External currency pricing and the East Asian crisis

David Cook a,*, Michael B. Devereux b

a Hong Kong University of Science and Technology, Hong Kong, China
b University of British Columbia and CEPR, Canada

Received 9 September 2004; received in revised form 19 April 2005; accepted 28 June 2005

Abstract

This paper provides a quantitative investigation of the East Asian crisis of 1997–1999. We stress two essential features of the crisis. First, the crisis was a regional phenomenon; the depth and severity of the crisis were exacerbated by a large decline in regional demand. Second, the predominance of the US dollar in the pricing of export goods in Asia (which we document empirically) led to a powerful internal propagation effect of the crisis within the region, contributing greatly to the decline in regional trade flows. We construct a multi-country macroeconomic model which contains these two features and show that it can do a good job in accounting for the response of the main macroeconomic aggregates in Korea, Malaysia and Thailand during the crisis. A key advantage of our model is that it can explain the very slow response of exports to the large real exchange rate depreciations that took place during the crisis. Without the regional dimension and dollar pricing of exports, we find that the model fails to account for the depth and severity of the crisis.

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Keywords: East Asian crisis; Sticky prices; External currency pricing

JEL classification: F4 Macroeconomic Aspects of International Trade and Finance

* Prepared for San Francisco Federal Reserve Bank Conference “Emerging Markets and Macroeconomic Volatility,” June 4–5, 2004. Devereux thanks SSHRC, the Royal Bank of Canada, and the Bank of Canada for financial assistance. Cook thanks the Research Grants Council of Hong Kong (Project No. HKUST6291/03H) for financial assistance. We thank conference participants at a seminar at the IMF Institute, Paul Bergin, Enrique Mendoza and two anonymous referees for their very helpful comments.

* Corresponding author.

E-mail addresses: davcook@ust.hk (D. Cook), devm@interchange.ubc.ca (M.B. Devereux).

0022-1996/$ - see front matter © 2005 Published by Elsevier B.V.
doi:10.1016/j.jinteco.2005.06.010
1. Introduction

Exports have played a central role in the rapid industrialization of the economies of East Asia. The unprecedented growth in the region has coincided with the development of a regional trading bloc. In the early 1980s, the majority of exports from the newly industrializing economies of East Asia went to OECD countries. By the late 1990s, however, exports to other Asian (excluding Japan) countries were almost as large as exports to developed economies (including Japan). This suggests that in order to understand the Asian crisis of 1997–1999, it is important to incorporate the regional interdependence of the Asian economies.

A second important feature of the East Asian trading bloc is that intra-regional trade has been denominated in currencies which are external to the region, principally the US dollar. While considerable attention has been paid to the macroeconomic implication of the foreign currency denomination of external debt in East Asia,1 much less attention has focused on this aspect of trade pricing.

In this paper, we combine these two aspects of the East Asian trading system into a dynamic general equilibrium environment to conduct a quantitative examination of the East Asian crisis of 1997–1999. We show that these new elements can help to explain some of the more puzzling aspects of the crisis. In particular, it has been difficult to explain why very large real exchange rate devaluations failed to generate an expansionary export boom. Despite real depreciations of 60% or more, export volumes either stagnated or actually fell for a year or more in most of the worst hit crises countries, including Korea, Malaysia and Thailand. A second difficulty in accounting for the crisis is to explain the scale and persistence of the drop in a GDP and other macroeconomic aggregates within a general equilibrium framework.

This paper will ask three related questions of a quantitative dynamic general equilibrium model of the East Asian crisis. First, can external currency pricing in a regional trading bloc account for the decline in exports during a financial crisis? Second, how much of the surprising decline in output that occurred in East Asia can be attributed to this decline in exports? Third, does external currency pricing imply that fixing the exchange rate of regional currencies to the external currency help stabilize the economy in the face of these shocks?

Our quantitative approach to modeling the crisis is similar to a number of previous papers that make use of a sticky price open-economy macroeconomic framework.2 We emphasize two additional points however. We view the crisis as not simply a capital market shock that hits a single small, open economy in isolation, but as a generalized aggregate shock to a region in which countries are interlinked through trade flows.3 We add to this framework a very specific assumption about price setting of export goods. In our model, all export goods prices are quasi-fixed in terms of US dollars, even for trade

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1 For example, Aghion et al. (2000, 2001), Burnside et al. (2001a), Cespedes et al. (2004), Choi and Cook (2002), Cook (2004), and Devereux et al. (in press).
2 See for example, McKibbin (1999), Cook and Devereux (in press) and Gertler et al. (2003).
3 There is some similarity in this regard with Corsetti et al. (2001) which studied monetary policy in an economy with 3 countries.
within the region. We refer to this aspect of East Asian export pricing as ‘Dollar Currency Pricing.’ We use detailed price data from East Asian countries to argue, as previously pointed out by McKinnon and Schnabl (2004), that this pricing assumption accurately characterizes the response of prices following the crisis, as well as the average behavior of prices over a longer sample period.

What difference does this pricing assumption make? We show that dollar currency pricing goes a long way in explaining the observed behavior of net exports in the East Asian crisis and, in particular, helps to understand the lack of an immediate devaluation-fueled export boom. In our model, devaluation does not immediately stimulate net exports through lower export prices abroad, since these prices are temporarily fixed in terms of US dollars. But at the same time, the devaluation leads to a big fall in import demand, given the immediate pass-through of exchange rate changes into imported goods. The key channel of our model, however, is that devaluation of a neighboring country will reduce its import demand for a given country within the East Asian region just as much as it affects the neighbor’s demand for exports from countries in the rest of the world, even if the given country itself has itself devalued. That is, devaluation of a country does not immediately make its exports more competitive within East Asia, because they are priced in US dollars, and devaluation of a regional trading partner leads to a big drop in demand for that country’s exports, since it leads to an immediate jump in the regional partner’s price of the country’s exports.

We calibrate our model and simulate its response to a crisis shock when this dollar currency pricing applies, and when regional interdependence in trade is important. We contrast this with the alternative of ‘local currency pricing’ of exports, and also with a model which ignores regional trade flows. Without these two additional features, the model is able to reproduce many of the main qualitative features of the East Asian crisis. Quantitatively, however, it fails to explain the depth and severity of the crisis, and it is highly inaccurate in modeling the post-crisis behavior of exports. But with dollar currency pricing and regional interdependence, the model does well in providing both a qualitative and quantitative account of the crisis. The effect of dollar currency pricing is to lead to a precipitous drop in trade within the East Asia region, which helps us to quantitatively account for the observed export series, as well as the scale and persistence of the shock to output.

