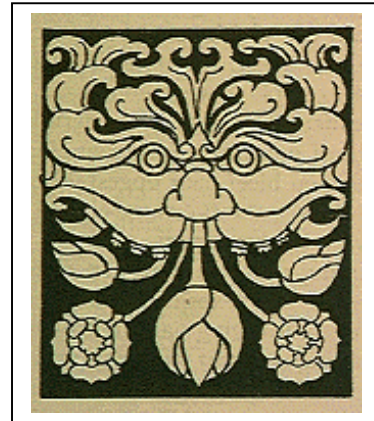


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# **Effects of the Asian Economic Crisis on Singapore and Its Policy Responses: A General Equilibrium Analysis\***

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## **Abstract**

The declining regional demand for Singapore's exports due to contraction in the crisis economies, slower growth in real investment, and loss of competitiveness in the face of competitive devaluations posed new challenges for Singapore which must adopt policies to combat the crisis. This paper examines the impact of the crisis on Singapore and the effects of proposed policies using the computable general equilibrium (CGE) modelling approach. We use two CGE models: a world model and a model of Singapore. First, the impact of the crisis is simulated using the GTAP (Global Trade Analysis Project) model. Then the effects of policy responses are examined using the Singapore model. In particular, we examine wage reduction, domestic demand stimulation, and exchange rate policies.

## **Introduction**

Singapore's experience with the Asian crisis and its quick recovery following the policy responses makes it a worthwhile and an interesting case study. In terms of both current and capital accounts, Singapore has a very open economy, yet the impact of the crisis was less severe in comparison to much less open economies in the region which have experienced dramatic economic and social repercussions. In Singapore, the crisis impacted different sectors unevenly. Sectors such as commerce, transport, tourism, and financial services, which have a large regional exposure, were badly hit. Interestingly, the policy responses to the crisis were not to reject globalization and liberalization and adopt capital control measures but to make much stronger domestic financial system and to improve Singapore's international competitiveness (Chia, 1998). Since the crisis, many alternative explanations have emerged as the causes for the substantial economic downturn in the region. Among these some political economy arguments and weakening of macroeconomic fundamentals caused by the adoption of policies that are inconsistent with a peg exchanged rate regime have occupied an important part of the debate (see Lee, 1999; Karunaratne, 1999).

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\* This research was funded by a grant from the University of New England. The authors are grateful to two anonymous referees for their helpful comments and suggestions.

This paper examines the impact of the crisis on Singapore and the effects of proposed policies using the computable general equilibrium (CGE) modelling approach. We use two CGE models: a world model and a model of Singapore (Siriwardana and Schulze, 2000). First, the impact of the crisis is simulated using the GTAP (Global Trade Analysis Project) model. Then the effects of policy responses are examined using the Singapore model. In particular, we examine wage reduction, domestic demand stimulation, and exchange rate policies.

The paper is organised as follows: Section two is a brief discussion of the Asian crisis and its implications for Singapore. Section three outlines the theoretical framework of the GTAP model which is used to quantify the impact on Singapore of the crisis. The simulation results obtained from the GTAP model are discussed in Section four. Section five reviews her policy responses to the crisis. Section six presents the results of policy simulations. Section seven concludes.

## **The Asian Crisis and Its Implications for Singapore**

The Asian crisis began as an exchange rate crisis in Thailand and spread almost immediately to Malaysia, Indonesia, and the Philippines. This led to financial crises which, in turn, produced severe downturns in real economic activity in these, and other, countries. While a full discussion of the causes, propagation channels, and effects are beyond our scope,<sup>1</sup> some points need to be made to show how, and to what extent, Singapore was caught up in the crisis. We focus on Thailand, the first domino. An overvalued exchange rate pegged to the US\$,<sup>2</sup> declining exports,<sup>3</sup> and a growing current account deficit made her vulnerable to a speculative exchange rate attack. The falling yen and an effective depreciation of about 10 per cent of the yuan contributed to her reduced export competitiveness<sup>4</sup>. The resulting devaluation triggered a financial crisis. Substantial capital inflows, about 6 per cent of GDP, had fuelled price bubbles in real estate and the stock market. Although these bubbles peaked at the end of 1993, by the end of 1997 share prices fell to about 29 per cent of their 1995 levels while the property company share index fell to 10 per cent of its 1995 level (Edison, Luangaram and Miller, 1998, p.4). In addition, relatively high domestic interest rates and the pegged exchange rate led to increases in foreign short-term borrowing<sup>5</sup> that was largely unhedged. As the exchange rate fell, financial institutions suffered large capital losses as the value of their foreign denominated debt increased.

These losses were magnified since most bank lending was backed by collateral, particularly real estate. Financial system solvency, already impaired, was further damaged as the value of their collateral collapsed<sup>6</sup> and nonperforming loans increased. New domestic credit dried up, as did foreign credit with capital outflows of about 2 per cent of GDP. Otherwise viable firms were

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<sup>1</sup> For general reviews of the Asian crisis see Moreno (1998), Moreno, Pasadilla and Remolona (1998). Goldstein and Hawkins (1998), Glick (1998) and Corsetti et al. (1999). Mishkin (1997) provides an excellent, asymmetric information based discussion of the causes and propagation of financial crises.

<sup>2</sup> See Chinn (1998).

<sup>3</sup> Thai exports fell by 1% in US\$ terms in 1996, following two years of growth in excess of 20% caused, in part, by cyclical declines in the prices of computer chips and other electronic goods (BIS, 1997).

<sup>4</sup> China's exports and those of the four South East Asian countries most affected by the currency crisis are very similar in content and destination. From 1989 to 1996, China's exports increased from about 12% to nearly 30% of US imports in 1996 while the corresponding shares for Thailand, Malaysia, Indonesia and the Philippines were roughly constant (between 5-10%). Another indicator of the size of the real shock to South East Asia was the fact that China's trade balance changed from a deficit of US\$10.6 billion the year before the devaluation to a surplus of US\$4.2 billion in the subsequent year (1994) (Huh and Kasa, 1997).

<sup>5</sup> From 19% of GDP in 1994 to 29% in 1997. These borrowings increased from 101% to 148% of foreign reserves over the same period (Moreno, Pasadilla and Remolona, 1998, p.22).

<sup>6</sup> See Kiyotakhi and Moore (1997). Thailand also exhibited signs of a financial panic precipitated by a run on the Bangkok Bank of Commerce in 1996.

unable to finance working capital and new investment, leading to widespread bankruptcies and sharp declines in aggregate demand and real output.<sup>7</sup> Financial system weaknesses (including implicit government guarantees against risk, inadequate monitoring, and supervision) prevented the devaluation from stimulating the economy since exporting firms were unable to take immediate advantage of their increased price competitiveness (Montes and Popov, 1999).

There were (at least) three channels through which the initial exchange rate crises spread. We consider them with particular reference to Singapore. First, they spread to economies with similar macroeconomic, including financial, fundamentals. Second, they spread because of financial panic and speculative attacks which reduced international capital flows. Third, they spread through, and to, economies with strong trade linkages. The first two channels are interactive. Singapore's strong macroeconomic fundamentals and healthy financial system explain why it was the least affected ASEAN state. For example, its M2 to foreign reserves ratio, an indicator of the vulnerability of the financial system to external funds, was much lower than the ASEAN countries most affected, helping to explain why Singapore did not experience extreme disruptions to its capital flows<sup>8</sup>. Singapore's better exchange rate performance was also underpinned by these factors. From July 1997 to October 1998 the Singapore dollar fell by about 16 per cent against the US\$, but appreciated by about 20 per cent against the Ringgit, Baht, and Peso and 60 per cent against Rupiah.

