Accounting for the East Asian Crisis
A Quantitative Model of Capital Outflows in Small Open Economies

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Abstract
To what degree can the qualitative and quantitative aspects of the East Asian crisis be accounted for within a dynamic general equilibrium model? This paper investigates that question, in a framework where the crisis itself is modeled as an exogenous shock to the country risk premium. The exercise has an empirical discipline because the scale of the shock can be measured by the behavior of the reported risk premium. We calibrate a quantitative sticky-price dynamic general equilibrium model of a small open economy to match the features of three East Asian economies: Thailand, Korea, and Malaysia. We identify a shock to the country risk premium using published data from international bond markets and identify short-run monetary policy using observed domestic interest rates. We find that the modeled response to the observed increase in external interest rates substantially matches macroeconomic data on prices and quantities at the aggregate and sectoral level. The model has more difficulty explaining the large exchange rate devaluations that occurred in those economies.

Keywords: East Asian crisis, sticky prices, small open economy.
JEL Code: F4 Macroeconomic Aspects of International Trade and Finance

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I. Introduction

In the middle of 1997, a number of East Asian economies underwent a common financial crisis. Korea, Malaysia and Thailand each experienced severe exchange rate devaluations and current account reversals. In each economy, the currency devaluations were followed by large real contractions. Other economies in the region, including Hong Kong, Indonesia, the Philippines, Singapore, and Taiwan, were also affected to varying degrees. This paper will examine some of the common features of these contractions and examine the ability of standard, but modern, business cycle theory to quantitatively capture these features. The purpose is to “account” for the East Asian crisis using a quantitative small open economy model whose principles are drawn from the equilibrium sticky-price open economy macroeconomic (S-POEM) literature.

We model the crisis as an exogenous rise in the country risk premium on foreign lending into a small open economy. Data on bond yields show that the premium on the US dollar bonds issued by entities in these countries rose dramatically during the crisis. In our model, we assume a rise in the country risk premium to exactly match the rise in the country risk premium observed. We compare the dynamic response of the model to the macroeconomic impact of the financial crisis in three East Asian economies (Korea, Malaysia and Thailand) that were among those most severely affected by the crisis. In a sticky-price economy, however, the response of the economy to a given shock will depend on the stance of monetary policy. We note that inter-bank lending rates rose dramatically at the onset of the crisis. We model this steep rise in nominal interest rates as deviations from a monetary policy rule that targets domestic inflation and output. The deviations are calibrated to exactly match the rise in interest rates in the data.

The distinguishing characteristic of the S-POEM literature (see Lane, 2001, for a review) is that an equilibrium includes the optimal decision rules of forward-looking agents with rational expectations, but nominal prices converge only over time to market-clearing levels due to menu costs. A rise in the real interest rate causes households to delay consumption and firms to delay investment spending. In the absence of a sufficient monetary easing, the external shock to the economy generates a contraction in nominal demand for domestic goods. The contraction in nominal demand translates into a contraction in real demand in the presence of sticky prices.

In East Asia, the U.S. dollar is the currency of denomination of much international trade. In our model, both imports and export prices are set in a foreign currency, while goods produced for the domestic economy are priced in domestic currency. A rise in external interest rates above domestic interest rates leads to an exchange rate depreciation. A nominal exchange rate depreciation increases the price of imports relative to domestic goods, leading to a switching of expenditure toward domestic goods. Conversely, the exchange rate depreciation does not reduce the real price of exports. This pricing model combines the producer currency pricing framework of Obstfeld and Rogoff (1995), which emphasizes expenditure switching, and the local currency pricing framework of Betts and Devereux (1996, 2000), in which exchange rate changes have no immediate expenditure-switching
effects. This model of pricing is effective in matching the immediate response of export and import prices to the currency devaluations observed in East Asia.

Another aspect of the data in which we are interested is the sectoral response of output. A textbook response of a small open economy to an external interest rate shock is a switch from the production of non-traded goods for domestic use to the production of traded goods needed to repay foreign debts (see for example Sachs and Larrain, 1993). However, this does not match the sectoral response observed in the data for East Asia. During the crisis we observe a sharp drop in production of both traded and non-traded goods. To deal with this, we depart from the textbook model by incorporating intermediate imported materials into production. In our model, imported intermediate materials are an important factor in the production of traded goods. These inputs must be purchased in advance, subjecting them to finance costs. The rise in the price of international borrowing during the crisis results in higher costs of obtaining the working capital needed to purchase imported materials. This results in an equilibrium fall in output of traded goods.

We find that when we match the shocks to internal and external interest rates in our model to the data, the modeled responses of nominal and real macroeconomic aggregates match their counterparts in the data both qualitatively and quantitatively. One controversial aspect of the crisis was whether the monetary response of the respective central banks contributed to the severity of the crisis. We examine a counterfactual case in which the monetary policy response to the crisis is described by a Taylor (1995) rule. In this case, the contraction in output and investment are substantially less persistent.

Our paper is related to a large literature on the causes of emerging market crises of the mid- to late-1990s. Explanations might be divided into two broad categories: internal and external. Internal crisis theories explain the crisis as the result of either policy failings or limitations of financial markets within the affected economies. External explanations describe the crisis as the result of imperfections within international financial markets themselves. Our paper is essentially agnostic with respect to this distinction. We measure the exogenous shock that drives the crisis from observed country risk spreads on U.S. dollar bonds. These spreads could be driven by herding behavior among international investors (see Calvo and Mendoza, 2000) or by an elimination of loan guarantees by domestic fiscal authorities (see Corsetti, Pesenti, and Roubini, 1999). In this sense the shock may be consistent with either an ultimately internal or external source. Thus, our paper does not offer a fundamental explanation of the source of the crisis. Rather, we impose a maintained hypothesis that, whatever the underlying source, the scale of the crisis itself can be represented by the movement in observed risk spreads, and that these risk spreads are independent of the subsequent path of the economy and the stance of monetary policy. Under this hypothesis, we ask how well the response to the crisis can be tracked by a sticky-price multi-sector dynamic open economy model.

A number of theories have explained crises as the outcomes of policy errors or market failures internal to the affected countries. Chang and Velasco (1998, 2000a & b, 2001) implicate bank runs
caused by a maturity mismatch in the domestic banking sector as the source of the crisis. Dooley (2000) argues that implicit loan guarantees of private-sector debt in East Asia would lead to a currency crisis if those guarantees were called and the resulting debts were to be monetized. Krugman (1998a) is an influential early paper calling attention to crony capitalism that characterized some East Asian economies. Burnside, Eichenbaum and Rebelo (2001) construct a model that allows for a quantitative study of the size of debts that might be incurred and the resulting effect on exchange rates. Corsetti, Pesenti and Roubini (1999) argue that government loan guarantees would lead to over-investment; when a crisis caused guarantees to be removed, the resulting dis-investment would result in a real contraction. Our model abstracts from the fiscal aspects of the currency crisis, although in principle our approach is consistent with the view that the discovery of loan guarantees caused a deterioration in the external borrowing environment, so long as the subsequent path of the economy can be represented as in the dynamic model.

