WEATHERING THE ASIAN CRISIS: THE ROLE OF CHINA

During the Asian crisis, China’s healthy reserves and low debt made possible the avoidance of a ‘country run’. Nonetheless, it did experience a substantial increase in private savings, an associated increase in capital outflow and a slowdown in economic growth. This paper employs a global general equilibrium analysis to examine the relative contributions of external and internal shocks to the Chinese economy during the crisis. The change in private savings, driven by ongoing domestic reforms, appears to have been the dominant force. By coincidence of timing, this shock was also a significant contributor to the international effects of the crisis. Nonetheless, the maintenance since before the crisis of near fixed parity with the US dollar made the combined internal and external shocks more contractionary in China than would have been the case had it been possible to retain a flexible exchange rate regime.

Introduction

The previously spectacular growth of the East and Southeast Asian economies stalled in 1997 following a combined financial and currency crisis. Several economies that had earlier been major contributors to this growth experienced very substantial contractions associated with a surge of insolvencies following capital flight and unexpectedly large currency depreciations (McLeod and Garnaut 1998; Goldstein 1998; Wong 1998). The government of China chose to hold fast to its US dollar parity, however. Its comparatively large official foreign reserves and its capital controls restricting short-term capital inflows meant less risk of a serious ‘country run’ than in the most affected crisis countries. Nonetheless, the external crisis appears to have combined with domestic reforms and changes in macroeconomic policy to retard economic growth and increase unemployment (Meng 1999).

The primary effects of the crisis in China were a real appreciation of the renminbi against the currencies of most trading partners and a rise in the risk premium demanded by investors in China (Fernald and Babson 1999). Given the fixed exchange rate, these external shocks had to be contractionary. But the crisis came at a time when employment in China’s relatively secure state sector had begun to decline (Meng 1998). Perceiving increased risk from this source, and possibly also from the crisis elsewhere in Asia, Chinese households
appear to have chosen to substitute savings for consumption. This decrease in consumption spending should have acted to offset the real exchange rate effect of the crisis. Nonetheless, both it and the external crisis acted to reduce prices and retard output growth. The severity of these contractionary effects depends on how much of the increased savings was channelled abroad and on the response of the Chinese government and central bank. The available evidence suggests that the capital outflow from China has been considerable, offset only partially by a virtual cessation of the previously rapid accumulation of official foreign reserves. Over and above the continuing domestic structural reforms, the immediate macroeconomic policy responses have been the retention of parity with the US dollar and a substantial fiscal expansion, described as a ‘hard currency, soft budget’ policy.

This paper reviews the information available about China’s aggregate performance during and since the crisis, examines the implications of both the external and internal shocks using elemental macroeconomic analysis and quantifies some of the real effects using a global general equilibrium model. It is important to use such a model because the high level of intra-regional trade was one of the reasons the Asian crisis led to so deep a regional recession. The effects of the crisis were transmitted, at least in part, through trade flows. In what may have been an accident of timing, the rise in private savings in China accelerated capital outflows at the same time as capital was fleeing the crisis countries. The changes in the Chinese economy tended, therefore, to enlarge the flow of capital to the industrialised economies, particularly the United States. This paper also examines the implications of this capital flight.

In simulating the crisis, we make no attempt to reproduce its short-run dynamics. Instead, the analysis is comparative static, taking as the starting point the real shocks that emerged in its wake. Its focus is on the short-run consequences of these shocks – those that emerged in the first year. They included a severe contraction of domestic investment in the affected countries (as domestic savings fled abroad and foreign savings in Asia were withdrawn). The contractionary effects were exacerbated by the temporary unemployment of capital as many Asian firms foundered under the escalated cost of foreign borrowing and the credit crunch that followed. Recent evidence suggests that a considerable number of firms in the most affected countries were rendered insolvent, and a larger number illiquid (World Bank 1999), and that this explains the bulk of the initial contractions in output.

The paper begins by briefly reviewing the crisis and examining the simultaneous changes in China. An elemental comparative static macroeconomic analysis of China’s
response and current policy options is presented. The general equilibrium analysis is introduced and a summary of the model's structure and behaviour is provided. Our construction of the crisis and policy shocks is described and the simulation results are presented.

**Events in the crisis countries**

This paper focuses on the real shocks associated with the crisis, rather than its financial origins. For the most affected Asian economies, there were two primary shocks. First, as savings fled, domestic investment declined. The process was gradual in Japan, with investment falling by about 14 per cent in the two years from late 1997. In the most affected economies of developing Asia, however, the initial panic of 1997 was so great that domestic investment declined by as much as half. Domestic capital goods and construction demand collapsed and private consumption demand also fell, driven by the associated wealth effects of asset price declines. Imports also fell dramatically.

The second of the real shocks was a further short-run decline in domestic production in the affected economies. Because the credit squeeze was greatly exacerbated by an associated currency crisis and hence a blowing out of the costs of servicing dollar-denominated debt, there was a high incidence of illiquidity and insolvency. This was the more severe in developing Asia because of the rapid expansion of private sector credit there during the early 1990s. It was therefore inevitable that the substantial rise in costs of servicing debt would drive more than the usual proportion of firms in the most affected economies into insolvency. This was the principal cause of the output contractions in developing Asia in the first year following the onset of the crisis.

**Events in China**

Economic and social change has been rapid in China during the past two decades. Underlying it has been the gradual but continuous transfer of economic activity from the public sector to the private sector and the expanded reliance on markets in the allocation of resources. This process appears to have accelerated just prior to the crisis. The most notable external changes were an increase in outflows on the capital account, the government's adherence to fixed exchange rate parity with the US dollar during and following the Asian crisis and the resulting rise in China's real exchange rate relative to its Asian neighbours. Evidence
suggests that these changes were not directly related to the Asian crisis but were economic policy decisions that would have occurred even in its absence.

In the early years of China's reforms, the capital goods required for domestic investment were financed primarily by exports, combined with a trade tax in the guise of a dual exchange rate system. A key policy objective was to 'get the exchange rate right'. Accordingly, since the early 1980s, a 'real targets' approach had been adopted whereby the nominal rate facing importers and investors was set in relation to the cost of earning a unit of foreign exchange through exports. In effect this stabilised the real exchange rate. As the reforms deepened, however, foreign investment increased rapidly, especially after 1992, and with it came pressure for unification and greater stability of the exchange rate. Unification was achieved in 1994 and the rate against the US dollar stabilised thereafter, being held to quite rigidly during the subsequent crisis. The extent of the associated departure from the real targets approach can be seen in Figure 1. Nominal parity with an appreciating US dollar in a period

**Figure 1 China's real exchange rate**

![Graph showing China's real exchange rate](image)

**Note:** The real exchange rate is expressed as $e_t = \frac{E_t}{P_t}/\frac{P^*}{P}$, where $E$ is the nominal rate in foreign currency units per unit of home currency, $P$ is the home price level and $P^*$ is the foreign price level.

**Source:** IMF 1999b.
of low inflation ensured real appreciations against the currencies of almost all China’s trading partners.

Within China, however, the price level fell. This deflation made possible a real depreciation relative to the US dollar and, more recently, against European currencies. In spite of the reduced competitiveness of Chinese exports relative to those from crisis-affected countries, the value of Chinese exports continued to grow through early 1998, only beginning to fall off later that year. Exports to other Asian countries fell first, and most dramatically, while growth of exports to the United States and Europe virtually ceased by the end of 1998 (Fernald and Babson 1999; Hu 1999).

China’s capital controls notwithstanding, outflows on the capital account appear to have accelerated markedly in 1997 and 1998, as indicated in Table 1. Estimates of unsanctioned outflows include both private flows on the capital account and, on the current account, the effects of under-invoicing of exports on the one hand and over-invoicing of imports on the other. Taken together, these outflows appear to have more than doubled, to about 6 per cent of China’s gross domestic product (GDP). Take, for example, flows on the capital account (excluding changes in official foreign reserves). Between 1996 and 1998 these changed from a net inflow of US$29 billion to a net outflow of US$27 billion. This change was offset by a decline in the annual accumulation of reserves by about US$30 billion. The corresponding fall in the current account was about a fifth of that experienced collectively by the crisis-affected countries (principally Indonesia, Malaysia, Thailand and Korea). It was smaller than that experienced by Korea, but larger than that of any other affected country. As a proportion of GDP, the decline was about half the collective decline of the crisis-affected countries.