The trade channel operates through both price and income effects. Export-competing countries are at a price disadvantage in their export markets when a competitor devalues. Falling real income also reduces demand for imports from trading partners (see Glick and Rose 1998). ASEAN trade can be characterised by two stylized facts: (1) ASEAN exports, largely labour-intensive manufactured goods, are very similar and, thus, compete with each other and (2) intra-ASEAN trade, while not high in some measures, is quite significant.<sup>9</sup>

Singapore plays a central role as an entrepot, accounting for about half of all intra-ASEAN trade. In addition, most of her exports of communication, transportation, finance, and tourism services are to ASEAN neighbors. Its remarkable openness, with exports plus imports exceeding GNP, exposes Singapore particularly to contagion via trade linkages. It is also an important source of direct foreign investment in other ASEAN states, further exposing the country to negative income effects. The likelihood that the trade channel has been most important in Singapore's case has important implications for the policies it adopted to combat the crisis (Chia, 1998).

## Overview of the GTAP Model

The analytical framework used to quantify the impact of the crisis is a well-known GTAP model (Hertel, 1996), which is a comparative-static multi-regional computable general equilibrium (CGE) model of the Johansen type comprising a system of linear equations of percentage change of variables (Johansen, 1960).

The modelling of each region in GTAP is based on the ORANI model (Dixon et al., 1982). This paper uses the version four of GTAP database, which distinguishes 45 regions and 50 sectors in each region. The base year for the version four database is 1995.

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<sup>7</sup> Other devaluation effects on real economic activity flow through increases in domestic interest rates (which compound declines in asset prices as well as lowering aggregate demand directly), increases in the cost of imports, and inflation which may produce additional negative wealth effects.

<sup>8</sup> M2 to foreign reserve ratio was as follows: Malaysia (3.3), Indonesia (4.7), Philippines (6.2), Thailand (5.7%), and Singapore (1.1),

<sup>9</sup> See Frankel and Wei (1996). They find that "two ASEAN countries trade six times more than two otherwise-similar countries" (p. 13). Intra-ASEAN trade accounts for over 20% of all ASEAN trade.

The model has many general features which include product differentiation by country of origin, explicit recognition of savings by regional economies, a capital goods producing sector in each region to service investment, international mobility of capital, multiple trading regions, multiple goods and primary factors, empirically based differences in production technology and consumer preferences across regions, and explicit recognition of a global transport sector. It is also featured by many policy variables, including taxes and subsidies on commodities as well as on primary factors, making the model more attractive to policy analysts.

In each region both factor and commodity markets are assumed to be perfectly competitive. Producers operate with constant returns to scale production functions where the technology is described by Leontief and CES functions. Two broad categories of inputs to production are identified, namely intermediate inputs and primary factors. Each regional sector is assumed to choose a mixture of inputs to minimise total cost for a given level of output. At the first level, producers use composite units of intermediate inputs and primary factors in fixed proportions according to a Leontief function. At the second level of the production nest, intermediate input composites are obtained as combinations of imported bundles and domestic goods of the same input-output class, and primary factor input composites are created as combinations of skilled-labour, unskilled-labour, capital, land, and natural resources. A CES function is used in forming both types of composites. Finally at the third level, imported bundles are created via a CES aggregation of imported goods of the same class from each region.

On the demand side, the GTAP model adopts a sophisticated specification of consumer behaviour which allows for differences in both price and income responsiveness of demand in different regions, depending on the level of development and regional specific demand patterns. Each region has a single representative household. This regional household receives all the income generated through payments to primary factors, and net tax revenue. Its behaviour is governed by an aggregate utility function over private household consumption, government consumption, and savings. The aggregate utility is modelled by a Cobb-Douglas function with constant expenditure shares. The government consumption is also described by a Cobb-Douglas function over composite commodities where the demand for the latter is a CES aggregation of imports and domestic goods. Private household consumption is explained by a CDE (Constant Difference of Elasticities) expenditure function. These households purchase bundles of commodities where the bundles are CES aggregation of domestic goods and imported bundles. The imported bundles in turn are formed by a CES aggregation of imports from different regions.

Capital creation takes place in each region according to a technology that is similar to producing current goods except that it requires only domestic and imported intermediate inputs. This capital creation services the investment which is financed by a global pool of savings. Each region contributes a share of its income to a savings pool at a global bank. This bank is designed to mediate world savings and investment. There are two methods available in the standard GTAP model for allocating global savings to investment in each region. The first method allocates global savings across investment in a fixed proportion of the total savings so that the regional composition of global investment remains unaltered. The second method allows investment to take place in each region according to the relative rates of return.

As noted before, the version four of GTAP database divides the world into 45 countries and distinguishes 50 sectors (commodities). For our analysis, we aggregate the database into 13 regions and 9 sectors as shown in the Appendix Table A1. As our focus is on the Asian economic crisis and its impact on Singapore, the regional aggregation highlights the importance of trading partners to Singapore, and the regions directly involved in the crisis. The 9 commodity groups are chosen in accordance with the sectoral aggregation reported in Singapore input-output tables. In particular, the manufacturing sectors are aggregated into two sectors, namely manufacturing-oil and nonoil. This aggregation also matches with the sectoral disaggregation of the Singapore model used in the policy analysis of this paper.

The aggregation of GTAP database has a significant bearing on the final results. The regrouping of regions and sectors into well-defined categories depending on the purpose of the analysis has been the common practice of almost every user of the GTAP model. There are two

obvious advantages in working with aggregations. Firstly, it allows researchers to focus on important sectors and regions in the light of the research problem that is examined. Secondly, the interpretation of results, which is a major part of any modelling exercise, becomes meaningful when simulations are undertaken with appropriate aggregations of the database. A majority of studies using the GTAP model have adopted less than twelve-region and twelve-sector aggregations<sup>10</sup>. The sector and regional groupings are generally chosen so as to maximise between-group differences and minimise within-group differences.

It is acknowledged that the construction of a benchmark equilibrium database for a CGE model is a difficult task and therefore there are numerous advantages in a model specification which has a large residual sector and a region. However, this procedure is not free from drawbacks. The aggregation bias is the first to encounter. In an analysis of APEC trade liberalization, Gehlhar and Frandsen (1998) have shown how aggregation of agricultural sectors changes key qualitative findings. This is attributed to the tendency to generate fictitious competition between countries that produce mostly different products. Inappropriate aggregations could also alter the welfare implications implied by the CGE simulations. Bach and Martin (1997) illustrate a way of mitigating this outcome by using Anderson and Neary's Trade Restrictiveness Index in connection with CGE models.

Despite these difficulties, global modeling is desired to answer many questions because the consequences of many regional shocks such as the Asian crisis are expected to be widespread. Coyle, McKibbin and Wang (1998) use a global CGE model to examine the Asian financial crisis on U.S. agriculture. Numerous other studies have been conducted dealing with the crisis where GTAP database has been used with varying degree of aggregations. Findings of such studies have enlightened various aspects of the crisis (see GTAP web site < [www.agecon.purdue.edu/gtap/apps](http://www.agecon.purdue.edu/gtap/apps) > for details).

