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A general equilibrium analysis of macroeconomic and trade policy changes in Taiwan

Implications for commodity markets

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Rapid economic growth and a changing comparative advantage in favour of processed commodities relative to agricultural and mineral products are key features of the Taiwanese economy. The macroeconomic and trade policies adopted by Taiwan shape its trade pattern with countries like Australia. In this paper the impacts of Taiwan's policy to boost domestic spending as a proportion of gross domestic product through increased public expenditure and to liberalise trade through tariff cuts are examined. A computable general equilibrium model is used to conduct the policy experiments. It was observed that a moderate change in aggregate real domestic absorption relative to gross domestic product and small changes in trade distortions in key agricultural and resource commodities in Taiwan can have considerable effects on trade volumes.

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Introduction

The newly industrialising countries of Asia (Hong Kong, the Republic of Korea, Singapore and Taiwan) have become increasingly important in the world economy because of their high economic growth rates and the associated expansion in trade with other countries. Since the mid-1960s, average economic growth in these countries has been more rapid than in most of the world's developing and developed countries, and their share of world trade increased from around 2 per cent in the early 1960s to more than 7 per cent in the late 1980s (International Monetary Fund 1988; General Agreement on Tariffs and Trade 1990). Much of this trade growth was in the Asia Pacific region.

Australia has benefited from this expanding trade. In the early 1980s Australian exports to newly industrialising countries of Asia were approximately equal to those of North America or the European Community. Following rapid growth during the 1980s, the value of Australian exports to the Asian industrialising countries is now twice that to either the European Community or North America (Department of Foreign Affairs and Trade 1991). The share of the industrialising Asian economies in total Australian exports has risen from just under 14 per cent in 1980 to around 25 per cent in recent years. Because of their limited agricultural and natural resource endowments these countries, both individually and collectively, are likely to remain important and growing markets for primary commodity exports.

The focus in this paper is on the Taiwanese economy. Taiwan is Australia's sixth most important export market. Total Australian exports to Taiwan increased from around $A130 million in the mid-1970s to about $A2 billion in the late 1980s. More than half of these exports have been mineral products. The Taiwanese economy grew at an average annual rate of over 7 per cent during the 1980s, though it is expected that economic growth will moderate slightly over the medium term (Asian Development Bank 1991). In world merchandise trade, Taiwan has moved up from being the 25th largest in 1979 to the 12th largest importer in 1989 (General Agreement on Tariffs and Trade 1990). It has a high density of population and limited arable land and natural resources. Any policy changes in Taiwan that will directly or indirectly influence import demand are therefore of some importance to commodity exporting countries such as Australia. The potential policy changes considered in this paper are a sustained increase in domestic absorption relative to gross domestic product, together with removal of trade distortions in key primary commodities in Taiwan.

The paper is organised in the following way. In the next section a brief background to the key recent policy developments in Taiwan is provided. Then, an overview is provided of the relationship between an increase in domestic absorption and removal of trade barriers in key primary industries, on the one hand, and potential primary commodity imports to Taiwan, on the other. The effects on Taiwanese primary commodity imports of such policy changes are then analysed using a computable general equilibrium model of Taiwan. In the final section some implications for primary commodity exporters such as Australia are discussed.

Background

A key development in Taiwan which accompanied the high economic growth and expanding trade during the 1980s was the gradual emergence of a large surplus in the current account (table 1). In 1986, Taiwan's current account surplus reached around US$16 billion, which was equivalent to around 22 per cent of its gross national product, although it subsequently declined to around 8 per cent of gross national product by the end of the decade. A current account surplus emerges whenever total expenditure in an economy is less than total production. Such a shortfall in expenditure relative to production will be equal to the excess of total savings in an economy over total investment expenditure. Taiwan

Table 1: Savings, investment and current account balance in Taiwan
As proportions of gross national product

	Saving a	Investment a	Current account balance
	%	%	%
1980	32	34	-2
1981	31	30	1
1982	30	24	6
1983	31	22	9
1984	33	21	12
1985	33	17	16
1986	37	15	22
1987	37	19	18
1988	32	23	9
1989	30	22	8

a Private and public.
Source: Asian Development Bank (1990).

generally maintained a high rate of domestic savings (around 30 per cent a year on average) in the 1970s and 1980s. Domestic investment in Taiwan tended to be less than domestic savings during the 1980s, hence generating a current account surplus.

Given this background the Taiwanese government has begun implementing a program of stimulating domestic demand under the current six-year (1991–96) development plan. A key component of this program is major public sector expenditure projects. Consequently, gross domestic investment as a proportion of gross domestic product is expected to increase from 22 per cent in 1990 to 24 per cent in 1992 (Asian Development Bank 1991).

