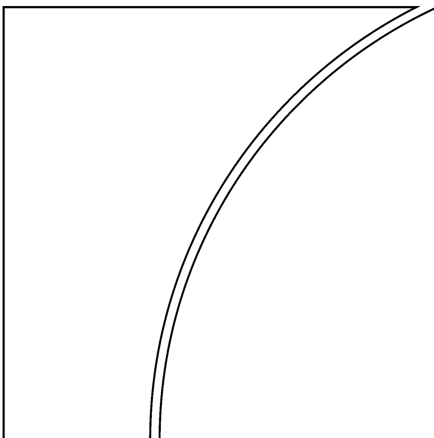
BANK FOR INTERNATIONAL SETTLEMENTS



BIS Working Papers

No 139

External constraints on monetary policy and the financial accelerator

by Mark Gertler*, Simon Gilchrist** and Fabio M Natalucci***

Monetary and Economic Department

September 2003

* New York University and NBER

** Boston University and NBER

*** Board of Governors of the Federal Reserve System

Abstract

We develop a small open economy macroeconomic model where financial conditions influence aggregate behavior. We use this model to explore the connection between the exchange rate regime and financial distress. Fixed exchange rates are shown to exacerbate financial crises. Quantitative exercises calibrated to match the Korean experience during the recent Asian crisis are able to replicate key macroeconomic outcomes including the sharp increase in lending rates and the observed drop in output, investment and productivity during the 1997-1998 episode. These exercises imply that welfare losses following a financial crisis are significantly larger under fixed exchange rates relative to flexible exchange rates.

BIS Working Papers are written by members of the Monetary and Economic Department of the Bank for International Settlements, and from time to time by other economists, and are published by the Bank. The views expressed in them are those of their authors and not necessarily the views of the BIS.

Copies of publications are available from:

Bank for International Settlements
Press & Communications
CH-4002 Basel, Switzerland

E-mail: publications@bis.org

Fax: +41 61 280 9100 and +41 61 280 8100

This publication is available on the BIS website (www.bis.org).

© *Bank for International Settlements 2003. All rights reserved. Brief excerpts may be reproduced or translated provided the source is cited.*

ISSN 1020-0959 (print)

ISSN 1682-7678 (online)

Foreword

On 28-29 March 2003, the BIS held a conference on "Monetary stability, financial stability and the business cycle". This event brought together central bankers, academics and market participants to exchange views on this issue (see the conference programme and list of participants in this document). This paper was presented at the conference. Also included in this publication are the comments by the discussants. The views expressed are those of the author(s) and not those of the BIS. The opening speech at the conference by the BIS General Manager and the prepared remarks of the four participants on the policy panel are being published in a single volume in the BIS Papers series.

Conference on
“Monetary stability,financial stability and the business cycle”
28-29 March 2003, Basel

Conference programme

Opening keynote remarks

Andrew Crockett (Bank for International Settlements)

Session I: The lessons from history

Chair: William White (Bank for International Settlements)

Paper 1: The price level, relative prices and economic stability: aspects of the interwar debate

Author: David Laidler (University of Western Ontario)

Discussants: Olivier Blanchard (Massachusetts Institute of Technology)
Nobuhiro Kiyotaki (London School of Economics)

Paper 2: The Great Depression as a credit boom gone wrong

Authors: Barry Eichengreen (University of California, Berkeley)
Kris Mitchener (Santa Clara University)

Discussants: Michael Bordo (Rutgers University)
Charles Goodhart (London School of Economics)

Session II: Monetary and financial frictions in business fluctuations

Chair: John Moore (London School of Economics)

Paper 3: Public and private information in monetary policy models

Authors: Jeffery Amato (Bank for International Settlements)
Hyun Song Shin (London School of Economics)

Discussants: Marvin Goodfriend (Federal Reserve Bank of Richmond)
Lars Svensson (Princeton University)

Paper 4: External constraints on monetary policy and the financial accelerator

Authors: Mark Gertler (New York University)
Simon Gilchrist (Boston University)
Fabio Natalucci (Board of Governors of the Federal Reserve System)

Discussants: Philippe Bacchetta (Study Center Gerzensee)
Philip Lowe (Reserve Bank of Australia)

Session III: Monetary policy challenges

Chair: Charles Freedman (Bank of Canada)

Paper 5: Asset prices, financial imbalances and monetary policy: are inflation targets enough?

Author: Charles Bean (Bank of England)

Discussants: Ignazio Visco (Bank of Italy)
Sushil Wadhwani (Wadhwani Asset Management LLP)

Paper 6: Financial strains and the zero lower bound: the Japanese experience

Author: Mitsuhiro Fukao (Keio University)

Discussants: Ignazio Angeloni (European Central Bank)
Jürgen von Hagen (University of Bonn)

Session IV: Achieving monetary and financial stability

Panel discussion

Chair: Andrew Crockett (Bank for International Settlements)

Panellists: Roger Ferguson (Board of Governors of the Federal Reserve System)
Otmar Issing (European Central Bank)
Michael Mussa (Institute for International Economics)
Yutaka Yamaguchi (formerly Bank of Japan)

Conference on
"Monetary stability,financial stability and the business cycle"
28-29 March 2003, Basel

Participants in the conference

Ignazio Angeloni	European Central Bank
Philippe Bacchetta	Study Center Gerzensee
Armando Baqueiro Cãrdenas	Bank of Mexico
Charles Bean	Bank of England
Olivier J Blanchard	Massachusetts Institute of Technology
Michael Bordo	Rutgers University
Barry Eichengreen	University of California, Berkeley
Charles Freedman	Bank of Canada
Mitsuhiro Fukao	Keio University
Simon Gilchrist	Boston University
Marvin Goodfriend	Federal Reserve Bank of Richmond
Charles Goodhart	London School of Economics
Otmar Issing	European Central Bank
Nigel Jenkinson	Bank of England
Thomas J Jordan	Swiss National Bank
Nobuhiro Kiyotaki	London School of Economics
David E Laidler	University of Western Ontario
Flemming Larsen	International Monetary Fund
Philip Lowe	Reserve Bank of Australia
Kris J Mitchener	Santa Clara University
John Moore	London School of Economics
Michael Mussa	Institute for International Economics
Fabio M Natalucci	Board of Governors of the Federal Reserve System
Peter Praet	National Bank of Belgium

Jan F Qvigstad	Central Bank of Norway
Hermann Remsperger	Deutsche Bundesbank
Hyun Song Shin	London School of Economics
Marc-Olivier Strauss-Kahn	Bank of France
Lars E O Svensson	Princeton University
Giovanni Toniolo	University of Rome Tor Vergata
José Viñals	Bank of Spain
Ignazio Visco	Bank of Italy
Jürgen von Hagen	University of Bonn
Sushil B Wadhwani	Wadhwani Asset Management LLP
Charles Wyplosz	Graduate Institute of International Studies
Yutaka Yamaguchi	formerly Bank of Japan
Gang Yi	The People's Bank of China
Andrew Crockett André Icard William White Renato Filosa Claudio Borio Gabriele Galati Jeffery Amato William English Andrew Filardo Ben Fung (Representative Office for Asia and the Pacific)	Bank for International Settlements

Contents

Foreword iii

Conference programme v

Participants in the conference vii

External constraints on monetary policy and the financial accelerator
Mark Gertler, Simon Gilchrist and Fabio M Natalucci 1

Discussion by Philippe Bacchetta 43

Discussion by Philip Lowe 45

Discussion by V V Chari 49

1 Introduction [1]

Over the past fifteen years there has been a dramatic rise in the frequency of financial crises that have led to significant contractions in economic activity. One feature of these crises, that pertains in particular to open economies, is the strong connection with a fixed exchange rate regime. In a study covering the 1970s through the 1990s, Kaminsky and Reinhart [27] document the strong correlation between domestic financial strains and currency crises. Put differently, countries in the position of having to defend an exchange rate peg were more likely to have suffered severe financial distress. The likely reason is straightforward: defending an exchange rate peg generally requires the central bank to adjust interest rates in a direction that reinforces the crisis. Moreover, this connection between external constraints on monetary policy and financial crises is not simply a post-war phenomenon: during the Great Depression, as Eichengreen [22] and others have shown, countries that stayed on the gold standard suffered far more severe financial and economic distress than countries that left early.