## **GTAP Model Simulation and Results**

The Asian financial crisis can be modelled in many different ways using CGE models. The crisis created a serious recession in the affected economies. This recession was an outcome of series of disturbances to foreign investment of those economies<sup>11</sup>, resulting a substantial reduction in aggregate employment of factors of production. Noland et al. (1998) modelled the financial disruptions to these economies as a series of negative supply-side shocks to total factor productivity. In a similar fashion, Adams (1998) used the GTAP model with two sets of shocks to directly affected economies. They consist of negative shocks to real investment to represent the capital outflow, and a series of supply side shocks, reducing the employment of capital, labour, and land equally in all the sectors of crisis economies.

In the present analysis we follow Adams (1998) and simulate the GTAP model by imposing negative investment and factor employment shocks<sup>12</sup>. The magnitudes of the shocks are based on data appearing in Table 1. It reports a comparison of consensus forecasts of real GDP growth and real investment growth together with the level of currency depreciation for six severely affected East Asian economies. The growth forecasts are for 1998 made in June 1997 and in June 1998. The latter has taken the financial crisis into account. Hence the difference between the two forecasts may be attributed to the crisis. For example, the magnitude of the negative investment shock for Indonesia is 49.8 per cent and the negative factor employment shock is 25.1 per cent across all sectors. In the case of the latter, we assume that the level of decline in real GDP growth represents the level of reduction in factor employment.

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<sup>10</sup> For a comprehensive listing of references to global modelling based on the GTAP database with different levels of aggregations, the reader must visit the following web site: [www.agecon.purdue.edu/gtap/apps](http://www.agecon.purdue.edu/gtap/apps).

<sup>11</sup> The fragile Thai financial system became apparent to foreign investors with the collapse of the Thai bath and it was a warning to investors that similar situation could be replicated in other Asian economies. This eventually caused a rapid withdrawal of funds by foreign creditors from countries such as South Korea, Malaysia, and Indonesia (Goldstein and Hawkins, 1998).

<sup>12</sup> Under factor employment shock, we reduce the employment of skilled labour, unskilled labour, capital, land, and natural resources equally in line with the change in GDP growth.

**Table 1: Change in Exchange Rate, Real GDP and Investment: Consensus Forecasts for Directly Affected Regions<sup>1</sup>**

Region	Exchange rate(%change Jan 97 to Jan 98) <sup>2</sup>	Forecasts for real GDP growth (%) in 1998 <sup>3</sup>			Forecasts for real investment growth (%) in 1998 <sup>3</sup>		
		June 1997	June 1998	%-point difference	June 1997	June 1998	%-point difference
KOR	-50.0	6.5	-3.6	-10.1	6.5	-32.8	-39.3
IDN	-75.0	7.6	-17.5	-25.1	12.1	-37.7	-49.8
MYS	-45.0	8.0	-2.8	-10.8	10.5	-18.8	-29.3
PHL	-50.0	6.1	1.3	-4.8	8.9	-19.1	-28.0
SGP	-21.0	7.2	0.9	-6.3	10.5	0.9	-9.6
THA	-50.0	4.2	-8.7	-12.9	3.8	-36.4	-40.2

Notes: 1. These forecasts have been compiled from *Asia Pacific Consensus Forecasts* (Consensus Economics Inc.) and the *Pacific Economic Outlook* (Pacific Economic Co-operation Council).

2. These percentage changes in exchange rates represent the level of depreciation of local currencies with respect to the US\$ during 1997.

3. These growth forecasts of real GDP and real investment are for 1998 made in June 1997 and June 1998. The latter takes the crisis into account and can be compared directly with the former to gauge the extent of the impact of the crisis.

One major drawback of our analysis is its inability to deal with the dynamic adjustments between equilibria. The model does not contain banking or an explicit financial sector which was central to the crisis. Thus the role of the interest rate is not recognized directly in the analysis. We believe that the rate of return on capital acts as a good substitute for this missing variable and therefore the GTAP model can be used to model the crisis with minimum constraints.<sup>13</sup> The same argument applies to the Singapore model, which is used for the analysis of economic policies, adopted by Singapore. In essence, we employ a modeling approach which is governed by the real

<sup>13</sup> Some recent CGE studies have incorporated the dynamic intertemporal characteristics in examining the Asian crisis. They have been used to examine the impact of changes in risk perceptions and productivity collapses on Asian economies and the transmission of the shock to the rest of the world, via both international trade and international capital flows (see McKibbin, 1998a; McKibbin 1998b). Two studies by Noland et al. (1998) and Kawasaki (1998) also looked at the impact of the crisis on the trade flows within and outside Asia.

**Table 2: Effects of the Asian Crisis on Macroeconomic Variables of Different Regions<sup>1</sup>**

Region <sup>2</sup>	Real GDP	Real domestic absorption	Real private Consumption	Balance of trade as % of GDP	Export volume	Import volume	Terms of Trade
(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
AUS	0.01	0.27	-0.04	-0.29	-1.65	-0.26	-0.21
NZL	-0.00	0.22	-0.05	-0.26	-0.77	-0.06	-0.12
JPN	-0.01	0.41	0.01	-0.41	-3.91	0.50	0.13
KOR	-10.26	-22.02	-11.93	10.21	18.62	-16.57	-3.76
IDN	-25.20	-32.24	-26.04	6.71	-1.47	-28.33	-0.51
MYS	-10.56	-16.04	-10.10	6.00	-5.70	-12.96	0.58
PHL	-5.25	-11.94	-5.96	6.24	3.87	-9.91	-1.03
SGP	-6.24	-6.85	-4.73	1.92	-5.96	-6.23	0.68
THA	-13.87	-26.54	-14.46	12.33	2.12	-23.39	-0.65
CHN	0.09	0.37	0.12	-0.25	-0.58	0.21	0.01
TWN	-0.01	0.07	-0.13	-0.22	-0.50	-0.41	-0.27
NAM	0.01	0.29	0.03	-0.25	-1.69	0.53	0.17
ROW	0.02	0.39	0.05	-0.36	-1.08	0.37	0.13

Source: These results were obtained by simulating the GTAP model as explained in the text.

Note: 1. All projections are percentage deviations from the base except the balance of trade which is expressed as absolute percentage-point change.

2. See Appendix Table 1 for the definitions of regional aggregations.

variables in explaining the financial crisis and the subsequent effects of economic policies adopted in combating the crisis. We believe that the macroeconomic modeling approach could be well suited in handling monetary phenomenon. Nevertheless CGE models could provide alternative explanations of financial crises by emphasising the outcomes in terms of real side of the economy.

Tables 2 reports the effects of the Asian crisis on selected macroeconomic variables of different regions in the world. As shown by the projections in columns (iii) and (iv) of the table, severely affected six Asian regions experience significant contractions in domestic consumption due to the crisis. The real domestic absorption of these economies decline more rapidly than their real GDP, resulting an improvement in the net trade volumes and the ratio of balance of trade to GDP. For Indonesia, Malaysia, and Singapore, the improvement in the net trade position is mainly due to the large reductions in the volume of imports rather than the increased export volumes. Korea, Philippines, and Thailand experience an expansion in export volumes with the depreciation of their currencies. In general, all six affected regions experience real exchange rate depreciation but the potential for the growth in export volumes is hindered by the significantly

declining demand for imports within the Asian region. In general, Singapore stands out as the least affected economy in the region. The projections of real domestic absorption for the rest of the regions indicate that they are marginal gainers out of the crisis in Asia.