This substantial increase in net outflows appears to have been stimulated by a crisis-linked rise in the premium demanded on returns earned by investments in China and fuelled by a rise in the rate of domestic private savings. The change in the savings rate is shown in Table 2. There are many forces within China that could be contributing to this change, but two main causes are likely. First, the liberalisation of the housing market began in the mid-1990s, sanctioning private ownership in urban areas. There has been a rapid increase in privately owned housing and an obvious incentive to save to achieve private ownership. Second, the transfer of production activity from the state to the private sector has accelerated (Meng 1999). The proportion of workers enjoying cradle-to-grave welfare services in the state sector has declined from about 60 per cent in the mid-1990s to less than half, with substantial and comparatively prominent lay-offs taking place in 1997. Thus, the perceived
Table 1  Estimated components of China's balance of payments (US$ bn)

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<tr>
<td>Capital account</td>
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<tr>
<td>+ Capital inflow, KI</td>
<td>40.9</td>
<td>41.0</td>
<td>46.2</td>
<td>53.4</td>
<td>50.4</td>
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<tr>
<td>- Sanctioned capital outflow, KOS</td>
<td>5.7</td>
<td>-7.8</td>
<td>6.2</td>
<td>19.0</td>
<td>14.8</td>
</tr>
<tr>
<td>- Unsanctioned capital outflow, KOF</td>
<td>8.4</td>
<td>18.3</td>
<td>11.1</td>
<td>31.6</td>
<td>62.9</td>
</tr>
<tr>
<td>- Change in reserves, ∆R</td>
<td>30.5</td>
<td>22.5</td>
<td>31.7</td>
<td>35.7</td>
<td>5.1</td>
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<tr>
<td>= Capital account surplus, KA</td>
<td>-3.7</td>
<td>8.0</td>
<td>-2.8</td>
<td>-32.9</td>
<td>-32.4</td>
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<tr>
<td>Current account, CA</td>
<td></td>
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<tr>
<td>+ Observed CA surplus, CAO</td>
<td>1.6</td>
<td>-5.8</td>
<td>-0.3</td>
<td>20.6</td>
<td>20.1</td>
</tr>
<tr>
<td>+ Misinvoicing outflow, CAM</td>
<td>2.1</td>
<td>-2.2</td>
<td>3.1</td>
<td>12.3</td>
<td>12.3</td>
</tr>
<tr>
<td>= True CA surplus, CA</td>
<td>3.7</td>
<td>-8.0</td>
<td>2.8</td>
<td>32.9</td>
<td>32.4</td>
</tr>
<tr>
<td>Unsanctioned outflows, KOF</td>
<td>8.4</td>
<td>18.3</td>
<td>11.1</td>
<td>31.6</td>
<td>62.9</td>
</tr>
<tr>
<td>%GDP</td>
<td>1.5</td>
<td>2.6</td>
<td>1.3</td>
<td>3.4</td>
<td>6.3</td>
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Note: a This is an estimate of the true trade surplus, as distinct from the observed one.

Sources: Synthesis of capital flight calculations made originally by W.B. Song (1999). Data are from W.B. Song (1999), A Statistical Survey of China, State Statistical Bureau (1999) for 1998 capital inflows and foreign reserves; and IMF (1999a) for the 1998 current account balance and bank foreign asset data. Capital flight via misinvoicing is assumed to be the same as for 1997 (W.B. Song 1999). Smuggling data are from Yu (1999), who assumes that import smuggling is 10–15 per cent of total imports. We assume that net smuggling (M-X) is 5 per cent of total imports. Outward FDI is derived from inward FDI from A Statistical Survey of China and the net FDI is available from the Macro Team of CASS (1999).

Table 2  The private savings rate in China

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<tr>
<td>Rural households</td>
<td>15</td>
<td>17</td>
<td>18</td>
<td>23</td>
<td>26</td>
</tr>
<tr>
<td>Urban households</td>
<td>15</td>
<td>17</td>
<td>19</td>
<td>19</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>17</td>
<td>19</td>
<td>21</td>
<td>24</td>
</tr>
</tbody>
</table>

Note: The private savings rate is approximated from estimates of private income and consumption expenditure.

Sources: A Statistical Survey of China; and China Statistical Yearbook (State Statistical Bureau 1997).
probability of obtaining or retaining state employment has declined and the need for savings
to finance health, education and retirement has increased (Wu 1999). All this suggests that
the rise in savings and the associated increase in the capital account deficit are related to the
crisis in other Asian countries through an accident of timing.

China's domestic and macroeconomic policies are continuing to evolve, but two policy
changes stand out as having significance for the economy in the crisis period. First, as
indicated above, the retention of the fixed US dollar parity has tended to tie up monetary
policy, which has been tight. Despite the increase in the supply of domestic savings, the real
interest rate facing the relatively privileged customers of the state banking system is
estimated to have risen from –4.8 per cent in 1995, to 1.8 per cent in 1996, 5.8 per cent in 1997
and 7.2 per cent in 1998 (IMF 1999a). Second, a 'soft budget' policy has been maintained
since the mid-1990s. Official estimates of fiscal deficits have been in the vicinity of 0.8 per cent
of GDP until 1998, when there was a rise to 1.1 per cent. Government spending was below
12 per cent of GDP in the two years prior to the crisis but rose to 13 per cent in 1998 (IMF
1999a).

The combination of the real appreciation, which reduced export growth, a restrictive
monetary policy and the switch by the private sector from consumption to savings appears
to have contracted overall domestic demand, causing deflation. Growth in the consumer price
index (CPI), which had exceeded 24 per cent in 1994, has declined each year since, reaching
–0.8 per cent in 1998. Estimated GDP growth does appear to have slowed as a consequence,
from the 10 per cent achieved in the mid-1990s to an official 7.8 per cent in 1998. The central
government's 1998 ambitious target of 8 per cent apparently induced overstated estimates of
output by provincial authorities, leading to some controversy and a slight downward revision
of national GDP by the central government. The official rate for 1998 is widely believed to be
an overestimate, however. Moreover, an unusually large part of GDP in 1998 was investment,
including inventory investment, by state-owned enterprises. Nonetheless, total investment
as a share of GDP has risen slightly and productive capacity continues to be transferred from
the state sector to the presumably more productive private sector, all of which suggests the
slowdown is not the result of lower productivity growth. Nominal wages that are sticky
downward, excessive real wage growth and rising unemployment are more likely causes.

Wage rigidities are not surprising in China, where the labour market is more regulated
than in other developing countries. The evidence presented in Table 3 suggests that the
deflation in 1998 was indeed associated with a spurt in real wages. Again, however, the data on which this conclusion is based ignore non-wage and over-contract (bonus) payments. The former are large in state-owned enterprises while the latter are comparatively important in the private sector. The evidence on unemployment is also mixed. The principal source of layoffs has been the state sector, yet these workers are not included in the unemployment statistics. The official unemployment rate is therefore an underestimate considering that more than a tenth of the nation’s workers have moved out of the state sector in recent years. In addition, there is anecdotal evidence that millions of rural migrants have returned to the countryside because of reduced opportunities in urban employment (Macro Team of CASS 1999). On balance, we conclude that there has been a slowdown in output growth associated with a rise in unemployment.

In sum, then, macroeconomic events in China during the crisis period can be seen as comprising three important shocks and two key policy changes. The shocks are the crisis-driven decline in foreign prices, the rise in the interest premium on investments in China and the spontaneous substitution of private savings for private consumption in the domestic economy. The policy changes are the adoption of a fixed nominal exchange rate and the fiscal expansion. Before turning to our global general equilibrium analysis of these events, we work through them in the context of an elemental macroeconomic model, primarily through a graphical exposition.
An elemental macroeconomic analysis

The model

To foster intuition about Chinese policy, we begin with an elemental macroeconomic analysis of a small open economy, where the foreign real interest rate, $r^*$, and the price level, $P^*$, are exogenous. Our analytical model emphasises the short run, or at least a length of run within the average gestation period of investment. The productive capital stock is therefore constant and unaffected by the level of investment. The model is comparative static, so expectations and their implications are not endogenous and there is no continuous inflation to separate the real from the nominal rate of interest. Flows on the capital account are motivated by real interest rate changes.

The demand side of the model has equilibrium in the markets for money and ‘loanable funds’. Money market equilibrium equates real money demand, $m_D$, with real money supply, $m_S$, yielding an LM curve. The nominal money supply, $M_S$, then depends on the monetary base and hence the assets of the central bank. GDP is $Y$, the domestic interest rate is $r$ and the domestic price level is $P$.

$$LM : m_D = g_1 Y - g_2 r = \frac{M_S}{P}$$

The monetary base is $B = M_S/\theta$, where $\theta$ is a money multiplier. Official foreign reserves are $R$ and $DC$ is the central bank’s holding of domestic credit, so that $B = R + DC$.