Many papers have stressed the aggregate importance of balance-sheet aspects of the East Asian crisis. Many private East Asian debtors faced a mismatch in the currency denomination of their assets and liabilities. Krugman (1998b) and Aghion, Bachetta, and Bannerjee (2000, 2001) show how balance-sheet constraints may lead to a self-fulfilling exchange rate crisis. Arrellano and Mendoza (2002), and Gustavo, Roldos, and Christiano show that balance-sheet constraints may be important in generating ‘sudden stops,’ defined as a switch towards a binding national constraint on capital inflows for a borrowing country (see also Calvo and Reinhart, 1999). Since any binding constraint on capital flows can by definition be reinterpreted as a rise in the external borrowing rate, our paper is also consistent with this literature.

A few papers have studied the quantitative impact of interest rate shocks, an exercise very similar to ours. Mendoza (2001) studies the business cycle effects of sudden stops in a quantitative business cycle model. McKibbin (1998) studies the effect of an interest rate shock on a multi-country model at annual frequencies. Neumayer and Perri (2001) examine the business cycle behavior of emerging markets subject to country risk premium shocks calibrated to the time-series behavior of Argentine spreads. Burstein, Eichenbaum and Rebelo (2002) quantitatively examine the effect of interest rate shocks on exchange rates and nominal prices. None of these papers focus on the quantitative accounting question that is the center-piece of our analysis. Kim (2002) constructs a dynamic multiple equilibrium model to examine whether ‘animal spirits’ shocks can explain quantitative features of the Asian crisis. Gertler, Gilchrist and Natalluci (2000) explore whether balance sheet effects help in explaining the contraction that occurred following the East Asian currency crisis.

The rest of the paper is organized as follows. Section II documents the key macroeconomic facts of the East Asian crisis in Korea, Malaysia, and Thailand. Section III sets out a two-sector sticky-price model of a small open economy. Section IV explains how we calibrate the model. Section V presents the results, and section VI offers some conclusions.
II. The East Asian Crisis

This section documents the macroeconomic response of Korea, Malaysia and Thailand to the East Asian crisis. Figure 1, Column A graphs the month-by-month movements in the Korean won, the Malaysian ringgit, and the Thai baht relative to the U.S. dollar from 1997 to 2002. Through early 1997, these currencies are stable against the U.S. dollar. In the third quarter of 1997, each currency experiences a large depreciation. After a large but brief overshooting, the currencies settle at levels between 30 and 40% weaker than pre-crisis levels. The timing of the depreciations varied across countries. The baht begins depreciating at the outset of the third quarter, while the ringgit and won do not depreciate until late in the third quarter.

Figure 1, Column B shows the response of the country risk premium for each of these economies. Since early 1997, HSBC has calculated yields on an index of U.S. dollar bonds issued in each of a number of Asian emerging markets. We measure the country risk premium for Korea, Malaysia, and Thailand as the spread between the HSBC yield indices and contemporaneous yields on three-month U.S. Treasury bills. In early 1997, the observed spreads in each country are between 100 and 200 annualized basis points. During late 1997, spreads rise dramatically in Korea and Thailand, approaching levels between 600 and 800 annualized basis points and reaching a peak in late 1998. Malaysia experiences a more moderate rise of 400 basis points in late 1997 before rising to more than 1200 basis points in late 1998. Later, spreads narrow but remain between 300 and 500 basis points even 5 years later.

To identify the macroeconomic effects of the East Asian crisis, we utilize its large size and clear timing, which is reflected in the movements in the country risk premium. We assume that the shock in the risk premium that occurred in the third quarter of 1997 and beyond was responsible for the difference between the actual realizations in the economy and its previous path. A downside of this identification scheme is that it disregards subsequent shocks. However, the unprecedented size of the crisis makes it possible to trace its impact even in the presence of background noise.

We report results from seasonally adjusted quarterly national income accounts. The real variables we examine are GDP, Personal Consumption Expenditure, Gross Fixed Capital Formation, Exports, Imports, Traded Goods Value Added (the traded goods sector being the sum of manufacturing, mining, and agriculture), and Non-Traded Goods Value Added (GDP minus traded goods). The nominal variables are the deflators of domestic absorption, exports, imports, traded goods, and non-traded goods. We must first estimate the pre-crisis paths of each economy’s

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3 Data on the HSBC indices are from Bloomberg. The remaining East Asian national income accounting, exchange rate and interest rate data used in this paper are from CEIC/DRI Asia database, which gathers published data from official sources.
macroeconomic aggregates. We detrend all variables except the exchange and interest rates with a log-linear quadratic trend. In many cases, real variables are substantially above trend in mid-1997. We estimate AR(1) processes for each of the detrended variables. Figures 2-4 show the difference between each series and their outcomes if they had reverted geometrically back to trend after the third quarter of 1997.

Each country experiences a sharp real contraction in both production and absorption of goods at the end of 1997; the decline in GDP reaches a trough of more than 10% below the pre-shock path. Korean and Malaysian GDP return to trend by early 2000. Thai GDP returns to trend later in 2001. Personal consumption expenditure and gross fixed capital formation contract in each country. In Thailand, the contraction in consumption is of approximately the same size as GDP. In Korea and Malaysia, the contraction in consumption is slightly more severe than the contraction in GDP, reaching a trough more than 15% below the pre-crisis path. The sharpest contractions occur in fixed investment. The trough of investment is 25% below the pre-crisis path in Korea. In Thailand and Malaysia, investment falls to more than 50% below the previous path. The contraction in absorption is much sharper than the contraction in output. In each country, there is a sharp decline in imports to around 30% below the previous path. By comparison, there is no obvious immediate impact of the crisis on exports. During 1998, exports fall in Thailand and Malaysia. Two years after the crisis, however, there is a large surge in exports in each country, rising to a level that is 8-12% above the previous path of exports. Contractions occur in both traded and non-traded goods sectors and are, initially, of approximately the same size in the two sectors. The recovery is much sharper in the traded sector and the contraction much more persistent in the non-traded sector.

In each economy, the domestic currency prices of both exports and imports rise contemporaneously with the exchange rate depreciation. The price increase in these categories is of comparable size to the exchange rate depreciation. In each country, there is a much smaller rise in the absorption deflator (perhaps reflecting the rise in the price of imports). In each country, there is a rise in the price of traded goods (perhaps reflecting the rise in domestic currency export prices). All of these price spikes converge back to trend. In Thailand, there is a mild rise in non-traded prices in the immediate aftermath of the shock. Contemporaneous changes in the non-traded price level are minimal in Korea and Malaysia.