**Table 3: Simulation Results of the Effects of the Crisis on Singapore's Trade and Production<sup>1</sup>**

Sector	Export volume	Import volume	Output
Agriculture	-7.2	-3.8	-5.5
Manufacturing-oil	-10.6	-7.3	-9.3
Manufacturing-nonoil	-6.3	-6.4	-6.5
Utilities	-9.7	-4.9	-6.7
Construction	-8.2	-5.0	-9.5
Commerce	-5.8	-5.8	-6.9
Transport & communication	-4.0	-3.9	-5.0
Financial & business services	-5.2	-5.4	-6.9
Other services	-5.7	-2.9	-5.5

Source: These projections were obtained by simulating the GTAP model.

Note: 1. All projections are percentage deviation from the base. The base period of GTAP Version 4 database is 1995.

Table 3 reports projections of trade and output effects at sectoral level for Singapore. All sectors experience reductions in exports, imports, and the level of output. This may explain to a large extent the recession in Singapore that has resulted in a severe slowdown in growth rate in 1998. Singapore has been caught up in the crisis mainly through the decline in inter-regional trade in Asia. This is evident from the projections of export volumes reported in Table 4. Exports from Singapore to its main trading partners in Asia decline significantly. As the Asian crisis has made a recession in world trade in general, there is a somewhat moderate contraction in exports to rest of the regions as well.

### **Singapore's Policy Package**

Singapore's GNP grew by 7.8 per cent in 1997 but growth declined sharply to 1.5 per cent in 1998<sup>14</sup>. As revealed by the results in the previous section, this is a manifestation of the trade linkages operating through two effects: an income effect via falls in aggregate demand in other ASEAN states and a price effect (reduction in export competitiveness) via the appreciation of the Singapore dollar vis-à-vis her Asian competitors. Another important cause of the reduction in competitiveness was the increase in Singapore's unit labor costs relative to other newly industrializing economies which by the end of 1997 had increased by 70 per cent from a cyclical low in 1993.<sup>15</sup> Since external demand accounts for about two-thirds of total demand, these effects

<sup>14</sup> Ministry of Trade and Industry (1998, p. 24).

<sup>15</sup> Ministry of Trade and Industry (1998, p. 24).

are quite serious.<sup>16</sup>

**Table 4: Impact on Singapore's Exports by Region**

Sector	AU	NZL	JPN	KOR	IDN	MYS	PHL	THL	CHN	TWN	NAM	ROW
Agriculture	-6.9	-7.6	-6.8	-7.3	-8.2	-14.4	-12.6	-14.4	-6.1	-7.0	-5.7	-6.6
Manufacturing-oil	-4.2	-4.0	-4.4	-11.8	-27.1	-12.7	-8.5	-17.3	-4.1	-4.0	-4.3	-4.6
Manufacturing-nonoil	-2.6	-2.5	-2.7	-21.8	-33.0	-15.7	-13.5	-28.0	-3.5	-3.1	-1.8	-1.2
Utilities	-6.5	0.0	-4.8	-18.0	-23.8	-12.6	-8.6	-19.0	-5.4	-6.5	-3.8	-3.5
Construction	-1.8	-2.1	-3.2	-18.2	-27.0	-11.4	-24.9	-20.8	-2.7	-3.2	-1.2	-0.0
Commerce	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transport & communication	-4.6	-4.5	-4.9	-15.1	-34.8	-13.7	-12.7	-20.0	-4.5	-4.8	-4.0	-3.5
Financial & bus. service	-4.0	-3.8	-4.1	-20.6	-35.8	-14.3	-10.7	-19.3	-3.8	-4.2	-2.9	-2.8
Other services	-4.2	-3.9	-4.7	-20.4	-34.2	-13.0	-12.3	-19.2	-4.0	-4.5	-3.1	-2.7

Source: These projections were obtained by simulating the GTAP model.

Note: All projections are percentage deviations from the base.

The government has adopted the policy package recommended in the report of the Committee on Singapore's Competitiveness (CSC) (Ministry of Trade and Industry, 1998). It contains both short and medium term recommendations. Our focus is the short-term responses. Its main feature is a 15 per cent reduction in total wage costs (through a 10 percentage point reduction in the rate of employers' contributions to the Central Provident Fund and reductions in the variable components of wages). Other business costs such as foreign worker levies, land and factory rentals, charges for government-supplied services and vehicle-related costs also have been cut. The Committee estimated that this package would reduce business costs by about S\$10 billion per year or about 7 per cent of GDP.<sup>17</sup>

In addition to the CSC recommendations, the Budget Statement of 1999 announced further measures to boost domestic expenditure to arrest the economic slowdown. It proposed a 6 per cent increase in government expenditure. Various corporate and personal income tax rebates were also adopted. These measures should help cushion the effect of wage cuts on domestic demand. Another significant part of the package was an extension of the Local Enterprise Finance Scheme to bolster working capital flows to local businesses.

<sup>16</sup> Domestic aggregate demand has also been affected by negative wealth effects from declines in asset prices, higher interest rates and a mild slowdown in bank credit. Foreign direct investment has also slowed.

<sup>17</sup> Ministry of Trade and Industry Singapore (1998, p. 32).

The next section discusses the probable effects of these measures on the economy. We use a CGE model of Singapore (Siriwardana and Schulze, 2000) to examine the impact of different policy scenarios. The model is useful in identifying the economy-wide impacts of various policies, e.g., the effects on macro aggregates such as GDP, employment, consumption, balance of trade, consumer price level and real exchange rate. It is also a valuable tool to examine the effects of policies at the micro level, e.g., the impact on sectoral outputs, employment, exports, etc (see McKibbin, 1998c). The basic features of the Singapore model are outlined in the appendix.

A CGE model is particularly attractive to analyse the impact of various policy options for Singapore.<sup>18</sup> For example, a cut in nominal wages will have various effects throughout the economy as it affects consumption, production and investment decisions of individuals and firms. There is a chain of events originating from the initial wage cut and only economy-wide general equilibrium model can capture them as it comprises both factor and commodity markets together with the behaviour of various economic agents. Unlike macroeconometric models which heavily rely on historical data for the quantification of different relationships of economic variables, most of the parameter estimation for CGE models are based on microeconomic level data of a benchmark year. This makes a CGE model of the type used in this paper well suited to establishing counterfactual responses of the economy to an exogenous shock such as currency depreciation, given different macroeconomic scenarios such as zero or partial wage indexation (i.e., fixed or variable money wage). Furthermore, the flexibility of the solution approach allows us to switch between exogenous and endogenous variables in conducting different policy experiments without having to rewrite the solution algorithms. As demonstrated in this paper, the model can easily be used to answer a wide variety of different policy questions just by the selection of alternative sets of exogenous variables.

A number of reviews now appear in the literature analysing the crisis and its causes (see Krugman (1998); McLeod and Garnaut (1998); and Radelet and Sachs (1998)). The arguments in these are more imaginative than possible for empirical investigations. As McKibbin (1998c) has argued, it may not be the fault of authors but it is empirically difficult to test the alternative scenarios without using the general equilibrium framework. Similar to the present study, McKibbin and Martin (1998) have used the G-Cubed model to examine the effects of policy responses to the crisis within crisis economies and in OECD countries. Their modelling work reveals that a mix of fiscal and monetary expansion in the crisis economies will have neutral effect on the exchange rate of these economies, but supports domestic demand. The general equilibrium results further suggest that the depreciation of the exchange rate would be rapid but will stabilise quickly and therefore be responsive to the changes in the real economic activity. McKibbin and Martin (1998) also dealing with policy responses outside crisis economies show that a temporary fiscal expansion in Japan is in fact more expansionary for Japan and the crisis economies than a permanent fiscal stimulus.