Turning to the components of domestic absorption, consumption ($C$) depends on the real interest rate and disposable income and the tax system is assumed to be linear, so that $C = a_1 - b_1 r + c (Y - T)$, where $T = t + \tau Y$. Investment is $I = a_2 - b_2 r$; and government spending, $G$, is exogenous. Private saving by domestic residents is $S_D = Y - T - C$, which is the same as $S_D = s^* Y - a_1 - st + b_1 r$. The marginal propensity to save out of domestic GDP is $s^* = (1-c)(1-\tau)$. Saving in the home economy by foreigners net of saving abroad by domestic residents is $S_{NF}$. This is the private component of net inflow on the capital account and it depends on the domestic and foreign real interest rates, so that $S_{NF} = S_{NF}^0 + \phi (r-r^*)$, or $S_{NF} = (S_{NF}^0 - \phi r^*) + \phi r$. We now have total private saving in the home economy, which, along with government saving, must equal domestic investment. Thus, the Hicksian IS identity is

$$I = (T - G) + S_D + (S_{NF} - \Delta R).$$

The IS curve takes the form:
By substituting the traditional money market equilibrium (LM) condition, above, we have the aggregate demand (AD) curve:

\[ AD : P = \frac{M_S}{f_1 Y - f_2 (G + \Delta R) - f_3 r^* - f_4} \]

Here the fs are positive constants that consolidate the above parameters. This relationship is useful when the exchange rate is floating and the nominal money supply is exogenous. When the exchange rate is fixed, however, the monetary instruments are dedicated to its fixity and therefore endogenous. It is then useful to construct a version of the AD curve along which the exchange rate is constant. To do this we need to represent the current account of the balance of payments. Recall that private net inflows on the capital account are \( S_{NF} = S_{NF}^0 + \phi (r - r^*) \). Ignoring the net capital income component of the current account, inflows on the capital account must finance any surplus of imports \( M \) over exports \( X \). Thus, \( S_{NF} - \Delta R = M - X = NM \). Net imports \( NM \) depend positively on domestic disposable income and the real exchange rate, so that \( NM = a_3 + b_3 e_R + m(Y - T) \). Here the real exchange rate is defined as the relative price of domestic goods to foreign goods, or \( e_R = E.P / P^* \), where the nominal exchange rate, \( E \), is the value of the home currency in terms of the foreign (say, US dollars).

Returning to the IS curve, the interest rate can this time be substituted out by the above balance of payments condition. This yields the alternative AD, or IS-BOP, curve:

\[ IS - BOP : P = \frac{P^*}{E} \left( h_1 + h_2 G - h_3 \Delta R - h_4 r^* - h_5 Y \right) \]

Here too, the hs are positive constants that consolidate the parameters introduced earlier. The main exogenous shifters are the nominal exchange rate, \( E \), the foreign price level, \( P^* \), the change in official foreign reserves, \( \Delta R \), government spending, \( G \), and the foreign interest rate, \( r^* \). The change in reserves is made exogenous here so that the central bank's sterilisation behaviour can be reflected. Monetary policy, or at least its ultimate effect on the nominal money supply, is endogenous.
It remains to close the model with the supply side. Recall that the length of run considered here is one over which the stock of useful physical capital is unaffected by new investment. If the technology is Cobb-Douglas and the expenditure share of variable labour is b, output depends on variable labour input as \( Y = \alpha L^\beta \). At this length of run, in a heavily regulated economy such as that of China, we would expect to see at least some nominal wage rigidity. Equating the marginal product of mobile labour with the real wage, \( W/P \), and setting the nominal wage, \( W \), exogenous, we have the short-run aggregate supply curve:

\[
SAS(W) : P = \frac{W}{\alpha \beta} \left( \frac{Y}{\alpha} \right)^{1-\beta}
\]

In equilibrium these three curves in P–Y space intersect at a common point, as illustrated in Figure 1.\(^{20}\) They must always do so since one of the downward sloping curves always has an endogenous shifter. If the exchange rate is fixed, the IS-BOP curve applies and monetary policy must conform, thereby shifting the AD curve for consistency with the other two. If the exchange rate is floating, \( E \) is endogenous and the AD curve is active. Monetary policy is set exogenously and the exchange rate adjusts, shifting the IS-BOP curve to conformity.

The directions of these shifts are also shown in Figure 2. When the exchange rate is floating, the AD curve is active and shifts conventionally, with rises in either government spending or the nominal money supply shifting it upward or to the right.\(^{21}\) When the exchange rate is fixed, the IS-BOP curve is active. It has more exogenous shifters. A rise in the foreign price level, \( P^* \), shifts the IS-BOP curve upward and to the right. Imagine that the level of output is fixed in a labour market that clears. The direction of any vertical shift is determined by the change in the domestic price level. Since output is fixed and the only shock is that to \( P^* \), savings supply is unaffected and therefore there are net inflows on the capital account. The real exchange rate and net imports must be constant. So, the domestic price level rises by the same proportion as the foreign one. Hence, for a constant output, a rise in \( P^* \) raises the demand-side equilibrium price level and hence the IS-BOP curve shifts upward. A rise in the foreign interest rate, \( r^* \), or in the interest premium required to attract savers to China, shifts the curve downward and to the left, however. This is because an increase in outflows on the capital account reduces net imports and depreciates the real exchange rate. For a given output and given \( E \) and \( P^* \), the demand-side equilibrium price level is therefore lower.
Finally, an increase in official foreign exchange reserves also shifts the IS-BOP curve downward and to the left. This is because, other things equal, the increase adds to outflows on the capital account. Net imports contract and the relative price of foreign goods in the home economy rises, implying a real depreciation. For a constant output and a fixed nominal exchange rate, this implies a lower price level and hence the curve shifts downward. For a given equilibrium \( Y, P \) combination, however, the IS-BOP curve represents a relationship between the nominal exchange rate and the change in official foreign reserves. A rise in one is consistent with a fall in the other. Throughout our analysis we consider the change in reserves to be exogenous. When the exchange rate is floating, we will consider reserves to be constant, so that it is always the more sustainable change in \( E \), rather than in \( \Delta R \), that restores equilibrium. When the exchange rate is fixed, changes in \( \Delta R \) become important in the short run. Because the nominal money supply is then endogenous, however, the change in it, combined with the change in reserves will imply a pattern of sterilisation via \( \Delta R + \Delta DC = \Delta B \).
The crisis and the Chinese domestic savings shock

The first of the three key shocks to be considered is the decline in the foreign price level, $P^*$, representing the increased competitiveness of exports from China's crisis-affected neighbours. The second is a rise in the interest premium required on Chinese investments and the third is the increase in the marginal propensity to save associated with domestic policy reforms. We can represent the second shock as a rise in the external interest rate, $r^*$. Consider the first two, crisis-related, shocks and ignore, for the moment, the domestic policy-driven component of any savings change. China's fixed exchange rate requires that the active downward sloping curve be the IS-BOP curve. The curve shifts downward, as explained in the previous section and as shown in Figure 3. Although the two shocks have opposing effects on the real exchange rate, both contract domestic demand and the price level falls. The real wage therefore rises and output declines. Because the nominal money supply is endogenous, it must contract sufficiently for the AD curve to make a compatible downward shift. Monetary policy is therefore restrictive in defence of the fixed nominal exchange rate.

Evidence presented earlier suggests that the Chinese central bank slowed the growth of official foreign reserves between 1997 and 1998. Such a contraction in $\Delta R$ causes an offsetting upward shift in the IS-BOP curve because it tends to appreciate the real exchange rate and, with a fixed $E$, this raises the price level and hence restores some lost output. Of course the contraction in $M_S$ implies a contraction in the monetary base, $B$. Any difference between the change in $B$ and the new $\Delta R$ implies a complementary change in the level of domestic credit. That the price level in China did fall nonetheless confirms that the response was only partially offsetting.

The appeal of a floating rate in this circumstance is clearly illustrated by Figure 3. Under a floating rate, the active downward sloping curve is the AD curve. For a given money supply target, $M_S^0$, and assuming no change in government spending or the foreign interest rate, the real economy is unaffected by the change in foreign competitiveness. There is no change in the real exchange rate or the real money supply. Since the nominal money supply is fixed, there can be no change in the price level. And, from the definition of the real exchange rate, there can therefore be no change in the ratio $E/P^*$. The nominal exchange rate simply carries all the adjustment, by falling equiproportionally with the foreign price level.

As Dornbusch (1999) points out, however, the downside of a flexible rate, which would yield a nominal depreciation under these shocks, is that this is a 'beggar thy neighbour' policy
in any but a truly small country and could elicit competitive devaluations in neighbouring countries. A float would also remove the exchange rate as the ‘nominal anchor’ (Edwards 1996). Moreover, moral hazard problems make a pure float impractical while the Chinese banking sector is so heavily burdened with bad debts and therefore so dependent on direct and indirect government subsidies. There would also be the risk that a float would facilitate instability. Although Zhang (1999) finds this risk small in China’s case, the 1990s have seen periods when Chinese inflation has been high by Asian standards.

A rise in private savings driven by domestic policy (say a fall in the marginal propensity to consume, $c$, in the consumption equation) also shifts the IS-BOP curve downward and to the left. The increased supply of savings reduces the home interest rate and raises domestic investment even while it raises the net outflow of savings from China. The rise in the net
outflow on the capital account reduces net imports and raises the relative price of foreign goods in the domestic market. The real exchange rate therefore depreciates. The fixed nominal exchange rate requires that this change come about entirely through a decline in the domestic price level. If the nominal wage is sticky downward, output must decline. Although the source of the shock is different, the resulting deflation and output contraction has the same effect, as shown in Figure 3.

