qquad \forall i \tag{A1.13}$$

$$P_i^E = erPW_i^E \qquad \forall i \tag{A1.14}$$

where t_i is the tariff rate on imports in sector i, ρ_i is the quota premium rate in sector i, PW_i^E is the world price of the import good in sector i, and er is the exchange rate.

Domestic market equilibrium

Three equations are required for domestic market equilibrium, one for the commodity market and two others for the factor markets:

$$Q_i = D_i + C_i + G_i + I_i \qquad \forall i \tag{A1.15}$$

$$\sum_i K_i = K \tag{A1.16}$$

$$\sum_i L_i = L \tag{A1.17}$$

Income and government revenue

Income and government revenue are summarised by the following six equations:

$$R_T = \frac{\sum_i t_i P_i^M M_i}{(1+t_i)} \tag{A1.18}$$

$$R_Q = \sum_i \rho_i erPW_i^M M_i \qquad \text{(A1.19)}$$

$$Y = Y_L + Y_K + GT + R_Q \qquad \text{(A1.20)}$$

$$\sum_i P_i^Q G_i + GS + GT = R_T \qquad \text{(A1.21)}$$

$$S = mpsY + GS + erFS \qquad \text{(A1.22)}$$

$$I = \sum_i P_i^Q I_i \qquad \text{(A1.23)}$$

where R_T is tariff revenue and R_Q is quota rents.

Foreign sector closure

The balance of payment equation is:

$$\sum_i PW_i^M M_i + \frac{R_Q}{er} = \sum_i PW_i^E E_i + FS \qquad \text{(A1.24)}$$

Macro closure

The macro closure must be specified according to the specific purpose. For more information, see Hertel (1997).

Table A1 Bilateral trade among APEC countries in 1999 (US$ million)

Partner	Aus	Canada	Chile	China	Hongk	Indon	Japan	Korea	Malay	Mexico	NZL	Philip	Singap	Taiwan	Thail	USA	Vietn	Total
Aus	0	146.46	13.44	631.16	170.73	258.21	2102.27	600.38	343.67	38.55	606.61	99.17	438.03	414.88	220.62	1669.72	101.95	7855.85
Canada	182.80	0	58.15	476.70	140.02	72.04	1482.30	328.08	100.75	534.55	36.14	89.98	85.17	385.35	103.54	34508.42	16.31	38600.29
Chile	13.38	52.65	0	126.87	13.17	16.89	307.00	127.07	18.06	121.02	3.54	8.08	16.24	67.16	11.24	609.97	1.70	1514.06
China	784.59	779.25	101.57	0	8480.77	378.80	6618.56	2254.49	445.27	205.60	108.50	228.68	960.68	2347.67	435.60	10035.09	131.81	34296.96
Hongk	225.82	161.51	12.00	4375.46	0	208.85	2376.97	952.57	538.62	43.13	41.46	332.60	1193.17	1719.27	367.43	2194.97	65.01	14808.85
Indon	270.96	94.93	18.99	483.00	162.21	0	1743.19	651.45	295.42	33.80	26.94	69.47	0.02	172.92	207.08	1216.18	33.16	5479.71
Japan	2123.00	1576.77	291.13	6617.39	2166.85	1524.16	0	3996.29	2331	588.65	334.28	1404.61	2684.97	4143.90	2050.20	18916.51	358.48	51108.18
Korea	602.74	371.20	109.81	2503.38	862.71	253.87	3889.14	0	589.55	295.39	86.16	425.46	771.97	931.11	267.04	5446.14	170.94	17576.60
Malay	346.79	166.57	14.85	527.93	411.89	252.65	2183.30	678.44	0	103.91	54.86	293.09	3616.11	732.85	461.02	3063.99	63.31	12971.56
Mexico	50.76	751.97	119.93	95.09	25.76	18.87	604.38	230.86	35.29	0	16.82	39.68	128.41	165.89	43.52	19209.11	3.07	21539.43
NZL	595.20	38.77	3.83	82.42	37.80	23.48	338.28	86.96	57.98	15.66	0	17.85	59.39	62.08	33.95	378.52	7.96	1840.14
Philip	99.17	89.98	8.08	228.68	187.25	69.47	1404.61	425.46	293.09	39.68	17.85	0	573.54	0	174.13	1985.44	0	5596.43
Singap	391.55	109.15	6.70	856.33	821.04	470.74	2151.05	708.17	2300.45	101.96	50.20	573.54	0	1001.44	803.89	3334.97	201.90	13883.06
Taiwan	414.88	385.35	67.16	2347.67	1360.19	172.92	4143.90	931.11	732.85	165.89	62.08	0	1001.44	0	439.82	5439.01	0	17664.28
Thail	226.88	121.84	9.67	421.56	311.12	178.14	2014.37	279.74	521.98	48.10	33.97	174.13	1027.32	439.82	0	1990.03	80.13	7878.76
USA	1865.47	34736.41	573.87	6149.11	1933.3	884.65	19717.75	5413.84	2993.78	22824.29	409.83	2006.17	4105.13	5587.16	1908.51	0	94.55	111203.8
Vietn	101.95	16.31	1.70	131.81	27.37	33.16	358.48	170.94	63.31	3.07	7.96	0	201.90	0	80.13	93.21	0	1291.301
Total	8295.95	39599.13	1410.89	26054.57	17112.17	4816.89	51435.53	17835.85	11661.07	25163.27	1897.21	5762.50	16863.49	18171.51	7607.71	110091.3	1330.28	365109.3

