ON THE DIFFERENTIAL IMPACT OF THE ASIAN CRISIS ON THE WORLD ECONOMY: A GENERAL EQUILIBRIUM PERSPECTIVE

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Abstract. Three years and more have passed since the outbreak of the Asian Financial crisis in 1997. We observe that the world economy was far from a ‘global slump,’ yet the burden of adjustment had been uneven across countries. The crisis had a negative effect on the other developing countries, while the impact on industrial economies had been small, and even positive at the onset of the crisis. In this paper, we attempt to shed light on this differential impact of the crisis, and illustrate the uneven mechanics of adjustment in a world with commodity trade and capital flows. The analysis is conducted in an intertemporal general equilibrium model with multi-region and multi-commodity specification.

1. INTRODUCTION

‘Fortune presents gifts not according to the book’ is the opening lyrics of a song by the well-known rock group, Dead Can Dance. It can also serve as a good depiction of the world economies since the financial crisis first broke out in East Asia in the summer of 1997. With much of the dust now settled in East Asia, we observe that the world economy is far from a global slump. Furthermore, although the growth in the crisis-affected economies and other emerging market economies slowed quite significantly, growth was generally sustained in North America and Western Europe, indeed with further strengthening in some cases. According to IMF (‘World Economic Outlook,’ October 1999), between 1997 and 1999, the world total output has grown at rates of 4.2, 2.5, and 3.0 percent from a year earlier. While advanced economies have grown at rates of 3.2, 2.2 and 2.8 percent, developing economies have grown at rates of 5.8, 3.2 and 3.5 percent, and transition economies 2.2, −0.2 and 0.8 percent. Table 1 presents the real GDP growth rates for selected countries.

The conventional view, on the other hand, had been rather pessimistic until very recently. It was feared that the economic stress that had begun in South-East Asia would worsen and spread to the rest of the world, including to many of the industrial economies. Many economists forecasted much

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slower growth rates for the next few years (see among others, DRI forecasts). Even the usually sanguine Fed chairman Alan Greenspan remarked that,

‘Moreover, it is just not credible that the United States can remain an oasis of prosperity unaffected by a world that is experiencing greatly increased stress. Developments overseas have contributed to holding down prices and aggregate demand in the United States in the face of strong domestic spending. As dislocations abroad mount, feeding back on our financial markets, restraint is likely to intensify.’

The puzzling question that naturally arises is ‘why had the world economies adjusted unevenly to the crisis?’

In this paper, we attempt to tackle this question from a general equilibrium perspective. The strategy here is to use a standard growth model augmented with a multi-region and multi-sector apparatus to analyze how a set of real shocks on crisis countries affect the world economy, as well as economies in different regions. We particularly implement the shocks so as to reach the broad magnitudes of order reported in the recent literature on the crisis. These economic shocks are transmitted through commodity trade and capital flow. Our analysis focuses exclusively on our observations that the burden of adjustment to the crisis has been uneven across regions. It had a larger negative effect on other developing countries,


while the impact on industrial economies had been small and even positive at the onset of the crisis. The results obtained in this paper suggest that policy actions that have generally been viewed as responsible for the robust growth of industrialized nations in the face of the financial crisis after all may not matter much. These policy actions include monetary policies adopted by industrial countries, as well as the continued progress with stabilization and reform in Asian crisis countries that have implemented policy programs supported by the IMF. In other words, it could well be that many common concerns were over-stated and not based on a careful economic analysis.

It has to be made clear that our task here is not to offer yet another explanation of the crisis and its causes. Rather we attempt to disentangle, with the aid of a general equilibrium model of real trade and capital flows, the spill-over effects of the crisis on the other regions of the world. In doing so, we illustrate the general equilibrium macro-mechanisms which have generated such widely uneven problems of adjustment across the globe.

Surprisingly, while various explanations of the East Asian financial crisis have been advanced, much less effort has been placed on analyzing the adjustment process both within the crisis countries and outside following the initial crisis. There are a few exceptions. McKibbin and Martin (1998) examine the impact of changes in risk perceptions and policy, among other things, on individual Asian economies and the rest of the world using a dynamic intertemporal general equilibrium model. Although we focus on different aspects of the adjustment process (developed versus developing economies) and we abstract from the nominal side of the economy, our results are generally consistent with theirs in that both papers reach the conclusion that the impact on the crisis countries is big, while that on the rest of the world can be small. Coyle, McKibbin, Wang and Lopez (2000), Stoeckel, Fisher, McKibbin and Borrell (1998), and Diao and Roe (2000) study the impact of the crisis on local and world agricultural markets. Noland, Liu, Robinson and Wang (1998) and Kawasaki (1998) look at the impact on the composition of international trade flows and economic structures within and outside Asia using static computable general equilibrium models. McKibbin (1998) provides a more complete overview of studies that have attempted to model the crisis in Asia, including studies that predicted the crisis and studies that have tried to explain the crisis ex-post.

The remainder of the paper is organized as follows. In section two, we summarize briefly the salient features of the Asian crisis. In section three, we highlight the mechanisms of adjustment. We introduce our formal model in section four, and conduct two alternative simulation analysis in section five. Section six concludes the paper.