A global general equilibrium framework

For our numerical analysis of the global effects of the crisis, we shed the small country assumption and the very simple supply side embodied in the elemental model. A precise numerical representation of the crisis requires multiple regions and a representation of both trade and capital flows between them. To capture trade flows, multiple products distinguished according to factor proportions are required. The representation of capital flows requires that the model have an open capital account in each region and therefore an explicit treatment of savings and investment. Finally, the short-term consequences of crisis-related shocks are very sensitive to the behaviour of the labour market. It is therefore essential that the model represent both China's regulated labour market and the more flexible labour markets of most other Asian economies. We meet these requirements by adapting the GTAP global general equilibrium model to our purpose. Its analytics are summarised in Table 4. This model has no monetary or financial sector, yet for an analysis of the real effects of the crisis it offers the following useful microeconomic generalisations:

1) a capital goods sector in each region to service investment;
2) explicit savings in each region, combined with open regional capital accounts that permit savings in one region to finance investment in others;
3) multiple trading regions, goods and primary factors;
4) non-traded goods and services;
5) product differentiation by country of origin;
6) empirically based differences in tastes and technology across regions;
7) non-homothetic preferences; and
8) explicit allowance for transportation costs and policy distortions.
Table 4 Model analytics

Single household in each region.
Utility Cobb Douglas in:
- private household expenditure,
- government expenditure, and
- savings.
Government consumption: Cobb-Douglas composite of all goods.
Private household consumption: CDE\textsuperscript{a} expenditure function.
- CES decomposition between home goods and imports.
- CES decomposition of imports by region of origin.
Firms are perfectly competitive with constant returns to scale.
Technology is a nested CES combination of intermediate inputs and primary factors.\textsuperscript{b}
Intermediate demand is decomposed to home goods and imports as for household final consumption.
Factor specificity: Land specific to agriculture.
Natural resources specific to mining.
Physical capital is sector specific.
Labour and skill intersectorally mobile.\textsuperscript{c}
Primary factor supply: all factors are inelastic in supply at the regional level.
Capital returns are intra-regional.
Investment is financed in each region from a global pool of savings.
Capital goods are a Cobb-Douglas composite of domestic goods and services.
Investment does not affect the current installed capital stock but it does consume capital goods and its pattern of regional allocation has a significant influence on the capital account of each region's balance of payments, and hence on the real exchange rate.
When savings are assumed interregionally mobile, investment is endogenous. It is then allocated across regions so that its proportional change is larger in regions, \(i\), with high values of the average net rate of return on installed capital, \(r_i^c\) (the marginal product of capital net of depreciation). In this process, a global 'expected return', \(r_i^w\), is calculated such that \(\Sigma_i si = \Sigma_i li = \Sigma_i Ii [ri^c, r_i^w(1+\pi_i)]\), where \(si\) is the domestic savings rate in region \(i\), \(Y_i\) is total income, \(I_i\) is (net) investment and \(\pi_i\) is a region-specific risk premium.\textsuperscript{d} Our precise investment demand formulation takes the following form:

\[
\frac{K_i + I_i}{K_i} = \beta_i \left( \frac{1 + r_i^c}{1 + r_i^w (1 + \pi_i)} \right)^{\varepsilon_i}
\]

where \(K_i\) is the (exogenous) installed capital stock, \(\beta_i\) is a positive constant and \(\varepsilon_i\) is a positive elasticity.

Notes:
\(\text{a}\) CDE = Constant Difference of Elasticities. See Hertel (1997).
\(\text{b}\) For the primary factor demand structure, see Figure 1 in Yang and Tyers (1999).
\(\text{c}\) Households can transform labour between skilled and unskilled jobs. However, this capability is reduced to negligibility in the applications discussed in this paper.
\(\text{d}\) The formulation of expected returns in the original model, along with some alternative investment allocation rules, is discussed in Hertel and Tsigas (1997, pp. 54–60).
Our analysis remains comparative static and, as before, we examine short-run, or single period, effects of internal and external shocks. In the short run, the stock of physical capital is fixed and sectorally immobile. Investment within a region contributes to aggregate demand but its effects on the productive capital stock occur in a subsequent period. In these respects the model is the same as the elemental one above.

For the corresponding database, we use the GTAP Version 4 database for 1995, aggregated into the regions listed in Table 5. The grouping ‘recessed developing Asia’ is used to represent the most seriously affected Asian region. Within this region there is considerable variance in the degree to which countries were affected by the crisis. The shocks we impose are averages and do not reflect the extent of the crisis in the most severely hit economies such as Indonesia.

Households and firms in the model consume a composite of goods and services that includes domestic products and imports. The composition of domestic products depends on relative prices and elasticities of substitution. Imports are a blend of the products of all regions and depend on regional trading prices and elasticities of substitution. This structure facilitates the departures from the law of one price that tend to occur even in tradeable goods sectors in the short and medium run. For this reason, we do not adopt the practice common amongst GTAP model users of choosing larger than the standard elasticities of substitution in all industries when doing long-run comparative static analysis.

Our adaptation of the model involves changes to its assumptions about intermediate inputs and labour demand. In particular, to accurately represent substitution between inputs and primary factors, output is made a CES (Constant Elasticity of Substitution) composite of intermediate products and primary factors. Also, to better reflect the impacts external shocks have on factor markets, a further composite of skilled and unskilled labour is introduced. This allows the two types of labour to be differently substitutable for each other than each is substitutable for the other mobile factor, capital. Finally, the short-run nature of the Asian crisis necessitates the use of a version of the model that restricts intersectoral capital mobility in all regions. Returns to physical capital therefore vary across industries and regions.
Table 5  Model structure

<table>
<thead>
<tr>
<th>Regions</th>
<th>Share of world GDP(^f)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Recessed developing Asia(^a)</td>
<td>5.1</td>
</tr>
<tr>
<td>2. Japan</td>
<td>18.0</td>
</tr>
<tr>
<td>3. China(^b)</td>
<td>2.5</td>
</tr>
<tr>
<td>4. European Union(^c)</td>
<td>29.0</td>
</tr>
<tr>
<td>5. United States</td>
<td>25.2</td>
</tr>
<tr>
<td>6. Australasia</td>
<td>3.5</td>
</tr>
<tr>
<td>7. Rest of world</td>
<td>16.8</td>
</tr>
</tbody>
</table>

Primary factors

1. Agricultural land
2. Natural resources
3. Skilled labour\(^d\)
4. Unskilled labour\(^d\)
5. Physical capital

Sectors\(^e\)

1. All agriculture
2. Mining and energy (coal, oil, gas, other minerals)
3. Skill-intensive manufacturing (petroleum, paper, chemicals, processed minerals, metals, motor vehicles and other transport equipment, electronic equipment, other machinery and equipment)
4. Labour-intensive manufacturing (textiles, apparel, leather and wood products, metal products, other manufactures)
5. Skill-intensive services (electricity, gas, water, financial services, public administration)
6. Labour-intensive services (construction, retail and wholesale trade, dwellings)

Notes:

\(^a\) Korea (Rep.), Indonesia, the Philippines, Malaysia, Singapore, Thailand, Vietnam.
\(^b\) China includes Hong Kong and Taiwan.
\(^c\) The European Union of 15.
\(^d\) The labour disaggregation is based on the ILO Classification of Occupations. Professional workers are defined as including managers and administrators, professionals and para-professionals. Production workers are plant and machine operators and drivers, tradespeople, clerks, labourers and related workers, salespeople and personal service workers.
\(^e\) These are aggregates of the 50-sector GTAP Version 4 database. See McDougall et al. (1998).
\(^f\) Share of 1995 GDP in US dollars measured at market prices and exchange rates.

Constructing three scenarios

We begin with a reference scenario that includes all the real shocks associated with the crisis as well as the simultaneous changes in China. Two counterfactuals are then considered. First, we imagine that the Chinese economy was passive during the crisis, being subjected to no domestic shocks. This scenario indicates the contribution of the external crisis to China’s economic slowdown. The difference between it and the reference scenario tells us how changes
in China affected the crisis countries and the capital flows to the older industrial economies. The second counterfactual is designed to shed some light on the effects of the fixed parity decision. All the shocks of the reference scenario are introduced but it is assumed that a floating exchange rate regime allowed control over the price level via monetary policy and that this would have prevented any over-trend rise in real wages in China.