It is widely perceived that social welfare expenditure in Asian newly industrialising countries, including Taiwan, has lagged behind economic growth and industrial development (Kim and Yun 1988; Asher 1989). However, in the short to medium term, demand for social welfare services in these countries, including Taiwan, is likely to rise with further income growth (Gunasekera, O'Mara and Dlugosz 1990). As a result, part of the rising government expenditure in Taiwan is likely to be allocated to social welfare related expenditure. Further, if expenditure on social welfare were to increase, private individuals' incentive to save would be likely to decline because they would perceive less need to make provision for their old age or for periods of sickness or unemployment (Gunasekera et al. 1990). As a consequence, private individuals' incentive to spend on additional consumption would be likely to increase, hence raising overall consumption expenditure relative to gross national product in Taiwan.

Another important recent policy development in Taiwan which has implications for major sectors of the economy is some recent reforms to the foreign trade system (Office of the US Trade Representative 1991; Glance, Murtough, Johnston and Winton 1991). These include considerable progress in reducing average tariff levels on non-agricultural products in Taiwan over recent years. In early 1989, Taiwan implemented a 'Trade Action Plan' intended to reduce its trade surplus with the United States. Tariff reductions are a key component of this plan, which established average nominal tariff rate targets, including 10.3 per cent for 1989, 9.2 per cent for 1990 and 8.1 per cent for 1991. Nevertheless, high trade barriers remain on most agricultural products in Taiwan. The average nominal tariff rate on agricultural products in Taiwan is just over 23 per cent. Fresh fruit and processed agricultural products often face import duties of up to 50 per cent ad valorem (Office of the US Trade Representative 1991). Moreover, resource imports to Taiwan typically escalate with the degree of processing, creating a bias toward the import of unprocessed raw materials at the expense of more processed imports. Tariffs on processed mineral and metal

products in Taiwan are, on average, several times larger than for ores, concentrates, waste and scrap. For example, Taiwanese tariffs on ores and concentrates range from 0 to 5 per cent, while on highly processed mineral and metal products they range from 0 to 20 per cent (Glance et al. 1991).

Absorption, trade reform and commodity imports in Taiwan

The high aggregate domestic savings, and particularly private savings in Taiwan, have been associated with a number of factors. These include changes in demographic variables such as rising life expectancy and a changing age structure of the Taiwanese population, and rapid increases in income per person associated with high rates of economic growth and declining population growth (see Gunasekera et al. 1990 for a detailed discussion of the factors underlying the current account surplus in Taiwan). One of the key policy actions that the Taiwanese government has taken to redress the external imbalances is to increase the growth in domestic demand. This process has also been facilitated by appreciation of the Taiwanese currency and a reduction of tariffs on a range of manufactured imported goods in Taiwan in recent years.

A change in the rate of growth of aggregate real absorption relative to the rate of growth of gross domestic product can be expected to have at least two major effects. First, it will give rise to changes in the demand–supply balance for many goods. Second, it will lead to changes in relative prices in order to bring about the required substitution between traded and non-traded goods. An across-the-board relative increase in real absorption can be expected to increase the price of non-traded goods relative to the price of traded goods. This is because the excess demand for non-traded goods associated with an across the board relative increase in real absorption requires an increase in the relative price of non-traded goods in order to re-establish equilibrium in that market. Total exports will decline, or grow less quickly than otherwise, as the higher price of non-traded goods diverts production from exports to non-traded goods. Total imports will increase, or grow more quickly than otherwise, because demand for importable goods will be greater than otherwise and the fall in the price of traded goods relative to non-traded goods will discourage additional production in import competing industries.

A removal of import restrictions such as tariffs on primary commodities, which have had the effect of providing a high level of assistance to domestic import competing primary industries, can be expected in most cases to reduce output in those industries and increase imports of the products in question. The reduction in output in these industries and the

associated reallocation of resources in the economy would then lead to an increase in output in other unassisted or lightly assisted exporting or import competing industries.

Effects on primary commodity imports of policy changes in Taiwan

There is a variety of possible approaches to examining the effect of macroeconomic and trade policy changes on commodity trade, including the use of single commodity partial equilibrium models and general equilibrium models. As Chambers and Just (1979) and Orden (1986) have demonstrated, to examine the impact of policy changes which affect a wide range of sectors, it is necessary to take account of the interactions between sectors. Therefore, it is more appropriate to use a general equilibrium model rather than a partial equilibrium model to capture the interactions between commodities and between sectors in production and consumption within the economy.

Modelling framework

A general equilibrium model is used in this paper to analyse the effects of an increase in absorption and a reduction in trade distortions in the agricultural and resource commodities on Taiwan's commodity imports. The model is of the ORANI type (Dixon, Parmenter, Sutton and Vincent 1982) and is comparative static in nature and employs basic techniques drawn from neoclassical price responsive general equilibrium models. The model has two primary factors — capital and labour. The model is short run in character, with capital assumed to be fixed in each sector while labour is mobile. Primary factor inputs are aggregated into a composite input using a constant elasticity of substitution (CES) function. Intermediate inputs are assumed to be used in fixed proportions to industry outputs and the composite primary factor input.

For many goods, there are marked differences among the products produced for the export market. This product differentiation also extends to domestic and imported products consumed. Hence, following Armington (1969), domestic goods, exports and imported products are regarded as imperfect substitutes in the model. The demand for an export good in the model is determined by the price of Taiwan's exports relative to the price of exports from the rest of the world, and the total world demand for that particular commodity. Taiwanese importers are assumed to be price takers on world markets.