See, for example, the comprehensive surveys at Corsetti, Pesenti and Roubini (1999); Radelet and Sachs (1998); the recent symposiums in the Journal of Economic Perspectives, Fall 1999; and the Journal of Policy Modeling 21(3), 1999. The well-celebrated websites of Roubini at http://www.stern.nyu.edu/~nroubini/asia, and of Krugman at http://web.mit.edu/krugman/www/disinter.html also provide many useful links.
2. WHAT HAPPENED?

While there is no consensus on the definite causes of the crisis, there is now evidence that the region’s economies had been confronting a deteriorating macroeconomic environment since the early 1990s (see, e.g., Krugman (1998), Radelet and Sachs (1998), Flood and Marion (1999), Corsetti, Pesenti and Roubini (1999), Chang (1999), and Whitt (1999). A description shared by many is that given by Chang (1999)).

Several countries in the region experienced a real appreciation in their currencies during the 1990s, and by 1997 had sizeable current account deficits. These deficits were mostly financed through short-term foreign borrowing. The history of sustained economic growth for more than two decades had also attracted foreign portfolio and direct investment. The growth rate of exports and industrial output in crisis countries, on the other hand, slowed substantially during the same period.

The rapid inflow of capital and the slowing of growth in the region unveiled a host of inherent structural problems in the region’s financial systems. These problems included lack of competition, supervision, and regulation of the financial sector, and heavy government intervention in credit allocation. Under these conditions, financial intermediaries whose liabilities are guaranteed by the respective governments naturally posed a serious problem of moral hazard, and resulted in excessive borrowing and lending, mostly from abroad.

The essence of the crisis is a huge, sudden reversal of capital flows due to the sharp downturn in expectations about the future profitability of investments in these countries which cause investors to liquidate their claims. This downturn in expectations has a range of sources. Krugman (1998) attributes earlier, higher expectations to the anticipation that investment failures would be bailed out. Young (1994) argues that the ongoing rate of investment has been excessive, and that investment returns have therefore been declining, following the profile of diminishing returns to capital. Tobin (2000), on the other hand, views the foreign exchange transactions in the crisis countries as mostly speculative.

Accustomed to large scale capital inflows, the sudden turn-around in flows caused by the downward revision in investors’ expectation about their investment profitability was an enormous shock to the Asian economies. This initial shock was further compounded by other factors. According to McKibbin and Martin (1998), the most prominent of these factors is the emergence of higher risk premia on loans to the affected countries, and the related reluctance of creditors to roll over short term credits. With a dramatic depreciation in the real value of their currencies, and high domestic interest rates, domestic credit conditions tightened, which lead to a rapid rise in non-performing loans and a sudden loss of bank capital. The resulting collapse of domestic bank capital added to the contraction by further restricting bank lending. The result was the abandonment of planned investments by some

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3 According to Adelman and Yeldan (2000), the persistent failure of uncovered interest parity to hold had led to hasty and excessive investments in crisis countries.
firms, and the curtailing of production activities by others. Accompanying the decline in current income and diminished expectations of future income, the consumption demand fell. All of the crisis countries experienced a collapse in GDP growth in 1998.

3. **4TH ECONOMICS ADJUSTMENT TO THE CRISIS**

The crisis affected the rest of the world, not only through the international financial system, but also through international commodity trade and capital mobility. Since one region’s imports are another’s exports, the decline in imports of crisis countries can cause sectoral exporting countries to experience a decrease in their exports, and hence a fall in their sectoral receipts. The higher the ratio of sectoral exports to total production, the larger the negative effects are likely to be.

A decline in the prices of internationally traded inputs tends to lower production cost, thus affecting the competitiveness of various sectors depending on the intensity of the use of these inputs in production. Offsetting the decline in intermediate input cost is the cost of domestic resources, such as labor, that are not traded internationally. The cost of these resources may rise due to the expansion of production at home.

Another effect of the crisis is through capital markets. Capital leaving crisis countries will flow into non-crisis countries, putting downward pressure on interest rates there. The reduced domestic interest rates will in turn stimulate investment and thus growth in the domestic capital stock. Sectors that experienced increased capital formation, either directly or indirectly from these flows, will respond by increasing their demand for other resources whose productivity is increased by growth in capital stock. Thus, the growth in capital stock can, by increasing the demand for labor and associated inputs, also contribute to the bidding up of the prices of purely domestic or non-traded resources and further raising the cost of production.

Effects of the Asian crisis on the world economy depend, in the long run, on three factors: the extent to which pre-crisis expectations of long-run returns to capital were grossly in error; the likelihood that the crisis will spread to other regions; and post-crisis policies of crisis-ridden economies. In the next two sections, we turn to a general equilibrium modeling study of these issues.

4. **4TH MODEL ECONOMY**

We formalize the modes of adjustment presented above, and estimate the spill-over effects of the crisis on other regions of the world in this section. The model used here belongs to the family of multi-sector, multi-region, computable general equilibrium setup. These frameworks are used widely to analyze the impact of global trade liberalization and structural adjustment programs. The model draws in many ways upon recent contributions by Adelman and Yeldan (2000), McKibbin (1993), Mercenier and Sampaio de Souza (1994), Mercenier and Yeldan (1997), and Diao and Somwaru (2000). The model incorporates

considerable detail on sectoral output, consumption, and trade flows—both bilateral and global. It does not include financial market phenomena that capture effects such as investor confidence. However, as will be demonstrated below, the model and the assumed shocks account for most of the fall in investment, output and terms of trade in the Asian countries.