In the benchmark model, we assume a monetary policy represented by an ‘inflation targeting’ interest rate rule taken from Cook and Devereux (in press). But, given the effect of exchange rate devaluations in reducing intra-regional trade, we might ask whether putting more emphasis on a fixed exchange rate against the US dollar might help to stabilize regional output during a financial crisis. To investigate this, we look at the effects of a crisis where notably greater weight is placed on exchange rate stability than in the benchmark monetary rule. We find that a small economy performs much worse when exchange rate stability is its primary goal. Moreover, even if one economy follows inflation targeting, it is not necessarily desirable for its regional trading partner to fix its exchange rate against the dollar. While this would prevent a fall in exports to the trading partner due to the relative price effect of devaluation (with dollar currency pricing), it would exacerbate the fall in exports due to reduction in absorption of the trading partner. In our benchmark calibration, the latter effect tends to dominate.
A large number of papers have explored the underlying causes of the crisis, whether from errors in policy-making or fragility in international capital markets. We avoid taking a stand on this by modeling the crisis as an exogenous shock to country risk spreads on US dollar bonds. Neumayer and Perri (2005) argue that exogenous country risk premium shocks are central to the business cycle behavior of emerging markets. Burstein et al. (2005) quantitatively examine the effect of interest rate shocks on exchange rates and nominal prices. In principle, this movement in spreads could be driven by herding effects in international markets (see Calvo and Mendoza, 2000) or by an elimination of loan guarantees by domestic authorities (see Corsetti et al., 1999).

A number of other papers have quantitatively modeled ‘sudden stops,’ defined as a switch towards a binding national constraint on capital inflows for a borrowing country (see Calvo and Reinhart, 1999). Mendoza (2002) studies the effects of sudden stops in a quantitative business cycle model. Arellano and Mendoza (2003) show that balance-sheet constraints may be important in generating sudden stops. Our paper is comparable to this literature in so far as a sudden stop could be shown to be equivalent to a sharp exogenous rise in country risk spreads.

The rest of the paper is organized as follows. Section 2 discusses the importance of US dollar pricing of East Asian export goods and then describes the effects of the East Asian crisis on the main macroeconomic aggregates, trade and exchange rates for Korea, Malaysia and Thailand. Section 3 describes a three country, open-economy model. Section 4 discusses the calibration of the model. Section 5 presents the results, and Section 6 offers some conclusions.

2. Export pricing and the East Asian crisis

2.1. Pricing in the East Asian trade block

Our analysis is based on the premise that East Asia is an interdependent trading bloc, and that trade is predominantly done in US dollars. Table 1 provides evidence in support of this. First, intra-regional trade is important to East Asia. For seven emerging East Asian economies, panel (A) shows the fraction of exports to Asia (ex Japan) as a percentage of exports to Asia plus the EU, North America and Japan. With the exception of Indonesia, the share of regional exports was growing for all countries through the 1990s. In 1996, all countries except the Philippines had an excess of 40% of exports going to the Asian region. This share fell quite sharply between 1996 and 1998 (again with the exception of the Philippines), but more recently has grown strongly, exceeding the levels of the mid-1990s.

That the US dollar is the most important currency for international trade is widely acknowledged. McKinnon and Schnabl (2004) emphasize the central role of the US dollar in both Asian goods and Asian financial markets. Panel (B) reports the currency of trade...
### Evidence on external currency pricing

#### A

<table>
<thead>
<tr>
<th>Evidence on external currency pricing</th>
<th>Exports to Asia as share of exports to Asia, NAFTA, EU and Japan (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>74.76</td>
</tr>
<tr>
<td>Korea</td>
<td>14.21</td>
</tr>
<tr>
<td>Malaysia</td>
<td>45.99</td>
</tr>
<tr>
<td>Philippines</td>
<td>22.18</td>
</tr>
<tr>
<td>Taiwan</td>
<td>19.68</td>
</tr>
<tr>
<td>Thailand</td>
<td>30.20</td>
</tr>
</tbody>
</table>

#### B

<table>
<thead>
<tr>
<th>Structure of payments by external currency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thailand</td>
</tr>
<tr>
<td>US $</td>
</tr>
<tr>
<td>Other major external currencies</td>
</tr>
</tbody>
</table>

#### C

<table>
<thead>
<tr>
<th>Trade prices and exchange rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>Export price</td>
</tr>
<tr>
<td>Import price</td>
</tr>
<tr>
<td>Euro(^{d}) /DM</td>
</tr>
<tr>
<td>UK £</td>
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<tr>
<td>R(^2)</td>
</tr>
</tbody>
</table>

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\(a\) In panel (A), we sum various economies’ monthly exports to Asia, NAFTA, EU, and Japan over 2-year periods and report the percent that goes to Asia.

\(b\) In panel (B), we report survey data on the invoice currency of Thailand and Korea in 1995 and 2000, and reporting the share of trade invoiced in US dollars as well as other major external currencies (Japanese yen, euros, and British pounds).

\(c\) In panel (C), we report the coefficients of a regression of growth rates of monthly export and import price indices from Korea and Thailand on the growth rates of various major external currencies.

\(d\) D-mark substituted for euro before 1997.

* Significant at 10 level.

*** Significant at 1 level.
invoicing for exports and imports for Korea and Thailand. For Korea in the mid-1990s, 80% of industrial imports and almost 90% of exports were invoiced in US dollars. In Thailand in 1995, US dollar invoicing covered 81% of imports and 91% of exports. Since the US share in total exports for both countries is only about 22%, and the US import share is lower, the US dollar clearly plays a disproportionate role in trade pricing. Strikingly, the local currency has only a tiny weight in either import or export currency invoicing. In particular, for Thailand in 1997, only about 2% of exports and imports were invoiced in Thai baht.6

Invoicing data alone do not establish that prices are sticky in the invoicing currency, since it is not automatically true that the contractual price and the invoicing price of a traded good are in the same currency. But the very high exchange rate pass-through into local currency prices offers separate evidence of this. In Fig. 1, Row 1, we examine the high frequency pass-through of exchange rates into domestic currency trade prices around the time of the crisis. Growth rates of the US dollar exchange rate move very closely with growth rates of monthly import and export price indices in Korea and Thailand and growth rates of quarterly import and export deflators in Malaysia.

Panel (C) of Table 1 illustrates the importance of the US dollar relative to other international currencies in trade pricing. This panel shows the results of a regression of monthly changes in export and import prices indices for Korea and Thailand on monthly changes in bilateral exchange rates for the US dollar, the Japanese yen, the euro and the pound sterling.7 This can be interpreted as a simple-minded pass-through regression on import and export prices. The coefficient on the US dollar is large and highly significant for import and export prices in both countries. In Korea, the yen is significant, but with a much lower coefficient value, while the yen is marginally significant for import prices but not export prices in Thailand, with a very small coefficient. Note in particular that the implied ‘pass-through’ of US dollar exchange rate changes to export prices is higher than that for import prices, in both countries.