Source: NAPES database, Australian National University

Appendix 2 Modifications to the model

Modifications to improve the accuracy of the model for the long run

In the long run assumption developed by Walmsley (1998), the closure assumes that the differences in the expected rates of return across regions are explained using different risk premiums. Therefore, the current rate of return in region r (*RORCUR(r)*) is equal to the risk-free rate of return (*RORCFREE(r)*) plus a premium for risk (*RISK(r)*).

$$RORCUR(r) = RORCFREE(r) + RISK(r) \tag{A2.1}$$

Similarly, the expected rate of return (*ROREXP(r)*) is equal to a risk-free return (*RORERFREE(r)*) plus risk premium (*RISK(r)*).

$$ROREXP(r) = ROREFREE(r) + RISK(r) \tag{A2.2}$$

The relationship between the expected and current rates of return is now between the risk-free components of these rates of return.

$$ROREFREE(r) = RORCFREE(r) \times \left[\frac{KE(r)}{KB(r) \times AVGROWTH} \right]^{-RORFLEX(r)} \tag{A2.3}$$

Thus, the risk-free component of expected rated of return (*ROREFREE(r)*) is from the real rate across all regions, while the growth rate differs across regions. The current rate of return is determined by both the rental price and the cost.

Furthermore, combining functions A2.1–A2.3 with the relationship between end-of-period capital and beginning-of-period capital (functions A1.4–A1.6), the capital stock in the long run simulation is finally determined endogenously.[16]

$$KE(r) = KBGROWTH(r) \times KB(r) \tag{A2.4}$$

$$KBGROWTH(r) = 1 + \frac{NETINV(r)}{VKB(r)} \tag{A2.5}$$

$$AVGROWTH = \sum_{r \in REG} \frac{VKB(r)}{GLOBKB} \times KBGROWTH(r) \tag{A2.6}$$

In this paper, I assume that a shock does not affect the risk component of the current rate of return.[17] As a result, the absolute change in the current rate of return must equal the absolute change in the risk-free component of current rate of return for each region.

$$RORCUR(r) \times rorc(r) = RORCFREE(r) \times rorcf(r) \tag{A2.7}$$

For more details, including the definition of variables and function explanation, see Walmsley (1998).

Separating government investment and private investment

In the original GTAP model, for convenience, the gross investment is defined as the function of the market price for capital goods. Here I separate it into two parts – government investment and private investment – by CES function in order to examine the impact of public investment. Assume that the total supply of investment is constant,[18] while the demand of investment satisfies the CES function. The marginal rate of substitution between government investment and private investment is supposed to be 1.[19] After linearising, the linear functions are:

$$qgcgds(r) = qcgds(r) - sigma \times [pcgds(r) - pgcgds(r)] \tag{A2.8}$$
$$qpcgds(r) = qcgds(r) - sigma \times [pcgds(r) - ppcgds(r)] \tag{A2.9}$$

The total price for capital goods is the average of public and private investment.

$$pcgds(r) = [REGINVG(r) / REGINV(r)] \times pggds(r) + [1 - REGING(r) / REGINV(r) \times ppcgds(r) \tag{A2.10}$$

Next, the separation is only determined by the spread between the public and private investment price. Obviously, the price of private investment is determined at market:

$$ppcgds(r) = sum\{h, CGD\_COMM, [VOA(h,r) / REGINV(r)] \times ps(h,r) \tag{A2.11}$$

where *ppcgds(r)* is the market price for private investment.