The inherent structural problem of the crisis economies is modeled as over-investment in selected industries, given government policies and herd behavior in the presence of an unregulated banking sector. The outbreak of the crisis and its later contagion are modeled as an adverse shock on those sectors’ expected return on investment resulting from a temporary fall in total factor productivity and an increased risk premia associated with investment in these sectors. Such an increase in risk premia can be due either to policy changes that eliminate some of the benefits to firms, or to the impaired collateral firms could offer. McKibbin and Martin (1998) examine a range of shocks including those that are external to the region, and those that are internal to the affected countries. They identify the primary cause of the crisis to be fundamental reassessment of the profitability of investment in the region. They further argue that the increase of risk premia on loans to the crisis countries has become an important secondary shock for the region. The magnitudes of these shocks are described in more detail below as we analyze alternative scenarios.

The world economy is aggregated into three regions: the developing region, the developed region, and the crisis region. There are four production sectors in each region, and they each produce a single aggregate commodity. These sectors include (1) agriculture and food processes (agriculture); (2) mineral, materials, and intermediates (intermediaries); (3) manufacturing; and (4) services.

Within each region, a representative consumer makes joint decisions on consumption and savings. Similarly, on the supply side, a representative producer in each sector makes production and investment decisions simultaneously. The model also incorporates multilateral trade and capital flows among regions. Commodities produced for domestic markets are assumed imperfect substitutes for those imported from abroad. The price of a good imported by a region, therefore, is not necessarily the same as the price of the same good produced at home or exported. A detailed description of the model is as follows.

4.1. Firms

Producers within each sector of a region are aggregated into a representative firm. A firm makes production and investment decisions to maximize its intertemporal profits. In doing so, the firm chooses levels of labor and intermediate inputs every period, taking as given prices of outputs, the wage rate, prices of intermediate inputs, and the stock of capital. Outputs are either sold in the domestic market or exported to foreign markets.

Firms are owned by a representative household/consumer, and investment is financed by the household’s domestic saving and international borrowing. At
each period, firms’ profits, \( div_{n,i,t} \) – equivalent to the gross revenue minus labor costs, intermediate input costs, and investment costs – are distributed to the household. Investment raises the stock of capital in the presence of capital adjustment costs. Investment goods are purchased from the sectors of intermediates (providing materials), manufacturing (providing equipment), and services (providing construction services). While the construction services are mainly ‘home good,’ materials and equipment can be imported from abroad. The investment goods are combined by a Cobb-Douglas technology with capital adjustment costs to become new physical capital. Formally, the firm’s problem can be described as follows:

\[
V_{n,i} = \max_{\{I_{n,i}, L_{n,i}, ITD_{n,i,j}, \ldots, ITD_{n,i,j,t}\}} \sum_{t=1}^{\infty} R_{n,i} div_{n,i,t} 
\]

\[
\text{s.t.} \quad X_{n,i,t} = f(L_{n,i,t}, K_{n,i,t}, ITD_{n,i,j,t}, \ldots, ITD_{n,i,j,t}) 
\]

\[
K_{n,i,t+1} = (1 - \delta_{n,i})K_{n,i,t} + I_{n,i,t}. 
\]

The dividend is defined as

\[
div_{n,i,t} = P_{n,i,t} X_{n,i,t} - \sum_j PC_{n,j,t} ITD_{n,j,t} - W_{n,t} L_{n,i,t} - PL_{n,i,t} I_{n,i,t} \left( 1 + \phi_{n,i} \frac{I_{n,i,t}}{K_{n,i,t}} \right). 
\]

The variable \( V_{n,i} \) is the value of firm \( i \) in region \( n \) in the first period; \( R_{n,t} = \prod_{s=1}^{t} \frac{1}{1+r_{n,s}} \) is the discount factor for future returns; \( X_{n,i,t} \) is the final output; \( P_{n,i,t} \) is the price of the output; \( L_{n,i,t}, K_{n,i,t}, \) and \( ITD_{n,i,j,t} \) are, respectively, labor, capital and intermediate inputs in the production of \( X_{n,i,t} \); \( W_{n,t} \) is the wage rate; \( PC_{n,j,t} \) is the price of the intermediate input used by firm \( i \) in the production of \( X_{n,i,t} \); \( PL_{n,i,t} \) is the price of the investment good; \( \delta_{n,i} \) is the capital depreciation rate; and \( \phi_{n,i} \frac{I_{n,i,t}}{K_{n,i,t}} \) is the adjustment cost per unit of capital investment. The symbol \( I_{n,i,t} \) is the quantity of new capital built through investments at time \( t \):

\[
I_{n,i,t} = A_{n,i} \prod_j invD_{n,i,j,t}^{d_{n,i,j}}. 
\]

where \( A_{n,i} \) is the efficient coefficient for investment, and \( invD_{n,i,j,t} \) is the capital good inputs to develop the physical capital, \( I \), \( 0 < d_{n,i,j} < 1 \), and \( \sum_j d_{n,i,j} = 1 \).

Because of the presence of adjustment cost on capital, marginal products of capital differ across sectors resulting in unequal, though optimal, rates of investments. Furthermore, once investment is installed as fixed physical capital, it cannot further be reinvested in other sectors, nor in other assets such as foreign bonds. There also exists other regional risk factors associated with investment. We model such risk by adding a risk premium on the interest rate faced by firms. That is, in each region, firms face an interest rate defined as

\[
r_{n,t} = (1 + \pi_{n,t}) r_t, 
\]

\( \pi_{n,t} \) being the risk premium.
where \( \pi_{n,t} \) is the risk premium for firms and is set exogenously in the model, and \( r_t \) is the riskless interest rate facing the world finance market. We assume this riskless interest rate also prevails in developed economies.