## **Results of Policy Simulations**

The national CGE model was simulated to identify the impact of different policies pursued by Singapore. Given the nature of the crisis and its transmission to the Singapore economy, it is apparent that it faces two main challenges. First, Singapore's exports will lose international competitiveness, *ceteris paribus*, with the appreciation of the S\$. Second, there will be a decline in external demand for goods and services due to the contraction in regional demand. The economic policy responses, as outlined above, must be directed toward minimising the negative impact of these exogenous shocks. In the analysis, we attempt to answer the following four counterfactual questions:

- . What would have been the effects of a 15 per cent reduction in wage costs as suggested by CSC on the economy in the absence of any other policy reaction?

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<sup>18</sup> Chia (1993) has employed a CGE model to investigate the impact of tax policies in Singapore. He also explains the appropriateness of the CGE approach in analysing the macroeconomic policy issues in Singapore using the CGE approach.

- . What would have been the effects of a 6 per cent increase in government expenditure as proposed in the Budget Statement without a wage cut?
- . What would have been the effects of a 6 per cent increase in real private consumption on the economy in the absence of a wage cut and fiscal expansion?
- . What would have been the effects of a 15 per cent nominal devaluation without resorting to any of the other options?

**Table 5: Macroeconomic Impact of Different Policy Shocks**

Variable	15% wage cut		6% increase in government expenditure		6% increase in real private consumption expenditure		15% nominal devaluation	
	0% WI	50% WI	0% WI	50% WI	0% WI	50% WI	0% WI	50% WI
Real GDP	9.28	10.16	0.41	0.37	1.21	1.03	8.58	4.61
Aggregate employment	22.31	24.48	0.92	0.83	2.43	2.00	20.59	10.95
Employment by occupation:								
Professional	22.53	24.73	1.41	1.32	3.44	3.03	20.79	11.04
Administrative	22.90	25.13	0.50	0.41	2.24	1.79	21.13	11.23
Clerical and related	25.80	28.31	0.25	0.14	0.82	0.27	23.83	12.67
Sales and service workers	23.62	25.91	0.69	0.59	3.11	2.66	21.80	11.59
Production workers	18.59	20.39	1.32	1.25	2.44	2.09	17.15	9.13
Real private consumption	6.48	7.09	0.45	0.42	6.00	6.00	5.98	3.21
Aggregate exports	10.03	10.97	-0.16	-0.21	-1.08	-1.33	9.28	4.99
Aggregate imports	6.05	6.62	0.18	0.15	1.02	0.90	5.59	3.01
Balance of trade/GDP	0.03	0.03	-0.00	-0.00	-0.02	-0.02	0.03	0.01
Consumer price index	-2.59	-2.82	0.13	0.14	0.65	0.73	12.42	13.58
Money wages	-15.00	-16.41	0.00	0.07	0.00	0.36	0.00	6.79
Real wages	-12.41	-13.59	-0.13	-0.07	-0.65	-0.36	-12.42	-6.79
Nominal devaluation	0.00	0.00	0.00	0.00	0.00	0.00	15.00	15.00
Real devaluation <sup>2</sup>	5.38	5.87	-0.16	-0.19	-0.79	-0.94	4.99	2.71
Utility per household	9.73	10.66	0.67	0.63	9.01	9.01	8.99	4.82

Source: These results were obtained by simulating the Singapore mode as described in the text.

Notes: 1. All projections are percentage deviations except the balance of trade which is expressed as absolute percentage-point change.

2. Negative sign implies an appreciation.

3. WI means wage indexation.

4. Under 0% WI there is no endogenous change in the money wage and therefore real wages adjust fully according to the change in CPI. For example, an increase in CPI by 0.13 per cent implies no change in money wages but 0.13 per cent reduction in real wages. However, when 50% WI is adopted, both money and real wages adjust partially (i.e., by 50 per cent) depending on the change in CPI. This means 0.14 increase in CPI will give 0.07 per cent increase in money wages and 0.07 per cent reduction in real wages.

The simulations were conducted in the short-run economic environment of the CGE model.

In closing the model, we assume that the nominal exchange rate is fixed and acts as a numeraire. Under this exchange rate assumption, the change in domestic price level is relative to the world price level. The physical capital stock in each industry is fixed. Since the mid- 1980s, the National Wage Council (NWC) adopted a flexible market-based wage adjustment system for different employment groups. In the light of this wage setting mechanism, all four policy simulations were conducted under two different wage indexation scenarios: zero per cent and 50 per cent. Hence, likely outcomes can be inferred if different wage indexations were simulated. Fundamental to the employment outcome is the extent to which the real wages adjust in the economy in response to different policy scenarios. In other words, the sensitivity of wage indexation can be inferred readily from results in Table 5<sup>19</sup>.

The macroeconomic effects of the four policy shocks are presented in Table 5 and the industry-wide effects are reported in Table 6. The simultaneous impact of two or more policy shocks can easily be obtained by adding the appropriate columns under the appropriate wage indexation

#### ***Impact of a wage reduction policy:***

The first two columns of Table 5 show the effects of the 15 per cent reduction in wage costs under two different wage indexations. The macroeconomic outcomes of this wage policy are driven by the declines in real costs due to lower real wage costs, on the order of 12 to 14 per cent. This leads to a real devaluation of the Singapore dollar which enhances the price competitiveness of exports. As suggested by the CSC, the policy of reducing wage costs to boost demand for exports appears to be beneficial in many different ways. Wage moderation produces an outcome which is compatible with the goals of increasing employment and improving the international competitiveness of the economy. Real GDP expands well over 9 per cent and real private consumption increases by more than 6 per cent. The most striking outcome is the growth in the demand for labour. At zero per cent wage indexation, the model projects nearly a 22 per cent increase in the demand for labour. This is extremely good news given the 3.2 per cent unemployment rate in 1998. As shown by the employment projections, wage moderation seems to generate a healthy demand for different employment groups. Employers may meet their additional labour requirements by recruiting many migrant workers.

The industry level projections (see Table 6, columns 1 and 2) clearly show the advantage of reduced wage costs and their effects on output, employment and exports. Deflationary effects in the economy are more favourable to the trading sectors, particularly the manufacturing sectors. Increased domestic consumption benefited the service and non-trading sectors of the economy. As these sectors are labour intensive, declining wage costs allows them to expand employment.

#### ***Impact of domestic demand stimulation policies:***

The next two simulations increase domestic demand either by increasing government expenditure or expanding real domestic household consumption. The Budget Statement of 1999 indicated a 6 per cent expansion in government expenditure, which may improve domestic demand to supplement foreign demand. An alternative to higher government expenditure is to stimulate private consumption. This was hinted at in the Budget Statement via reduced corporate and personal taxes. Simulating the 6 per cent increase in real private consumption captures effects of these fiscal measures and compares the outcomes with increased government expenditure. Columns 3 to 6 of Table 5 report the simulation results for aggregate demand. Moving from zero to 50 per cent wage indexation makes only a marginal difference to the results.

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<sup>19</sup> We have conducted sensitivity analysis of the results to different export demand elasticities and capital labour substitution elasticities. Outcomes are remarkably similar to original findings and therefore sensitivity results are not reported here.