Although most of the attention is focused on the behaviour of real variables in the model, a simple monetary sector is also incorporated into the model to allow determination of the aggregate price level as a numeraire. The model is solved, not in terms of the levels of the variables, but in a linearised form in which the variables explicitly appearing are percentage changes of the original variables (Johansen 1960).

The basic data for the model were taken from the input–output table for Taiwan for 1986, the latest currently available (Republic of China 1990). The input–output table for Taiwan on which the model is based is presented in appendix A. It contains 17 sectors. In addition to the input–output data described above, the model required several sets of other information. These included various elasticities ranging from consumer demand elasticities to elasticities of substitution between primary factors. These parameter values were obtained from Su (1990) and Higgs (1986). The set of equations making up the model is presented in appendix B together with the definitions of the variables and coefficients. The model is linear in percentage changes and was solved using the GEMPACK program (Codsi and Pearson 1988).

Policy experiments and results

The computable general equilibrium model briefly described in the previous section and detailed in appendix B is used to carry out the three policy experiments described below:

- a 5 per cent increase in aggregate real domestic absorption relative to gross domestic product in Taiwan;

- a 5 per cent reduction in implicit tariffs (ratio of domestic price to border price) for pork, beef, wool, other livestock products and crop based agricultural commodities;

- a 5 per cent reduction in implicit tariffs for steel and iron, aluminium and aluminium products and coal and coal products.

It is important to recognise that the actual magnitudes of the policy changes undertaken in these experiments are chosen for illustrative purposes. For example, given the lack of detailed information about the specific magnitudes of the possible changes in the different components of domestic aggregate absorption (as a consequence of the Taiwanese government's program of stimulating domestic demand under the 1991–96 development plan), it is assumed here that all the components of the domestic aggregate absorption will

change by the same proportion. Given that the model is linear in percentage changes, the effect of a 'k' per cent change in a policy variable is 'k' times that of a 1 per cent change.

The first experiment involves an across the board increase in all components of aggregate real absorption. This experiment provides a useful benchmark case for evaluating the effects of a strategy to stimulate domestic demand via various expenditure programs. The effects on primary commodity imports to Taiwan of the assumed increase in domestic absorption are presented in table 2. As would be expected, these results indicate that an

Table 2: **Changes in Taiwan's primary commodity markets: experiment 1**

Variable	5 per cent increase in absorption
	%
Macro variables	
Real gross domestic product	0.03
Volume of exports	–4.43
Volume of imports	3.18
Exchange rate (new Taiwan dollar/US dollar)	–8.66
Sectoral variables	
Volume of imports	
Beef a	2.96
Wool b	3.00
Other livestock products	2.73
Crop based agricultural commodities	2.38
Steel and iron	2.14
Aluminium	3.69
Coal and coal products	4.22
Domestic production	
Beef a	–0.21
Other livestock products	–0.15
Crop based products	–0.50

a In the input–output tables for Taiwan, beef is grouped together with non-ruminent meats and by-products under the 'slaughtering and by-products' sector. According to Fu (1990) beef imports to Taiwan accounted for around 70 per cent of the total meat imports in the 1980s. b In the input–output tables for Taiwan, wool is grouped together with worsted fabrics under the 'wool and worsted fabrics' sector. According to the Commonwealth Secretariat (1991) raw wool imports to Taiwan accounted for around 75 per cent of the total imports of wool and worsted fabrics in 1980s.

increase in domestic absorption in Taiwan would lead to increases in both agricultural and resource commodity imports to Taiwan, with coal being the major commodity affected.

The results of experiments 2 and 3 on trade policy changes are presented in tables 3 and 4 respectively. In experiment 2, a reduction in trade distortions in key agricultural commodities leads to a reduction in domestic production and an increase in imports of these goods. For

Table 3: Changes in Taiwan's primary commodity markets: experiment 2

Variable	5 per cent reduction in implicit tariffs on key agricultural imports
	%
Macro variables	
Real gross domestic product	a
Volume of exports	0.02
Volume of imports	0.09
Exchange rate (new Taiwan dollar/US dollar)	0.28
Welfare index b	0.02
Sectoral variables	
Volume of imports	
Beef c	3.16
Wool d	1.21
Other livestock products	3.37
Crop based agricultural commodities	3.54
Volume of exports	
Wool based products	5.18
Domestic production	
Beef c	–0.55
Other livestock products	–0.39
Crop based agricultural commodities	–0.16
Wool based products	6.33

a Less than 0.01 per cent. b Change in nominal gross domestic product minus the change in the weighted average household consumer price. c In the input–output tables for Taiwan, beef is grouped together with non-ruminent meats and by-products under the 'slaughtering and by-products' sector. According to Fu (1990) beef imports to Taiwan accounted for around 70 per cent of the total meat imports in the 1980s. d In the input–output tables for Taiwan, wool is grouped together with worsted fabrics under the 'wool and worsted fabrics' sector. According to the Commonwealth Secretariat (1991) raw wool imports to Taiwan accounted for around 75 per cent of the total imports of wool and worsted fabrics in 1980s.