Panels (M)–(O) show the response of the nominal and real exchange rate with the U.S. dollars and nominal interest rates. Real exchange rates are calculated using absorption deflators as relative prices. To assess the response of the nominal and real exchange rate to the crisis, we examine deviations from the mean exchange rate in the first half of 1997. Each economy experiences a sharp exchange rate depreciation in mid-1997. The size of these depreciations are large, with the won and baht depreciating by more than 60% and the ringgit by more than 40%. There is some overshooting in each country, with the currencies finding a persistent level somewhere near 40% of the original value. Malaysia adopts a peg in late 1998, while Korea and Thailand float their currencies. In each economy,
crisis-era inflation was higher in the affected economies than in the U.S., so the real exchange rate depreciates by less than the nominal exchange rate. However, the price rise is not as large as the exchange rate depreciation, so the real exchange rate depreciations are substantial. In each economy, the real exchange rate initially depreciates by 30–40% in late 1997. The real exchange rate depreciation appears quite persistent. In both Malaysia and Thailand, the real exchange rate remains at more than 20% above the pre-crisis path. The rapid disinflation that occurs in Korea leads to a real exchange rate that is currently 50% weaker than the pre-crisis level.

To assess the response of the nominal interest rate, we examine deviations of the short-term inter-bank lending rate from the mean interest rate in the first half of 1997. In each economy, the inter-bank lending rate rises sharply during the initial periods of the crisis. In Korea, the interest rate at peak is 1200 basis points above the pre-crisis level. In Malaysia and Thailand, the rise in the interest rate is not as sharp, reaching a peak 400 basis points above the previous level. After the fall of 1998, however, interest rates in all three countries drops sharply. In Korea and Thailand, the nominal interest rate is 800 basis points below the pre-crisis level by 1999. In Malaysia, the nominal interest rate is 400 basis points below the pre-crisis level by 1999.

III. The Model

We model a small open economy populated by a representative agent that owns the factors of production and borrows from the world economy at an exogenous interest rate. A range of non-traded and traded goods are produced and sold by a range of monopolistically competitive firms.

A. Demand

1. The Representative Agent

The infinitely-lived representative agent and has rational expectations. In any period, the agent derives utility from consumption, $C_t$, and disutility from labor, $H_t$. The agent’s subjective discount function is a declining function of the agent’s consumption level.

$$ V_t = \max_{C,H} \left[ \log(C_t) - \Gamma H_t \right] + \beta(C_t) E_{t+1} \left[ V_{t+1} \right] $$

The subjective discount rate is a concave function ($\beta' < 0$ and $\beta'' > 0$) of current consumption with enough curvature to ensure a stationary level of wealth. The agent issues foreign currency debt, $D_t$, at an exogenous rate $1 + r_t$. Sector-specific capital $K^T$ and $K^N$ is rented to firms in the traded goods and non-traded goods industries in competitive markets at rates $R^T$ and $R^N$ respectively. The agent supplies labor in competitive markets at wage rate $W_t$, and receives profits from monopolistically competitive firms that sell traded and non-traded goods domestically as well as exporters; total profits are $\Pi = \Pi^T + \Pi^N + \Pi^{EX}$. Agents purchase final goods at price $P$ and allocate goods to consumption and to traded and non-traded goods investment, $I^T$ and $I^N$. Lump-sum taxes finance government spending, $G$. Define $S$ as the spot exchange rate. The budget constraint is:

$$ S_{t+1} = \frac{E_{t+1} S_t}{E_{t+1} E_{t+1} S_{t+1}} $$
Consumption, investment, and government goods are defined as a nested CES combination of domestically produced non-traded goods, $X^N$, domestically produced traded goods, $X^{Td}$, and imported traded goods, $X^m$. Domestic and foreign traded goods are combined into a quantity of traded goods absorbed, $X^T$. The price index is the cost-minimizing marginal cost of acquiring these goods.

\[
C_t + I^T_t + I^N_t + G_t = X_t = \left[ a^{\phi - 1} \left( X^T_t \right)^{\phi} + (1 - a)^{\phi - 1} \left( X^N_t \right)^{\phi} \right]^{\frac{1}{\phi}}
\]

The non-traded aggregate is a Dixit-Stiglitz aggregate of a unit range of differentiated goods, $x^N_i$. The domestic traded aggregate is a combination of differentiated goods, $x^{Td}_i$. The price index of domestic traded and non-traded goods are denoted by $P^{Td}_t$ and $P^N_t$.

\[
X^N_t = \left[ \int \left\{ x^N_{i,j} \right\}^\xi \, di \right]^{\frac{1}{\xi}} \quad P^N_t = \left[ \int \left\{ p^N_{i,j} \right\}^{1-\xi} \, di \right]^{\frac{1}{1-\xi}}
\]

\[
X^{Td}_t = \left[ \int \left\{ x^{Td}_{i,j} \right\}^\xi \, di \right]^{\frac{1}{\xi}} \quad P^{Td}_t = \left[ \int \left\{ p^{Td}_{i,j} \right\}^{1-\xi} \, di \right]^{\frac{1}{1-\xi}}
\]

The price index of imported goods is $S \times P^*$. The price of the cost-minimizing combination of domestic traded goods and imports is then $P^T_t$, defined in a straightforward manner from the aggregator $X^T_t$.

The representative agent accumulates capital in each sector through investment, subject to adjustment costs

\[
K^T_{t+1} = (1 - \delta) K^T_t + I^T_t - \frac{\xi}{2} (I^T_t / K^T_t - \delta)^2 K^T_t
\]

\[
K^N_{t+1} = (1 - \delta) K^N_t + I^N_t - \frac{\xi}{2} (I^N_t / K^N_t - \delta)^2 K^N_t
\]

The home agent maximizes utility subject to the budget constraint and the accumulation equations for sectoral capital. The first-order conditions that characterize the optimal plans are:

\[
\frac{1}{C_t} + \beta' (C_t) V_{t+1} = P_t \Omega_t
\]

\[
\Gamma = W_t \Omega_t
\]

\[
\lambda^*_t = \frac{\Omega_t P_t}{1 - e^\left( I^*_t / K^*_t - \delta \right)}
\]
where $\Omega_t$ is the shadow value of domestic currency and $\Lambda^T_t$ and $\Lambda^N_t$ are the shadow values of sector-specific capital. Equations (6) and (7) describe the optimal choice of consumption and labor supply. Equations (8) and (9) characterize the choice of investment in the two sectors. Equations (10)-(11) and (12)-(15) respectively describe the demand for aggregate non-traded goods and traded goods, and the individual demands for each good. Equations (16) and (17) describe the Euler equations for international borrowing, and equations (18) and (19) describe the optimal choices for capital accumulation in each sector.