4.2. Households

In each region a representative household owns labor and financial assets, including equity in domestic firms and foreign bonds. The household allocates income to consumption and savings to maximize his lifetime utility:

\[
\max_{\sum_{t=1}^{\infty}} \left( \frac{1}{1+\rho} \right)^t \log(TC_{n,t})
\]

subject to the following budget constraint:

\[
SAV_{n,t} = W_{n,t} L_{n,t} + TI_{n,t} + div_{n,t} + r_t B_{n,t-1} - PTC_{n,t} TC_{n,t},
\]

where \( \rho \) is the positive rate of time preference; \( TC_{n,t} \) is the aggregate consumption at time \( t \); \( SAV_{n,t} \) is the household saving; \( B_{n,t-1} \) is the stock of foreign assets; \( r_t B_{n,t-1} \) is the interest earned from ownership of foreign bonds; \( PTC_{n,t} \) is the consumer price index, and \( TI_{n,t} \) is the lump-sum transfer of government revenues from taxes and tariffs. We assume no government saving-investment behavior. Government spends all its tax revenues on consumption or as transfers to the household. \( TC_{n,t} \), the instantaneous consumption, is generated from the consumption of final goods by maximizing a Cobb-Douglas function:

\[
TC_{n,t} = \Pi_i c_{n,i,t}^b_{n,i}
\]

subject to

\[
\sum_i PC_{n,i,t} c_{n,i,t} = PTC_{n,t} TC_{n,t},
\]

where \( c_{n,i,t} \) is the final consumption for good \( i \), and consumption shares \( b_{n,i} \) satisfy \( 0 < b_{n,i} < 1 \), and \( \sum_i b_{n,i} = 1 \).

4.3. World commodity markets and capital flows

International trade flows are tracked by their origin and destination. The variable \( M_{n,s,i,t} \) represents the trade flow of commodity \( i \) from region \( n \) to \( s \) at time \( t \), and is endogenous in the model.

International borrowing and lending correspond to the respective current account deficits and surpluses, and are endogenous in the model. When a region’s current consumption plus its investments exceed its current domestic income, the region experiences a trade deficit. If the reverse is true, the region experiences a trade surplus. If the region does not own enough foreign assets to offset the deficit, the trade deficit has to be financed by international borrowing (i.e., \( SAV_{n,t} \) is negative). Once international borrowing occurs, we observe foreign capital flowing into the country. The current period’s foreign

borrowing becomes a net debt burden and either increases the country’s total outstanding debt or reduces its foreign assets, that is,

\[
FB_{n,t} = \sum_{i} \sum_{s} (PW_{n,s,i,t}M_{n,s,i,t} - PW_{s,n,i,t}M_{s,n,i,t}),
\]

(10)

\[
B_{n,t+1} = (1 + r_t)B_{n,t} + FB_{n,t},
\]

(11)

where \(FB_{n,t}\) is the foreign trade surplus of region \(n\), \(PW_{n,s,i,t}\) is the world price of commodity \(i\) from region \(n\) to \(s\) at time \(t\), and \(B_{n,t}\) is the foreign assets. A negative \(FB_{n,t}\) implies trade deficit for region \(n\), while a negative \(B_{n,t}\) is foreign debt for \(n\).

We define a region’s real exchange rate as the ratio of the region’s consumer price index over that of the developed economies, that is, the consumer price index for developed economies is chosen as the model’s numeraire.\(^4\) Movements in a region’s real exchange rate reflect changes in the price level relative to that of developed economies, and does not capture any change in nominal magnitudes in response to changes in the region’s exchange rate policy or policies for financial or monetary sectors.

4.4. Government policies

Government policy instruments include import tariffs, indirect taxes imposed on production processes, and sales taxes on final consumption.\(^5\) Our main purpose here is to capture the effects of government interventions and weak financial systems, how they lead to over-investment in financially-dubious projects within crisis economies. However, such information is not available in a quantifiable form in the original database. Government intervention in crisis countries has often taken the form of implicit insurance that is equivalent to a stock of contingent public liabilities not reflected by data on debt nor the deficit until the crisis occurred. Even though there were differences in the specifics of governments’ policies to enable firms to expand their investment, they all led to the same outcome: excessive concentration of investments in certain key sectors of the economy. We introduce an ‘investment subsidy policy’ to capture the basic features of government interventions in firms’ investment strategies. The subsidy is thought to be granted only for manufacturing firms, with no comparable provisions for the other three sectors.\(^6\) The subsidy is designed to lower firms’ capital installation (adjustment) costs in their investment process as well as to put a ceiling on the interest rate faced by firms in manufacturing.

\(^4\) This price index is the average of consumption good prices weighted by their base year levels of consumption.

\(^5\) Further information about these instruments along with their initial levels are included in the database used for conducting the calibration. See Global Trade Analysis Project (GTAP) Database, version 3, in McDougall (1997).