Before we describe the scenarios in detail, it is useful to reflect briefly on their technical underpinnings. The model is simply a set of \( n \) non-linear simultaneous equations in \( n+m \) variables. In such a system, only \( n \) variables can be endogenous. We must find values elsewhere for the remaining \( m \) exogenous variables. The software we use draws on the initial database for 1995 to derive initial values for the entire \( n+m \) variables. Then, in effect, it transforms the equations so as to allow the selection of any \( n \) of these variables as endogenous. The remaining \( m \) variables are then either assumed to hold their database values or they can be subjected to exogenous shocks. This selection of variables as either endogenous or exogenous is what we refer to as the closure. The full set of reference shocks and closures is detailed in Table 6.

**The reference crisis shock**

Consider first the crisis-affected regions: recessed developing Asia and Japan. Because our comparative static model does not have intertemporal optimisation by households or firms, we capture the capital account effects of the crisis by observing levels of investment and current account imbalances in the immediate aftermath, making these exogenous and then endogenising average rates of private saving.\(^\text{31}\) By themselves, however, the capital account shocks had only small short-run effects on output. As indicated above, the more serious problem was the foreign-denominated debts held by domestic firms and financial institutions in recessed developing Asia. ‘Country runs’ therefore precipitated numerous insolvencies and the sluggish resolution of the associated property rights issues led to the closure of some plants and considerable lay-offs at others. To capture these effects, we make output exogenous in affected sectors, based on the survey by the World Bank (1999), and allow some sectoral physical capital to be idled.\(^\text{32}\)

Turning to the representation of China, once again the level of investment and the current account imbalance are exogenous and shocked, as observed in the crisis period (Table 1). The associated change in China’s average rate of savings (private plus government gross
Table 6 Reference shocks and closures

Recessed developing Asia:
Regional investment is exogenous and reduced from 1995 to 1998 levels.
Regional expected rate of return on current investment, and hence the risk premium, is endogenous.\(^c\)
The average regional savings rate, S/Y, is made endogenous.\(^b\)
The trade balance, X–M, is exogenous and changes as observed.
Sectoral production volumes are exogenous and shocked as observed.\(^f\)
Sectoral capital use is endogenous, so that capital is idled in contracting sectors.\(^f\)
Labour in agriculture is reduced by 5 per cent while land productivity is raised by 2 per cent.
Labour (skilled and unskilled) remains sectorally mobile and is fully employed.

Japan:
Regional investment is exogenous and reduced from 1995 to 1998 levels.
Regional expected rate of return on current investment, and hence the risk premium, is endogenous.\(^c\)
The average regional savings rate, S/Y, is made endogenous.\(^b\)
The trade balance, X–M, is exogenous and changes as observed.
Sectoral production volumes are exogenous and shocked as observed.\(^f\)
Sectoral capital use is endogenous, so that capital is idled in contracting sectors.\(^f\)
Labour (skilled and unskilled) remains sectorally mobile and is fully employed.

China:
Regional investment as a percentage of GDP is exogenous and is increased by 3 per cent.
Regional expected rate of return on current investment, and hence the risk premium, is endogenous.\(^c\)
Government spending as a percentage of GDP is exogenous and increases as observed.
The average rate of savings is endogenous, while the current account surplus (X–M) is made exogenous and shocked as per the observed 1998 change.
Sectoral production volumes are endogenous, while sectoral capital use is exogenous.
Labour (skilled and unskilled) remains sectorally mobile.
Nominal wage is fixed so that real wage depends on the endogenous real exchange rate and external nominal price shock. Full employment is therefore not ensured.

US, EU, Australasia and Canada, and the rest of world:
Regional investment is endogenous.
Regional current account, X–M, is exogenous and changes as observed.
Regional expected return on current investment is endogenous.\(^c\)
Sectoral production volumes are endogenous, while sectoral capital use is exogenous.
Labour (skilled and unskilled) remains sectorally mobile and the real wage of raw labour is flexible upward only.\(^d,e\)

Notes:
\(^a\) In all scenarios, capital is completely sector specific in all regions, so that the rate of return differs across sectors.
\(^b\) Since the capital account and current account must be equal in magnitude and opposite in sign, I–S=M–X. For both recessed developing Asia and Japan, these shocks impose explicit contractions in investment and imports relative to exports. The volume of savings then follows endogenously.
\(^c\) In the subsequent scenarios, regional investment is endogenous to equalise regional average ‘expected returns’, adjusted for risk premia. The trade balance is endogenous, while the average savings rate is retained as exogenous and the observed reference scenario shock to it are imposed. Expected rates of return on current investment are then exogenous and also shocked as indicated in the reference scenario.
\(^d\) In the end, this constraint does not bind since the real wages of raw and skilled labour both rise.
\(^e\) Since home products are differentiated from imports, the ratio of home goods prices and import prices does vary. That between the prices of home goods and exports remains fixed, however.
\(^f\) The approach taken to this assumption, and its numerical consequences, are detailed by Yang and Tyers (1999).

Source: IMF (1998, 1999b); Statistics from Websites for countries concerned, as summarised in Duncan and Yang (2000). The sources for China are indicated in Section 3.
of depreciation), $S/Y$, is endogenous, so that this scenario also serves to calibrate the Chinese savings shock. This change turns out to be from 35 per cent to 42 per cent, a rise of 7 percentage points, which is of a similar order to the change observed in the rate of private household savings (Table 2).

Because China's labour markets are more regulated than those elsewhere in Asia, we assume there is downward rigidity of the nominal wage over the length of run considered and that the nominal exchange rate is fixed against the US dollar. To incorporate these nominal rigidities in our real model, we take advantage of the definitions of the real wage and the real exchange rate and the fact that data are now available on changes in price levels during and since the crisis. Eliminating the domestic price level from the definitions of the real wage, $w = W/P$, and the real exchange rate, $e_R = (E/P^*)P$, we have that:

$$w = \left( \frac{WE}{P^*} \right) \frac{1}{e_R}$$

In proportional change form, when the nominal wage is fixed, this implies:

$$\dot{w} = -\dot{P} = (\dot{E} - \dot{P}^*) - \dot{e}_R$$

This equation is incorporated in the model, in which the real wage, $w$, and the real exchange rate, $e_R$, are already endogenous variables. For China alone, this change also renders the real wage and the level of employment endogenous. Thus, when nominal wage rigidity is assumed in the first scenario, the observed proportional change in $E/P^*$ is introduced as an exogenous shock. For this purpose, we use the trade-weighted average of the ratio $E/P^*$ for the five regions trading with China. Over the first four quarters following the crisis, this rose by 3.5 per cent.

A key element of the crisis and its consequences for the world economy is the flight of savings from Asia and the resulting global redistribution of investment. When investment is made endogenous, it is allocated across regions so that its proportional change is larger in regions, $i$, where the average rate of return on installed capital, $r_i^c$, is high. In this process, as detailed in Table 4, a global 'expected return', $r^w$, is calculated such that $\Sigma_i S_i = \Sigma_i S_i Y_i = \Sigma_i I_i \left[ r_i^c, r^m(1+\pi_i) \right]$, where $S_i$ is the domestic savings rate in region $i$, $Y_i$ is total income, $I_i$ is (net) investment and $\pi_i$ is a region-specific risk premium. In this reference crisis scenario, however, the observed global distribution of investment is imposed as exogenous. This requires that the
risk premia, $\pi_i$, be endogenous. The simulated changes in these premia then imply the extent of crisis-linked risk as perceived by investors in China. Relative to the United States, the results show a rise in the risk factor, $(1+\pi_i)$, for recessed developing Asia of 78 per cent. In the case of China, the increase is 14 per cent. In the subsequent counterfactual scenarios, these risk premia are imposed as exogenous shocks and the current accounts are made endogenous. Investment is then allocated across regions so as to equalise expected rates of return adjusted for the fixed risk premia.

The ‘passive China’ scenario

In our first counterfactual scenario, the crisis experiment is run against a China in which there is no change in the rate of national savings, implying no change in the rate of private savings out of disposable income and no fiscal policy shock. To see how this is done, recall that the crisis, as it affected China, comprised three elements. First, there was a trade shock due principally to the collapse of imports and the expansion of exports in recessed developing Asia and Japan. Second, there was a rise in the risk premium on investment, not only in the affected countries but also in China, and, third, there was an increase in the savings rate and an associated expansion in the capital account deficit. To construct the passive China scenario, we replace the shocks to investment and the current accounts of recessed developing Asia and Japan with shocks to risk premia and savings rates drawn from the results of the reference scenario. Investment and the current account are now endogenous in these regions, although were these to be the only changes, the simulation would simply reproduce the reference case. What distinguishes this simulation is our treatment of China. For China we also endogenise investment and the current account and exogenise the risk premium, imposing the change in the reference risk premium as an exogenous shock. The savings rate is exogenised as well, except that in China it is not shocked to its new post-crisis level. It is held constant at its pre-crisis level.