2. Exports
Some traded goods are sold overseas by exporting retailers. The retailers sell differentiated traded goods at a foreign currency price, $p^{ST}$. Define aggregate exports, $EX$, as a Dixit-Stiglitz combination of these differentiated goods and an associated price index, $P^{ST}$.

$$EX_T^T = \left[ \int_0^{\xi} \left\{ e^{x_{ijT}} \right\}^e di \right]^{1\over 1-e} \quad P_T^{ST} = \left[ \int_0^{\xi} \left\{ p_{ijT}^{ST} \right\}^{1\over 1-e} di \right]^{1\over 1-e}, \quad 0 < \xi < 1$$

The foreign demand for these exports is determined in parallel to the domestic demand for imports.

$$P_T^{ST} (1 - b^*)^{\mu - 1} \left\{ EX_T^T \right\}^{\mu - 1} \left\{ X_T^{*T} \right\}^{1 - \mu} = P_T^{ST}$$

where $X_T^{*T}$ represents total foreign demand for traded goods.

B. Production

1. Traded Goods

Traded goods are produced with a combination of sector-specific capital, labor $H_T^T$, and imported materials $M$.

$$Y_T^T = A \left[ d^{d-1} \left\{ V_T^T \right\}^\gamma + (1 - d)^{d-1} \left\{ M_T \right\}^\gamma \right]^{1\over \gamma} \quad V_T^T \equiv A^2 \left\{ K_T^T \right\}^{\theta_1} \left\{ H_T^T \right\}^{1 - \theta_1}$$

where $V_T^T$ is domestic value added in the traded goods sector. Traded goods manufacturers are price takers in output and input markets. The manufacturers purchase the imported materials, one period in advance with foreign currency borrowed at rate $r_{t-1}$. The first-order conditions of the firms’ profit-maximization problem are

$$PPI_T^T (1 - \theta_2) {V_T^T \over H_T^T} d^{d-1} \left\{ V_T^T \over Y_T^T \right\}^{\gamma-1} = W_T, \quad \theta_2 \left( {V_T^T \over K_T^T} \right) d^{d-1} \left\{ V_T^T \over Y_T^T \right\}^{\gamma-1} = R_T$$

$$\left( 1 - d \right)^{d-1} E_{t-1} [PPI_T^T \left\{ M_T \over Y_T^T \right\}^{\gamma-1}] = (1 + r_{t-1})P^{TS} E_{t-1} [S_T]$$

where $PPI_T^T$ is the producer price of traded goods and $P^{TS}$ is the foreign currency price of imported materials. Conditions (22) characterize the optimal choice of labor and capital in traded goods production, while (23) represents the optimal choice of imported materials. Note that the output of traded goods will be limited within any period by the pre-set quantity of imported materials. In addition, the foreign interest rate will adversely affect the purchases of imported materials.

2. Non-Traded Goods

Price-taking non-traded goods manufacturers use labor and capital to produce goods, $Y^N$, sold at price $PPI^N$. 

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The first-order conditions of the firms’ profit-maximization problem, for the choice of labor and capital, are

\[
Y_t^N = \left\{ K_t^N \right\}^{\theta_N} \left\{ H_t^N \right\}^{1-\theta_N}
\]

The first-order conditions of the firms’ profit-maximization problem, for the choice of labor and capital, are

\[
PPI_t^N (1 - \theta_N) \frac{Y_t^N}{H_t^N} = W_t \quad PPI_t^N \theta_N \frac{Y_t^N}{K_t^N} = R_t^N
\]

C. Sticky Prices

In this model, there are three types of sticky prices: retail prices of non-traded goods; domestic retail prices of traded goods; and foreign currency prices of exported goods. The dynamics of each of these prices follow a similar framework. For each, there is a range of monopolistically competitive price setters who purchase an undifferentiated input good (i.e. traded or non-traded) from manufacturers at a scale invariant marginal cost, generically referred to as \( \bar{MC} \), and face a constant elasticity demand curve. In each period, a randomly distributed fraction \( 0 \leq (1 - \kappa) \leq 1 \) of price setters get a chance to adjust prices, as described by Calvo (1983) and Yun (1996). The price-setting mechanism can be described as follows. Define \( \tilde{p} \) and \( \tilde{q} \) as the price and quantity of the individual generic price setter, and the generic aggregate output and price indices as \( \bar{Q} \) and \( \bar{P} \).

\[
\tilde{Q}_t = \left[ \int_0^{\tilde{\xi}_i} \tilde{q} \, d\tilde{\xi}_i \right]^{\frac{1}{\tilde{\xi}_i}} \\
\tilde{P}_t = \left[ \int_0^{\tilde{\xi}_i} \frac{1}{\tilde{p}^{1 - \tilde{\xi}_i}} \, d\tilde{\xi}_i \right]^{\frac{1}{1 - \tilde{\xi}_i}} \\
\tilde{q}_{t,i} = \left( \frac{\tilde{p}_{t,i}}{\bar{P}_t} \right)^{\frac{1}{1 - \tilde{\xi}_i}} \tilde{Q}_t
\]

Since the model set out above assumes that the elasticity of substitution of the final goods purchaser (whether domestic households or foreigners) for both traded export goods, and non-traded goods are all equal and constant at level \( \tilde{\xi} \), then this description of price and quantity aggregators applies to each of these activities equally.

Generic profits are \( \bar{\Pi} \equiv (\bar{p} - \bar{MC}) \cdot \bar{q} \). Price setters with an opportunity to change their price maximize the sum of expected discounted profits over the expected life of the price. We assume shocks occur after the price setters have chosen their prices. Thus, the price index is quasi-fixed in any period, as described in Rotemberg and Woodford (1997).

\[
\max_p E_{t-1} \left[ \sum_{j=t}^{\infty} \left( \prod_{i=t}^{j-1} \frac{\kappa}{1+\delta_i} \right) \Pi_j \right] = \max_p E_{t-1} \left[ \sum_{j=t}^{\infty} \left( \prod_{i=t}^{j-1} \frac{\kappa}{1+\delta_i} \right) \tilde{P}_j^{\frac{\tilde{\xi}_i}{1-\tilde{\xi}_i}} \tilde{Q}_j \left( \tilde{p}_{t,i} - \frac{1}{\tilde{\xi}_i} \bar{MC}_j \right) \right]
\]

Optimal price \( \tilde{p}_t \) is choice that maximizes expected profits as
The price index evolves over time as

\[ \tilde{p}_t^{\xi} = \kappa \tilde{p}_t^{\xi-1} + (1 - \kappa) \tilde{p}_t^{*\xi-1} \]

Each of the price setters in the three areas follows this pattern. A unit measure of non-traded (traded) retailers purchase undifferentiated goods in the non-traded (traded) manufacturing sector and sell differentiated non-traded (traded) goods to the home country household. Likewise, a unit measure of retailers purchase undifferentiated traded goods and sell them as differentiated export goods to foreign residents. In the non-traded sector, retailing firms purchase goods at marginal cost, \( PPIN \), and sell to the household at price \( pN \). In the traded goods sector, retail firms buy at marginal cost, \( PPIT \), and sell at price \( pT \) (domestic traded goods retailers) or \( Sp^{ST} \) (export retailers). See Table 1 for a one-to-one matching of the elements of the particular price setter and the basic sticky-price framework.