However, for government investment, the price is defined according to Harberger (1971) and Harberger and Jenkins (1998), where social welfare is considered. According to the theory of public finance, the price for public goods should not be determined by market price, since there are some extra benefits that are omitted by private sectors. Hence, the real price should be a shadow price. As mentioned by Harberger (1971), it is a synthetic result of private return and social return. Here I just adjust it with the total social welfare by using a new index that discounts the social benefit. It is:

$$PGCGDS(r) = \frac{1}{SPI(r)} \times PPCGDS(r) \tag{A2.12}$$

where[20]

$$SPI(r) = \frac{WEN(r)}{RENTAL(r)} \tag{A2.13}$$

Finally, the determination of the shadow price for government investment is a change function:

$$pgcgds(r) = -wve(r) + rental(r) + ppcgds(r) + govinv(r) \tag{A2.14}$$

where *wve(r)* is the change rate of social welfare and *rental(r)* is the discounting rate in region *r*.

Additionally, a new shock variable is added to the *qcgds(r)* to express the government investment policy, which is exogenous to the model.[21]

Table A2 Exogenous variables for closure in the GTAP model: static and dynamic

Macroeconomy closure in the short run	Macroeconomy closure in the long run
Pop profitslack Incomeslack Endwslack cgdslack saveslack govslack tradslack psaveslack Ao af afe ava atr To txs tms tx tm Tf tpm tpd tgm tgd tfm tfd	Pop Profitslack incomeslack endwslack Cgdslack saveslack govslack Tradslack psaveslack Ao af afe ava atr To txs tms tx tm Tf tpm tpd tgm tgd tfm tfd
psave govsve qo(ENDWM_COMM,REG) qo(ENDWS_COMM,'ROW')	psave rsk qo('lab', REG) qo('slab', 'REG') Growavslack kbgrow avgrow growth

Source: GTAP model simulation.

Notes

1 The five countries are the United States, Japan, Canada, China and Australia.

2 See Singh et al. (1986).

3 Since the mechanism used here is an indirect one, the new variable 'govinvest' is an estimate of the shadow price and is therefore exogenous.

4 Created from the simulation of the GTAP file TMS.txt.

5 The subregional arrangements are the tariff cuts within subregions, such as NAFTA and ASEAN.

6 The aggregation can be used to simulate the subregional tariff cuts, since we can make use of the relationships within the new data. Of course, it is better to make such a simulation in a structure with more disaggregated country groups. However, the software that I used restricts the dimension of the simulation.

7 Thamels et al. (1999).

8 Since the EVSL process was not actually implemented, I used the real MFN tariff cuts for APEC members from 1996 to 2000 as the basis for the shock of trade liberalisation in the APEC region. On the one hand, it embodied the characteristics of EVSL; on the other hand, it reflected the real process of trade liberalisation after EVSL in the APEC region.

9 The more China exports, the less revenue it will get, because trade conditions will worsen.

10 Mainly wool and woollen products; see Elek (1992).

11 From decreased exports in the short run to increased exports in the long run.

12 For products exported from China to Australia, FOB decreases by 2.18 per cent, CIF by only 0.54 per cent.

13 Since the world price for wood and wood products is increasing considerably.

14 See Table 7. The production elasticity of factor endowments in this sector increases quickly after a free trade shock.

15 This is a typical dual economic characteristic in China.

16 As defined in Francois et al. (1997), the investment is decided by $I_1 = I_0(\frac{K_1}{K_0})$ where K_1 and I_1 are the end-of-period capital and investment and K_0 and I_0 are beginning-of-period capital and investment.

17 See Walmsley (1998).

18 Due to the macroeconomy closure condition, the 'total investment' should be equal to the 'total saving', which has nothing to do with the separation of investment. Thus, in

analysis of investment, we can treat it as a constant variable. However, it is endogenous within the model.

19 I here assume that the government has the same efficiency as the private sector. Of course, a more realistic assumption should be based on the estimation of this ratio and the result from sensitivity analysis.

20 The social welfare term, *WEN(r)*, is calculated using the equivalent variation method used in the normal GTAP model. Here I assume that the decision of the government is based on the total social welfare.

21 The variable *govinv(r)* is an indirect variable for quantity of investment.

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