In this paper we develop a small open economy macroeconomic model where financial conditions influence aggregate behavior. Our goal is to explore the connection between the exchange rate regime and financial distress. Specifically, we extend to the open economy the financial accelerator framework developed in Bernanke, Gertler and Gilchrist [7] (hereafter BGG). We then consider the role of fixed versus flexible exchange rates in exacerbating a financial crisis. In the process, we quantify the role of the financial accelerator in explaining economic downturns during crisis episodes.

The core model is a new open economy macro model with money and nominal price rigidities (as in, e.g., Obstfeld and Rogoff [34]). The financial accelerator mechanism links the condition of borrower balance sheets to the terms of credit, and hence to the demand for capital. Via the impact on borrower balance sheets, the financial accelerator magnifies the effects of shocks to the economy. As in Kiyotaki and Moore [28] and BGG, unanticipated movements in asset prices provide the main source of variation in borrower balance sheets. As in BGG, a countercyclical monetary policy can potentially mitigate a financial crisis:

[1] The views in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the BIS, of the Board of Governors of the Federal Reserve System or of any other person associated with the Federal Reserve System. We thank Philippe Bacchetta, V.V. Chari, and Philip Lowe, as well as conference participants at the BIS conference on "Monetary stability, financial stability and the business cycle"

easing of rates during a contraction, for example, helps stabilize asset price movements and hence borrower balance sheets. External constraints on monetary policy, instead, limit this stabilizing option.

To understand the empirical relevance of the financial accelerator in crisis episodes, we use this model to conduct a quantitative exercise aimed at replicating the key features of the Korean experience during the Asian financial crisis of 1997-1998. We think the Korean episode is interesting because it is symptomatic of many financial crises that have occurred over time: the country experienced a sharp contraction in both output and productivity, along with a sharp deterioration in credit conditions, including falling asset prices and increasing credit spreads.[2] As well, in the process the country was attempting to defend a fixed exchange rate regime.

We model the financial crisis as the endogenous response to a large unanticipated increase in the country risk premium. With flexible exchange rates, the increase in the risk premium would be offset by a devaluation of the domestic currency. Such a devaluation would mitigate the effect on domestic interest rates, largely avoiding the contraction in asset values and investment spending that appears to drive the downturn during such episodes. With fixed exchange rates, the increase in the country risk premium causes an immediate rise in domestic interest rates which generates the financial collapse. As a consequence, asset prices plummet, external finance premia rise sharply and investment spending collapses.

Our quantitative exercise indicates that the financial accelerator in conjunction with fixed exchange rates can account for the 14 percent drop in economic activity experienced by Korea during the 1997-1998 episode. In contrast, in the absence of the financial accelerator mechanism, this same exercise accounts for only half of the measured drop in Korean output during this time period. Our model also captures the sharp rise in borrowing rates experienced by the private sector, and the collapse in Korean investment spending that ensued. By endogenizing capital utilization decisions, we are also able to capture the slowdown in measured labor productivity experienced by the Korean economy during this period. Our demand-driven explanation for endogenous movements in labor productivity suggests that it is unlikely that supply-side technology stories play a strong role in explaining the economy's response to the financial crises.

Following the financial collapse, the Korean authorities abandoned the fixed exchange

[2] Both Cole and Ohanian [20] and Chari, Kehoe and McGrattan [16] have emphasized declines in measured productivity as a robust feature of crisis episodes.

rate and let the currency devalue. We consider the potential benefits to such a policy by developing a hybrid model whereby the monetary authority is initially following a fixed exchange rate but abandons the peg with some positive probability following the external shock. Our modeling exercise indicates that a policy of an initial peg followed by abandonment produces an initial contraction that is nearly as severe as the fixed-exchange rate policy itself. Abandoning the peg and allowing real interest rates to fall produces a rapid recovery however. Consistent with the Korean experience, in our model experiment, the primary channel through which the recovery occurs is an increase in domestic investment owing to the positive effects that reduced real interest rates have on asset values and net worth, rather than an increase in exports owing to increased competitiveness following the devaluation.

The rest of the paper is organized as follows. Section 2 presents macroeconomic evidence on the Korean experience. Section 3 presents the model. In section 4 we conduct various policy experiments, including the exercise designed to capture key macroeconomic features of the Korean financial crisis. Section 5 provides concluding remarks.

2 The Korean Financial Crisis

The financial crisis that hit the Asian economies began in the summer of 1997. However, according to Krueger and Yoo [29], there was no evidence of a crisis in Korea until the final quarter of 1997, despite the fact that the Thai crisis started in June 1997, and the Indonesian crisis unfolded during the summer of that year. Although Korean off-shore banks held substantial quantities of dollar-denominated foreign loans from countries such as Indonesia and Russia, this was not widely understood, and it was not until October 1997 that S&P downgraded Korea's sovereign risk status. Capital flight began early in the fourth quarter of 1997, and reserves were depleted rapidly as Korea sought to defend its currency. Overnight call rates rose from 12 percent in July to 14 percent in November, and then jumped to 25 percent after Korea approached the IMF for assistance. The evidence suggests that capital outflows and the subsequent collapse in bank lending occurred for reasons that were largely exogenous to Korea's economic situation at the time. Nonetheless, the financial crisis had important effects on both real interest rates and real outcomes.

Figure 1 plots the real-side behavior of the Korean economy during this time period. Real GDP had been consistently above trend for several years before the crisis and showed

no weakness until the fourth quarter of 1997. During the first quarter of 1998, real GDP fell 8 percent and subsequently contracted by another 6 percent, implying an overall contraction in real GDP of 14 percent from peak to trough during the crisis period. Real gross capital formation had been gradually weakening since the beginning of 1997 and then experienced a 40 percent contraction in the first quarter of 1998. Real gross capital formation fell another 10 percent in the subsequent two quarters. Real consumption spending tracked GDP during the downturn, falling by 14% in the first quarter of 1998 and 18 percent overall during the crisis period. Employment fell by somewhat less than GDP – 8 percent from peak to trough, implying a 6 percent reduction in labor productivity, as measured by GDP per worker. Using electricity consumption as a proxy for capital services, the drop in labor productivity is associated with a sharp reduction in capital utilization over this time period.[3]