The data above do not distinguish between export prices for goods sold to developed economies and goods exported within the region. According to our hypothesis, exchange rate pass-through should be similar (and high) for both prices. To address this question, we construct region-specific export prices indices. We use bilateral trade data on value and units from Feenstra et al. (2005) to construct annual export price indices for Korea, Malaysia and Thailand by destination region: the OECD (ex Korea) or Asia (ex Japan). For each country and region, we select those categories of 4-digit SIC codes of goods with consistent unit measurements (either in number of units or weight) and positive values of exports in every year between 1995 and 2000. In each case, there are between 450 and 550 goods categories included in the indices. For each category of goods, we construct a unit price and measure continuous inflation (i.e., log differences in prices). The unit measures at the 4 digit SIC code level can be thought of as a rough measure of quantities. For each export destination for each export category, approximately 3–10% of the value exported was in goods categories in which unit prices more than doubled or halved in value. These

6 More detailed evidence for Thailand indicates that substantial Baht export invoicing is used only for smaller ASEAN countries, in particular, Laos, Cambodia, and Myanmar.
7 For pre-1997 data, we use the bilateral d-mark exchange rate instead of the euro.
Fig. 1. Pass-through and the Asian crisis. Row 1 is the log first difference of the exchange rate, and an import and export price index using monthly data for Korea and Thailand and quarterly data for Malaysia. Row 2 contains annual data on the exchange rate and the export deflator from national income accounts as well as export price indexes by destination constructed using unit cost data from Feenstra et al. (2005).
extreme price changes often coincided with large changes in the number of units sold. Since in these instances, it may be quite difficult to accurately measure units, we drop these positive and negative extreme values. Using the remaining goods, we construct weighted average of the export inflation rates. In order to construct a superlative index, we set the weights for each good as an average of the value shares in the start and end periods. We then chain the weighted inflation rates to calculate an export price index. We convert the annual indices from US dollars to local currencies using exchange rates from the Penn-World Tables (Heston et al., 2002).

The results (in logarithms) are reported in Fig. 1, Row 2. Despite the limitations of calculating unit costs using 4-digit data, we see two things using these indices. First, there is substantial pass-through of exchange rates into the export price indices. Second, we find no significant differences along these lines between the indices of exports to Asia and the OECD. There is large pass-through into exports to both regions and these are of similar scale in each case. As a check on the usefulness of our indices, we also report the NIPA export price index for these countries, and see that it behaves in quite a similar fashion to our constructed indices.

2.2. Anatomy of the Asian Crisis

We now outline the main aggregate macroeconomic patterns of the Asian crisis for three countries: Korea, Malaysia and Thailand. These countries directly experienced a currency and financial crisis with a fairly common set of characteristics. We define the “Asian crisis” as the difference between actual outcomes and the conditional expectation of the variable at the end of the second quarter of 1997. Fig. 2 shows the impact of this identified shock for a number of variables (all data are from the CEIC database). We first examine the impact on some aggregate quantity series drawn from the national income accounts. The variables are seasonally adjusted GDP, investment, consumption, imports and exports. Investment is defined as gross capital formation while consumption is personal or household consumption expenditure. Korean data are adjusted by the Korean statistical authorities, while we adjust Malaysian and Thai data using the X-12 filter. We then estimate a second-order AR with log linear and quadratic trends using quarterly data from 1980, or the beginning of quarterly accounts data (1991, in the case of Malaysia and, 1993, in the case of Thailand) through the first quarter of 2004. Forecasts of the post-June 1997 path of the variables are constructed using this estimated AR process with trend. Fig. 2, Panels (A–E) illustrate the difference between the historical sample and these forecasts.

Though some details vary, we see a similar pattern for each of the three countries. In each country, there is a persistent, hump-shaped contraction in GDP with a peak decline between 8 and 12%. After 10 quarters, the path of GDP has approximately returned to the trend-growth path. Investment and consumption also decline for 10 quarters in a similarly humped-shaped path. At the trough, investment declines by approximately 50% relative to
the pre-crisis forecast, while the trough of consumption ranges from 12 to 15% below the pre-crisis forecast.

The fact that GDP falls by much less than absorption points to a key aspect of the crisis in East Asia—a major improvement in the trade balance occurs in all countries. But the trade balance improvement is due much more to a substantial fall in imports more than to a rise in exports. Imports fall by between 20% and 40% and remained persistently below trend until 2000. Exports, on the other hand, responded in a mixed fashion. While it would be anticipated that a real devaluation of the size experienced in Korea, Malaysia and Thailand would stimulate a substantial boom in exports, exports actually fell to approximately 8% below the pre-crisis forecast in Malaysia and Thailand, and remained essentially unchanged in Korea. About a year and a half after the crisis, an export boom starts up in all countries. Exports are substantially above trend in late 1999.

Each of the countries collects monthly data on exports by country of destination, at least from 1988. For each quarter, we measure the exports that go to Asian economies (excepting those countries of the former Soviet Union and the Middle East). We add the exports that go to Australia, New Zealand, EU, NAFTA and Japan, and define these as exports to the developed world. Korean data (which are recorded in US dollar values) are converted to won using the average spot won–dollar rate. We convert these values into constant dollars using export deflators from the national income accounts. In the case of Malaysia, quarterly export deflators prior to 1991 are estimated using annual growth rates in the export deflator. For Thailand, we use a monthly export price index to estimate quarterly inflation in the export deflator before 1993. We define the sum of the two series (exports to Asia and exports to the Developed world) as total exports. Each export series is seasonally adjusted with the X-12 filter. For each series, we estimate a fourth-order auto-regression with a linear-quadratic term. As before, we identify the Asian crisis as the difference between the June 1997 conditional forecast and the actual realization during the crisis.

Why do exports remain so depressed following a substantial real devaluation? Exports to the East Asia region fall sharply and persistently, reaching a trough around 12% below trend in Korea and Malaysia and slightly more than 20% in Thailand. This underscores the fact that the East Asian crisis took on the character of a wide regional slump. In the model developed below, we argue that this regional interaction is critical in order to understand the magnitude and persistence of the crisis, and the inability of even very large devaluations to expand aggregate demand in these economies. By contrast, exports to the developed world rise above trend, albeit slowly.

Using the national income accounts, we also construct a measure of the absorption deflator (the ratio of constant dollar to current dollar absorption). Fig. 2H shows the response of this nominal price index to the shock. In each country, we see a relatively small rise in the price level, followed by a reversion to trend. This is interesting given the response of the nominal exchange rate to the crisis. We measure the response of the spot US dollar exchange rate to the crisis as the difference between the log of the actual realization of the exchange rate and the mean log exchange rate in the first half of 1997. We observe, in Fig. 2I, sharp nominal depreciations in either the 3rd or 4th quarter of 1997, reaching extremes of 50–60% below the pre-crisis value. Over the course of 1998, all currencies strengthen before reaching a level 25 to 40% below the pre-crisis level.
3. The model

The model consists of two small open emerging market economies, Korea and Thailand, which interact with a larger, developed world through trade in goods and a single risk-free bond. The currency of the developed world is the dollar. In the baseline model, all international transactions are denominated in dollars, even those between agents in Korea and Thailand. We will then contrast that with an alternative ‘local currency pricing’ assumption, where prices of export goods are set in the currency of the importing country. The prices of goods produced in the developed world are exogenous to the emerging market economies. Within the two emerging market economies, households consume, work, and accumulate capital. Firms produce a range of country-specific goods which are sold to domestic consumers, to the developed world, and to the other emerging market economy. Firms set prices in advance and adjust them gradually. Finally, monetary authorities in each economy follow an interest rate rule.