example, a 5 per cent reduction in implicit tariffs in key agricultural commodities contributes to increases in the volume of imports of beef, other livestock products and crop based agricultural commodities by just over 3 per cent. In the case of wool, the fall in implicit tariffs leads to an increase in imports of just over 1 per cent. Moreover, the Taiwanese wool processing sector expands and increases exports as a consequence of the reduction in implicit tariffs on wool. The reduction in implicit tariffs on key resource commodities in Taiwan also leads to increases in imports, with coal and coal products being the major commodities affected. Furthermore, manufacturing industries in Taiwan that use key resource commodities such as aluminium as a major input expand their output and increase exports as a result of the fall in implicit tariffs on their major input items.

Reductions in implicit tariffs on key agricultural and resource commodities in Taiwan also lead to a marginal increase (less than 0.01 per cent) in real gross domestic product. Although

Table 4: Changes in Taiwan's primary commodity markets: experiment 3

Variable	5 per cent reduction in implicit tariffs on resource commodity imports
	%
Macro variables	
Real gross domestic product	a
Volume of exports	0.01
Volume of imports	0.03
Exchange rate (new Taiwan dollar/US dollar)	a
Welfare index b	0.03
Sectoral variables	
Volume of imports	
Steel and iron	0.04
Aluminium	0.04
Coal and coal products	2.02
Volume of exports	
Aluminium based products	5.39
Domestic production	
Aluminium based products	2.78

a Less than 0.01 per cent. b Change in nominal gross domestic product minus the change in the weighted average household consumer price.

changes in real gross domestic product might be interpreted as a measure of change in economic welfare, in a short run computable general equilibrium model such as the one used in this study, change in real gross domestic product (which measures the change in real volume of production) is less likely to provide an appropriate indication of the change in welfare. This is because the model assumes full employment of factors of production and also because it does not capture the impacts of long run structural changes associated with the resource reallocation resulting from the simulated policy changes.

Therefore, in this study an alternative welfare indicator, measured by the change in nominal gross domestic product minus the change in weighted average household consumer prices, is used. This alternative welfare measure is likely to provide a better indication of the changes in the real purchasing power of the economic agents in the Taiwanese economy. As illustrated in tables 2 and 3, a reduction in implicit tariffs on key agricultural and resource commodities in Taiwan leads to a rise in this alternative welfare measure of 0.02 per cent in experiment 2 and 0.03 per cent in experiment 3. This estimate, while still very small, is somewhat larger than the measured increase in real gross domestic product, reflecting the more efficient use of resources in Taiwan following the decline in protection.

It is important to recognise, however, that even this alternative welfare measure is unable to capture fully the adjustments taking place in consumer behaviour resulting from the simulated policy changes. In particular, this measure is based on fixed weights in the expenditure 'basket' and hence does not capture the potential benefit to consumers from modifying their expenditure patterns in response to changes in relative prices. This is again a reflection of the short run nature of the model that has been used here. The welfare gains are potentially larger in the long run relative to the short run for the Taiwanese economy. However, the framework used in this study is limited to estimating short run welfare gains.

Given that the model responses are linear in percentage terms, the cumulative effects of a 5 per cent reduction in trade distortions in key agricultural as well as resource commodities can be obtained by adding up the results of the experiments 2 and 3. These cumulative effects (table 5) indicate that the increases in the volume of imports of key farm products and resource commodities are marginally greater than when trade distortions were reduced for key agricultural products and resource commodities separately. This implies the relatively larger resource reallocation effects in Taiwan associated with an across the board reduction in trade distortions among the key agricultural and resource commodities.

Table 5: Changes in Taiwan's primary commodity markets: cumulative effects of experiments 2 and 3

Variable	5 per cent reduction in implicit tariffs on key agricultural and resource commodity imports
Macro variables	%
Real gross domestic market	a
Volume of exports	0.03
Volume of imports	0.12
Exchange rate (new Taiwan dollar/US dollar)	0.28
Welfare index b	0.04
Sectoral variables	
Volume of imports	
Beef c	3.19
Wool d	1.28
Other livestock products	3.40
Crop based agricultural commodities	3.56
Steel and iron	0.08
Aluminium	0.06
Coal and coal products	2.05
Volume of exports	
Wool based products	5.31
Aluminium based products	6.73
Domestic production	
Beef	–0.56
Other livestock products	–0.40
Crop based agricultural commodities	–0.16
Wool based products	6.07
Aluminium based product	2.72

a Less than 0.01 per cent. b Change in nominal gross domestic product minus the change in the weighted average household consumer price. c In the input–output tables for Taiwan, beef is grouped together with non-ruminent meats and by-products under the 'slaughtering and by-products' sector. According to Fu (1990) beef imports to Taiwan accounted for around 70 per cent of the total meat imports in the 1980s. d In the input–output tables for Taiwan, wool is grouped together with worsted fabrics under the 'wool and worsted fabrics' sector. According to the Commonwealth Secretariat (1991) raw wool imports to Taiwan accounted for around 75 per cent of the total imports of wool and worsted fabrics in 1980s.