We had initially intended to simulate the continuation of the ‘real targets’ approach to exchange rate policy by holding China’s real effective exchange rate constant. When subjected to the decline in the foreign price level and the rise in the investment premium, however, a constant real exchange rate could only have been maintained with an unrealistically extreme contraction of the domestic economy. Moreover, we have no observations on nominal variables with which to complement our real model in this case. We therefore retain the fixed
parity with the US dollar and assume that, had China remained otherwise ‘passive’ during the crisis, the changes in bilateral nominal exchange rates and foreign price levels would have been the same as in the reference case. The same shock as before is therefore administered to the real wage equation. Of course, relative to the reference scenario, the change in the Chinese real wage will differ in this passive China scenario because the Chinese real exchange rate differs.

The flexible exchange rate scenario

The second counterfactual scenario differs from the reference one only in that China is assumed to adopt a flexible exchange rate and a monetary policy designed to keep employment constant. As in the passive China case, we first replace the shocks to investment and the current accounts of the crisis-affected countries and China with the reference changes in risk premia and savings rates. This time, however, the Chinese foreign exchange policy response is to adopt sufficient nominal exchange rate flexibility to give monetary policy power over the domestic price level. The real wage is then unaffected by nominal wage rigidity. In this closure we therefore fix total labour supply and allow the real wage to be determined endogenously. The real wage equation, \( w = \frac{W}{P} \), is therefore disabled and replaced with the labour supply constraint.

Simulation results

The three scenarios were run as three different sets of shocks against the GTAP Version 4 database. For each of the six regions represented, the effects on the balance of payments, real exchange rate and the terms of trade are summarised in Table 7. The corresponding changes in output and in total employment are given in Table 8, while Table 9 lists the effects on real unit factor rewards. All the results are comparative static and should therefore be seen as changes relative to some growth trend.

The reference scenario

The substantial redistribution of global investment away from Asia and into the older industrial economies is clear from Table 7. In China a rise in total domestic savings and a fall in investment fuel the outflow in the capital account. The Chinese average domestic savings
Table 7  Short-run changes in the balance of payments, the real exchange rate, and the terms of trade (US$ billion, 1995)a

<table>
<thead>
<tr>
<th>Sector</th>
<th>Dev. Asiab</th>
<th>Japan</th>
<th>China</th>
<th>US</th>
<th>EU</th>
<th>Canada, Aust, NZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference crisis scenario</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital account surplus (I–S)=(M–X)</td>
<td>–134</td>
<td>–33</td>
<td>–28</td>
<td>126</td>
<td>75</td>
<td>14</td>
</tr>
<tr>
<td>Investment, I</td>
<td>–186</td>
<td>–187</td>
<td>–13</td>
<td>162</td>
<td>85</td>
<td>17</td>
</tr>
<tr>
<td>Savings, S</td>
<td>–52</td>
<td>–154</td>
<td>15</td>
<td>36</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>Imports, M</td>
<td>–166</td>
<td>–48</td>
<td>–19</td>
<td>70</td>
<td>38</td>
<td>8</td>
</tr>
<tr>
<td>Change in real effective ratec (%)</td>
<td>–14.2</td>
<td>–5.5</td>
<td>–1.9</td>
<td>12.9</td>
<td>4.2</td>
<td>0.6</td>
</tr>
<tr>
<td>Real appreciation against US$d (%)</td>
<td>–21.5</td>
<td>–15.6</td>
<td>–1.9</td>
<td>12.9</td>
<td>4.2</td>
<td>0.6</td>
</tr>
<tr>
<td>Terms of tradee (%)</td>
<td>–5.6</td>
<td>–6.7</td>
<td>–1.2</td>
<td>10.3</td>
<td>1.3</td>
<td>0.2</td>
</tr>
<tr>
<td>Counterfactual: passive Chinaf</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment, I</td>
<td>–186</td>
<td>–191</td>
<td>–7</td>
<td>154</td>
<td>76</td>
<td>16</td>
</tr>
<tr>
<td>Savings, S</td>
<td>–50</td>
<td>–154</td>
<td>5</td>
<td>35</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Imports, M</td>
<td>–163</td>
<td>–49</td>
<td>5</td>
<td>66</td>
<td>34</td>
<td>7</td>
</tr>
<tr>
<td>Exports, X</td>
<td>–28</td>
<td>–12</td>
<td>2</td>
<td>–53</td>
<td>–32</td>
<td>–6</td>
</tr>
<tr>
<td>Change in real effective ratec (%)</td>
<td>–13.8</td>
<td>–5.8</td>
<td>2.6</td>
<td>12.2</td>
<td>3.9</td>
<td>0.6</td>
</tr>
<tr>
<td>Real appreciation against US$d (%)</td>
<td>–20.7</td>
<td>–15.3</td>
<td>–9.4</td>
<td>0.0</td>
<td>–6.3</td>
<td>–5.2</td>
</tr>
<tr>
<td>Terms of tradee (%)</td>
<td>–5.2</td>
<td>–7.1</td>
<td>1.9</td>
<td>9.7</td>
<td>1.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Counterfactual: flexible exchange rateg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital account surplus (I–S)=(M–X)</td>
<td>–135</td>
<td>–32</td>
<td>–35</td>
<td>128</td>
<td>78</td>
<td>15</td>
</tr>
<tr>
<td>Investment, I</td>
<td>–189</td>
<td>–185</td>
<td>–17</td>
<td>164</td>
<td>89</td>
<td>18</td>
</tr>
<tr>
<td>Savings, S</td>
<td>–53</td>
<td>–153</td>
<td>18</td>
<td>37</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>Imports, M</td>
<td>–167</td>
<td>–47</td>
<td>–17</td>
<td>72</td>
<td>41</td>
<td>8</td>
</tr>
<tr>
<td>Change in real effective ratec (%)</td>
<td>–15.0</td>
<td>–4.8</td>
<td>–4.5</td>
<td>13.3</td>
<td>4.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Real appreciation against US$d (%)</td>
<td>–22.5</td>
<td>–15.6</td>
<td>–16.2</td>
<td>0.0</td>
<td>–6.4</td>
<td>–5.5</td>
</tr>
<tr>
<td>Terms of tradee (%)</td>
<td>–5.9</td>
<td>–6.3</td>
<td>–3.2</td>
<td>10.5</td>
<td>1.4</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Notes:  

a Reference closure and shock details are indicated in Table 6. Here, flows on the balance of payments are valued in 1995 US dollars (simulated values in the model are deflated by the simulated US GDP deflator). Imports and exports are valued at border prices.  

b Recessed developing Asia, excluding China.  
c The ratio of the home GDP deflator to a trade-weighted average of the GDP deflators of other regions.  
d The ratio of the home GDP deflator to that of the United States.  
e Change in the value of exports at endogenous prices, weighted by fixed 1995 (base period) export volumes, divided by the value of imports, and weighted by fixed 1995 import volumes.  
f Here the shocks to other regions are as for the reference case, except that investment risk premia are exogenous in place of current accounts. In China, the savings rate remains at its pre-crisis level and the reference changes to the ratio E/P* are introduced, implying the retention of fixed nominal parity with the US dollar.  
g Here the shocks to other regions are as for the reference case, except that investment risk premia are exogenous in place of current accounts. In China the savings rate rises to its reference (post-crisis) level and the nominal exchange rate is assumed flexible enough to permit price changes that avoid excessive real wage increases. Employment therefore remains constant.  

Source: Model simulations described in the text.
### Table 8  Short-run changes in output and employment (per cent)\(^a\)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Dev. Asia(^b)</th>
<th>Japan</th>
<th>China</th>
<th>USA</th>
<th>EU</th>
<th>Canada, Aust, NZ</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reference crisis scenario</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.2</td>
<td>-0.1</td>
<td>-6.7</td>
<td>-1.6</td>
<td>-0.8</td>
<td>-1.6</td>
</tr>
<tr>
<td>Mining</td>
<td>-3.9</td>
<td>-2.7</td>
<td>-1.0</td>
<td>-0.4</td>
<td>-0.2</td>
<td>-0.3</td>
</tr>
<tr>
<td>Manufacturing: labour intensive</td>
<td>-11.4</td>
<td>-3.8</td>
<td>2.2</td>
<td>-3.0</td>
<td>-0.9</td>
<td>-2.1</td>
</tr>
<tr>
<td>skill intensive</td>
<td>-12.1</td>
<td>-3.0</td>
<td>-4.9</td>
<td>-0.5</td>
<td>-0.4</td>
<td>-0.3</td>
</tr>
<tr>
<td>Services: labour intensive</td>
<td>-11.0</td>
<td>-5.4</td>
<td>-5.2</td>
<td>1.2</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>skill intensive</td>
<td>-10.1</td>
<td>-6.2</td>
<td>-3.7</td>
<td>-0.2</td>
<td>0.0</td>
<td>-0.3</td>
</tr>
<tr>
<td>GDP</td>
<td>-10.3</td>
<td>-5.1</td>
<td>-4.2</td>
<td>0.1</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Employment (% labour force)</td>
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<td>-9.8</td>
<td>0.0</td>
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<tr>
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<td></td>
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</tr>
<tr>
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<td>-1.4</td>
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<tr>
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<td>-0.3</td>
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<tr>
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<td>-2.7</td>
<td>-0.7</td>
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<td>-0.2</td>
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<td>-1.5</td>
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<td>-1.6</td>
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<td>10.0</td>
<td>-3.2</td>
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<td>-0.8</td>
<td>-0.5</td>
<td>-0.4</td>
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**Notes:**
\(^a\) Reference closure and shock details are indicated in Table 6.
\(^b\) Recessed developing Asia, excluding China.
\(^c\) Here the shocks to other regions are as for the reference case, except that investment risk premia are exogenous in place of current accounts. In China the savings rate remains at its pre-crisis level and the reference changes to the ration E/P* are introduced, implying the retention of fixed nominal parity with the US dollar.
\(^d\) Here the shocks to other regions are as for the reference case, except that investment risk premia are exogenous in place of current accounts. In China the savings rate rises to its reference (post-crisis) level and the nominal exchange rate is assumed flexible enough to permit price changes that avoid excessive real wage increases. Employment therefore remains constant.