3.1. The developed world

The developed world produces goods which are available in unlimited quantities to Korea and Thailand at a dollar price $P^D_t$. The developed world has an iselastic demand for an East Asian composite export good:

$$X_t^{D,EA} = s_{D,EA} \left( \frac{P_{t}^{EA,D}}{P^D_t} \right)^{-\phi} A_t^D$$  \hspace{1cm} (3.1)

where $A_t^D$ is total absorption of the developed world, $P_{t}^{EA,D}$, $(P^D_t)$ represents the dollar price of East Asian exports to the developed world (dollar price of absorption for developed world), parameter $\phi$ is the elasticity of demand for East Asian exports in general and finally, $s_{D,EA}$ represents a share parameter. The composite demand for East Asian goods is itself a CES function of goods from Korea and Thailand (denoted KR, and TH, respectively):

$$X_t^{D,EA} = \left[ 1/2^{\frac{1}{\gamma}} \{ X_t^{D,KR} \}^{1-\frac{1}{\gamma}} + 1/2^{\frac{1}{\gamma}} \{ X_t^{D,TH} \}^{1-\frac{1}{\gamma}} \right]^{\frac{1}{1-\gamma}}$$ \hspace{1cm} (3.2)

where

$$X_t^{D,j} = 1/2 \left( \frac{P_{t}^{j}}{P_t^{EA,D}} \right)^{-\gamma} X_t^{D,EA}$$ \hspace{1cm} (3.3)

Here, $X_t^{D,j}$ is the exports of country $j$ to the developed world, $P_{t}^{j}$ is the dollar price of the exports of country $j$. The price index for $P_t^{EA,D}$, is:

$$P_t^{EA,D} = \left( 1/2 \left( P_{t}^{KR}_{t} \right)^{1-\gamma} + \left( 1/2 P_{t}^{TH} \right)^{1-\gamma} \right)^{\frac{1}{1-\gamma}}$$ \hspace{1cm} (3.4)

parameter $\gamma$ is the elasticity of demand for each individual East Asian country good.

International financial markets provide funds to each country at an exogenous interest rate, $1 + r_t^{EA,j}$. Interest rates are a function of the world interest rate, $r_t$, an exogenous
regional premium, \( r_p \), and an endogenous country risk premium which is a function of the deviation of net foreign debt \( D_t^j \) from an exogenous steady-state level \( \overline{D}^j \).

\[
1 + r_{t}^{EA,j} = (1 + r_t)(1 + r_p)\left(D_t^j/\overline{D}^j\right)^{\theta}
\]  

(3.5)

3.2. Households

Each small economy, \( j = \{\text{Korea, Thailand}\} \) is populated with a continuum of worker–households that accumulate capital and international debt and own local firms. The agent issues dollar denominated debt, \( D_t \), at the dollar interest rate \( 1 + r_{t}^{EA,j} \), and domestic currency debt, \( B_t \), at nominal interest rate \( 1 + i_t^j \). Capital \( K_t^j \) and labor \( H_t^j \) is rented to firms in competitive markets at rates \( R \) and \( W \) respectively. The agent receives profits, \( \Pi_t \), from monopolistically competitive firms. Agents purchase final goods at price \( P_t^j \) and allocate goods to consumption, \( C_t^j \), and investment, \( I_t^j \). Lump-sum taxes finance government spending, \( G_t^j \). Define \( S_t^j \) as the spot exchange rate (the price of US dollars). The budget constraint is:

\[
S_t^j D_t^j + B_t^j = (1 + r_{t-1}^{EA})S_{t-1}^j D_{t-1}^j + (1 + i_{t-1}^j)B_{t-1}^j + P_t^j[C_t^j + I_t^j + G_t^j] - \left(W_t^j H_t^j + R_t^j K_t^j + \Pi_t^j\right)
\]  

(3.6)

Capital accumulation is determined by the condition:

\[
K_{t+1}^j = (1 - \delta)K_t^j + I_t^j - \frac{\Phi_K}{2} \left(\frac{I_t^j}{I_{t-1}^j} - 1\right)^2 I_t^j
\]  

(3.7)

where the household face adjustment costs of changing capital that depend on the rate of change of investment. We follow Christiano et al. (in press) in using this alternative model of investment adjustment costs in order to allow the investment response to the crisis to be more persistent.\(^8\)

The infinitely lived households maximize discounted utility, defined by:

\[
E_t[U_t] = E_t \sum_{j=t}^{\infty} \beta^j \{ \ln(C_t^j - hC_{t-1}^j) - \Gamma H_t^j \}.
\]  

(3.8)

Households display ‘habit persistence’ with respect to consumption. Again, this specification is introduced to allow for greater persistence in the response of aggregate consumption to the crisis.

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\(^8\) Christiano et al. (2004) argue that this adjustment cost function generates a more empirically plausible response of investment and output to monetary shocks in the US economy. In particular, the investment response is larger and hump-shaped, and the output response is more persistent. In both these dimensions, the response is closer to estimated VAR evidence of the response to money shocks. Note that this specification does not generally have the property that average and marginal ‘Tobin’s \( q \)’ are equal, as in the standard adjustment cost function (see Hayashi, 1982).
3.3. Imports

The final goods absorbed by the small economy, $X^j_t$, are a CES function of goods produced within the East Asian region $X^j_t, EA$ and goods imported from the developed economy (which is the rest of the world):

$$C^j_t + I^j_t + G^j_t = X^j_t = \left[ a^{\frac{1}{\gamma}} \left( X^{j,EA}_t \right)^{1-\frac{1}{\gamma}} + (1-a)^{\frac{1}{\gamma}} \left( IM^{j,D}_t \right)^{1-\frac{1}{\gamma}} \right]^{\frac{\gamma}{1-\gamma}} \quad (3.9)$$

Goods absorbed from East Asia are themselves a CES function of goods produced in each country:

$$X^{KR,EA}_t = b^{\frac{1}{\gamma}} \left( X^{KR,EA}_t \right)^{1-\frac{1}{\gamma}} + (1-b)^{\frac{1}{\gamma}} \left( X^{TH,EA}_t \right)^{1-\frac{1}{\gamma}}$$

$$X^{TH,EA}_t = b^{\frac{1}{\gamma}} \left( X^{TH,EA}_t \right)^{1-\frac{1}{\gamma}} + (1-b)^{\frac{1}{\gamma}} \left( X^{KR,EA}_t \right)^{1-\frac{1}{\gamma}} \quad (3.10)$$

3.4. Production

The economy produces value-added using capital and labor, with a Cobb–Douglas technology:

$$Y^j_t = \left\{ K^j_t \right\}^\theta \left\{ H^j_t \right\}^{1-\theta}. \quad (3.11)$$

Capital and labor are rented from households in competitive markets. Producers sell their output in a competitive market to exporters and retailers at a price, $MC^j_t$. Factor prices are determined by the conditions:

$$MC^j_t \frac{Y^j_t}{K^j_t} = R^j_t, \quad MC^j_t (1-\theta) \frac{Y^j_t}{H^j_t} = W^j_t.$$  