It is important to recognise here that, given Taiwan's relatively small share of world primary commodity imports (table 6), the changes in primary commodity imports by Taiwan estimated in this study are likely to have only a limited impact on the international supply and demand balance of these commodities and hence their world prices. Any consequences for primary commodity exporting countries such as Australia, therefore, are likely to be *direct*, through changes in their primary commodity exports to Taiwan (in response to the above mentioned changes in Taiwanese primary commodity imports) but not *indirect* via substantial world price changes. Further, to the extent that the *direct* effects would spread across the major primary commodity exporters to Taiwan, the impact on any single exporting country would be small.

Table 6: Taiwan's share of world imports, by primary commodity product group

	1980	1988
	%	%
All food products a	2.02	2.86
Minerals, ores and metals b	2.27	2.73
Primary commodities c	2.93	4.81

a Includes food and live animals; beverages and tobacco; animal and vegetable oils, fats and waxes, oilseeds and oleaginous fruit (SITC sections 0, 1, 4 and division 22). b Includes crude fertilisers and minerals; metalliferous ores, metal scrap and non-ferrous metals (SITC divisions 27, 28 and 68). c Includes food; raw materials; ores and minerals; non-ferrous metals (SITC sections 0, 1, 2, 4 and division 68).

Sources: United Nations (1990); General Agreement on Tariffs and Trade (1990).

It should be recognised that capital is assumed to be fixed in each sector of the model used in this study. Furthermore, the model is static and therefore cannot trace the time path of changes in economic variables of interest. Yet it is important to recognise that the results of this study still provide useful insights into the short to medium term effects of key macroeconomic and trade policy changes in Taiwan.

Sensitivity analysis

The question naturally arises about how sensitive the model results are to changes in the values of the various parameters. The emphasis here is on two sets of key parameters relevant to the present study, namely the elasticity of substitution between domestic and imported goods and the elasticity of substitution between domestic and export goods. To test the sensitivity of some important model results to these parameters, a method proposed

Table 7: **Sensitivity elasticities of some key model variables with respect to changes in key parameter values: experiment 1**

	Parameter	
Variable	**Elasticity of substitution between domestic and imported goods**	**Elasticity of substitution between domestic and exported goods**
Real gross domestic product	–0.14	0.22
Total import volume	0.85	–0.75
Volume of imports of wool	0.26	–0.17
Volume of imports of aluminium	0.10	–0.98

by Pagan and Shannon (1984) was used. This method involves computing 'sensitivity elasticities' for the key parameters — that is, the percentage changes in the results produced by a 1 per cent change in a parameter value. Model results can be considered as sensitive if the absolute value of the sensitivity elasticity is greater than one.

In order to test the sensitivity of the model results, experiment 1 was repeated twice. First, the elasticity of substitution between domestic and imported goods was increased by 33 per cent, for all commodities, (following Pagan and Shannon 1984) while all the other parameters were held at their 'benchmark' levels. Second, the same experiment was repeated with the elasticity of substitution between domestic and export goods, for all commodities, increased by 33 per cent, again with all the other parameters at their 'benchmark' levels. Results from these experiments, divided by 33 to obtain the sensitivity elasticities are given in table 7. It can be seen that 1 per cent changes in the elasticity of substitution between domestic and imported goods and in the elasticity of substitution between domestic and export goods have, in general, little effect on the model results associated with the changes in macroeconomic and sectoral variables. Thus, if the sensitivity of the results in table 7 can be taken as a general guide, they suggest that the results of the experiments undertaken in this study are relatively robust around the current values of the key parameters.

Concluding remarks

Sustained high rates of economic growth combined with a relatively small per person endowment of arable land and natural resources has made Taiwan an important market for

primary commodity exporting countries such as Australia. The opportunities for primary commodity exporters are likely to be enhanced further by the recent policy initiatives undertaken by the Taiwanese government to stimulate aggregate domestic demand and by the ongoing tariff reductions in Taiwan.

According to the results of the macroeconomic and trade policy changes in Taiwan analysed in this study, a moderate change in aggregate real domestic absorption relative to gross domestic product and even quite small changes in trade distortions in key agricultural and resource commodities in Taiwan may have considerable effects on trade volumes, particularly on the volume of beef, wool and coal imported by Taiwan. This is likely to have a favourable impact on primary commodity exporting countries such as Australia.

It is important to recognise that the changes in primary commodity imports by Taiwan reported in this paper are unlikely to be large enough to influence the world prices to any significant extent. Nevertheless, there are likely to be opportunities for Australia to expand its share of primary commodity exports to Taiwan for two key reasons. First, much of the trade growth in Asian newly industrialising countries (including Taiwan) has been concentrated in the Asia Pacific region. More than half of the trade of Asia Pacific countries is within the region, even though the Asia Pacific region accounts for only a third of world trade. This bias toward intraregional trade means that a disproportionately large share of the benefits of Asian newly industrialising countries' trade growth are accruing to countries within the Asia Pacific region, including Australia (Tyers, Phillips and Drysdale 1988). Second, the geographic proximity is likely to give Australia a competitive edge (relative to other major primary commodity exporting countries) in transporting agricultural commodities including perishable products and low value to volume resource commodities to Taiwan at a relative lower cost.