D. Monetary Policy

Define real GDP as the sum of the value added in the traded and non-traded sectors. The former is measured as the sales to domestic consumers, plus the sales to foreigners, less the cost of material imports. Real GDP is then implicitly defined as

\[ P_t GDP = P_t GDP_i \quad X_t^{Td} + S_t^{ST} \quad EX_t \quad - (1 + r_{-1}) S_t^{ST} \quad M_t \quad + \quad P_t^{Nt} \quad Y_t^{NT} \]

The monetary policy rule has two components. The central bank determines a long-term nominal growth rate that implies a long-term nominal interest rate, \( \tilde{i} \), and CPI inflation rate, \( \tilde{\pi} \). The authorities also set short-term interest rates to respond to fluctuations in inflation and GDP from their stationary steady states.

\[ i_t - \tilde{i} = \rho \left( \frac{P_t}{P_{r-1}} - \tilde{\pi} \right) + \rho \left( GDP_t - GDP \right) + \varepsilon_t \]

where \( \varepsilon_t \) is a stationary function that allows the monetary authority to target interest rates for a finite time period in response to shocks.

E. The Crisis and Equilibrium

We study the response of the economy to a single shock that occurs at time \( t=1 \). The single shock generates a dynamic path for the country risk premium through finite time period \( T, \{ r_t \}_{t=1}^{T} \), and monetary policy through time period \( L, \{ \varepsilon_t \}_{t=1}^{L} \).
Define $\Xi_t$ as the history of the economy up to time $t$. An equilibrium is a set of policy functions of the representative agents, manufacturers and price setters: $C(\Xi_t)$, $I^T(\Xi_t)$, $I^N(\Xi_t)$, $X(\Xi_t)$, $X^T(\Xi_t)$, $X^N(\Xi_t)$, $EX(\Xi_t)$, $IM(\Xi_t)$, $Y^T(\Xi_t)$, $Y^N(\Xi_t)$, $M(\Xi_t)$, $H(\Xi_t)$, $H^T(\Xi_t)$, $H^N(\Xi_t)$, $D(\Xi_t)$, $K^T(\Xi_t)$, $K^N(\Xi_t)$, $w^T(\Xi_t)$, $w^N(\Xi_t)$, $p^T(\Xi_t)$, $p^N(\Xi_t)$, $p^ST(\Xi_t)$; and price functions: $P(\Xi_t)$, $P^T(\Xi_t)$, $W(\Xi_t)$, $R^T(\Xi_t)$, $R^N(\Xi_t)$, $PPIT(\Xi_t)$, $PPIN(\Xi_t)$, $S(\Xi_t)$, $i(\Xi_t)$; which solve the first-order conditions of the agents’ optimizations problems and labor and goods markets clear:

$$H^T_t + H^{NT}_t = H, \quad \int_0^1 x^T_{t,i}di + \int_0^1 x^N_{t,i}di = Y^T_t \int_0^1 x^N_{t,i}di = Y^N_t$$

IV. Calibration

Lacking a closed-form solution, we log-linearize and solve the approximate linear model using the solution algorithm in King and Watson (1995). We calibrate the dynamics of adjustment at standard values from the calibrated business cycle literature. Following Baxter and Crucini (1993), the depreciation rate of capital is set at $\delta = .025$ and the capital adjustment cost is set so the steady-state elasticity of the investment-capital ratio with respect to marginal Tobin’s $q$, $(e\delta)^{-1} = 15$. Following Gali and Gertler (2001), we set $\kappa = .75$, so that prices change on average once per year.

The elasticity of substitution between domestic production and imports (and the demand elasticity of exports) is set at $\frac{1}{1-\mu} = .6$, which is an average of the estimates from Asia, reported in Reinhart (1995). Kollmann (2001) uses the same elasticity for a model of developed economies. The elasticity of substitution between traded and non-traded goods is $\frac{1}{1-\phi} = .66$, based on a GMM estimate using pooled data from five Asian countries as described by Ostry and Reinhart (1992). The elasticity of substitution between materials and value added, $\frac{1}{1-\gamma} = .7$, is set at .7 following Rotemberg and Woodford (1996).

We will examine three separate numerical cases, one for each of Korea, Malaysia, and Thailand. We calibrate the long-term macroeconomic ratios of each case to the national income data of the corresponding country from the time period 1980-1996 in Korea and Thailand and 1987-1996 for Malaysia. Lane and Milesi-Feretti (2001) construct country-level data on net international investment positions. Row [A], Table 2 shows the average of net external assets positions as a share of GDP. We calibrate the subjective discount rate function, $\beta(\cdot)$, so steady-state debt as a share of GDP matches Row [A]. Exports as a share of GDP are reported in Row [B], Table 2. The share of imports that is intermediate materials is reported in Row [C]. We calibrate $b$ and $d$ in each case to match Rows [B] and [C]. Non-traded goods as a share of GDP are reported in Row [D]. We calibrate $a$ in each case to match these shares. Row [E] shows government spending as a share of GDP. We calibrate the steady-state government consumption-GDP ratio to match Row [E].

Sarel (1997) uses cross-country data to estimate the capital intensity of various one-digit ISIC code industries. For 1990-1996, we calculate weighted averages of Sarel’s capital intensity
estimates of the traded sectors (Agriculture, Manufacturing, and Mining), where the weights are the share of the one-digit industry in traded value added. We then estimate $\theta_T$ as the average traded goods capital intensity across time. We repeat the process for the remaining one-digit sectors that are classified as non-traded to estimate $\theta_N$. The capital intensity parameters are reported in Table 2, Rows [F] and [G].

We calibrate the technology parameters, $A^1$, $A^2$, and $A^t$ plus the parameters of export demand function so that, (1) the steady-state marginal cost of domestic value added in the traded sector is equal to the marginal cost of imported materials; (2) the steady-state marginal cost of domestic final goods is equal to the marginal cost of imported final goods; (3) the steady-state marginal cost of traded goods is equal to the steady-state marginal cost of non-traded goods; and (4) the real exchange rate between the foreign CPI and the domestic traded good price is equal to 1. We calibrate the economy near the case where steady-state profits are arbitrarily near zero.