Figure 2 plots the behavior of various financial variables, including the call rate, the exchange rate, the corporate-treasury spread and the EMBI spread, which may be viewed as a measure of the country risk premium. The country risk premium as measured by the EMBI jumped from 100 basis points to 600 basis points in a two-month period following the onset of the crisis.[4] The corporate-treasury bond spread rose 9 percentage points in response. Monetary policy was conducted in such a way as to first defend the exchange rate, and later abandon the peg in favor of flexible rates. This policy led to a 12 percentage point rise in the overnight call rate in the final quarter of 1997, followed by a gradual reduction in interest rates throughout the next year. It is reasonable to believe that prior expectations regarding the probability that Korea would abandon the fixed exchange rate were low. Once the Bank of Korea failed in its attempt to defend the won, the currency depreciated by 40 percent. Inflation, which was averageing 4 percent before the crisis, increased 5 percentage points in the first quarter of 1998 as import prices rose sharply following the devaluation. The overall reductioin in economic activity led to a sharp contraction in inflation however. By the first quarter of 1999, inflation had fallen to 0.5 percent, well below its pre-crisis level. The stock market, which had been trending downward prior to the crisis, lost 200 points, or a third of its value, in the immediate aftermath of the crisis. Following a brief rally, stock

[3]If energy and capital services enter the production function as perfect complements owing to a Leontief technology, electricity is a perfect measure for capital utilization. Econometric estimates imply a very low degree of substitutability between capital and energy especially in the short run, making electricty a very good proxy even in the absence of perfect complementarity.

[4]The country risk spread also rose sharply following the Russian crisis. This had very little effect on the Korean economy however. By this time, the Korean monetary authority had abandoned the fixed exchange rate.

prices lost another 100 points before beginning a recovery in the second quarter of 1998.

Figure 3 plots the foreign sector of the Korean economy. The 40 percent decline in the real exchange rate led to a 15 percent increase in net exports. Nearly all of this increase in net exports is attributable to the 40 percent decline in imports rather than an expansion in exports however. Thus it appears that the competitiveness effect of the devaluation had at best only a modest expansionary effect on the economy. This in part reflects the fact that many of Korean's Asian trading partners were also suffering from the crisis environment. It also reflects the fact that the Korean economy was unable to grow its way out of the recession by exporting more goods to economically stable trading partners such as the U.S. and Europe.

For modeling purposes, we take away the following implications from the Korean experience: the 5 percent rise in the country risk premium that occurred in the fourth quarter of 1997 arguably occurred for reasons that were exogenous to the existing macroeconomic conditions in Korea; the Bank of Korea initially followed a fixed exchange rate policy (with some drift) and then abandoned the policy after the crisis had begun to unfold; the sharp rise in domestic interest rates led to an immediate and large contraction in real GDP, investment spending, and labor productivity, and a sharp increase in loan rate spreads. The subsequent devaluation led to a rise in inflation and a significant reduction in imports but only a modest expansion in exports.

Explaining the measured contraction in Korean real GDP as the endogenous response to an increase in the country risk premium requires a substantial amplification mechanism relative to the standard open economy New Keynesian model. In the next section, we outline the open economy version of the BGG model, which naturally provides such an amplification device. We then consider the ability of this model to quantitatively account for various features of the 1997-1998 Korean crisis.

3 The Model

We consider a small open economy framework with money and nominal price rigidities, along the lines of Obstfeld and Rogoff [34], Svensson [38], Gali and Monacelli [25], Chari, Kehoe and McGrattan [15], and others. The key modification is the inclusion of a financial accelerator mechanism, as developed in BGG. Within the model there exist both households and firms. There is also a foreign sector and a government sector. Households work, save, and

consume tradable goods that are produced both at home (H) and abroad (F). Domestically and foreign made goods are imperfect substitutes.

Within the home country, there are three types of producers: (i) entrepreneurs; (ii) capital producers; and (iii) retailers. Entrepreneurs manage the production of wholesale goods. They borrow from households to finance the acquisition of capital used in the production process. Due to imperfections in the capital market, entrepreneurs' demand for capital depends on their respective financial positions - this is the key aspect of the financial accelerator. In turn, in response to entrepreneurial demand, capital producers build new capital. Finally, retailers package together wholesale goods to produce final output. They are monopolistically competitive and set nominal prices on a staggered basis. The role of the retail sector in our model is simply to provide the source of nominal price stickiness.

We now proceed to describe the behavior of the different sectors of the economy, along with the key resource constraints.

3.1 Households

3.1.1 Consumption Composites

Let C_t be a composite of household tradable consumption goods. Then the following CES index defines household preferences over home consumption, C_t^H, and foreign consumption, C_t^F:

$$C_t = \left[(\gamma)^{\frac{1}{\rho}} \left(C_t^H \right)^{\frac{\rho-1}{\rho}} + (1-\gamma)^{\frac{1}{\rho}} \left(C_t^F \right)^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}} \tag{1}$$

The corresponding consumer price index (CPI), P_t is given by

$$P_t = \left[(\gamma) \left(P_t^H \right)^{1-\rho} + (1-\gamma) \left(P_t^F \right)^{1-\rho} \right]^{\frac{1}{1-\rho}} \tag{2}$$

The domestic consumption good, C_t^H, is a composite of differentiated products sold by domestic monopolistically competitive retailers. However, since we can describe household behavior in terms of the composite good C_t^H, we defer discussion of the retail sector until section (3.3.3) below.

3.1.2 The Household's Decision Problem

Household preferences are given by

$$E_0 \sum_{t=0}^{\infty} \beta^t U \left(C_t, L_t, \frac{M_t}{P_t} \right) \tag{3}$$

with

$$
\begin{aligned}
U\left(C_t, L_t, \frac{M_t}{P_t}\right) &= \frac{\left[(C_t)^{1-\varsigma}(1-L_t)^{\varsigma}\right]^{1-\sigma}}{1-\sigma} + \log\left(\frac{M_t}{P_t}\right) \\
\sigma &\geq 0,\ \varsigma \in (0,1).
\end{aligned}
\tag{4}
$$

Let W_t denote the nominal wage; Π_t real dividend payments (from ownership of retail firms); T_t lump sum real tax payments; M_t nominal money balances; S_t the nominal exchange rate; B_{t+1} and B^*_{t+1} nominal bonds denominated in domestic and foreign currency, respectively; and $(1+i_t)$ and $(1+i^*_t)$ the domestic and foreign gross nominal interest rate, respectively. The household's budget constraint is then given by

$$
C_t = \frac{W_t}{P_t}L_t + \Pi_t - T_t - \frac{M_t - M_{t-1}}{P_t} - \frac{B_{t+1} - (1+i_{t-1})B_t}{P_t} - \frac{S_t B^*_{t+1} - S_t\left(1+i^*_{t-1}\right)B^*_t}{P_t} \tag{5}
$$

The household maximizes (3) subject to (5).

3.1.3 Consumption Allocation, Labor Supply, and Saving

The optimality conditions for consumption, labor supply, and saving are reasonably conventional:

consumption allocation

$$
\frac{C^H_t}{C^F_t} = \frac{\gamma}{1-\gamma}\left(\frac{P^H_t}{P^F_t}\right)^{-\rho}; \tag{6}
$$

labor allocation

$$
(1-\varsigma)\frac{1}{C_t}\frac{W_t}{P_t} = \varsigma\frac{1}{1-L_t}; \tag{7}
$$

consumption/saving

$$
\lambda_t = \beta E_t\left\{\lambda_{t+1}(1+i_t)\frac{P_t}{P_{t+1}}\right\}; \tag{8}
$$

where λ_t, the marginal utility of the consumption index C_t, is given by

$$
\lambda_t = (1-\varsigma)(C_t)^{(\sigma-1)(\varsigma-1)-1}(1-L_t)^{\varsigma(1-\sigma)} \tag{9}
$$

and $(1+i_t)\frac{P_t}{P_{t+1}}$ denotes the gross real interest rate.