Finally, the analysis presented in this paper could be extended in several ways. First, it would be useful to repeat the analysis with a long run version of the model to explicitly incorporate capital mobility and also land resources. Future research could also involve analysis of the impacts of changes in particular components of domestic aggregate absorption in Taiwan, in contrast to the present analysis in which it was assumed that all components of absorption would change equaproportionately. Moreover, given the significance of tariff escalation for mineral and metal products in Taiwan, it would be useful to assess the impact of reducing tariff escalation for these products using a more disaggregated version of the model.

Appendix A: **Input–output table for Taiwan, 1986** *(market prices, current million New Taiwan dollars)*

	Hogs	Other livestock	Slaughtering and by-products	Crop based agricultural products	Export competitive ag and food products	Import competitive ag and food products	Low traded industrial products	Highly exported industrial products
Hogs	12 146	0	42 606	195	9 182	553	0	0
Other livestock	0	1 046	20 725	69	2 488	384	0	29
Slaughtering by-products	0	0	2 171	0	8 842	0	0	14 159
Crop based agricultural products	814	1 827	0	54 452	14 360	181	915	153
Export competitive agricultural and food products	36 104	21 737	0	579	58 009	90	247	564
Import competitive agricultural and food products	1 186	1 128	0	13 033	53 497	3 920	974	11 114
Low traded industrial products	56	11	212	2 861	14 679	691	84 987	29 737
Highly exported industrial products	47	1	17	842	3 574	146	1 976	334 264
Wool and worsted fabrics	0	0	0	0	0	0	22	6 432
Other export competitive industrial products	11	6	95	5 518	7 289	445	5 317	238 568
Steel and iron	0	0	0	0	5	0	1 848	24 022
Aluminum	0	0	0	222	186	0	259	7 462
Other import competitive industrial products	674	149	34	5 480	6 459	7 171	16 448	81 468
Coal and coal products	0	0	1	69	80	0	3 999	130
Other highly imported industrial products	0	0	0	24	46	0	78 396	436
Construction and utilities	363	445	212	980	5 135	295	9 576	16 891
Services	6 195	4 227	8 998	18 609	33 161	10 155	28 728	116 611
Intermediate factors	57 596	30 577	75 071	102 933	216 992	24 031	233 692	882 040
Primary factors								
Labour	2 569	2 768	3 601	25 534	48 248	46 166	35 874	233 252
Capital	5 530	3 245	3 504	18 542	36 170	18 420	77 660	103 221
Indirect taxes	1 264	755	1 784	50 123	4 032	379	20 685	10 971
Gross output	66 959	37 345	83 960	197 132	305 442	88 996	367 911	1 229 484

Appendix A *(continued)*

	Wool worsted and fabrics	Other export competitive industrial products	Steel and iron	Aluminium	Other import competitive industrial products	Coal and coal products	Other highly imported industrial products	Construction and utilities
Hogs								
Other livestock	3 553	0	0	0	26	0	0	0
Slaughtering by-products	317	0	0	0	139	0	0	0
Crop based agricultural products	0	150	2	0	846	0	0	0
Export competitive agricultural and food products	0	123	0	0	779	0	0	0
Import competitive agricultural and food products	0	25 412	3	0	228	0	0	405
Low traded industrial products	217	29 914	4 107	731	28 627	121	200	59 089
Highly exported industrial products	210	42 102	552	69	10 213	115	55	22 841
Wool and worsted fabrics	6 614	461	0	0	0	0	0	0
Other export competitive industrial products	1 181	367 672	8 632	193	18 937	268	69	47 651
Steel and iron	0	74 425	146 843	186	38 230	13	143	30 825
Aluminum	0	8 380	344	10 407	2 366	0	0	397
Other import competitive industrial products	318	154 886	13 952	1 440	167 786	249	284	26 086
Coal and coal products	3	1 949	7 162	79	1 592	6 199	0	17 541
Other highly imported industrial products	0	1 806	10	3	1 136	0	52	4 155
Construction and utilities	288	33 429	7 753	690	12 465	536	77	26 662
Services	1 016	87 905	32 614	2 201	44 137	739	358	51 783
Intermediate factors	13717	828 614	221 974	15 999	327 507	8 240	1 238	287 435
Primary factors								
Labour	2 015	169 205	18 998	3 056	77 881	3 718	1 398	92 015
Capital	1 314	120 312	26 153	1 710	65 098	1 085	5 398	99 402
Indirect taxes	72	18 959	926	260	4 703	64	240	4 063
Gross output	17 118	1 137 090	268 051	21 025	475 189	13 107	8 274	482 915