3.5. Sticky prices

Each of the three categories of demand for domestic goods, $X^{D,j}_t, X^{KR,j}_t, X^{TH,j}_t$ are Dixit–Stiglitz indices of goods provided by a unit range of domestic retailers or exporters indexed by $i$. Define the index $l=D, KR, TH$. We define the quantity aggregator $X^{l,j}_t$ and prices, $P^{l,j}_t$, as well as the demand curve for each individual retailer:

$$X^{l,j}_t = \left[ \int_0^1 \left\{ X^{l,j}_i \right\}^{1-\frac{1}{\xi}} \, di \right]^{\frac{1-\gamma}{\xi}} \quad P^{l,j}_t = \left[ \int_0^1 \left\{ P^{l,j}_i \right\}^{1-\frac{1}{\xi}} \, di \right]^{\frac{1-\gamma}{\xi}} \quad \frac{X^{l,j}_t}{P^{l,j}_t} = \left( \frac{P^{l,j}_t}{P^{l,j}_{t-1}} \right)^{-\frac{\xi}{\gamma}}. \quad (3.12)$$

In the case of domestic demand ($l=j$), retailer $i$ buys materials at the competitive price $MC^j_t$. Retailers also face direct costs of price change however. Following Bergin and Tchakarov (2004), we model these costs as resources used up in the process of adjusting prices. If retailer $i$ changes its price, then it suffers a resource loss of $\Delta^{l,j}_i = \frac{\xi}{2} \left( \frac{P^{l,j}_i - P^{l,j}_{t-1}}{P^{l,j}_{t-1}} \right)^2$ per
unit of output. Hence, if the retailer purchases \( x_{l,i}^{j} \) from competitive suppliers, and changes its price at time \( t \), then its effective revenue (in the currency of sale) net of costs of price change will be:

\[
 p_{t,i}^{l,j} x_{l,i}^{j} = p_{l,i}^{t,j} x_{l,i}^{j} \Delta_{l,i}^{j} = p_{l,i}^{t,j} x_{l,i}^{j} - \frac{\kappa}{2} \left( \frac{p_{t,i}^{l,j} - p_{t-1,i}^{l,j}}{p_{t-1,i}^{l,j}} \right)^2 x_{l,i}^{j}
\]

where \( \Delta_{l,i}^{j} \) is implicitly defined. Hence, in each period, retailers have profits equal to:

\[
\prod_{l,i}^{j} = \left[ p_{l,i}^{t,j} - \text{MC}_{l}^{i} - \Delta_{l,i}^{j} \right] \cdot x_{l,i}^{j}
\]  

(3.13)

We assume that retailers must set the price for period \( t \) before the beginning of the period (as in Rotemberg and Woodford, 1997) to maximize expected profits, \( E_{t-1} \left[ \sum_{m=t}^{\infty} \left( \prod_{n=t}^{m} \frac{1}{(1 + i_n)} \right) \left\{ (p_{m}^{l,j})^{1-\xi} - \text{MC}_{m}^{i} (p_{m}^{l,j})^{-\xi} \right\} - \frac{\kappa}{2} \left( \frac{p_{m}^{l,j} - p_{m-1}^{l,j}}{p_{m-1}^{l,j}} \right)^2 (p_{m}^{l,j})^{-\xi} X_{m}^{l,j} (p_{m}^{l,j})^{\xi} \right] \]

(3.14)

We derive the first-order conditions for expected profit maximization, and then impose symmetry so that the price for all \( i \) firms is identical. The optimal price for sale in the domestic market (when \( l=j \)) follows the dynamics:

\[
\xi - 1 = E_{t-1} \left[ \frac{\text{MC}_{l}^{i} + \Delta_{l,i}^{j}}{p_{l,i}^{t,j}} + \kappa \frac{(p_{l,i}^{t,j} - p_{l,i}^{t-1,j})}{p_{l,i}^{t,j}} - \frac{\beta}{(1 + i_{t})} \left( \frac{X_{l+1}^{j}}{X_{l}^{j}} \right) \right]
\]

\[
\left\{ \frac{\kappa}{(1 + i_{t})} \left( \frac{p_{l,i}^{t,i+1} - p_{l,i}^{t,j}}{p_{l,i}^{t,j}} \right) + \kappa \frac{\Delta_{l,i+1}^{j}}{p_{l,i}^{t,j}} \right\} \right]
\]  

(3.15)

(Both exports to the other Asian economy and to the developed world are priced in dollars. Profits in terms of domestic currency for \( (l \neq j, l=D) \) are given by:

\[
\prod_{l,i}^{j} = S_{l}^{j} \left( p_{l,i}^{t,j} - \text{MC}_{l}^{i} / S_{l}^{j} - \Delta_{l,i}^{j} \right) x_{l,i}^{j} \Delta_{l,i}^{j} = \frac{\kappa}{2} \left( \frac{p_{t,i}^{l,j} - p_{t-1,i}^{l,j}}{p_{t-1,i}^{l,j}} \right)^2 \]

The retailers selling to the external buyers maximize expected profits, defined as follows:

\[
\max_{p} E_{t-1} \left[ \sum_{m=t}^{\infty} \left( \prod_{n=t}^{m} \frac{1}{(1 + i_n)} \right) S_{m}^{j} \left( p_{m}^{l,j} \right)^{\xi} X_{m}^{l,j} \left\{ \left( p_{m}^{l,j} \right)^{1-\xi} - \text{MC}_{m}^{i} / S_{m}^{j} - \Delta_{l,i}^{j} \right\} \right] \]

(3.16)
Again imposing symmetry, the first-order condition for this problem is given by:

$$\xi - 1 = E_{t-1} \left[ \xi \frac{MC^j_{t+1}}{P^j_{t+1}} + A^j_{t+1} - \beta \kappa \left( \frac{P^j_{t+1} - P^j_t}{P^j_t} \right) - \frac{\beta \kappa}{1 + i_t} \left( \frac{S^j_{t+1}X^j_{t+1}}{S^j_tX^j_t} \right) \right]$$

The consumer (or absorption) price index in country $j$ is then defined as

$$P^j_t = \left( a \left( P^{	ext{EA},j}_t \right)^{1-\phi} + (1-a) \left( S^j_tP^{	ext{IM},j}_t \right)^{1-\phi} \right)^{\frac{1}{1-\phi}}$$

while the East Asian price index for each country defined as:

$$P^{	ext{EA},KR}_t = \left( b \left( P^{	ext{KR},KR}_t \right)^{1-\gamma} + (1-b) \left( S^j_tP^{	ext{KR},KR}_t \right)^{1-\gamma} \right)^{\frac{1}{1-\gamma}},$$

$$P^{	ext{EA},TH}_t = \left( b \left( P^{	ext{TH},TH}_t \right)^{1-\gamma} + (1-b) \left( S^j_tP^{	ext{KR},TH}_t \right)^{1-\gamma} \right)^{\frac{1}{1-\gamma}}$$

### 3.6. Interest rates

The regional risk premium is assumed to follows an exogenous AR (1) process:

$$r^j_t = \rho \cdot r^j_{t-1} + \epsilon_t$$

Domestic interest rates are set according to an inflation-targeting interest rate rule, with some weight given to exchange rate stability:

$$1 + i_t = \left( 1 + i \right) \left( \frac{P^j_t}{P^j_{t-1}} \right)^{\frac{i}{i^*}} \left( \frac{S^j_t}{S^j_{t-1}} \right)^{\frac{i}{i^*}}$$

This rule represents a reasonable description of monetary policy in the post-crisis East Asia period. In the crisis countries, the previous exchange rate pegs had been abandoned. What followed the pegs evolved into the current practice of inflation targeting in Korea and Thailand. But nominal interest rates rose sharply in the post-crisis period, undoubtedly reflecting some concern with limiting the extent of exchange rate depreciation. Hence, both inflation stability and exchange rate stability seem to be separate concerns of the monetary authorities.