The shock to the external interest rate is calibrated to average quarterly spreads between HSBC’s country-level U.S. dollar bond yield indices (for Korea, Malaysia, and Thailand) and U.S. Treasury bills. The steady-state interest rate, $r$, is set equal to the average yield in the first half of 1997. The modeled shock is a projected path for the country risk premium beginning in period $t=1$. For periods $t=1\ldots19$, this path exactly follows the observed spread between the HSBC index and the 3-month U.S. Treasury rate over the period 1997:4 to 2002:2 (see Figure 1, Column B). For the periods $t = 20\ldots80$, the country risk premium follows the average over the initial 19 periods of the shock. Subsequently, the country risk premium reverts to zero.

The immediate response to the crisis in each of the three countries was a sharp increase in short-term nominal interest rates (see Figure 1, Column C). Following the crisis the monetary policies of the countries diverged, with Korea and Thailand adopting some form of inflation targeting and Malaysia adopting an exchange peg with the U.S. dollar. However, we take the position that predicting long-term monetary policy was difficult following the large exchange rate devaluations. As a default, we assume that monetary policy converges to a benchmark Taylor (1996) rule, $\rho_y = 1.5$, and $\rho_v = .5$. In the short-run, we set the monetary policy shock, $\epsilon_t$, so that the rise in nominal interest rates exactly matches the rise in interest rates observed in the data. The increase in the nominal interest rate is calibrated as the difference between the observed interest rate and the average interest rate observed in the first half of 1997.

V. Impulse Responses

One advantage of examining the East Asian crisis is that the singular, unpredicted nature of the event makes it possible to identify its macroeconomic effects. However, the same singular nature makes it more difficult to use standard statistical analysis to formally test the model. Our main
analysis will consist of visually and numerically comparing the impulse responses of an external risk premium shock to the actual paths of output and other variables.

A. Qualitative Outcome

Here we briefly summarize the qualitative effects of the crisis. The rise in the country risk premium will raise the cost of repaying net foreign debt. This will have both substitution and income effects. The substitution effect causes the representative agent to delay consumption and reduce investment in capital goods. As all three economies are net debtors, the interest rate rise has a negative income effect, reducing optimal consumption at all price levels. At given relative prices, the contraction in real demand would reduce the components of domestic absorption: imports, domestic traded goods, and non-traded goods. However, the response to the shock will also involve an adjustment of relative prices.

Given that the shock induces a persistent rise in the external interest rate above the domestic nominal rate, the interest parity condition will imply an immediate depreciation in the nominal exchange rate followed by a persistent expected appreciation. Since there is full exchange rate pass-through into import prices, the relative price of imports rises sharply. Home agents substitute domestic goods for imports, which bear the brunt of the decline in demand. Domestic goods, however, are relatively imperfect substitutes for foreign goods, so changes in the relative price generate only small substitution effects. Hence, in equilibrium there is a decline in demand for domestic goods. Because exporters practice local currency pricing, the exchange rate depreciation does not immediately increase the quantity of exports. Only over time, as exporters lower their prices to reflect the weakening exchange rate, do exports increase.

The impact of the risk premium shock on production depends on the stance of monetary policy. With a passive or expansionary monetary policy, the authorities could leave domestic nominal interest rates unchanged, or even attempt to reduce interest rates, in response to the risk premium shock. Given the presence of uncovered interest rate parity, this would involve a large immediate real and nominal exchange rate depreciation. The depreciation would lead to a cushioning of the demand effects of the shock on domestic traded and non-traded goods. But the contractionary monetary policy, observed in the data and matched by our model, involves an increase in domestic interest rates. This mitigates the immediate real exchange rate depreciation, and hence leads to a greater decline in absorption and output in domestic traded and non-traded goods.

The decline in domestic absorption induced by a rise in the external risk premium can potentially have different effects according to the sector. All output of the non-traded sector is absorbed by the domestic economy, while the output of the traded sector will over time face an increasing demand from the export channel. Moreover, because domestic traded goods are better substitutes for imported traded goods than are non-traded goods, the nominal depreciation will elicit a bigger substitution response towards domestic traded goods, whose prices are sticky. Thus, we anticipate a bigger fall in
output in the non-traded sector. On the other hand, the traded goods sector employs imported intermediate inputs, and the rise in the external real interest rate directly increases the price of these inputs.

The particular pricing structure that we assume generates some results for outcomes of nominal prices. The local currency pricing that we assume for exports implies that, in the short-run, export prices denominated in the domestic currency will rise, along with the exchange rate devaluation. Since domestically produced traded goods are a combination of exports and domestically traded goods whose prices are quasi-fixed, the traded goods price will also rise to reflect devaluation. Over time, as exporters and domestic retailers change their prices, the export and traded goods deflator will fall. Since importers pass the full effects of changes in the exchange rate through to domestic prices, the exchange rate depreciation leads to a one-for-one rise in the price of these goods, at least in the short-run. Total home absorption is a combination of non-traded goods (which have quasi-fixed prices), domestic traded goods, and foreign imports. As a result, the absorption deflator rises with the exchange rate and import prices in the short-run. Over time, contractionary monetary policy will reduce the price of domestically produced goods. This disinflation will initially be muted by sticky nominal prices.

B. Quantitative Comparison: Model vs. Data

We examine three different cases, corresponding to Korea, Malaysia or Thailand, that differ in terms of the calibration of the parameters and the dynamic shocks to domestic and external interest rates. Figures 5, 6, and 7 illustrate the theoretical impulse responses for 15 macroeconomic series for Korea, Malaysia, and Thailand, respectively. These series correspond with the 15 variables from the data reported in Figures 2-4. The benchmark responses are represented by the solid line with stars. The counterfactual response, had policy followed a Taylor rule, is illustrated by the dashed line. The modeled response of real macroeconomic aggregates is close to the data along qualitative and quantitative dimensions. A V-shaped contraction in GDP is observed in both the data and the models. In each economy, GDP contracts sharply in the period of the shock and converges back to the mean in subsequent periods before ultimately achieving a level slightly higher than the initial steady state. In the data, GDP for all three economies reached a trough approximately 10% below the pre-crisis path. In the models, GDP reaches a trough of approximately 10% below the steady state. Because the shocks are persistent, the GDP contraction also displays substantial persistence. However, the models do not fully match the persistence of the output contractions observed in the data. Actual output is below the previous path for at least eight quarters. By contrast, output has substantially reverted back to steady state after four quarters in all modeled economies. This is to be expected, given that we are using a relatively parsimonious dynamic general equilibrium specification without other mechanisms for generating endogenous propagation.
Panels (B) and (C) show the responses of investment and consumption to the shock in the calibrated models. A rise in the external interest rate leads to large contractions in consumption and investment. In the data, in each country, gross fixed capital formation contracted far more sharply than GDP. The models match this qualitative feature. Moreover, we observe that investment fell between 25 and 50% in the three economies. The model’s investment response varies between 30 and 50%. However, the pattern of investment response across countries is slightly counterfactual: the model predicts a higher investment response (50% decline) in Korea and Thailand, with a smaller response in Malaysia, while in reality Malaysia and Thailand experienced the largest response (about 50%), with Korea having a lower response (25%).