Appendix A *(continued)*

	Services	Household demand	Government demand	Fixed investment	Stock investment	Exports	Imports	Gross output
Hogs	0	0	0	1 313	928	72	36	66 959
Other livestock	256	11 088	24	1 099	415	568	4425	37 345
Slaughtering by-products	265	66 589	205	0	660	5 037	14 424	83 960
Crop based agricultural products	1847	129 443	514	0	–1 008	3 623	10 987	197 132
Export competitive Agricultural and food products	3270	130 694	1423	0	2 038	85 722	35 937	305 442
Import competitive agricultural and food products	570	52 850	325	3 226	–4 731	4 520	78 664	88 996
Low traded industrial products	92 323	39 637	18 280	1 408	–8 914	23 385	54 448	367 911
Highly exported industrial products	34 217	122 562	11 441	72 164	15 148	790 713	233 785	1 229 484
Wool and worsted fabrics	91	770	27	0	451	5 106	2 856	17 118
Other export competitive industrial products	32 334	68 645	5 706	46 953	3 772	406 827	128 999	1 137 090
Steel and iron	1 823	0	5 541	0	–5 596	20 309	70 566	268 051
Aluminum	150	11	1 438	0	–216	1 826	12 207	21 025
Other import competitive industrial products	33 967	24 923	6 561	102 580	5 102	99 732	280 560	475 189
Coal and coal products	88	17	1	0	–4 501	573	21 875	13 107
Other highly imported industrial products	185	58	0	0	1 381	0	79 414	8 274
Construction and utilities	74 302	38 718	6 481	247 776	0	151	310	482 915
Services	253 078	736 965	362 029	29 825	829	187 995	137 934	1 880 224
Intermediate factors	528 766	1 422 970	419 996	506 344	5 758	1 636 159	1 167 427	6 680 222
Primary factors								
Labour	802 069	0	0	0	0	0	0	0
Capital	488 401	0	0	0	0	0	0	0
Indirect taxes	60 988	15 981	2 886	11 175	198	1 362	0	0
Gross output	1 880 224	1 438 951	422 882	517 519	5 956	1 637 521	0	0

Appendix B

Structure of the computable general equilibrium model for Taiwan

Number of equations

Household consumption demands

(1) $q_i^{(3)} = \varepsilon_i\, a^* + \Sigma_k\, \eta_{ik} p_k^q$ ($k = i$ own-commodity relationship; $k \neq i$ cross-commodity relationship) — *n*

Fixed investment demand

(2) $q_i^{(2)} = a_R$ — *n*

Government demand

(3) $q_i^{(5)} = a_R$ — *n*

Traded good demand–supply

Export demand

(4a) $q_i^{(4)} = \beta_i(p_i^e)$ — *n*

Import supply to Taiwan

(4b) $q_{is} = E_i p_i^m$ ($s = 1$, import) — *n*

Intermediate demands

(5) $q_{ij}^{(1)} = x_j$ — *nm*

Domestic absorption of good *i* from all sources

(6) $q_i = \Sigma_j\, B_{ij}^{(1)} q_{ij}^{(1)} + B_i^{(2)} q_i^{(2)} + B_i^{(3)} q_i^{(3)} + B_i^{(5)} q_i^{(5)}$ — *n*

Domestic/import substitution

(7) $q_{is} = q_i - \sigma_i^m (p_{is} - p_i^q)$ ($s = 1$, imported; 2, domestic) $2n$

Commodity accounting relationship

(8) $x_i = \sum_j D_{ij} x_j$ n

Transformation in production

(9) $x_{id} = x_i + \sigma_i^T (p_{id} - p_i^x)$ (d = 2, domestic; 3, export) 2n

Primary factor inputs

(10) $q_{vj}^p = x_j - \sigma_j^p \left(p_{vj}^p - \Sigma_v S_{vj}^p p_{vj}^p \right)$ ($v = 1$, labour; 2, capital) $2m$

Product market clearing

Domestic market clearing ($s = d = 2$, domestic)

(11) $q_{is} = x_{id}$ n

Export market clearing ($d = 1$, export)

(12) $q_i^{(4)} = x_{id}$ n

Factor market clearing

Labour

(13a) $q_1^p = \Sigma_j L_j q_{1j}^p$ 1

Capital in sector j

(13b) $q_{2j}^p = k_j$ m

Zero pure profits at the margin

In production

(14a) $\sum_i R_{ij} p_i^X = \Sigma_i H_{ij}^{(1)} p_i^q + \Sigma_v H_{vj}^p p_{vj}^p + IDT_j$ (v = 1, labour; 2, capital) *m*

In importing ($s = 1$, import)

(14b) $p_{is} = (p_i^m + t_i + \phi_1)$ *n*

In exporting ($s = 3$, export)

(14c) $p_{is} = p_i^e + \phi_1$ *n*

GDP, absorption and household absorption

(15a) $gdp_R = Aga_R + SXe_R - SMm_R$ 1

(15b) $gdp = Aga + SXe - SMm$ 1

(15c) $a_R = \Sigma_i (SN_{i3} q_i^{(3)} + SN_{i5} q_i^{(5)} + SN_{i2} q_i^{(2)})$ 1

(15d) $a = \Sigma_i (SN_{i3} a^* + SN_{i5} (p_i^q + q_i^{(5)}) + SN_{i2} (p_i^q + q_i^{(2)}))$ 1