### 3.7. Equilibrium

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: $C(\Xi_t), I(\Xi_t)$,
\( X(\Xi_t), X^T(\Xi_t), X^N(\Xi_t), X^{T_d}(\Xi_t), EX(\Xi_t), IM(\Xi_t), Y^T(\Xi_t), Y^N(\Xi_t), M(\Xi_t), H(\Xi_t), H^T(\Xi_t), H^N(\Xi_t), D(\Xi_t), K^T(\Xi_t), K^N(\Xi_t), w^T(\Xi_t), p^T(\Xi_t), p^{ST}(\Xi_t); \) and price functions: \( P(\Xi_t), P^T(\Xi_t), W(\Xi_t), R^T(\Xi_t), R^N(\Xi_t), S(\Xi_t), i(\Xi_t); \) which solve the first-order conditions of the agents’ optimizations problems and labor and goods markets clear.

\[
\int_0^1 x_{i,j}^{D,j} \, di + \int_0^1 x_{i,j}^{j,i} \, di + \int_0^1 x_{i,j}^{j,p,i} \, di = Y^j_t \quad j = \text{TH, KR}. \tag{3.21}
\]

4. Calibration and solution

In the absence of a closed form solution, the model must be solved numerically. Since the Asian crisis represented a very large macroeconomic event by any metric, it seems inappropriate to rely on the usual log-linear approximation methods for characterizing the response to the crisis. Moreover, our interest is not in describing the average characteristics of these economies, but rather the response to the single large crisis event. In light of this, we solve a non-linear perfect foresight version of the model where there is a single, unanticipated, persistent shock to the world interest rate at the beginning of the crisis. We use the Dynare software from CEPREMAP which implements the Newton method described in Juillard (1996). Our assumption is that the model will converge back to steady state in less than 1000 periods. Given this, numerically exact perfect foresight solutions for the effects of the crisis may be computed.

The complete calibration of the model is described in Table 2. We assume that the two small open economies are symmetric. To calibrate the steady-state great ratios, we use an
averaging of the empirical counterparts for Korea and Thailand as reported in Cook and Devereux (in press). The share of government in GDP is set at 0.106. The capital share parameter is set as \( \theta = 0.3 \). The share parameter of East Asian exports, \( s_{D,EA} \), is set so that total exports as a share of GDP, \( (X_{t,D} + X_{t,J})/(GDP_{t}) \), is 0.301, for each country, when the relative price of East Asian goods to developed goods is 1. This corresponds to the average share for Korea and Thailand. The debt-sensitivity parameter, \( \bar{D} \), is set so that steady-state external debt to annualized GDP is 0.275, again an average for the two countries. The share parameter \( a \) is set so that steady-state imports are consistent with a real exchange rate equal to 1, which is the steady-state real exchange rate that we use to drive export and debt share. In addition, we set the share parameter \( b \) so that intra-regional exports as a share of trade \( (X_{t,J})/(X_{t,D} + X_{t,J}) = 0.4375 \), which is the average of that observed in Korea and Thailand in the 2 years prior to the Asian crisis (see Table 1).

Some parameters are fairly standard from the open-economy macro-literature. The depreciation rate is set at \( \delta = 0.025 \) and the discount rate is calibrated as in Backus et al. (1992), \( \beta = 0.99 \). The open-economy literature uses a range of parameterizations for the elasticity of substitution between goods in multi-good models. We calibrate \( \phi = \gamma = 2/3 \) which is on the less elastic end of this range and approximately equal to Reinhart’s (1995) estimate of the average elasticity of demand for imports in Asia. The parameter \( \zeta \) governs the elasticity of substitution between individual retail goods. We set this to achieve a steady-state markup of 1.15. The parameter governing the sensitivity of country specific interest rates to debt is set at a very small level; \( \nu = 0.0004 \). This ensures that the debt-elastic interest rate produces a stationary equilibrium but does not affect the response of the model to shocks except at very low frequency.

During the East Asian crisis, central banks raised interest rates drastically during the initial exchange rate depreciations. We set the benchmark monetary policy at \( \lambda_{p} = 1.2 \) and \( \lambda_{s} = 0.3 \). Cook and Devereux (in press) show that this rule does a reasonable job capturing the response of domestic interest rates in a dynamic general equilibrium model of the East Asian crisis.

The crisis shock is modeled as an exogenous rise in the regional risk premium. During the East Asian crisis, we observe dramatic increases in HSBC-constructed indices for US dollar bond yields in Korea and Thailand. Country premiums over 3 months US Treasuries reach a peak of approximately 700 annualized basis points. As such we calibrate a large interest rate shock, \( \varepsilon_{1} = 0.0175 \) occurring in period 1 indicating an initial rise in the annualized risk premium of 7%. After period 1, there are no further shocks. The observed risk premium shock was persistent. In fact, premiums on some long-term bonds rise by similar levels indicating a market belief that the shock would be highly persistent. In light of this, we calibrate the persistence parameter at \( \rho = 0.95 \). This is the same figure used in Gertler et al. (2003).

The real effects of the East Asian crisis were clearly quite persistent. The model includes a number of dynamic propagation mechanisms intended to capture this persistence, including consumption habit formation, investment adjustment costs, and sticky prices. Consumption habit formation and investment adjustment costs govern both the dynamics of the model as well as the size of the response of consumption and investment demand to the shocks. We set the consumption habit formation parameter to
\( h = 0.5 \) and the investment adjustment cost is set at \( \Phi_K = 1.4 \) to roughly match the size of the response of consumption and investment to the shock.

To induce a persistent output response, we assume a relatively large cost of adjusting prices. There are some microeconomic estimates that firms in the United States change prices very frequently—every one to two quarters (Bils and Klenow, 2004). On the other hand, macroeconomic estimates (such as Gali and Gertler, 1999; Sbordone, 2002) suggest greater price rigidity, with an average half-life of price adjustment to be 4 quarters or more. In a general equilibrium model of a small open economy with a local currency pricing, Bergin (2003) reports maximum likelihood estimates of the half-life of price adjustment of upward of 8 quarters for Australia, the UK and Canada.