**Table 6: Effects of Different Economic Policies on Outputs, Employment and Exports by Industry**

Variable	15% wage cut		6% increase in government expenditure		6% increase in real private consumption expenditure		15% nominal devaluation	
	0% WI	50% WI	0% WI	50% WI	0% WI	50% WI	0% WI	50% WI
<b>Outputs:</b>								
Agriculture	6.43	7.02	0.02	-0.01	0.11	-0.04	5.96	3.24
Manufacturing (oil)	2.59	2.83	-0.02	-0.03	-0.12	-0.18	2.41	1.31
Manufacturing (non-oil)	11.46	12.55	-0.04	-0.09	-0.23	-0.49	10.60	5.70
Utilities	7.29	7.98	0.32	0.29	1.65	1.52	6.73	3.62
Construction	1.02	1.12	0.02	0.02	-0.01	-0.04	0.94	0.51
Commerce	11.29	12.36	0.11	0.06	1.35	1.13	10.43	5.59
Transport & communication	9.32	10.21	0.01	-0.03	0.28	0.08	8.62	4.63
Financial & business services	8.49	9.29	0.17	0.13	1.13	0.97	7.84	4.21
Other services	9.16	10.02	3.13	3.11	4.95	4.86	8.46	4.54
<b>Employment:</b>								
Agriculture	14.35	15.73	0.04	-0.02	0.22	-0.09	13.27	7.11
Manufacturing (oil)	14.13	15.45	-0.12	-0.18	-0.63	-0.96	13.09	7.05
Manufacturing (non-oil)	26.81	29.41	-0.08	-0.20	-0.52	-1.12	24.75	13.17
Utilities	44.62	49.10	1.88	1.71	9.68	8.94	41.12	21.57
Construction	1.79	1.96	0.04	0.03	-0.02	-0.07	1.66	0.89
Commerce	24.78	27.19	0.23	0.12	2.90	2.42	22.88	12.16
Transport & communication	28.16	30.91	0.04	-0.08	0.82	0.23	26.00	13.81
Financial & business services	29.54	32.43	0.56	0.44	3.83	3.28	27.26	14.44
Other services	11.88	13.01	4.05	4.01	6.41	6.29	10.97	5.88
<b>Exports:</b>								
Manufacturing (oil)	2.61	2.85	-0.03	-0.04	-0.21	-0.28	2.42	1.32
Manufacturing (non-oil)	11.92	13.05	-0.12	-0.17	-0.66	-0.95	11.03	5.94
Commerce	18.12	19.85	-0.45	-0.53	-3.68	-4.17	16.76	8.99
Transport & communication	8.72	9.54	-0.17	-0.21	-1.39	-1.62	8.06	4.34
Financial & business services	8.03	8.78	-0.91	-0.95	-5.83	-6.15	7.43	4.00

Notes: 1. All projections are percentage deviations from the base and are obtained by simulating the Singapore model. 2. WI means wage indexation. See note 4 of Table 5 for details.

The macroeconomic results of increased government expenditure (Table 5) highlight the fact that it is moderately effective in generating employment opportunities. The 6 per cent boost to public expenditure causes less than a 0.5 per cent increase in real GDP and about a one per cent increase in aggregate demand for labour. As would be expected, external trade is highly insensitive to fiscal expansion. Overall, these findings are not surprising given the small size of the public sector in Singapore.

In contrast to fiscal expansion, the increase in private consumption increases

employment coupled with moderate growth in real GDP. The stimulus provided in this way comes at a cost; the consumer prices rise by about one per cent and there are indications the balance of trade deteriorates. Except for clerical and related workers, all other occupational categories experience significant increases in demand. The trade effect is very moderate apart from the increased demand for imports, reflecting the higher level of consumption of imports by the household sector than the public sector.

Table 6 shows the sectoral results of domestic demand expansion. As expected, higher domestic demand stimulates the services and non-trading sectors more than the export oriented sectors. Higher demand for both public and private consumption destimulates manufacturing exports, and output and employment in two manufacturing sectors.

Overall, these simulations suggest that domestic demand policies are relatively unimportant. This confirms the view expressed in CSC that "Given Singapore's small size and heavy dependence on global export markets, measures to stimulate domestic demand are unlikely to be effective" (Ministry of Trade and Industry, 1998, p.29).

### ***Impact of the nominal devaluation:***

The macroeconomic effects of the 15 per cent nominal devaluation are shown in columns 7 and 8 of Table 5. The depreciation leads to a 12 per cent increase in consumer prices under zero wage indexation and to a 13.5 per cent increase under partial wage indexation. The real impact is qualitatively similar to that is observed with the 15 per cent wage cut. With the fixed exchange rate, nominal devaluation implies a significant depreciation in the real exchange rate (a considerable improvement in the competitiveness in the traded, mainly exportable, sectors). The key to this is the contraction in the wages following the devaluation. Hence our results substantiate what Corden (1984) has observed in relation to Singapore when the exchange rate is targeted on employment growth. He writes "On the assumption that in Singapore, as elsewhere, it is somewhat easier to reduce real wages by a rise in the general price level than by reducing wages – an assumption which forms a keystone of *The General Theory* and which certainly applies in many countries – then in these special circumstances the exchange rate must be targeted on employment, or there must be a trade-off between an employment and a price-level target" (Corden, 1984, p.32).

While exports grow because of improved competitiveness, imports also increase as the economy is heavily import dependent. This is reflected in the moderate improvement in the balance of trade. The expansion in real private consumption together with increased external demand for exports produced considerable growth in employment in aggregate terms as well as in different occupational groups. These results imply that devaluation is a useful policy option for eliminating unemployment. It is an option which can avoid more obvious and reluctantly accepted nominal wage cuts.

Sectoral results of the nominal devaluation shown in Table 6 confirm that the manufacturing sectors experience significant growth in exports which generates employment. As GDP increases, all other sectors improve output and employment. These industry results are similar to those projected by the wage cut.

### **Conclusions**

Singapore represents a very open economy yet its experience with the Asian financial crisis was not as severe as in some of the less open economies in the region. The regional currency crisis has not led to an erosion of the Singapore dollar nor undermined the health of the financial sector. However, the slowdown in the growth rate and higher unemployment rate by the end of 1998 were signs that she has not escaped from the crisis completely. Good macroeconomic and financial fundamentals and sound macroeconomic policies have made the economy less vulnerable to external shocks. However, if the recession is prolonged, additional policy responses are necessary to return to the pre-crisis growth.

Policy makers have faced the key challenges of identifying different policies that will affect growth in the short to medium term. Should wage costs be reduced directly or should they be cut indirectly via the exchange rate? What would be the appropriate measures to stimulate domestic demand as external demand increases with improved competitiveness? Will increased government expenditure have a greater impact on the economy than increased private consumption? This paper first quantifies the impact of the crisis on Singapore by using the GTAP model. We found that Singapore was affected by mainly through reduced trade in the Asian region. Therefore her policy prescriptions need to be targeted toward improving competitiveness to enhance trade with other affected economies.

In an attempt to answer the questions raised above with respect to policies to combat the crisis, we simulated the national model. In the analysis, the outcomes of wage reduction policy, policies to stimulate domestic absorption via increased government and private demand, and devaluation have been examined. Given the theoretical limitations and uncertainties associated with empirical data in the CGE models, the results are to be viewed as indicative rather than exact outcomes.

Lowering the wage costs seems to restore international competitiveness via depreciation of the real exchange rate. Real GDP growth is likely to return to pre-crisis levels. The policy increases employment. As the economy is projected to grow faster, the wage policy will create demand for migrant labour as well. Hence the reduction in the foreign worker levy may encourage further growth.