**Source:** Model simulations described in the text.
### Table 9 Short-run changes in real unit factor rewards (per cent)\(^a\)

<table>
<thead>
<tr>
<th>Primary factor</th>
<th>Dev. Asia(^b)</th>
<th>Japan</th>
<th>China</th>
<th>USA</th>
<th>EU</th>
<th>Canada, Aust, NZ</th>
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<td>-4.5</td>
<td>-8.7</td>
</tr>
<tr>
<td>Land</td>
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<td>-23.4</td>
<td>-16.3</td>
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</tr>
<tr>
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<td>-0.1</td>
</tr>
<tr>
<td>Capital specific to:</td>
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<td></td>
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<td></td>
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</tr>
<tr>
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<td>-8.0</td>
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<tr>
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</tr>
<tr>
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<td>-0.1</td>
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</table>

**Notes:**

- a Short-run closure details are indicated in Table 6. All entries are unit rewards relative to the region's GDP deflator.
- b Recessed developing Asia, excluding China.
- c See footnote c to Table 8.
- d See footnote d to Table 8.

**Source:** Model simulations described in the text.
rate (private plus government), S/Y, rises from 35 per cent to 42 per cent. Since average domestic investment, I/Y, is exogenous and increased slightly in this shock, the decline in investment stems from a contraction in GDP, as indicated in Table 8.  

In these results, the real appreciation of China's currency against other Asian currencies, and the loss of export markets in Asia, is more than offset by the real depreciation against the older industrial economies. In the short run, Chinese exports expand since they compete against exports from other Asian countries that are constrained by insolvencies and idled capital. Output of Chinese agricultural and mineral products, largely directed to elsewhere in Asia, falls, as does output of 'elaborately transformed' products and services. China's main export sector, labour-intensive manufacturing, expands despite this economy-wide contraction.

The reference shocks generally raise real unit factor rewards in the older industrial economies and shrink them in Asia, as indicated in Table 9. There are three clear exceptions to this pattern, however. First, the real return to installed physical capital rises in the affected Asian countries. This is because so much of it is idled by insolvencies. Second, Chinese workers gain while those in the rest of Asia are worse off. This is because of the substantial deflation in China and our assumption that Chinese nominal wages are rigid downward in the short run. The model predicts a decline in China's real effective exchange rate of 1.9 per cent, while the exogenous nominal ratio E/P* rises by 3.5 per cent. The result is an average real wage rise of 5.4 per cent.  

Third, owners of land, natural resources and manufacturing capital in the older industrial economies are losers. This is because of the loss of exports of agricultural and natural-resource-based goods to Asia and the competitive pressure from cheaper imports following real currency appreciations in the older industrial economies.

**The ‘passive China’ scenario**

This scenario is designed to indicate the relative contributions to economic change in China of the external crisis shock on the one hand and the domestic savings shock on the other. It therefore differs from the first scenario in that there is no departure from the pre-crisis savings rate in China, implying no change in the private savings rate and no change in fiscal policy. Investment levels and current account imbalances are now endogenous in all regions, while the shocks come from the investment premia and any changes in average savings rates in recessed developing Asia and Japan.
Table 7 shows that the decline in Chinese investment is smaller than before, even though the risk premium change is the same as in the reference crisis scenario. This is because, by the investment demand equation given above, China’s share of the world’s investment depends on the relative magnitude of China’s rate of return on installed capital. The contraction in this rate of return is smaller in this scenario (Table 9) because the endowment of capital is fixed and the contraction in employment is now much smaller (Table 8). In the end, the marginal product of capital is higher at the end of the passive China shock than at the end of the reference crisis shock. But why does employment contract less in the passive China case? This is because there is no rise in domestic savings to fuel the capital outflow of the reference scenario. S/Y remains constant. The contraction in aggregate domestic demand in China is therefore smaller than before and there is a smaller deflation. This implies a smaller rise in the real wage and hence a smaller decline in employment. This smaller decline in employment yields a much smaller decline in Chinese GDP (Table 8).

In our ‘real’ model, the change in the deflation is reflected in the change in the real exchange rate. Recall that $e_R = (E/P^*)P$, where the ratio in parentheses is exogenous and rises by 3.5 per cent in both cases. From Table 7, the Chinese real effective exchange rate falls by 1.9 per cent in the reference crisis scenario, implying a deflation of 5.4 per cent and hence a real wage increase of this magnitude. In the passive China scenario, the real effective exchange rate rises by 2.6 per cent, implying a deflation of only 0.9 per cent and a much smaller real wage increase. The more moderate contraction in domestic demand in the passive China case, combined with the smaller decline in employment, is then consistent with smaller contractions in skill-intensive manufacturing and services (Table 8). Accordingly, real losses sustained by other primary factors are also smaller (Table 9).

Overall, these results indicate that the Chinese savings shock had a greater contractionary effect on the economy than did the external crisis. Of course, we have retained the fixed exchange rate here and one might think of the choice to maintain fixed US dollar parity as associated with the crisis. Yet, had the government attempted to retain its earlier ‘real targeting’ regime through the crisis, the extent of the crisis-driven contraction would have been larger.

**The flexible exchange rate scenario**

Here, the domestic savings shock is reintroduced but monetary policy is assumed free enough to effect a change in the price level sufficient enough to prevent excessive real wage growth.
and hence to retain the pre-crisis level of employment relative to trend. There is, therefore, no contraction in Chinese GDP. Output and income are greater and hence China’s savings increase by more than in the reference case, fuelling an increased capital account deficit and yielding a very much larger real depreciation relative to its trading partners than in either of the other scenarios. Exports expand by more and so the production of labour-intensive manufactures expands by more. In the older industrial economies, the corresponding contraction in labour-intensive manufacturing is therefore larger than in the other scenarios.

In Chinese factor markets, this time there is no real wage rigidity and employed unskilled workers lose substantially relative to the reference scenario, although only slightly when compared with the pre-crisis equilibrium. Skilled workers also lose relative to the reference scenario. They gain relative to the pre-crisis equilibrium because of an expansion in China’s skill-intensive services sector. The average real return on capital in China rises relative to the reference scenario and the pre-crisis equilibrium. The real volume of investment in China is therefore slightly higher. Because of the substantial real depreciation, however, the US dollar value of investment in China falls by more than in the reference case (Table 7). Export growth fuels a considerable expansion of China’s labour-intensive manufacturing sector. Since this sector is intensive in inputs from the skill-intensive services sector, that sector also expands.

Overall, employed Chinese workers are worse off under the flexible exchange rate response to the crisis than in the reference scenario. There is no increase in unemployment, however. The relatively painless return of GDP to trend is the attractive feature of a flexible exchange rate for the Chinese government, particularly given the continuing structural unemployment that must accompany necessary domestic reforms.

Conclusion

In China’s case the principal external shocks during and since the Asian crisis have been a real appreciation against the currencies of its Asian neighbours and a loss of exports to Asia, increased export competition in the older industrial economies and a rise in the interest premium demanded from investments in China. Within China, however, and for reasons mostly independent of the crisis, there has been a significant increase in private savings. In combination with the rise in China’s investment premium, this has caused a large increase in outflows on the capital account. Both the trade shock and the changes in China’s capital
market have tended to depress the domestic price level and hence, in the presence of nominal wage rigidity, they are contractionary in the short run. Our short-run comparative static analysis suggests that the capital market changes, and the private savings rate increase in particular, have been the more contractionary. At the same time, these changes have contributed at least an extra 10 per cent to capital flowing into the older industrialised economies. Output in those economies has therefore risen, particularly in the services sector, and workers have gained at the expense of the owners of capital and other resources specific to tradeable goods sectors.