Evidence on price stickiness for East Asia is scarcer. To a first-order approximation, quadratic adjustment costs produce inflation dynamics similar to those created by Calvo’s (1983) random staggered pricing model. Hence, as in Gali and Gertler (1999), we estimate a ‘New Keynesian’ inflation equation of the form \( \pi_t = c + \pi_{t-1} + (1 - \nu) \cdot (1 - \beta v) \cdot m_{ct} + \{ \beta \pi_{t+1} + (1 - v) \cdot (1 - \beta v) \cdot m_{ct} \} \) for Korean quarterly data, where \( \pi_t \) measures quarterly inflation and \( m_{ct} \) is a measure of percentage deviation of real marginal cost from steady state. For inflation, we use the implicit GDP deflator. The parameter, \( 1/1 - \nu \), measures the half-life of price adjustment. We construct real marginal cost index as the ratio of the real wage to a labor productivity index (of regular workers). We construct real wages by taking an average of monthly earnings deflated with the GDP deflator. The measure, \( m_{ct} \), is the log deviation from trend. We estimate the specification using GMM with three lags of inflation, three lags of \( m_{ct} \), and three lags of Hodrick–Prescott filtered GDP as instruments. The GMM-weighting matrix is calculated with a pre-whitened Newey–West estimator with three lags. As in Gali and Gertler (1999), the unconstrained estimates tend to produce implausible estimates of the discount factor. The optimal GMM estimates are \( \beta = 1.25_{(1.126)}, \nu = 0.828_{(0.060)} \) which indicates a price adjustment half-life between 5 and 6 periods. If we follow Gali and Gertler (1999) and restrict parameter \( \beta = 1 \), we estimate \( \nu = 0.895_{(0.021)} \) indicating a half-life between 9 and 10 periods. Our benchmark calibration of \( \kappa = 200 \) thus indicates a half-life of 6 quarters, which is at the lower end of the range estimated for Korea.

5. Results

5.1. Impulse response under the crisis

In this section, we describe the results of the ‘crisis’ shock in the form of an increase in the external risk premium, measured as described above. We describe the qualitative effects of a rise in the exogenous world risk premium on one economy, e.g., Korea. The effects on the other economy are analogous.

The rise in the world cost of borrowing leads to a fall in domestic investment and consumption. Consumption falls due to both substitution and wealth effects (since the economy is a net debtor). The fall in domestic absorption will lead to a decline in domestic aggregate demand and in GDP. The behavior of imports and exports depends on the particular pricing assumptions made. First assume that export prices within the region are
set in terms of local currencies (denoted LCP). That is, export prices from Korea to Thailand are set in terms of Thai baht, and exports to the United States are set in dollars. In that case, the nominal price of exports facing US consumers does not change, and demand is unaffected. In the same way, Thai consumers see no effect on their import prices. But exports to Thailand will fall anyway, because of the fall in Thai absorption. On the other hand, there is immediate and full pass-through of the nominal depreciation into import prices of Korea from the developed world. Thus, import prices rise, and imports fall. This generates a substitution in demand towards domestic goods (and imports from Thailand). But the overall effect is small, since imported goods and home produced goods are relatively poor substitutes, given our calibration.

If, on the other hand, all export prices within the region are set in US dollars (the benchmark model), then the regional shock has a much greater impact on aggregate demand in Korea. The reason is that Thailand’s devaluation will lead to a large fall in demand for Korean goods, as their price rises by just as much as the price of goods from the rest of the world. Korean exports to Thailand fall precipitously, causing a much bigger negative impact on Korean GDP.

Quantitatively, we make two comparisons. First, in Fig. 2, we show the response of the calibrated benchmark model to a shock, along with the response to the East Asian crisis from the data. Then, in Fig. 3, we show the response of the benchmark model along with two alternative models: (a) an LCP model, in which intra-regional trade is set in the currency of the customer and (b) a No Regional Trade model, in which there is no trade between the two small economies (so that we focus on the crisis hitting just one small economy on its own). In the case of the LCP model, we modify the first-order condition for optimal export pricing within the region to the following:

\[
\frac{E_{t-1} - 1}{\xi} = E_{t-1} \left[ \frac{MC^j_{i^j} + A^j_{i^j}}{P^j_{i^j}} + \kappa \left( \frac{P^j_{i^j} - P^{\sigma^j}_{i^j}}{P_t^j} \right)^{\beta \kappa} \right] - \left( \frac{S^j_{i^j} X^j_{i^j}}{S_t^{\sigma^j} X_t^{\sigma^j}} \right)
\]

(3.22)

where \(S_t^{i^j} \) is the cross rate between the two East Asian currencies. In the case of the No Regional Trade model, we merely set the parameter \(b=1\).

Fig. 2 shows that the benchmark model largely captures the quantitative response of output, consumption, investment and imports to the crisis. In particular, output decreases by about 10% in the period of the shock and remains persistently below trend for about the same number of periods as does GDP in the data. Investment declines by 50%, consumption by about 9%, and imports by about 25% below steady state. Investment and consumption reach their trough in periods after the initial period of the shock—i.e., we achieve a hump shaped response to the crisis shock. These declines are quite similar in size and persistence to those observed in the data, though it should be noted economic activity responds more quickly in the modeled economy than in the data.
Fig. 3. Model economy. This figure shows the response of macroeconomic variables to the shocks in the calibrated benchmark model, lcp pricing model in which all exports are priced in the currency of the customer and the No Regional Trade model in which all exports are with the external world.
Can the benchmark model explain the aggregate decline in exports observed in the data? Fig. 2, panel (E), shows that total exports in the benchmark model decline by about 8% and remain persistently below trend. This is within the range of the persistent declines in exports observed in Malaysia and Thailand. In the benchmark model, exports to the other East Asian economies decline by about 20%. This exceeds the decline observed in Korea and Malaysia but is very close to the decline in regional exports observed in Thailand. Exports to the developed world in the model show a slow but steady increase, similar to that observed in the data (see panel F).

How important is the assumption of dollar pricing and regional trade? Panel (A) of Fig. 3 shows the response of output in LCP model and the No Regional Trade model, compared to the benchmark model. We observe that output declines by substantially more in the benchmark model than either of the two alternative models. In the LCP model, output declines by slightly more than 5% compared with a decline of about 10% in the benchmark. Under dollar currency pricing, the post-crisis devaluation introduces an additional channel generating substantial propagation of the negative shock. As shown in panel (B), the sharper decline of output in the benchmark model results in a sharper decline in investment than in the LCP models. The decline in output in the No Regional Trade model is just over 7%, but still substantially less than the benchmark model. This suggests that regional links are critical in understanding the overall effects of the crisis.

Can the alternative models capture the decline in exports observed in the data? The evidence in Fig. 3, panels (D–G), suggests not. Panel (G) compares the post-crisis response of exports to the developed world in the benchmark model, and in the LCP and No Regional Trade models. In each model, the decline in the relative prices in the small economy results in an increase in exports to the developed economy. Because exports to the developed world have sticky prices in dollars, they respond only slowly to the crisis. In the No Regional Trade model, exports to the developed world are the same as total exports. These expand slowly as shown in panel (E). In the LCP model, there is no immediate change in the relative price of regional exports for the importing countries. Regional goods exports decline only due to the general decline in absorption in each economy. As shown in panel (F), this decline is much smaller than in the benchmark model in which dollar currency pricing implies an immediate increase in the relative price of regional exports. Overall then, in the LCP model aggregate exports decline by only a small amount, and only very briefly.