The household also decides money holdings. However, we do not report this relation in the model. Because we restrict attention to monetary regimes where either the nominal exchange or the nominal interest rate is the policy instrument, money demand plays no role other than to pin down the nominal money stock (see, e.g., Clarida, Gali and Gertler [17]).

3.1.4 International Arbitrage

Given frictionless international trade in bonds, the uncovered interest parity condition holds as follows:[5]

$$E_t \left\{ \lambda_{t+1} \frac{P_t}{P_{t+1}} \left[(1+i_t) - (1+i_t^*) \frac{S_{t+1}}{S_t} \right] \right\} = 0 \tag{10}$$

We distinguish between the wholesale (import) price of foreign goods and their retail price in the domestic market by allowing for imperfect competition and pricing to market in the local economy (see section 3.3.3). At the wholesale level, before pricing to market considerations, the law of one price holds. Let $P_{W,t}^F$ denote the wholesale price of foreign goods in domestic currency, and P_t^{F*} the foreign currency price of such goods, which is taken as exogenous. The law of one price then implies:

$$P_{W,t}^F = S_t P_t^{F*} \tag{11}$$

3.2 Foreign Behavior

We take as exogenous both the gross foreign nominal interest rate[6] $(1+i_t^*)$ and the nominal price (in units of foreign currency) of the foreign tradable, P_t^{F*}. Finally, we also assume that foreign demand for the home tradable, $C_t^{H^*}$, is given by

$$C_t^{H^*} = \left[\left(\frac{P_t^{H*}}{P_t^*} \right)^{-\varkappa} Y_t^* \right]^{\omega} \left(C_{t-1}^{H^*} \right)^{1-\omega}, \ 0 \leq \omega \leq 1 \tag{12}$$

where Y_t^* is real foreign output, which we take as given. The term $\left(C_{t-1}^{H^*} \right)^{(1-\omega)}$ represents inertia in foreign demand for domestic products.

3.3 Firms

We consider in turn: entrepreneurs, capital producers, and retailers.

[5] The arbitrage equation for the foreign-denominated bond is $\lambda_t = \beta E_t \left\{ \lambda_{t+1} (1+i_t^*) \frac{S_{t+1}}{S_t} \frac{P_t}{P_{t+1}} \right\}$. Combining this relation with the consumption euler equation then yields the uncovered interest parity condition.

[6] Because we do not assume complete international markets for sharing of consumption risk, the stock of net foreign indebtedness may be non-stationary. To address this issue, we follow Schmitt-Grohe and Uribe [36] by introducing a (very) small friction in the home country's ability to obtain funds on the world capital market. In particular, we assume that the home country borrows in the international capital markets at the world interest rate plus a premium that is an increasing function of the stock of debt held by the country. As in Schmidt-Grohe and Uribe, we set the elasticity of the interest rate with respect to the debt very close to zero so that the high frequency dynamics are unaffected by this friction. At the same time, the friction is sufficient to ensure that the stock of net foreign indebtedness reverts to a unique steady state.

3.3.1 Entrepreneurs, Finance, and Wholesale Production

Entrepreneurs manage production and obtain financing for the capital employed in the production process. Entrepreneurs are risk neutral. To ensure that they never accumulate enough funds to fully self-finance their capital acquisitions, we assume they have a finite expected horizon. Each survives until the next period with probability ϕ. Accordingly, the expected horizon is $\frac{1}{1-\phi}$. The entrepreneurs' population is stationary, with new entrepreneurs entering to replace those who exit. To get started, new entrepreneurs receive a small transfer of funds from exiting entrepreneurs.

Let Y_t, L_t, and K_t be domestic output, labor, and capital. To provide endogenous movements in measured total factor productivity, we introduce variable capital utilization. Let u_t denote the utilization rate of capital and $(u_t K_t)$ denote capital services. Then the production technology is given by

$$Y_t = A_t \left(u_t K_t\right)^{\alpha} \left(L_t\right)^{1-\alpha}. \tag{13}$$

Given the capital stock K_t, which is pre-determined within the period, entrepreneurs hire labor and decide on the optimal utilization rate u_t to maximize profits. Labor demand satisfies

$$(1-\alpha)\frac{Y_t}{L_t} = \frac{W_t}{P_{W,t}} \tag{14}$$

where $P_{W,t}$ is the nominal price of domestic wholesale output. We endogenize the utilization decision by assuming that increases in the utilization rate of capital are costly owing to faster depreciation rates (Greenwood, Hercowitz and Huffman [26]). We adopt the formulation of Baxter and Farr [5] and assume the following convex cost function for depreciation:

$$\delta\left(u_t\right) = \delta + \frac{b}{1+\xi}\left(u_t\right)^{1+\xi} \quad \text{with} \quad \delta, b, \xi > 0. \tag{15}$$

The optimality condition for capital utilization is

$$\alpha\frac{Y_t}{u_t} = \delta'\left(u_t\right) K_t \frac{P_{I,t}}{P_{W,t}} \tag{16}$$

where $P_{I,t}$ denotes the price of new investment goods, defined below. Equation (16) equates the marginal value of the output gain from a higher rate of utilization with its marginal cost owing to a higher rate of capital depreciation.

At the end of each period t, entrepreneurs purchase capital which can be used in the subsequent period $t+1$ to produce output at that time. Entrepreneurs finance the acquisition

of capital partly with their own net worth available at the end of period t, N_{t+1}, and partly by issuing nominal bonds, B_{t+1}. Let Q_t be the nominal price of capital in domestic currency. Then capital financing is divided between net worth and debt, as follows:

$$\frac{Q_t}{P_t}K_{t+1} = N_{t+1} + \frac{B_{t+1}}{P_t}. \tag{17}$$

Observe that the entrepreneur's net worth is essentially the equity of the firm, i.e., the gross value of capital net of debt, $\frac{Q_t}{P_t}K_{t+1} - \frac{B_{t+1}}{P_t}$. The entrepreneur accumulates net worth through past earnings, including capital gains. We assume that new equity issues are prohibitively expensive, so that all marginal finance is done with debt.[7] Finally, we assume for the time being that debt is denominated in units of domestic currency. Later we will consider the case where debt is issued in foreign currency units.

The entrepreneur's demand for capital depends on the expected marginal return and the expected marginal financing cost. As specified below, we assume that the price of capital reflects aggregate adjustment costs born by the capital-producing sector. We assume, however, that such adjustment costs apply to net rather than gross capital. To formulate such a specification, we therefore assume that entrepreneurs pay the "wear and tear" costs associated with capital use, before selling it on the market.

Accordingly, given the production technology, a unit of capital acquired at t and used at $t+1$ yields the expected gross return

$$E_t\left\{1 + r_{t+1}^k\right\} = E_t\left\{\frac{\frac{P_{W,t+1}}{P_{t+1}}\left(\alpha\frac{Y_{t+1}}{K_{t+1}}\right) + \frac{Q_{t+1}}{P_{t+1}} - \delta(u_{t+1})\frac{P_{I,t+1}}{P_{t+1}}}{\frac{Q_t}{P_t}}\right\} \tag{18}$$

where $\left(\alpha\frac{Y_{t+1}}{K_{t+1}}\right)$ is the marginal product of capital, $\frac{Q_t}{P_t}$ is the relative price of capital, and $\delta(u_{t+1})$ is the depreciation rate of capital.