Empirically, personal consumption expenditure fell by approximately the size of the contraction in output. In the data, this implies contractions in consumption of more than 14% below steady state. In the model economies, consumption also falls sharply, varying between a fall of 10% in the model based on Korea, and approximately 15% in the Thailand and Malaysia cases. The modeled consumption contractions are very persistent, due to permanent income effects.

Panels (D) and (E) display the responses of exports and imports. In each of the model economies, local currency pricing prevents the exchange rate depreciation from generating any immediate increase in exports. However, over time as export firms adjust their prices, modeled exports increase by between 3% (Korea) and 8% (Thailand). In the data, after some delay, there is a mild increase in exports in each country prior to the weakening of the U.S. business cycle after 2000. Each modeled economy faces a sharp decline in imports. Following a trough contraction in the first period of the crisis ranging between approximately 15% (in the Korea and Malaysia model) and more than 25% (in the Thailand), imports converge almost geometrically back to steady state. In the data, each of the economies faced a sharp contraction in imports early in the crisis period. In each case, the trough contraction was approximately 30% below the previous path. In all cases, imports returned to their long-run level after approximately three years.

In the data, both the traded and non-traded sectors contracted sharply in the initial part of the crisis. In each economy, traded goods converged back to the pre-crisis path almost two years before non-traded goods production recovered. In the model, the presence of short-term price stickiness in the domestic component of traded goods and the slow adjustment of export quantities combine to cause a fall in the output of traded goods in the immediate aftermath of the shock. In the model calibrated to Korea, traded goods production contracts by more than 10% in the period of the shock. In the models calibrated to Malaysia and Thailand, traded goods production contracts between 7-10%. As in the data, the contraction in traded goods production is more transitory than that in non-traded goods. By the third period of the crisis, traded goods production is slightly above steady state in each case, and expands in subsequent periods both because exporters are able to reduce foreign currency prices of exports in those periods and because traded goods producers are able to substitute cheaper imported materials for domestic value added.
Qualitatively, the model generates a large and persistent depreciation in the nominal exchange rate. Quantitatively, the exchange rate depreciation is in the range of 10-20% compared with persistent depreciations of at least 40% observed in the data. Moreover, the model has none of the overshooting seen in the data. The failure of the model to capture the short-run dynamics of exchange rate growth is interesting in that the model is calibrated to exactly match domestic and foreign interest rates.

In each version of the model, the import and export price level immediately rises in the period of the shock. Qualitatively, this “dollar-currency pricing” matches the data. Quantitatively, the rise in import and export prices is small relative to the data, just as the exchange rate depreciation is small relative to the data. In the model, the dynamic response of the imports deflator is equal to the response of the nominal exchange rate, since foreign prices are exogenous. The import price rise is persistent in the model; in the data, import prices converges back to the pre-crisis path as if foreign producers were cutting their foreign currency prices. In the model, the rise in export prices in the period of the shock exactly matches the exchange rate depreciation. Over time, the foreign currency price of export goods is adjusted downward. The data also follows this pattern.

In the model, the rise in import prices results in a small rise in the absorption deflator, varying between 0.5% and 5%. Over time, in each case, prices converge back to the initial steady state as domestic prices fall. On this count, our model seems to match the data quite closely. The peak rise in the absorption deflators is in the range of 6-8%. In the model, traded goods prices rise initially, as part of traded goods is used for exports. Over time, traded prices fall as domestic prices are reduced. This pattern is reflected in the data. The rise in traded prices ranges between 12 and 16% in the data and between 4 and 12% in the model, thus reflecting the relatively small depreciation in the model.

In the model, the non-traded price level is quasi-fixed. After the initial period, the decline in nominal demand results in a fall in the non-traded price level. The empirical behavior in non-traded prices in Korea seems to match this pattern, both qualitatively and quantitatively. In Thailand and Malaysia, the non-traded price level is subject to high-frequency movements, again making the effect of the shock difficult to delineate. In these countries, the quantitative decline in the non-traded price level is small in the data relative to the model.

By construction, modeled nominal interest rates exactly match the data in the first three periods of the crisis. In subsequent periods, when monetary policy follows a Taylor rule, the interest rate declines in both the model and the data. The empirical size of the decline in the interest rate in Korea was larger than in the model. The empirical declines in Thailand and Malaysia seem comparable with the outcomes in the model.

A natural question to ask of this model is how alternative monetary policies would have changed the outcome of the crisis. The dashed lines in each panel show the path of the variables under a strict Taylor rule with no exogenous rise in interest rates (i.e. \( \{ r_t = 0 \}_{t=1}^{\infty} \)). In Thailand, which has a
relatively high share of imports in final goods and thus a relatively sharp modeled response of inflation to an exchange rate devaluation, the Taylor rule proscribes a sharp immediate rise in the nominal interest rate. Thailand’s actual nominal interest rate was closest to that modeled under a Taylor rule. Thus, in Thailand, of the three countries, the benchmark results under the actual interest rates are closest to the results under the pure Taylor rule. The contraction in Thailand, in terms of each of the depicted real variables, is slightly milder and noticeably less persistent under a pure Taylor rule than under observed interest rates. The nominal exchange rate depreciates slightly more in Thailand under a Taylor rule response than under observed interest rates. However, this effect is small.

In the model of Korea, the monetary policy response is a mild but persistent cut in the nominal interest rate. In the model of Malaysia the monetary policy response in the first period is a small rise in the interest rate followed by a persistent, but mild cut in nominal interest rates. These more expansionary monetary policies result in much less sharp and persistent contractions in GDP and investment relative to the benchmark case. The rise in the external interest rate still implies a persistent decline in consumption under each monetary policy. The exchange rate depreciation is sharper under the Taylor rule, especially in Korea. However, this exchange rate depreciation is still much smaller than that observed in the data.

V. Conclusion
Our interpretation of these results is that there is sufficient match between models and data to build confidence in the sticky-price open macroeconomic framework. In this sense, our model does an adequate job of accounting for the experiences of these three countries following the East Asia crisis, when we measure the shocks using the observed rise in foreign currency risk premium, calibrate the structural models of these economies to reflect the observed features of these economies, and specify a monetary reaction rule that mirrors the behavior of domestic interest rates in the aftermath of the crisis. In terms of matching the response of most quantities, including output, consumption, investment, imports, and exports, as well as the sectoral composition of output, our model seems quite successful. The ‘dollar-currency pricing’ mechanism in our model allows us to understand the simultaneous observation of weak export response with a large fall in imports purely through substitution and income responses to the crisis, and without recourse to exogenous credit or financial constraints.

The key shortcomings of the model include the following.