The deflation in China has also benefited those Chinese workers who have remained employed, yet the analysis suggests that the proportion of unemployed has been boosted not only by the ongoing structural reforms but also because real wages rose during the crisis period. Although the increased unemployment and the reduced output may be ameliorated as the crisis shocks fade, the more contractionary change in domestic savings is likely to be permanent. To the extent that wage rigidities may be long lasting in China, it is tempting to consider the transition to a flexible exchange rate regime. From a domestic standpoint, this would free monetary policy to adjust the price level, ensuring that real wage rises do not reduce employment and offering the least politically painful approach to the restoration of output to its potential level. Indeed, our analysis suggests that a depreciation during the crisis could have avoided losses in the order of 4 per cent of GDP a year. With a more flexible exchange rate, two risks arise, however. First, the exchange rate is lost as a ‘nominal anchor’ and, depending on how China’s wage determination process evolves, it could initiate an inflationary spiral. Second, since China is a large economy, at least in its own region, there is the risk of competing devaluations and another round of Asian capital flight. This risk is the more serious and warrants consideration in the choice of China’s eventual exchange rate regime.
No. 308 October 2000

Notes

1. This paper was previously published as China Economy Program Working Paper No. CEP2000-1, Asia-Pacific School of Economics and Management, The Australian National University. The paper was presented at the Asian Crisis II conference, held at the University of Washington, Seattle, on 4-5 January 2000. Special thanks are due to George Fane, Meng Xin, Max Corden, Warwick McKibbin, Xiaolu Wang, Xinpeng Xu, E.C. Hwa and Ben Smith for constructive discussions and to the Economics Program of the Asia Pacific School of Economics and Management for resources provided in association with a Visiting Fellowship, August-December 1999. Thanks are also due to Kar-yiu Wong and to two anonymous reviewers for comments on an earlier draft.

2. Subsequent but associated ‘crises’ in Latin America, Eastern Europe and Russia followed. This paper focuses on the effects of the Asian shocks only.

3. A shorter version of this paper that leaves out the theoretical analysis and concentrates on the general equilibrium analysis of the real effects of the crisis on China is available as Yang and Tyers (2000a).


5. Although the events that precipitated the crisis are now fairly well understood (Chang and Velasco 1998; Krugman 1999), the best dynamic global macroeconomic models to date still do not fully endogenise the genesis of the capital flight of 1997 (McKibbin 1998; McKibbin and Martin 1998).

6. We examine medium-run effects in Yang and Tyers (1999). Of course, such cumulative, longer-run effects are best examined using the dynamic models of McKibbin (1998; McKibbin and Martin 1998).


8. This conclusion was borne out in a recent World Bank survey of 3,700 companies in the worst affected economies (World Bank 1999).

9. This view is put by Zhang (1999) and borne out in the form of a policy reaction function estimated by L.L. Song (1999).

10. This accorded with the strategy advocated by Corden (1993).


12. A survey by the Shanghai Statistics Bureau that found that a primary objective of household saving is to insure against uncertainty arising from the dissolution of state-owned enterprises (China News Digest, 7 February 2000).

13. The real interest rate is estimated here as the concurrent difference between the state bank lending rate and the rise in the CPI.
The statistics on government spending apparently ignore subsidies to state-owned enterprises. Such subsidies are large, although they probably take the form of transfers rather than spending on goods, services or public investment.

See the discussion by Fernald and Babson (1999), p 6.

Although the data in Table 3 for 1998 are drawn from the indicated sources without adjustment, they do look more out of line than we would expect and we regard them as questionable at best.

The extent of underestimation is moderated, however, by disguised employment amongst these workers. State workers who are made redundant retain generous allowances and payments in kind, which are denied to workers who take new jobs. These benefits end when new employment is found, and so these workers rarely concede this to officialdom (Meng 1999).

That China is not ‘small’ has been emphasised by others, including Dornbusch (1999). Our subsequent global general equilibrium analysis corrects for this. Even there, however, the 1995 database has China contributing only 2.5 per cent of global output.

More realistically, consumption might distinguish between the demand for home-produced goods, $C_H$, and imported goods, $M$, so that $C = C_H + M$. These two components both depend on the real exchange rate (the ratio of the prices of domestic to imported goods) but with opposing signs. For the sake of this elemental analysis, we assume that these two effects just cancel out, leaving total consumption, $C$, independent of the real exchange rate.

The shape of the $SAS(W)$ curve depends on the value of $\beta$. The labour share embodied in the GTAP general equilibrium database for China is $\beta = 0.45$ (McDougall et al. 1998) and this value does yield the shape shown.

Both $\Delta R$ and $r^*$ also shift the AD curve positively. A rise in $\Delta R$ raises outflows on the capital account, reduces the quantity of saving directed to the domestic economy and raises $r$. Imagine that output is fixed in a labour market that clears. At a higher $r$, money market equilibrium is only attained at a lower real money supply. Since the nominal money supply is exogenous, the result must be a higher price level and hence an upward shift of the curve. Similarly, if $r^*$ rises, or if the interest premium demanded of investments in China rises, once again, savings directed to the home economy fall and $r$ rises. Again, at constant output, a higher $r$ will only find equilibrium in the money market at a lower real money supply and hence a higher equilibrium price level.

The money supply is included as a stock while the change in reserves is a flow. Changes in domestic credit are implied by the levels of $\Delta R$ and any change in the monetary base required to meet the exchange rate target. In this comparative static analysis, however, the time period over which the change in the monetary base occurs is necessarily unspecified. For this reason, the change in domestic credit is not modelled explicitly.

The preliminary analysis using the elemental model presented in this section employs a purely graphical approach. Numerical simulations using this model are discussed by Tyers (2000). Here we used the elemental model to clarify the issues and proceed to a global framework for our corresponding numerical analysis.
24 Because of realignments amongst the major currencies, nominal parity with the US dollar has not prevented changes in the effective exchange rate. We allow for these later but ignore them here.

25 Expectations play an important role here. Such behaviour by a central bank well endowed with foreign reserves would have helped resist speculation against the nominal exchange rate at the time.

26 For a detailed description of the standard version of the Global Trade Analysis Project model, see Hertel (1997). Our modifications to the structure of the model are changes to the production technology and hence to the factor demand structure (examined in detail in Tyers and Yang 2000) and the sector specificity of capital in all regions.

27 We retain the real model here but in subsequent work we have included nominal variables to create a full comparative static macroeconomic model. See Yang and Tyers (2000b).

28 For a detailed description of the database, see McDougall et al. (1998).

29 Short-run departures from the law of one price occur across all tradeable goods sectors. See Engel (1999).

30 See the discussion of long-run shocks in Hertel et al. (1996, Appendix C, p. 212). Indeed, to reflect the unusually short-run nature of the shocks, we use smaller than the standard elasticities. The elasticities associated with trade in the relatively standardised natural-resource-based goods and labour-intensive manufactures are reduced by two-thirds, while those associated with skill-intensive manufactures and services are reduced by three-quarters.

31 As discussed later in the paper, in order that the global distribution of investment be exogenous in this scenario, we must endogenise the risk premium on each region’s ‘expected’ rate of return.

32 This approach and what it implies about the behaviour of firms is detailed in Yang and Tyers (1999).

33 Total savings comprises private saving, \( S \), and government saving, \( S_G = T - G - \Delta R \), where \( \Delta R \) is the rise in official foreign reserves. The information in Section 2 suggests that, in spite of the rise in \( G \), both private and government savings increased after 1996, the latter rising because foreign reserves grew by US$30 billion less in 1998 than in previous years.

34 As indicated in Table 5, both skilled and unskilled labour are included as primary factors. Since both markets are regulated in China, the resulting real wage rigidity applies to a weighted average of the two real wages.

35 Relative to the US rate of return, the premia for the other regions were: Japan, 25 per cent; the EU, 3 per cent; Canada and Australasia, 2 per cent; and the ‘rest of the world’, 6 per cent.

36 The tight monetary policy of the crisis period and the associated rise in the real interest rate could well have contributed to increased private savings in China. If so, the observed change in the savings rate may not have been only due to unrelated domestic reforms. This issue is examined in subsequent research, described in Yang and Tyers (2000b).
For a more complete discussion of the macroeconomics of this point, see Tyers (2000).

Investment as a proportion of GDP has not fallen in China, but the GDP growth rate has. A decline of 4 per cent relative to trend is a fall of US$40 billion, at least a third of which would be investment.

China’s export growth remained strong until mid-1998. See the Ministry of Foreign Trade and Economic Cooperation Web site at <http://www.moftec.gov.cn/moftec/>. The more recent slowdown in exports (Fernald and Babson 1999; Hu 1999) may reflect the resolution of property rights in the affected countries and a subsequent surge in competing exports. The true trade effects on China remain unclear, however, because of inaccuracies in the measurement of the current account, as indicated in Table 1.

This rise is relative to China’s GDP deflator, however, and so overstates that relative to the CPI.
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