\(^6\) In Korea, excess investments and associated profitability problems were concentrated in the manufacturing sector. In other countries, such as Thailand, the focus was on the real estate sector (Huh, 1997). Data availability and computational burden limit our analysis to the case of subsidy to manufacturing sector. Since manufacturing sector is more export oriented, this arrangement allows for a higher probability of spreading out of the crisis to the rest of the world. Therefore our analysis can be viewed as a worse case scenario from the viewpoint of non-crisis economies.
More formally, let $s_{n,t}$ be the subsidy rate on the capital installation cost, and $\gamma_{n,t}$ be the difference between the market interest rate and government’s interest ceiling. Then, the capital adjustment cost function is redefined for the manufacturing sector in the region of crisis economies as \((1 - s_{n,t}) \phi_{n,t} K_{n,t}/n_i\), and equation (5) becomes

$$r_{n,t} = (1 + \pi_{n,t})(1 - \gamma_{n,t})r_t,$$

where $s_{n,t}$ and $\gamma_{n,t}$ are positive for manufacturing and zero for the other three sectors in crisis economies. The investment subsidy is financed by a lump-sum tax on (or a lowered government transfer to) the household.\(^7\)

4.5. Equilibrium

Equilibrium requires that at each time period \((i)\) in each region, the demand for production factors equal their supply; \((ii)\) the world total demand for each sectoral good equals its total supply; \((iii)\) aggregate household savings equal zero. In the steady state equilibrium, the following constraints must also be satisfied for each region:

$$r_n = r_{ss},$$

$$r_{ss} = \frac{div_{is}}{V_{is}},$$

$$I_{is} = \delta K_{is},$$

$$FB_{ss} + r_{ss}B_{ss} = 0.$$

4.6. Data and model calibration

The data for the model’s calibration are mainly drawn from the Global Trade Analysis Project (GTAP) database, version 5, which typifies the world in 1997. The GTAP database includes production, consumer and government consumption, intermediate input and investment demand data for 65 countries or regions over 57 commodities in 1997. The database also provides initial capital stock and savings in each country or region. The database further includes the bilateral trade flows among these countries or regions for each of the 57 commodities in 1997.

We aggregate the GTAP database into three regions and four aggregate sectors. As previously defined, the three regions are crisis economy, developing economy, and developed economy, while the four sectors are agriculture and good processes (agriculture); mineral, materials, and intermediates (intermediaries); manufacturing; and services. We include in crisis economies a number of Asian countries (Indonesia, Korea, Philippines, Thailand, Malaysia, Singapore, Hong Kong and Taiwan), two Latin American countries (Brazil and Argentina), and Russia to better capture the later development of the

\(^7\) An appendix that contains further details of the model including a list of equations and a glossary is available upon request.
crisis. The developed region includes EU countries, US, Canada, Australia, New Zealand, and Japan. The rest of the world are accounted for in the group of developing countries.

The calibration of the model involves specifying values for certain parameters obtained from external sources and deriving the remaining ones from restrictions posed by the equilibrium conditions. The demand elasticities of substitution between domestic and imported goods or among the goods imported from different countries of origin are obtained from the GTAP database. In addition, parameters related to intertemporal decisions are obtained from other macroeconomic studies. The method used to calibrate parameters and initial values of variables associated with the intra-temporal economic activities involves standard processes used in static CGE modeling efforts. Discussion about the calibration strategy for the parameters and initial values associated with intertemporal behavior is in Appendix A.

5. 4TH ANALYSIS OF ALTERNATIVE SIMULATIONS

We focus on two sets of issues and conduct two scenarios. The first scenario (EXP-1) is used to evaluate the general equilibrium effects of the crisis on the world economy. The EXP-1 later is served as a ‘base’ in the second scenario (EXP-2) which is designed to investigate the possible effects of eliminating government investment subsidy in the crisis economy. That is, in EXP-2, in addition to what we will do for EXP-1, the investment subsidy in the crisis region will be removed.

5.1. EXP-1: general equilibrium outcomes of the crisis

In their recent paper, Corsetti, Pesenti and Roubini (1999) undertake an extensive analysis of the macroeconomic environment and financial system of crisis economies. Eschewing a purely financial panic explanation, they conclude that common domestic and international shocks hit several East Asian economies in the 1996–1997 period. Our simulation pursues this line of argument. However, in the absence of a full-fledged theory on financial-real economy linkages, we directly implement real-side consequences of the crisis on investment patterns by shocking the model (increasing the difficulty and risk premium in capital investment in the region) to simulate the investment contraction. The crisis resulted in currency depreciation, increases in domestic interest rate and prices, and increased unemployment and higher bankruptcy rates in affected countries. Such outcomes are likely to cause investment to fall and economic growth to slow down. Since the intertemporal general equilibrium is a real economy apparatus in which monetary terms and many financial assets are not explicitly recognized, it cannot capture the effects of currency depreciation on world financial and asset markets directly.8

8 However, the apparatus allows us to introduce the concept of real exchange rate as the ratio of domestic versus foreign commodity baskets. See, Obstfeld and Rogoff (1996, Ch. 4) for an analytical exposure.

Tables 2 and 3 summarize the trade flows among the three regions across agriculture, intermediaries, manufacturing and services. Crisis economies import mostly from developed economies; other developing economies import also mainly from developed economies; while developed economies import from both crisis economies and other developing economies, and they import relatively more from other developing economies agriculture and intermediary goods. In terms of export, crisis economies and other developing economies share similar structure in the sense that they export most of their commodities to developed economies in all the sectors. Developed economies export to both crisis and other developing economies.