The marginal cost of funds to the entrepreneur depends on financial conditions. Following BGG, we assume the existence of an agency problem that makes uncollateralized external finance more expensive than internal finance. This external finance premium affects the overall cost of finance and, therefore, the entrepreneur's demand for capital. In general, the external finance premium varies inversely with the entreprenuer's net worth: the greater the share of capital that the entrepreneur can either self-finance or finance with

[7] To be clear, being an equity holder in this context means being privy to the firm's private information, as well as having a claim on the earnings stream. Thus, we are assuming that the firm cannot attract new wealthy investors that costlessly absorb all firm-specific information.

collateralized debt, the smaller the agency costs and, hence, the smaller the external finance premium.

By definition, the entrepreneur's overall marginal cost of funds in this environment is the product of the gross premium for external funds and the gross real opportunity cost of funds that would arise in the absence of capital market frictions. Rather than present the details of the agency problem here, we simply observe, following BGG, that the external finance premium, $\chi_t(\cdot)$, may be expressed as an increasing function of the leverage ratio, $\frac{\frac{B_{t+1}}{P_t}}{N_{t+1}}$. Accordingly, the entrepreneur's demand for capital satisfies the optimality condition

$$E_t\left\{1+r_{t+1}^k\right\} = (1+\chi_t(\cdot))E_t\left\{(1+i_t)\frac{P_t}{P_{t+1}}\right\} \tag{19}$$

with

$$\begin{aligned} \chi_t(\cdot) &= \chi\left(\frac{\frac{B_{t+1}}{P_t}}{N_{t+1}}\right) \\ \chi'(\cdot) &> 0,\ \chi(0)=0,\ \chi(\infty)=\infty \end{aligned} \tag{20}$$

and where $E_t\{(1+i_t)\frac{P_t}{P_{t+1}}\}$ is the gross cost of funds absent capital market frictions.[8]

We interpret equation (19) as follows: at the margin, the entrepreneur is considering acquiring a unit of capital financed by debt. The additional debt, however, raises the leverage ratio, increasing the external finance premium and the overall marginal cost of finance. Relative to perfect capital markets, accordingly, the demand for capital is lower, the exact amount depending on χ_t. Here we emphasize that the agency problem defines the precise form of the function $\chi(\cdot)$ (see BGG).[9] We note, however, that the general form relating external finance costs to financial positions arises across a broad class of agency problems.

Equation (19) provides the foundation for the financial accelerator. It links movements in the borrower's financial position to the marginal cost of funds and, hence, to the demand for capital. Note in particular that fluctuations in the price of capital, Q_t, may have significant

[8] We do not allow the debt contract to be conditioned on aggregate risk. If entrepreneurs and households had identical risk preferences then it would be optimal for households to provide some insurance to entrepreneurs against fluctuations in their collateral. However, because households in our model are considerably more risk adverse than entrepreneurs, quantitative experiments suggest that hosueholds would be unwilling to provide this insurance in equilbrium.

[9] To parametrize $\chi(\cdot)$ in the simulation exercises that follow, we assume a costly state verification problem of the type analyzed by Townsend [40], where lenders must pay a fixed auditing cost to observe the ex-post realization of entrepreneurs' output. See BGG for details.

effects on the leverage ratio, $\frac{\frac{B_{t+1}}{P_t}}{N_{t+1}} = \frac{\frac{B_{t+1}}{P_t}}{\frac{Q_t}{P_t}K_{t+1}-\frac{B_{t+1}}{P_t}}$. In this way the model captures the link between asset price movements and collateral stressed in the Kiyotaki and Moore [28] theory of credit cycles. We add that though we have described equation (19) in terms of the behavior of an individual entrepreneur, we appeal to the assumptions in BGG that permit writing it as an aggregate condition. The key implication is that $\chi(\cdot)$ may be expressed as a function of the aggregate leverage ratio, i.e., $\chi(\cdot)$ is not entrepreneur-specific.[10]

The other key aspect of the financial accelerator is the relation that describes the evolution of entrepreneurial net worth, N_{t+1}. Let V_t denote the value of entrepreneurial firm capital net of borrowing costs carried over from the previous period, and D_t the transfer that newly entering entrepreneurs receive from exiting entrepreneurs. Then we can express N_{t+1} as a convex combination of V_t and D_t, where the weights reflect the fractions of surviving (ϕ) and newly entering $(1-\phi)$ entrepreneurs, respectively:

$$N_{t+1} = \phi V_t + (1-\phi)D_t \tag{21}$$

where V_t is given by

$$V_t = \left(1+r_t^k\right)\frac{Q_{t-1}}{P_{t-1}}K_t - \left[\left(1+\chi(\cdot)\right)\left(1+i_{t-1}\right)\frac{P_{t-1}}{P_t}\right]\frac{B_t}{P_{t-1}} \tag{22}$$

$(1+r_t^k)$ is the ex-post real return on capital, and $(1+\chi(\cdot))(1+i_{t-1})\frac{P_{t-1}}{P_t}$ is the ex post cost of borrowing.

As equations (21) and (22) suggest, the principle source of movements in net worth stems from unanticipated movements in returns and borrowing costs. In this regard, unforecastable variations in the asset price Q_t likely provide the principle source of fluctuation in $(1+r_t^k)$. It is for this reason that unpredictable asset price movements play a key role in the financial accelerator. On the liability side, unexpected movements in the price level affect ex post borrowing costs. An unexpected deflation, for example, reduces entrepreneurial net worth. If debt were instead denominated in foreign currency, then unexpected movements in the nominal exchange rate will similarly shift net worth - we explore this possibility later.

Entrepreneurs going out of business at time t consume and transfer some funds to new entrepreneurs out of the residual equity, $(1-\phi)V_t$. We assume that entrepreneurs have

[10] Following Carlstrom and Fuerst [13], BGG assume an agency problem that is essentially proportionate to the scale of the firm. This assumption, combined with a constant returns to scale production function, implies that all entrepreneurs choose the same leverage ratio. This allows us to express $\chi(\cdot)$ in terms of the aggregate leverage ratio.

preferences over domestic and foreign goods that are identical to the households' preferences specified in equation (1). Let C_t^e denote the amount of the consumption composite consumed by the entrepreneurial sector. The optimal mix of foreign and domestic tradable goods for entrepreneurial consumption satisfies an equation analagous to equation (6). Let D_t denote the transfer to new entrepreneurs. Since the costs of pure debt finance are infinite (see equation (20)), we include the transfer D_t to ensure that new entrepreneurs can operate. We take D_t as given, but observe that in our quantitative exercises it is of negligible size. Under these assumptions, entrepreneurial consumption satisifies

$$C_t^e = (1-\phi)(V_t - D_t) \tag{23}$$

3.3.2 Capital Producers

After production of output at time t, competitive capital producers make capital goods. Specifically, they purchase final goods from retailers and then use these goods to replace depreciated capital and produce new capital. Investment is assumed to be a composite of domestic and foreign final goods:

$$I_t = \left[(\gamma_i)^{\frac{1}{\rho_i}} \left(I_t^H\right)^{\frac{\rho_i - 1}{\rho_i}} + (1-\gamma_i)^{\frac{1}{\rho_i}} \left(I_t^F\right)^{\frac{\rho_i - 1}{\rho_i}} \right]^{\frac{\rho_i}{\rho_{i-1}}} \tag{24}$$