Panels (G) and (H) show the response of exchange rates and absorption deflators (which are analogous to CPI in the model). The model produces a persistent depreciation of the domestic currency relative to the developed economy currency. Facing a persistent rise in the risk premium, uncovered interest parity would imply a sharp immediate depreciation followed by an expectation of appreciation. However, the interest rate rule stabilizes the exchange rate by sharply raising domestic interest rates in the short-run. The persistence of the rise of the external interest rate combined with a sharp but temporary increase in the domestic interest rate result in a more restrained exchange rate depreciation. In the model, the long-run 30% depreciation is within the range of the 25–40% long-run depreciations observed in the data. However, the dynamics differ. In the data, there is a sharp overshooting of the exchange rate, with the initial depreciations approaching 60%. All countries exhibit this initial overshooting. In the model, however, the exchange rate adjusts more slowly, as the monetary rule targets a smooth exchange rate growth.
By contrast, the model does a fairly good job in matching the short-run response of the absorption deflator. This rises moderately, in both data and model. However, the permanent exchange rate depreciation results in a permanent increase in nominal prices in the model (in which the real exchange rate is stationary). In the data, by contrast, the absorption deflator converges back to its pre-crisis forecast.

5.2. Additional comparisons

Fig. 4 shows the response of some variables to the crisis shock under some alternative specifications to illustrate some of the mechanisms of the model. For comparison, we show the response of the benchmark specification and 4 specifications which each have one difference from the benchmark.

Our benchmark calibration assumed a substantial degree of price stickiness. The “4 Quarter” case changes the parameterization of the price adjustment cost to $\kappa = 75$ which implies a pricing half-life of 4 periods. The fall in output is somewhat smaller and somewhat less persistent than in the benchmark case and the fall in exports is also somewhat smaller. In the “Flexible Price” specification, we examine the more extreme case when all prices can immediately and costlessly adjust, so markups over marginal cost are constant. When prices are flexible, the rise in real interest rates during the crisis induces an increase in labor supply for reasons of intertemporal substitution. Output expands during the crisis. The increase in production means that the equilibrium decline in investment and consumption is also less sharp in the “Flexible Price” specification. With a significant decline in domestic demand and an increase in output, exports rise substantially. In equilibrium, the relative prices of domestic goods must fall to increase exports to the rest of the world.

The “Capital Adjustment Costs” case is identical to the benchmark case except there are costs to adjusting the capital stock $K_{t+1} = (1 - \delta)K_t + I_t - (\Phi_K)/(2) ((I_t/[K_t - \delta])^2 K_t$ rather than costs to adjusting investment. We calibrate $\Phi_K$ so that the elasticity of the investment to capital ratio with respect to marginal $q$ is 2.5 which is in the standard range. Fig. 4, panel (B), shows there is a counter-factually large drop in investment under the Capital Adjustment Costs specification, which dissipates more quickly than observed in the data. The initial drop in output is larger than in the benchmark case but the output effects of the crisis are less persistent with the economy returning to within 1% below steady state after 6 quarters.

The “No Habit Formation” case assumes a felicity function of $\ln (C_t) - \Gamma H_t$. Here there is a counter-factually large drop in consumption which dissipates more quickly than in the data. The initial drop in output is larger than in the benchmark case and the data but the output effects of the crisis are essentially the same as in the benchmark case after 2 quarters. The equilibrium response of exports and the real exchange rate in the Capital Adjustment Costs and No Habit formation case are similar to the benchmark case.

5.3. Alternative policy rules

In our model, the currency depreciations of the countries of the Asian dollar bloc play a major role in exacerbating the crisis. This might lead us to consider whether a monetary policy that places more weight on exchange rate stability could alleviate the effects of the crisis. In particular, in face of dollar currency pricing, it is better for a country to have its
Fig. 4. Alternate model specifications. This graph shows the response to the shock in the benchmark model, the case where prices have a half-life of 4 quarters, a Flexible prices model, a model with Capital adjustment costs rather than investment costs and a utility function with No habit formation.
trading partner stabilize its exchange rate vis-à-vis the US dollar? We briefly investigate this conjecture.

Fig. 5 shows the response of the two economies under an asymmetric monetary policy rule. The first economy (Korea) uses the benchmark monetary policy from the previous section (\( \lambda_p = 1.2 \) and \( \lambda_s = 0.3 \)). The second (Thailand) puts more weight on exchange rate
stability $\lambda_p=0.75$ and $\lambda_s=0.75$. For comparison, we also show the response under the symmetric benchmark model from the first section. Clearly, a country that attempts to prevent exchange rate adjustment incurs large immediate costs. Fig. 5, panels (G) and (H), shows that the exchange rate depreciates less and the absorption deflator rises more slowly than in the benchmark case. Since real interest rates must rise by much more, absorption and GDP fall by considerably more for the country that adopts exchange rate stabilization. In particular, GDP falls by about 70% more than in the benchmark case, and the recession is much more prolonged.

We also see that the selection of the exchange rate stabilization policy also impacts the partner country in the regional trading bloc. We observe that the exports of the partner actually fall more sharply than in the case in which both countries adopt the benchmark stabilization policy. As a result, the trading partner experiences a slightly greater fall in GDP. There are two determinants of regional exports: (1) the price of regional exports relative to domestically produced goods and (2) the total absorption of goods (i.e., total demand). If one country stabilizes its exchange rate relative to the dollar, it will also stabilize the first determinant, so that there is no rise in the price of regional imports. However, stabilizing the exchange rate also results in a large contraction in overall absorption. In the calibration in our model, the second effect is larger than the first, implying that a country’s exports to a regional trading partner will decline more when that trading partner stabilizes its exchange rate (see Fig. 5, panel F). However, it can be shown that this ranking is reversed if the goods produced by the two trading partners are better substitutes than in this calibration. In that case, the effects of changes in the relative price will have a strong effect on the volume of regional exports. In the case of very close substitutes, a country’s exports to a regional trading partner will decline less when that trading partner stabilizes its exchange rate.

6. Conclusions

We ask whether the regional propagation mechanism can explain the absence of the post-crisis export booms, and more generally, whether the persistence and severity of the crisis itself can be tied to the interdependence of the East Asian trading region. We have argued that the collapse in intra-regional trade is an important factor in the quantitative accounting for the East Asian crisis. The crisis was initiated as region-wide fall in capital flows (equivalent in our model to a rise in the world interest rate) which reduced demand and economic activity in all countries. But the importance of regional trade links in East Asia led to a significant magnification of the crisis through a fall in regional exports. Central to this mechanism, in our model, is the role of the US dollar in pricing exports. In a sense, this represents another aspect of dollarization that may be important in crises, quite distinct from “liability dollarization” which has been a major part of the recent literature on understanding crises.9

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9 It would be possible to add on a liability dollarization channel to our model. If liability dollarization was combined with collateral constraints in export production, similar or complementary results to ours might be obtained.
Overall, our results raise the question of why the US dollar is so dominant as a trade currency in East Asia. We leave this for future research.

7. Uncited references

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