In the model the investment subsidy is employed to reduce the capital adjustment cost while the interest ceiling reduces the risk of investment in the manufacturing investment. In our simulation, the subsidy rate is chosen such that the total subsidy is equivalent to 6.2 percent of total government expenditure. This is the number estimated by Dalla and Khatkhate (1995) while studying subsidies involved in policy loans in Korea. In addition, the interest rate ceiling results in the interest rate faced by firms in manufacture being 30 percent lower than the market rate of crisis economies. According to Dalla and Khatchate (1995), in the early 1990s, the average borrowing rate by manufacturing firms protected by governments in Korea was about 30 percent lower than the market rate. The rest of the model is calibrated to 1997 Global Trade Analysis Project (GTAP) Database.5 under the assumption that the initial current account is ‘sustainable’ and consistent with the initial interest rate.

Our baseline is designed mainly to simulate the crisis conditions. We exogenously raise the value of the region’s risk premium, \( \pi_{n,t} \), in equation (12)
and reduce the technological coefficient, $A_{n,t}$, in the sectoral investment functions in equation (4) for crisis countries in the first three years. We then lower the risk premium gradually, and raise $A_{n,t}$ to its original level in the following three years. The shocks are chosen so that output changes for crisis economies for the first five years match that of the real changes in these regions in the years 1997, 1998, 1999, and the IMF projection for these countries for the years 2000–2003 (*World Economic Outlook and International Capital Markets Interim Assessment*, International Monetary Fund, December 1998). Obviously, there are many combinations of risk premia and total factor productivity that can yield to the same output dynamics. In the simulation presented below, we choose the changes in total factor productivity so that it accounts for most of the drop in total output for the crisis economies (between 65 to 85 percent during the first seven years). Our results are not sensitive to the different combinations of risk premia and total factor productivity. The comparison of the simulation results and the real reduction plus IMF projection of changes in regional GDP is in figure 1. Simulation results for other variables of the three regions are summarized and compared with data of selected economies in those regions in figures 2–7.

From figure 1(a)–1(d), we observe that outcomes of the simulation are comparable with the development of the crisis and IMF’s projections. Total output in crisis countries decreases with a fall in investment. The output bottoms out in period 2 and starts to recover beginning in period 3. Our simulation results of the effect of the crisis on world total output also match well with the data (the last year of the data is a projection by IMF, “World Economic Outlook,” October 1999). The simulation results indicate that world output falls by 0.26 and 0.86 percent in 1997 and 1998, and starts to recover in 1999. While the result of change in world output in 1998 ideally matches the real economy, the recovery of the world economy in IMF’s projection for 2000 is slightly faster than the result in the model for the corresponding year (figure 1c).

Our simulation further captures the spillover effects of the crisis on the non-crisis economies. While in the simulation total output of the developing economies falls by 0.08 percent in 1997, it does not change significantly in the developed region in the same year. Growth further slows in 1998 for both the developing and developed economies, but the reduction is much greater in the developing economies than in the developed economies (0.18 percent versus 0.03 percent). Output starts to recover for both regions in 1999. These effects are consistent with qualitative growth patterns of the regional economies as indicated by table 1, and they are mainly the results of international commodity trade and capital mobility. Given that the model used here

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9 The growth rate for the region is a weighted (by GDP of countries within the region) average of the growth rates of each countries in the region subtracted by their average growth rates from 1990–1996. These numbers correspond to the percentage changes in GDP from the steady state reported from the model.

10 Note that the growth rates reported in table 1 are not detrended, therefore, not directly comparable with those generated by our simulation.
abstracts from many factors that may be important for growth, we do not expect our simulation to match the exact numbers along all dimensions. Regional aggregation also makes this comparison difficult. We will, nevertheless,

Figure 1. The impact of the crisis on the world economy

Figure 2. Crisis economy I: model versus selected countries (data source: IFS)
continue to compare our simulation results with qualitative growth and trade patterns of selected economies in each region.

Figures 2–3, (a)–(d) report the impact of the shocks on the crisis economy, its real exchange rate, current account position and trade in the model simulation. With the depreciation of real exchange rate, the price of traded goods increases relative to the price of domestically produced goods sold on the domestic market. Exports increase, imports decrease, and the trade balance improves. A trade surplus, together with a low level of investment, results in a current account surplus for the crisis economies. While these results are generally consistent with the real data, the magnitude of the change in the model is much smaller than that in the real data (see the selected countries in figures 2–3, b and d). It is well known that most of the crisis economies had substantially changed their exchange rate policy during the crisis, which would also affect the economic indicators we discuss here. Without taking into account the impacts of exchange rate policy and other policies in the area of banking and foreign currency administration, the model cannot be expected to generate a result exactly the same as the outcome of real economy. Moreover, countries aggregated into the crisis region in the model include other countries besides crisis Asian economies, which also makes the comparison difficult. Nevertheless, by comparing figures (a) and (c), with (b) and (d) in figures 2 and 3 respectively, our model results do capture the changing patterns of these indicators in the real economies.

One main purpose of the model exercise is to gauge the possible impacts of Asian crisis on the non-crisis economies. The spillover effects of the crisis in the

Figure 3. Crisis economy II: model versus selected countries (data source: IFS)
model simulation are summarized in figures 4 (a), 5–7, (a) and (c). In order to evaluate the quality of the results, we also present real data for the corresponding indicators for some selected economies embedded in the same figures in 4 (b), 5–7, (b) and (d). Note that since we use the developed economy as numeraire, its real exchange rate does not change over time in the model. The decline in commodity imports of crisis economies caused non-crisis regions to experience a fall in their exports. In the simulation, exports fall by 0.5–1.7 percent in developed economies, and 1.5–5 percent in developing economies during the first two years immediately after the crisis. However, exports as a percentage of total output in developed economies (11.7 percent) are much larger.