The production parameter γ_i measures the relative weight that domestic and foreign inputs receive in the investment composite. Capital producers choose the optimal mix of foreign and domestic inputs according to the intra-temporal first-order-condition

$$\frac{I_t^H}{I_t^F} = \frac{\gamma_i}{1-\gamma_i} \left(\frac{P_t^H}{P_t^F} \right)^{-\rho_i} \tag{25}$$

Owing to adjustment costs, I_t units of the investment composite yields $\Phi(\frac{I_t}{K_t} - \delta(u_t))K_t$ units of new capital goods (net investment). We assume that $\Phi(\frac{I_t}{K_t} - \delta(u_t))$ is increasing and concave.[11] We also assume, following BGG, that capital producers make their production plans one period in advance. The idea is to capture the delayed response of investment observed in the data. Since adjustment costs only apply to the net increase in the capital stock, capital accumulation satisfies

$$K_{t+1} = K_t + \Phi(\frac{I_t}{K_t} - \delta(u_t))K_t \tag{26}$$

[11] By assuming adjustment costs to new capital goods, our model may be viewed as a two-sector model whose endogenous movements in capital good prices may have important implications for the one-sector business cycle accounting frameworks employed by Chari, Kehoe and McGrattan [16] and Cole and Ohanian [20] to explain the Great Depression.

where gross investment is defined as $\Phi(\frac{I_t}{K_t} - \delta(u_t))K_t + \delta(u_t)K_t$.

Let

$$P_{I,t} = \left[(\gamma_i)\left(P_t^H\right)^{1-\rho_i} + (1-\gamma_i)\left(P_t^F\right)^{1-\rho_i}\right]^{\frac{1}{1-\rho_i}} \tag{27}$$

denote the investment good price index. It is straightforward to show that capital producers plan net investments to satisfy

$$E_{t-1}\left\{\frac{Q_t}{P_{I,t}} - \left[\Phi'\left(\frac{I_t}{K_t} - \delta(u_t)\right)^{-1}\right]\right\} = 0. \tag{28}$$

Equation (28) is a standard "Q-investment" relation, modified to allow for the investment delay. The variable price of capital, though, plays an additional role in this framework: as we have discussed, variations in asset prices will affect entrepreneurial balance sheets, and hence, the cost of capital.

3.3.3 Retailers, Price Setting, and Inflation

We assume there is a continuum of monopolistically competitive retailers of measure unity. Retailers buy wholesale goods from entrepreneurs/producers in a competitive manner and then differentiate the product slightly (e.g., by painting it or adding a brand name) at a fixed resource cost. We model the fixed (from the retailer's point of view) resource cost, κ. We assume that the fixed cost κ represents distribution and selling costs that are assumed to be proportional to the steady-state value of wholesale output. We choose the level of the fixed costs so that profits to the wholesale sector are zero in steady-state.

Let $Y_t^H(z)$ be the good sold by retailer z. Final domestic output is a CES composite of individual retail goods:

$$Y_t^H = \left[\int_0^1 Y_t^H(z)^{\frac{\vartheta-1}{\vartheta}} dz\right]^{\frac{\vartheta}{\vartheta-1}} - \kappa \tag{29}$$

The corresponding price of the composite consumption good, P_t^H, is given by

$$P_t^H = \left[\int_0^1 P_t^H(z)^{1-\vartheta} dz\right]^{\frac{1}{1-\vartheta}} \tag{30}$$

Domestic households, capital producers, the government, and the foreign country buy final goods from retailers. Cost minimization implies that each retailer faces an isoelastic demand for his product given by $Y_t^H(z) = \left(\frac{P_t^H(z)}{P_t^H}\right)^{-\vartheta} Y_t^H$. Since retailers simply repackage wholesale

goods, the marginal cost to the retailer of producing a unit of output is simply the relative wholesale price, $\frac{P_{W,t}}{P_t^H}$.

As we have noted, the retail sector provides the source of nominal stickiness in the economy. We assume retailers set nominal prices on a staggered basis, following the approach in Calvo [12]: each retailer resets his price with probability $(1-\theta)$, independently of the time elapsed since the last adjustment. Thus, each period a measure $(1-\theta)$ of producers reset their prices, while a fraction θ keeps their prices unchanged. Accordingly, the expected time a price remains fixed is $\frac{1}{1-\theta}$. Thus, for example, if $\theta = .75$ per quarter, prices are fixed on average for a year.

Since there are no firm-specific state variables, all retailers setting price at t will choose the same optimal value $\overline{P}_t^H$. It can be shown that, in the neighborhood of the steady state, the domestic price index evolves according to

$$P_t^H = (P_{t-1}^H)^{\theta}(\overline{P}_t^H)^{1-\theta}. \tag{31}$$

Retailers free to adjust choose prices to maximize expected discounted profits, subject to the constraint on the frequency of price adjustments.[12] Here we simply observe that, within a local neighborhood of the steady state, the optimal price is

$$\overline{P}_t^H = \mu \prod_{i=0}^{\infty} (P_{W,t+i})^{(1-\beta\theta)(\beta\theta)^i} \tag{32}$$

where $\mu = \frac{1}{1-1/\vartheta}$ is the retailers' desired gross mark-up over wholesale prices. In particular, note that if retail prices were perfectly flexible, equation (32) would simply imply $\overline{P}_t^H = \mu P_{W,t}$, i.e., the retail price would simply be a proportionate markup over the wholesale price. However, because their prices may be fixed for some time, retailers set prices based on the expected future path of marginal cost, and not simply on current marginal cost.

Combining equations (31) and (32) yields an expression for the gross domestic inflation rate (within the neighborhood of a zero-inflation steady state):

$$\frac{P_t^H}{P_{t-1}^H} = \left(\mu \frac{P_{W,t}}{P_t^H}\right)^{\lambda} E_t \left\{ \frac{P_{t+1}^H}{P_t^H} \right\}^{\beta} \tag{33}$$

where the parameter $\lambda = \frac{(1-\theta)(1-\beta\theta)}{\theta}$ is decreasing in θ, the measure of price rigidity. Equation (33) is the canonical form of the new optimization-based Phillips curve that arises from an

[12] Since it is standard in the literature, we do not report the maximization problem here.

environment of time-dependent staggered price setting (see, e.g., Gali and Gertler [24]). The curve relates inflation to movements in real marginal cost and expected inflation.