Balance of trade condition

(16) $\pi = SXe + SMm$ 1

Balance of trade identities

Total export value ($d = 3$, export)

(17a) $e = \Sigma_i V_i (p_3 + x_{id})$ 1

Total import value ($d = 2$, domestic)

(17b) $m = \Sigma_i M_i(p_2 + q_{id})$ 1

Total export volume ($d = 3$, export)

(17c) $e_R = \Sigma_i V_i x_{id}$ 1

Total import volume ($s = 1$, import)

(17d) $m_R = \Sigma_i M_i q_{is}$ 1

Composite price variables

Price level determination

(18a) $p^q = ms - a_R$ 1

Price deflator for GDP

(18b) $p^x = gdp - gdp_R$ 1

Price deflator for total absorption

(18c) $p^q = a - a_R$ 1

Price deflator for absorption of good i

(18d) $p_i^q = \Sigma_s A_{is} p_{is}$ (s = 1, import; 2, domestic) n

Price deflator for output of good i

(18e) $p_i^x = J_{i2} P_{i2} + J_{i3} P_{i3}$ ($d = 3$, export; 2 domestic) n

Total number of equations $17n + mn + 4m + 13$

Endogenous variables (percentage change)		No.
a	= Nominal absorption	1
a^*	= Household nominal absorption	1
π	= Balance of trade as a share of GDP	1
e	= Export value	1
e_R	= Export volume	1
gdp_R	= Real GDP	1
gdp	= Nominal GDP	1
m	= Import value	1
m_R	= Import volume	1
p_i^e	= Foreign currency price of export i	n
p_{vj}^p	= Return to primary factor v in sector j (v = 1, labour; 2, capital; 3)	m+1
p_i^m	= Foreign currency price of import i	n
p^q	= Composite price for absorption	1
p_i^q	= Price for absorption of good i	n
p_{is}	= Price of good i from source s = 1, import; 2, domestic; 3 export	$3n$
p_i^x	= Price for production of good i (composite of domestic and export)	n
p^x	= Aggregate price of output (GDP deflator)	1
q_i	= Total absorption of good i	n
$q_{ij}^{(1)}$	= Intermediate use of good i by sector j	nm
$q_i^{(2)}$	= Fixed investment demand for good i	n
$q_i^{(3)}$	= Household demand for good i	n
$q_i^{(4)}$	= Export demand for good i	n
$q_i^{(5)}$	= Government demand for good i	n
q_{is}	= Demand for good i from source s = 1, import; 2, domestic	$2n$
q_{vj}^p	= Demand for primary factor v by sector j (v = 1, labour; 2, capital)	$2m$
x_i	= Output level of good i	n
x_j	= Output level of sector j	m
x_{id}	= Supply of good i to destination d = 1, export; 2, domestic	$2n$
ϕ_1	= Market exchange rate (New Taiwan$/$US)	1

Total number of endogenous variables $17n + mn + 4m + 13$

Exogenous variables (percentage change)

a_R = Real absorption

k_j = Capital stock in sector j

ms = Money supply

q_l^p = Total labour force

t_i = Power of the tariff on imports of good i (1 + nominal tariff rate)

D_{ij} = Binary variable which equals 1 if good i belongs to good set j, zero otherwise

IDT_i = Power of the indirect tax on good i

Value share coefficients

Ag = Total absorption as a share of GDP

A_{is} = Share of absorption of good i derived from source s = 1, import; 2, domestic

$B_{ij}^{(1)}$ = Share of intermediate use in sector j in total absorption of good i

$B_i^{(2)}$ = Share of investment in total absorption of good i

$B_i^{(3)}$ = Share of household consumption in total absorption of good i

$B_i^{(5)}$ = Share of government in total absorption of good i

$H_{ij}^{(1)}$ = Share of intermediate good i in total costs of sector j

H_{vj}^{p} = Share of primary factor v in total costs of sector j (v = 1, labour; 2, capital; 3, land)

J_{id} = Share of good i production to destination d = 2, domestic; 3, export

L_j = Share of sector j in total employment

M_i = Share of good i in total imports

S_{vj}^{p} = Share of primary factor v in primary factor inputs of j

SM = Imports as a share of nominal GDP

SN_{ih} = Share of end-use demand h for good i in real absorption where h = 1, intermediate demand; 2, fixed investment; 3, household demand; 4, export demand; 5, government investment.

SX = Exports as a share of nominal GDP

V_i = Share of good i in total value of exports

W_i = Share of good i in nominal absorption

R_{ij} = Commodity revenue share coefficient of good i in sector j

Elasticity parameters

β_i = Export demand elasticity for good i

E_i = Elasticity of import supply for good i to Taiwan

ε_i = Household expenditure elasticity for good i

η_{ik} = Price elasticity of household demand for good i with respect to price k

σ_i^m = Elasticity of substitution between import and domestic products of good i

σ_j^p = Elasticity of substitution between primary factor inputs i in sector j

σ_i^T = Elasticity of substitution between domestic and export production of good i

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