1) Lack of Persistence of Output. The model generates contractions in output that at trough are comparable in size with the data. However, the contraction is less persistent in the model than in the data along two dimensions. First, the trough of the contraction occurs in the period of the shock in the model but several periods later in the data. Second, production converges back to steady state faster in the model than in the data. Our model simplifies this by assuming information about the future dynamic path of the country risk premium that was
revealed in the initial period. A richer dynamic of information revelation would be likely to generate richer dynamic responses.

2) *Exchange Rate Devaluations are too small.* The model generates too small an exchange rate depreciation relative to the data, despite the construction of exact matches of domestic and foreign interest rates in the periods following the shock. The model embeds an uncovered interest rate parity assumption that has been rejected in the paper and seems to display some shortcomings here.

**Bibliography**


Table 1. Sticky-Price Framework  For each of three price setters, exporters and the domestic retailers of traded and non-traded goods, this table shows the counterpart variables to the variables of the generic price setter described in Section III. C. in the text.

<table>
<thead>
<tr>
<th>Sticky Price</th>
<th>Generic</th>
<th>Non-Traded Prices</th>
<th>Domestic Traded Prices</th>
<th>Export Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price Index</td>
<td>( \bar{P}_t )</td>
<td>( P_t^N )</td>
<td>( P_t^T )</td>
<td>( P_t^{ST} )</td>
</tr>
<tr>
<td>Firm Price</td>
<td>( \bar{p}_i )</td>
<td>( P_{i,t}^{NT} )</td>
<td>( p_{i,t}^T )</td>
<td>( p_{i,t}^{ST} )</td>
</tr>
<tr>
<td>Quantity Index</td>
<td>( Q_t )</td>
<td>( X_t^N )</td>
<td>( X_t^{rd} )</td>
<td>( EX_t )</td>
</tr>
<tr>
<td>Firm Quantity</td>
<td>( q_t )</td>
<td>( x_{i,t}^N )</td>
<td>( x_{i,t}^T )</td>
<td>( ex_{i,t}^T )</td>
</tr>
<tr>
<td>Marginal Cost</td>
<td>( MC_t )</td>
<td>( PPI_t^N )</td>
<td>( PPI_t^T )</td>
<td>( PPI_t^{ST} / S_t )</td>
</tr>
<tr>
<td>Profits</td>
<td>( \Pi_t )</td>
<td>( \Pi_t^N )</td>
<td>( \Pi_t^T )</td>
<td>( \Pi_t^{ST} )</td>
</tr>
</tbody>
</table>

Table 2 Parameter Estimates  We calibrate three versions of the models, each pegged to parameter estimates from Korea, Malaysia, and Thailand. This table reports the estimates that were used to calibrate these models.

<table>
<thead>
<tr>
<th></th>
<th>Korea</th>
<th>Malaysia</th>
<th>Thailand</th>
</tr>
</thead>
<tbody>
<tr>
<td>[A] External Debt as a % of GDP</td>
<td>.88</td>
<td>1.78</td>
<td>1.41</td>
</tr>
<tr>
<td>[B] Exports as a % of GDP</td>
<td>.328</td>
<td>.728</td>
<td>.308</td>
</tr>
<tr>
<td>[C] Imported Materials as a % of Inputs</td>
<td>.583</td>
<td>.689</td>
<td>.273</td>
</tr>
<tr>
<td>[D] Non-Traded Goods as a % of GDP</td>
<td>.597</td>
<td>.512</td>
<td>.578</td>
</tr>
<tr>
<td>[E] Government Consumption as a share of GDP</td>
<td>.104</td>
<td>.123</td>
<td>.112</td>
</tr>
<tr>
<td>[F] Traded Capital Intensity</td>
<td>.307</td>
<td>0.350</td>
<td>.307</td>
</tr>
<tr>
<td>[G] Non-Traded Capital Intensity</td>
<td>.306</td>
<td>.296</td>
<td>.234</td>
</tr>
</tbody>
</table>
Figure 1: Financial Market Outcomes This figure shows monthly time-series data for Korea [Row 1], Malaysia [Row 2], and Thailand [Row 3]. The series includes the exchange rate with the U.S. dollar [Column A], the spread between the HSBC U.S. dollar bond index and 3-month Treasury yields [Column B], and the inter-bank lending rate [Column C].
Figure 2: Korea–1997:3 - 2002:2  This figure shows quarterly time-series data for Korea over the crisis. Data on real aggregates in Panels A–G and nominal aggregates in Panels H–L are the difference between the log of the actual realization of the detrended variable and a forecast of the path of the detrended variable from 1997:2. The variables are detrended with a log-linear quadratic deterministic trend. The forecast model follows an AR (1). The nominal and real exchange rate and the nominal interest rate are differences between actual variables and the mean in the first half of 1997.
Figure 3: Malaysia 1997:3 - 2002:2 This figure shows quarterly time-series data for Malaysia over the crisis. Data on real aggregates in Panels A–G and nominal aggregates in Panels H–L are the difference between the log of the actual realization of the detrended variable and a forecast of the path of the detrended variable from 1997:2. The variables are detrended with a log-linear quadratic deterministic trend. The forecast model follows an AR (1). The nominal and real exchange rate and the nominal interest rate are differences between actual variables and the mean in the first half of 1997.
Figure 4: Thailand 1997:3 - 2002:2 This figure shows quarterly time-series data for Thailand over the crisis. Data on real aggregates in Panels A–G and nominal aggregates in Panels H–L are the difference between the log of the actual realization of the detrended variable and a forecast of the path of the detrended variable from 1997:2. The variables are detrended with a log-linear quadratic deterministic trend. The forecast model follows an AR (1). The nominal and real exchange rate and the nominal interest rate are differences between actual variables and the mean in the first half of 1997.
**Figure 5: Model Calibrated to Korea** The figure shows the dynamic response to the shock in a model based on parameters and shock dynamics from Korea that occurs in period 1. The solid lines with x’s represent the benchmark response when monetary policy shocks are set to exactly match domestic interest rates in the first three periods of the crisis. The dashed lines represent the response when interest rates follow a Taylor rule in every period.
Figure 6: Model Calibrated According to Malaysia  The figure shows the dynamic response to the shock in a model based on parameters and shock dynamics from Malaysia that occurs in period 1. The solid lines with x’s represent the benchmark response when monetary policy shocks are set to exactly match domestic interest rates in the first three periods of the crisis. The dashed lines represent the response when interest rates follow a Taylor rule in every period.
**Figure 7: Model Calibrated According to Thailand** The figure shows the dynamic response to the shock in a model based on parameters and shock dynamics from Thailand that occurs in period 1. The solid lines with x’s represent the benchmark response when monetary policy shocks are set to exactly match domestic interest rates in the first three periods of the crisis. The dashed lines represent the response when interest rates follow a Taylor rule in every period.