Similarly, foreign goods sold in the local economy are subject to an analogous mark-up over the wholesale price owing to imperfect competition. We assume that retailers of foreign goods face the marginal cost $P^F_{W,t}$ - see equation 11 - and set prices according to a Calvo-style price setting equation. Let $1-\theta^f$ denote the probability that a retailer of foreign goods resets its price in any given period. The inflation rate for foreign goods satisfies

$$\frac{P^F_t}{P^F_{t-1}} = \left(\mu^f \frac{S_t P^{F*}_t}{P^F_t}\right)^{\lambda_f} E_t \left\{\frac{P^F_{t+1}}{P^F_t}\right\}^{\beta} \tag{34}$$

where $\lambda_f = \frac{(1-\theta^f)(1-\beta\theta^f)}{\theta^f}$.. This specification of the pricing process for domestically-sold foreign goods implies temporary deviations from the law of one price owing to delay in the exchange-rate pass through mechanism.[13] The coefficient θ^f captures the degree of this delay. When calibrating the model, we assume that retailers of domestic and foreign goods face the same degree of price rigidity, so that $\theta^f = \theta$.[14]

CPI inflation is a composite of inflation in domestic and foreign good prices. Within a local region of the steady state, CPI inflation may be expressed as

$$\frac{P_t}{P_{t-1}} = \left(\frac{P^H_t}{P^H_{t-1}}\right)^{\gamma} \left(\frac{P^F_t}{P^F_{t-1}}\right)^{(1-\gamma)}. \tag{35}$$

3.4 Resource Constraints

The resource constraint for the domestic traded good sector is

$$Y^H_t = C^H_t + C^{eH}_t + C^{H*}_t + I^H_t + G^H_t \tag{36}$$

where G^H_t is government consumption and C^{eH}_t is entrepreneurial consumption of the domestic good.

[13] Chari, Kehoe and McGrattan [15] also consider pricing-to-market specifications to explore the role of nominal rigidities in explaining exchange rate dynamics.

[14] Since foreign prices are exogenous, we can assume, without loss of generality, that the steady-state markup $\mu^f = \mu$.

3.5 Government Budget Constraint

We assume that government expenditures are financed by lump-sum taxes and money creation as follows:

$$\frac{P_t^H}{P_t} G_t^H = \frac{M_t - M_{t-1}}{P_t} + T_t. \tag{37}$$

Government expenditures are exogenous. Lump sum taxes adjust to satisfy the government budget constraint. Finally, the money stock depends on monetary policy, which we will specify in the next section.

Except for the description of monetary policy, we have completed the specification of the model. The distinctive aspect is the financial accelerator, characterized by just two equations: (19) and (21). The former characterizes how net worth influences capital demand. The latter describes the evolution of net worth. If we restrict the external finance premium $\chi(\cdot)$ to zero in equation (19), we effectively shut off the financial accelerator, and the model reverts to a reasonably conventional new open economy macroeconomic framework. In what follows, we will explore the performance of the model under alternative exchange rate regimes, with and without an operative financial accelerator.

3.6 Fixed versus Flexible Exchange Rate Regimes

In the quantitative analysis discussed in the next section, we consider shocks to the economy under three different scenarios: (i) a pure fixed exchange rate regime; (ii) a floating exchange rate regime where the central bank manages the nominal interest rate according to an open economy variant of the Taylor rule; and (iii) a hybrid case where the central bank initially fixes the exchange rate, but then eventually abandons the peg in favor of the floating exchange rate regime.

Under the fixed exchange rate regime, the central bank keeps the nominal exchange rate pegged at a predetermined level, i.e.

$$S_t = \overline{S}, \ \forall t \tag{38}$$

To do so, the central bank sets the nominal interest rate to satisfy the uncovered interest parity condition, given by equation (10).

Under the flexible exchange rate regime, the policy instrument becomes the nominal interest rate. The central bank adopts a feedback rule that has the nominal interest rate adjust to deviations of CPI inflation and domestic output from their respective target values.

Let Y_t^0 denote the output target level, which we take to be the level that would arise if prices were perfectly flexible. The feedback rule, accordingly, is given by

$$(1+i_t) = (1+rr^{ss}) \left(\frac{P_t}{P_{t-1}}\right)^{\gamma_\pi} \left(\frac{Y_t^H}{Y_t^0}\right)^{\gamma_y} \tag{39}$$

with $\gamma_\pi > 1$ and $\gamma_y > 0$, and where rr^{ss} is the steady state real interest rate. For simplicity, we take the target gross inflation rate to be unity.[15] We interpret this rule as being a form of flexible inflation targeting, in the sense of Bernanke et al. [8]. The central bank adjusts the interest rate to ensure that over time the economy meets the inflation target, but with flexibility in the short term so as to meet stabilization objectives. Importantly, we assume the central bank is able to credibly commit to the Taylor rule.

In the hybrid regime, as a shock hits the economy, the central bank intially maintains the exchange rate peg. Conditional on being on the peg in the current period, it abandons the peg with probability Π in the subsequent period, where Π is independent of time. Once off the peg, the cental bank reverts to the interest rate feedback rule given by equation (39).

3.7 Model Parametrization

Our quantitative analysis is meant to capture the broad features of an emerging market economy such as South Korea for which financial frictions and financial crises seem most relevant. We assume that capital markets are somewhat less developed relative to the U.S.; in this respect, we fix parameters to generate a steady state external finance premium that is about 3.5 percent, a number that is roughly 150 basis points higher than what U.S. data suggest. Also in line with the Korean experience relative to the U.S., we set the leverage ratio 50 percent higher than the historical U.S. average.

In addition to having less-developed financial markets, the Korean economy has a much higher capital share than the U.S economy, and is considerably more open. To match these characteristics, we set the capital share, α, at 0.5, and the steady state ratio of exports to domestic output at 0.4. For the remaining parameters, we use reasonably standard values.

[15] The results are robust to allowing for a managed float, where the Tayor rule is appended with a term that allows for a modest adjustment of the nominal interest rate to deviations of the nominal exchange rate from target.

3.7.1 Preferences

We set the quarterly discount factor β equal to 0.99. We set the elasticity of intertemporal substitution $\frac{1}{\sigma}$ equal to $\frac{1}{5}$. Intra-temporal elasticities of substitutions are $\rho_h = \rho_e = 1$ and $\rho_i = 0.25$. These parameters imply unit elasticity of substitution between domestic and foreign consumption goods and a substantially lower elastisicity of substitution for investment goods. We assume that the share of foreign goods in the consumption and investment composites is 0.5. Finally, we set the elasticity of labor supply equal to 2 and average hours worked relative to total hours available equal to $\frac{1}{3}$.

With regard to the parameters of the export demand 12, we set the elasticity $\varkappa$ equal to 1 and the share parameter ω equal to 0.25. This implies a relatively high degree of inertia in export demand, in line with the response of Korean exports during the 1997-1998 crisis.

3.7.2 Technology

Steady-state utilization rate is set to unity and steady-state quarterly depreciation, $\delta(u_{ss})$, is assigned the conventional value of 0.025. The elasticity of marginal depreciation $\delta'(u)$ with respect to utilization rate is set at 1, consistent with Baxter and Farr [5], who rely on estimates provided by Basu and Kimball [3]. The steady state mark-up value, μ, is set at 1.2. Consistent with the retail sector earning zero profits in steady-state, fixed costs in the retail sector are assumed to be 20 percent of wholesale output. The elasticity of the price of capital with respect to the investment-capital ratio is taken to be 2. As it is common in the literature on the Calvo [12] pricing technology, we assume the probability of the price not adjusting, θ, to be 0.75.

3.7.3 External Finance Premium

The non-standard parameters of the model affect the relation between real and financial variables. We choose the entrepreneurs' death rate, $(1-\phi)$, to be 0.0272. We set the idiosyncratic productivity variable to be log-normally distributed with variance equal to 0.28. Finally, we fix the fraction of realized payoffs lost in bankruptcy to 0.12. These parameters imply the following steady state outcomes: (i) a risk spread (external finance premium) of about 350 annual basis points; (ii) an annualized business failure rate of around 6 percent; and (iii) a leverage ratio roughly equal to 1.2.