It is apparent that the stimulation of government and private demand is ineffective, leading to a moderate expansion in the economy, milder inflation, and deterioration in the trade balance. The extra expenditure would be absorbed by imports and by non-tradeables. This is to be expected and may lead to employment creation in the non-trading sectors. Though our national model is not able to simulate it, growth in the service sectors and the increased factor incomes from overseas may ameliorate the worsening trade balance and may lead to its improvement in the long run.

In the event that wage cost reduction and domestic demand stimulation fail to deliver the growth targets, alternative policy instruments merit consideration. For example, in recent policy discussions, exchange rate policy has attracted the least attention. Historically, from 1973 to 1981, the external value of the Singapore dollar was determined by the market. Since 1981, the Monetary Authority of Singapore (MAS) has closely monitored the value of the Singapore dollar against a trade weighted basket of currencies. Until the currency crisis, this market intervention resulted in an appreciation of the S\$, targeted on non-inflationary sustainable growth. Since the crisis, the S\$ has depreciated by about 16 per cent against the US dollar, while appreciating against the currencies of the crisis economies by about 20 per cent on average. These movements in the exchange rate would have had a significant impact on trade. As a policy alternative, we simulated a nominal devaluation of the S\$ by 15 per cent. The results are remarkably similar to those of the wage reduction. The devaluation tends to increase GDP growth and employment at the expense of inflation.

Devaluation offers a useful policy complement to wage and demand expansion policies. As Singapore has been mostly affected through the trade channel, its recovery must be geared towards stimulating trade so that employment and GDP growth can be restored. Our results show that the key to the recovery is reducing the real costs of production. In the short to medium term, this can be achieved mainly through lower wage costs. Since it is easier to reduce the real wages by an increase in the general price level than by reducing nominal wages, the exchange rate should target employment. The wage reduction is achieved by reducing Central Provident Fund contributions. This may have long run implications for savings and capital formation. However the devaluation may jeopardize low inflation. Thus the wage and the exchange rate policies appear to be equal contenders for delivering economic recovery. Nevertheless there is a trade-off between employment and inflation.

As observed in the results, the lower growth in Asian economies due to the crisis resulted

in substantial capital outflows from the region. Consequently, the increased availability of capital in the rest of the world lowered world cost of capital. The disruption to capital markets and the process of capital formation in Asia resulted a contraction of the productive capacity in those economies. While our modeling exercise deals with this real phenomenon, it has not explicitly incorporated the financial sector's behaviour. The results were generated on a variety of plausible assumptions to mitigate the adverse effects of this drawback. To model the financial sector within the CGE framework, the types of input needed are very subjective. As McKibbin (1998c, p.351) noted, "Risk re-evaluation, in particular, appears to be crucial part of the story of the Asian crisis, but modelers, and economists in general, know very little about endogenous risk determination". He goes further to emphasise the fact that CGE models, which ignore financial parts of the economy, may be misleading for some scenarios. These models can be successfully exploited to deal with such issues with the added complexity and a certain degree of exogenous adjustments to the model.

## APPENDIX

### *A Description of the National (Singapore) CGE Model*

The CGE model used in the paper for policy analysis is an extended version of a model of Singapore (Siriwardana and Schulze, 2000). As a major extension, the Cobb-Douglas specification of the producer and consumer behavior of the original model was replaced by Constant Elasticities of Substitution (CES) production functions and an additive utility function which is characterised by the Linear Expenditure System (LES). As is common in most of the CGE models, the model focuses on the real side of the economy and its structure pays special attention to the microeconomic theory. The system of equations closely follow the ORANI-G model of the Australian economy (Centre of Policy Studies, 1998). The model consists of 9 sectors. It distinguishes five categories of labour: professional, administrative, clerical and related, sales and service workers, and production workers. The most recent input-output table (1990) of the Singapore economy is used to derive the bench-mark input-output database.

The model equation system concerning the producer and consumer behavior is derived from the constraint optimization of neo-classical production and utility functions. The main features of this process are as follows:

- (1) Producers choose an input bundle to minimize the costs of a given output subject to three level constant returns to scale production functions. At the first level is the Leontief assumption implying that there is no substitution between effective units of intermediate inputs and effective inputs of primary factor inputs. At the second level, we use the CES function, which allows substitution between domestic and imported sources of intermediate inputs of different types and between primary factors, namely capital and composite labour. At the third level is the CES function, which specifies substitution between five different categories of labour in the model.
- (2) Households choose their consumption of different goods to maximize utility subject to an aggregate budget constraint. Fundamental to the consumer behavior is the adoption of the Klien-Rubin utility function leading to the LES which allows substitution between effective units of commodities. Effective units are formed via the CES function which accommodates substitution between domestic and imported sources of a given commodity in household consumption.

The system of equations of the model is converted into linear percentage change form and then solved. Broadly, the model equations can be presented under six sub-headings.

#### *Final demands:*

The model recognises final demands for imported and domestic goods of Singapore in four categories: household consumption, government consumption, investment and exports. Equations related to household demand are derived by utility maximization model which allows consumers to substitute between domestic and imported sources of commodities in response to changes in relative prices. The choice between domestic and imported sources of different commodities is modelled with the conventional Armington elasticities. Households also substitute between different (composite) commodity categories within their choice of final consumption. This substitution is dependent upon own and cross-price elasticities of demand and income (expenditure) elasticities in addition to the relative prices. Similarly, model contains equations describing the demand for inputs to capital creation. Producers of capital goods substitute between domestic and imported sources in accordance with the change in relative prices between the two sources. The rest of the world is regarded to be large relative to the Singapore economy. However, the export demand is modelled to allow downward sloping demand curves. Finally, there are equations in the model to describe the government demand for imported and domestic commodities.

*Demand for industry inputs:*

This part of the model contains equations which describe the demand for intermediate inputs by domestic and imported sources, demand for capital and labour, and the demand for various categories of labour. The relevant substitution elasticities together with relative prices govern the demand for various inputs by industries.

*Zero pure profit conditions:*

The assumptions of constant returns to scale and the competitive pricing behaviour in each of the economic activity (i.e., current production, capital creation, importing and exporting) ensure that zero pure profits are earned in equilibrium.

*Market clearing:*

These are quantity constraints that are to be satisfied by the economy as a whole. The model assumes that demand equals supply for commodities, labour of different occupations, and fixed capital. However, the model does not necessarily imply full employment.

*Miscellaneous equations:*

Equations listed under this heading include consumption function, definitions of real household and investment expenditure, consumer and capital goods price indices, balance of trade, real and nominal GDP, and wage indexation.