Figure 4. Developed economy I: model versus selected countries (data source: IFS)
Figure 5. Developed economy II: model versus selected countries (data source: IFS)

Figure 6. Developing economy I: model versus selected countries (data source: IFS)
smaller than that in developing economies (19.2 percent). The same degree of decrease in export, therefore, has a relatively smaller impact on GDP for developed economies. Furthermore, given that developed economies account for about 70 percent of the world GDP and that the crisis does not affect the developed economies very much, the world GDP falls only slightly in the first year of the simulation, even though GDP falls by 2.2 and 0.18 percent respectively in the crisis and developing economies.

The decrease of export in developed economies is caused by the decreased demand of crisis economies and other developing economies, especially of manufacturing and services, while the decrease of export in developing economies is mainly a result of competitive pressure from crisis economies given their similar trade structure. Although the real exchange rate in developing economies depreciated in the simulation, it is much less significant compared with the depreciation in crisis economies. Therefore, exports in developing economies decrease as well, but at a slower rate than that in developed economies. Conversely, imports for both developed economies and other developing economies increased. These numbers are broadly consistent with the real ones. Among the three developed economies presented in figures 4 and 5 (Italy, UK, and US), all of them experienced substantial decrease in their exports between 1997 and 1998. All of them except Italy experienced a large increase in their imports in 1998. For the three developing countries presented in figures 6 and 7 (Mexico, South Africa and Turkey), all of them experienced moderate currency depreciation compared with the crisis.

Figure 7. Developing economy II: model versus selected countries (data source: IFS)
economy. Compared with the developed economies, all of them had larger
decrease in their exports. The increase in imports is less obvious except for
South Africa.

In the world capital market, the decrease in export and increase in import in
developed economies lead to large capital inflow into these economies causing
a significant drop in these economies’ current account position (as percent of
GDP) as shown in figure 4. The resulted increase in capital stock in turn raises
the production output and GDP in developed economies. The developing
economies also benefit from such capital inflows, but the benefits are much
smaller compared with the developed economies. In the data, all three
developed countries experienced a large drop in their current account. With the
exception of Turkey, current accounts deteriorated in all the developing
economies.

5.2. EXP-2: effects of government investment policy on economic recovery

In the second scenario, to study the possible effects of a change in government’s
investment policy, we gradually eliminate government’s investment subsidy in
the crisis economy’s manufacturing sector in the first six periods. We also
eliminate the interest ceilings applied to investment in manufacturing. The
parameters of the model are otherwise the same as those used in our first
experiment. Of course, without an explicit banking sector, the model cannot
capture all of the financial effects of a change in the government’s investment
policy, especially the intervention in the banking system and bank’s businesses.
Note, however, that even though the model lacks an explicit banking system, it
maintains an effective financial capital market and accommodates the main
attributes of financial intermediation of a market economy in a theoretically
consistent framework.

In the model, the investment subsidy and the interest ceiling are the two
policy tools which were employed to make investment in the crisis economy’s
manufacturing sector less costly and more profitable. Such a policy will
obviously distort firms’ investment decisions, leading to over-investment in
manufacturing and possibly under-investment in other sectors such as services
and agriculture. Hence, intuitively, removing such a subsidy would lower
manufacturing’s investment in the economy, while the effects on other sectors
have to be evaluated in a general equilibrium framework. Our simulation
results of EXP-2 show that investment in the crisis economy’s manufacturing
sector does fall significantly, which further causes a reduction in the output of
that sector. Figure 8 portrays the transitional paths (percentage changes in
comparison to EXP-1) upon to period 20 for the capital stock and output by
sector in the crisis economy. It shows that the removal of investment subsidy in
the manufacturing sector affects other sectors differently. The immediate effect
on the investment in services is negative, while it is positive in the agricultural
and intermediate sectors. However, over time when the subsidy is fully
eliminated in the manufacturing, investment eventually rises in services and
falls in the intermediate sector (figure 8).
With regards to the production level, we observe that the size of the manufacturing does not contract as much as its capital stock in the economy relative to EXP-1. Comparing the results of the two scenarios at the same period, output of the crisis economy’s manufacturing falls to 92 percent of its level obtained in the base scenario EXP-1, while the capital stock in this sector falls by a quarter in the same period. One reason is that, with less capital supply, the marginal product of capital rises. This causes the manufacturing sector to employ more labor or other inputs to substitute for capital in the production process.

Eliminating the investment subsidy in the manufacturing sector also affects the crisis economy’s trade structure. As shown in figure 9, compared with EXP-1, exports rise and imports fall for the other three sectors, while for the manufacturing sector, exports fall and imports rise.

We find that the effect of removal of the investment subsidy on the crisis economy’s GDP is negative, though quite small in comparison with that in the base scenario (figure 10). Even though production in services and agriculture rises in EXP-2, the significant contrast of the manufacturing sector drags down the level of GDP by one more percent compared with the base scenario.

Change in the crisis economy’s investment subsidy policy reinforces the aggregate effect of the crisis on the world economy in a modest way. The aggregate GDP in developing economies is observed to experience an additional small decline, while GDP rises slightly in the developed economies (figure 10). With a further decline in the crisis region’s GDP, world GDP further falls slightly (figure 10). In real life policy setting, one may encounter...
many other forms of distortions in the crisis economy in their industrial policies, banking systems, or capital markets. It can be conjectured that once such essential reforms are implemented by the countries in the region, adjustments in their economies as well as in the world will be much larger than what we simulate here. Moreover, these reforms are expected to improve the economy’s efficiency, stimulate productivity growth, and hence, the growth in these countries’ GDP. However, as most of these policies are not explicitly modeled, and since productivity growth is not endogenously affected by the policy reform in the model, such gains are not captured in the simulation results.

6. 4TH CONCLUDING COMMENTS

In this paper, we have investigated the differentiated impacts of the East Asian Crisis on the world economy with the aid of an intertemporal general equilibrium model. In the absence of a full-fledged model of real-financial linked theoretical apparatus, we tried to capture the real side effects of the crisis by studying its consequences on investment demand within a simulation-based applied general equilibrium framework.

Our simulation analysis indicates that the post-crisis adjustments led to a lower output in developing economies, yet aggregate GDP of the developed economies increased. Furthermore, the crisis had a bigger effect on developing economies than on developed economies. Capital flows from crisis economies to non-crisis developing economies and developed economies caused capital
account deficits in both regions, more so in the developed region. These results are robust to alternative specifications where additional risks are taken into consideration.¹¹

The paper also analyzed the general equilibrium results of possible policy reform on investment allocations conducted by the crisis economy. By eliminating the implicit investment subsidy in manufacturing, we tried to capture the efficiency gains associated with the removal of distortions to the firms’ intertemporal decisions on capital accumulation. We find that elimination of the subsidy in the manufacturing, in the long run, raised

¹¹ We conducted an additional experiment where we choose our shocks to reproduce the more pessimistic output dynamics first projected by IMF in October 1998. We find that the pattern of changes in investment, output, current account, exports, imports, and the real exchange rate are the same as the base simulation results, although the magnitude is slightly bigger. We do not report those results to save space.
investment in services and agriculture, and reduced investment in intermediaries. Exports in manufacturing fell, while imports rose. Exports in all other sectors rose, and imports fell. The effects of such a policy reform on world economy remained the same as those in the first experiment. The output in other developing countries fell, while the output in developed region rose slightly. Our analysis, therefore, suggests that the contagion of a ‘global slump’ to the developed economies may not be well founded, and the significance of the policy actions that are generally associated with the ‘recovery’ of the world economy may be a matter of debate.

REFERENCES

International Monetary Fund (1998, October) ‘World Economic Outlook.’
International Monetary Fund (1999, October) ‘World Economic Outlook.’


**APPENDIX A: 4TH CALIBRATION STRATEGY**

As in a static computable general equilibrium (CGE) model, where calibration begins with the assumption that data obtained for the domestic economy reflect an equilibrium in a given year, in the intertemporal CGE model, the world is assumed to be evolving along a balanced (equilibrium) growth path. In counterfactual experiments, this specification can be regarded as robust since the model is interested in deviation with respect to a reference path.

The method used to calibrate parameters or initial values of variables associated with intra-temporal economic activities involve standard processes used in static CGE modeling efforts. The more subtle intertemporal calibration is provided here. Starting from the balanced growth assumption, the household time discount rate, \( \rho \), equals the world interest rate, \( r \), which can be chosen from outside data, while a country’s foreign assets or debt are determined by equation (16) once the trade deficits or surplus are obtained from the database. The GTAP database provides both the values of each region’s stock of capital and the flows of capital. Using these data, together with the data of the value of total investment, it is easy to calculate the initial level of total dividend payments \( \text{div} = \text{value of capital flows} – \text{value of total investment} \). The initial value of the firms, \( V \), and hence the marginal value of capital, Tobin’s \( q \), are then obtained, that is, \( V = \text{div}/r, q = V/K \). The value of the capital depreciation rate, \( \delta \), and the coefficient in the capital adjustment costs, \( \phi \), have to be chosen consistently with the balanced growth condition. We can choose either \( \delta \) or \( \phi \) and then calculate the other one from the equilibrium conditions. If \( \phi \) is chosen first, then \( \delta \) is calculated from the following equation derived from the steady-state condition:

\[
\delta = \frac{q}{2P\phi} - \left[ \frac{rq - wk}{P\phi} + \left( \frac{q}{2P\phi} \right)^2 \right]^{\frac{1}{2}}.
\]

The quantity of total physical investment, \( I \), can be determined via \( I = \delta K \). The capital adjustment costs, and the unit cost for investment, \( P_I \), then can be easily obtained.

In an intertemporal general equilibrium model, the analysis typically focuses on the adjustments generated in the finite time periods in response to parametric changes of selected exogenous variables. In addition, the model is run by using GAMS. Hence, imposition of a terminal condition becomes

pertinent for a discrete time intertemporal model when there are out-of-steady-state transitional paths for the endogenous variables. Since the terminal conditions are, in fact, conditions for the steady state, an ideal period should be chosen when a steady state is asymptotically approached.

**APPENDIX B: BENCHMARK VALUES FOR SELECTED VARIABLES AND PARAMETERS**

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<th>Crisis</th>
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