**Appendix Table 1 Regional and Commodity Aggregation**

Aggregated Region	GTAP Region	Aggregated Commodity	GTAP Commodity
1 Australia (AUS)	Australia	1 Agriculture	Paddy rice Wheat
2 New Zealand (NZL)	New Zealand		Cereal grains nec Vegetables, fruits, nuts
3 Japan (JPN)	Japan		Oil seeds Sugar cane, sugar beet
4 Korea (KOR)	Korea		Plant-based fibers Crops nec
5 Indonesia (IDN)	Indonesia		Bovine cattle, sheep & goats Animal products nec
6 Malaysia (MYS)	Malaysia		Raw milk Wool silk-worm cocoons
7 Philippines (PHL)	Philippines		Forestry Fishing
8 Singapore (SGP)	Singapore	2 Manufacturing-oil	Oil
9 Thailand (THA)	Thailand		Petroleum, coal products
10 China (CHN)	Chins, Hong Kong	3 Manufacturing-nonoil	Coal
11 Taiwan (TWN)	Taiwan		Bovine cattle, sheep and goat, horse meat products
12 North America (NAM)	U.S.A., Canada, Mexico		Meat products nec Vegetable oils and fats
13 Rest of the World (ROW)	Rest of the world (30 regions)		Dairy products Processed rice Sugar Food products nec Beverages & tobacco prods Textiles Wearing apparel Leather products Wood products Paper products, publishing Chemical, rubber, plastic Mineral products nec Ferrous metals Metals nec Metal products Motor vehicles and parts Transport equipment nec Electronic equipment Machinery & equipment nec Manufactures nec
		4 Utilities	Electricity water Gas
		5 Construction	Construction
		6 Commerce	Gas manufacture, distribution
		7 Transport & communication	Trade, transport
		8 Financial & business services	Financial, business, recreational services
		9 Other services	Public admin. & defence, education, health Dwellings

## References

- Adams, P. D. (1998), "Prospects for the Australian Economy and the Impact of the Asian Crisis", *Australian Bulletin of Labour*, 24: 247-278.
- Bach, C. and Martin, W. (1997), *Would the Right Tariff Aggregator Please Stand Up?* Mimeo, World Bank: Washington D.C.
- BIS (1997), *Annual Report*, Basle.
- Centre of Policy Studies (1998), ORANI-G Document, Available at <http://www.monash.edu.au/policy/oranig.htm>.

- Chia, N.C. (1993), "Using a Computable General Equilibrium Model to Evaluate the Singapore Tax System", Staff seminar paper No. 17, National University of Singapore.
- Chia Siow Yue (1998), "The Asian Financial Crisis: Singapore's Experience and Responses", *ASEAN Economic Bulletin*, 15: 297-308.
- Chinn, M.D. (1998), Before the Fall: Were East Asian Currencies Overvalued? *NBER Working Paper No. 6491*.
- Corden, W.M.(1984), "Macroeconomic Targets and Instruments for a Small Open Economy", *Singapore Economic Review*, 24: 27-37.
- Corsetti, G., Pesent, P. and Roubini, N. (1999), "What causes the Asian currency and financial crisis?", *Japan and the World Economy*, 11: 305-373.
- Coyle, W., McKibbin, W. and Wang, Z. (1998), "The Asian Financial Crisis: Effects on U.S. Agriculture", U.S. Department of Agriculture, Economic Research Service, *Staff Paper*, No. 9805.
- Dixon, P.B., Parmenter, B.R., Sutton, J. and Vincent, D.P. (1982), *ORANI: Multisectoral Model of the Australian Economy*, North-Holland, Amsterdam.
- Edison, H.J., Lauangaram, P. and Miller, M. (1998), *Asset Bubbles, Domino Effects and 'Lifeboats': Elements of the East Asian Crisis*, BOGFRS International Finance Discussion Paper No. 606, March.
- Frankel, J. and Wei, S-J. (1996), ASEAN in a Regional Perspective, *FRBSF Working Paper No. PB 96-02*, August.
- Gehlhar, M. and Frandsen, S. (1998), Trade Elasticities, Aggregation Bias and Welfare Effects in the GTAP Model, paper presented at the First Annual Conference on Global Economic Analysis, June 8-10, Purdue University.
- Glick, R. and Rose, A.K. (1998), Contagion and Trade: Why Are Currency Crises Regional?, *FRBSF Working Paper No. PB 98-03*, September.
- Glick, R. (1998), Thoughts on the Origins of the Asia Crisis: Impulses and Propagation Mechanisms, *FRBSF Working Paper No. 98-07*, September.
- Goldstein, M. and Hawkins, J. (1998), The Origin of the Asian Financial Turmoil, *RBA Research Discussion Paper No. 9805*, May.
- Hertel, T.W. (1996), *Global Trade Analysis: Modelling and Applications*, Cambridge University Press, New York and Cambridge.
- Huh, C. and Kasa, K. (1997), A Dynamic Model of Export Competition, Policy Coordination, and Simultaneous Currency Collapse, *FRBSF Working Paper PB 97-08*.
- Johansen, L. (1960), *A Multisectoral Study of Economic Growth*, Amsterdam: North-Holland.
- Karunaratne, N. D. (1999), "The Asian Miracle and Crisis: Rival Theories, the IMF Bailout and Policy Lessons", *INTERECONOMICS*, January/February, 19-26.
- Kiyotakhi, N. and Moore, J. (1997), "Credit Cycles", *Journal of Political Economy*, 105: 211-248.
- Krugman, P. (1998), "What happened in Asia". Mimeo, MIT, Cambridge, MA. Available at <<http://www.web.mit.edu/krugman/www/DISINTER.htm>>

- Lee, L. T. (1999), "Singapore in 1998: the most serious challenge since independence", *Asian Survey*, 39: 72-78.
- MacFarlane, I.J. (1997), "The Changing Nature of Economic Crises", *RBA Bulletin*, December, pp. 17-22.
- McKibbin, W. (1998a), "The Economic Crisis in Asia An Empirical Analysis", *Brookings Discussion Paper in International Economics* No. 136, Washington D.C.: The Brookings Institution. Available at <<http://www.msgpl.com.au>>.
- McKibbin, W. (1998b), "Risk-Evaluation, Capital Flows and the Crisis in Asia", In *East Asia in Crisis: From Being a Miracle to Needing One?* Ed. R. McLeod and R. Garnaut, London: Routledge.
- McKibbin, W. (1998c), "Modelling the Crisis in Asia", *ASEAN Economic Bulletin*, 15: 347-352.
- McKibbin, W. and Martin, W. (1998), "The East Asia Crisis: Investigating Causes and Policy Responses, mimeo., Background Paper for World Bank, Washington D.C.
- McKibbin, W. and Wang, Z. (1998), G-Cubed (Agriculture) Model: A Tool for Analysing US Agriculture in Globalising World, unpublished manuscript, Washington D.C.: ERS/USDA.
- McLeod R.H. and Garnaut, R. (1998), *East Asia in Crisis: from being a miracle to needing one?*, Routledge: London.
- Ministry of Trade and Industry (1998), *Report of the Committee on Singapore's Competitiveness*, Singapore.
- Miskin, F.S. (1997), "The Causes and Propagation of Financial Stability" in Federal Reserve Bank of Kansas City, *Maintaining Financial Stability in a Global Economy*, 55-96.
- Montes, M.F. and Popov, V.V. (1999), *Asian Crisis Turns Global*, Institute of Southeast Asian Studies: Singapore.
- Moreno, R. (1998), "What Caused East Asia's Financial Crisis?" *FRBSF Economic Letter* No. 98-24, August 7.
- Moreno, R., Pasadilla, G., and Remolona, E. (1998), Asia's Financial Crisis: Lessons and Policy Responses, *FRBSF Working Paper* No. PB98-02, July.
- Noland, M., Liu, L.G., Robinson, S. and Wang, Z. (1998), *Global Economic Effects of the Asian Currency Devaluations*, Institute for International Economics, Washington.
- Radelet, S. and Sachs, J. (1998), "The Onset of the East Asian Financial Crisis". Mimeo, Harvard Institute for International Development, Cambridge, 1998.
- Siriwardana, M. and Schulze, D. (2000), "Singapore and the Asian Economic Crisis", *ASEAN Economic Bulletin*, 17: 233-256.