3.7.4 Government Policy

In the open economy version of the Taylor rule, we set the coefficients on inflation, γ_π, and domestic output gap, γ_y, equal to 2, and 0.75, respectively. These coefficients provide a reasonable approximation to the real interest rate response of the Korean economy following abandonment of the real exchange rate. We also take the steady state government expenditure ratio, $\frac{G^H}{Y^H}$, to be 0.2.

4 External Shocks and Financial Crises: a Quantitative Assessment

In this section we consider the response of the model to external shocks. We begin by displaying the response to a persistent one percentage point rise in foreign interest rates. In order to highlight the various model mechanisms, we consider the effect of this shock under alternative scenarios: fixed versus flexible exchange rates, and with versus without the financial accelerator. For robustness, we also explore how the results are affected when debt is denominated in units of foreign currency. We then turn to the quantitative exercise aimed at replicating the Korean experience during the 1997-1998 crisis period. This latter exercise considers two alternative policy scenarios: fixed exchange rates and a policy of abandoning the fixed exchange rate after the shock occurs.

4.1 Foreign Interest Rate Shock

We consider an unanticipated one hundred basis point increase in the foreign nominal interest rate. We assume further that the shock obeys a first-order auto-correlation process that persists at the rate of 0.95 per quarter. Figures 4A and 4B plot the response of twelve key variables under fixed versus floating rates.[16]

Under the fixed exchange rate regime, the domestic nominal interest rate rises to match the foreign rate. Due to nominal price rigidities, there is also a significant rise in the real interest which, in turn, induces a contraction in output. The financial accelerator magnifies the output drop – the rise in the real rate induces a contraction in asset prices, which raises

[16] We have also alternative experiments such as shocks to foreign demand. These experiments yield very similar conclusions regarding the effect of fixed versus flexible exchange rates in the presence of the financial accelerator.

the leverage ratio and the external finance premium. The increase in the latter further dampens investment and output.

Under flexible exchange rates, the domestic nominal interest rate is no longer tied to the foreign interest rate, and is instead governed by the feedback rule, equation (39). The rise in the foreign interest rate produces an immediate depreciation of the domestic currency, which in turn prompts an increase in exports and a sharp rise in CPI inflation. The central bank raises the nominal interest rate to fight inflation, according to the feedback rule. This monetary policy implies only a modest increase in the real interest rate however, and a moderate drop in investment. Because the rise in domestic inflation was due to a currency depreciation, it is short-lived. Nominal rates fall back to trend one period after the shock while real rates fall slightly below trend. Output falls slightly on net, due to offsetting effects of a reduction in investment demand and increasing exports. Overall, output is significantly more stable under the flexible exchange-rate regime.[17]

Figure 4A also shows the effect of the contraction in output on capital utilization and labor productivity. With either fixed or flexible exchange rates, the reduction in output implies a reduction in capital utilization of almost equal magnitude. As a consequence, labor productivity falls following a demand-driven slow-down, despite the fact that hours are contracting. The model implies a strongly pro-cyclical movement in measured TFP – under fixed exchange rates, measured TFP drops 1.5 percent in response to a 2 percent drop in utilization – despite the absence of any exogenous change in technology. These results suggest that the model is capable of producing quantitatively realistic productivity dynamics in response to demand rather than supply shocks.

The last two panels of Figure 4A show the effect of the rise in foreign interest rates on consumption and net exports. With flexible exchange rates, consumption falls more than output owing to the increased cost of imported consumer products following the depreciation. With fixed rates, this effect is muted and consumption falls by slightly less than output. As expected, with flexible exchange rates, net exports increase, albeit by a modest amount. Interestingly, net exports increase under fixed exchange rates as well. The rise in net exports is substantially larger under fixed exchange rates, despite the fact that the real exchange

[17] The monetary policy rule includes the output gap as well as inflation. In principle, output stability is influenced by the combined effect from targeting inflation and the output gap. Using an interest rate that puts zero weight on the output gap produces very similar results however. With zero weight on the output gap, the contraction in output produces less inflationary pressure and hence less need to raise real rates to fight inflation.

rate depreciates more under the flexible exchange-rate regime.

The fact that net exports expand more under fixed exchange rates is primarily due to the financial accelerator mechanism. Under either exchange-rate regime, pricing-to-market and sluggish export demand imply only a modest increase in exports. The expansion in net exports is thus primarily due to a contraction in demand for imported capital goods. With flexible rates, the reduction in demand for imported capital goods occurs for two reasons: capital goods prices rise in domestic currency terms following the devaluation; and overall investment demand falls. The strength of the second mechanism is closely tied to the strength of the financial accelerator. With fixed exchange rates, the import price mechanism is not operative and the reduction in demand for imported capital goods is solely due to the collapse of domestic investment demand. Because the effect of the financial accelerator is more severe under fixed exchange rates however, imports contract more under fixed rates relative to flexible exchange rates. As a result, the model implies that net exports are more likely to increase under fixed rather than flexible exchange rates following the rise in foreign interest rates.

Overall, these results imply a much larger drop in output, hours (not shown), and investment under a fixed exchange rate regime than under a flexible exchange rate regime in response to a rise in foreign interest rates. That output should decline more under fixed rates in this scenario is, of course, a feature of the standard model absent a financial accelerator. What we wish to stress here is that the financial accelerator greatly magnifies the difference. Figure 5 makes this point directly. The figure plots the response of output and investment across the two different exchange rate regimes, with and without an operative financial accelerator. Under fixed exchange rates, the financial accelerator doubles the contraction in investment (lower left panel) and, as a consequence, doubles the contraction in output (upper left panel) at the trough. Under flexible rates, instead, the effect of the financial accelerator is far more modest.

4.2 Foreign-denominated Debt

A number of authors have recently stressed that if private debts are denominated in foreign currency units - as it was recently the case for many emerging market economies - a fixed exchange rate regime may in fact be more desirable than a flexible exchange rate regime, since devaluations weaken borrowers' balance sheets.[18] In assessing the Korean experience below,

[18] See, for example, Aghion, Bacchetta and Banerjee [2].

we would like to make sure that our results are robust to such considerations. Accordingly, we briefly consider the effect of foreign-indexed debt for the response of the model to a rise in the foreign interest rate.[19]

Figure 6 plots the response of output and investment under three different scenarios: flexible exchange rates with foreign-denominated debt; flexible exchange rates with domestic-denominated debt; and fixed exchange rates. As one would expect, foreign currency debt makes the flexible exchange rate regime considerably less attractive. Allowing for foreign currency debt implies a contraction in investment that is twice as large as the contraction obtained in the case of domestic currency debt. With foreign currency debt, the depreciation of the exchange rate reduces entrepreneurial net worth, thus enhancing the financial accelerator mechanism. Nonetheless, even in this instance, the output drop remains smaller under flexible rates than under fixed rates. Put differently, the impact of the exchange rate on the balance sheets under flexible rates is less damaging than the contraction in asset prices under fixed rates.

Cespedes, Chang and Velasco [14] (CCV) also find that the output response remains greater under fixed rates but for different reasons.[20] In CCV, domestic assets do not serve as collateral but certain restrictions on the physical environment ensure that flexible rates dominate. In CCV, because capital is fully depreciable, there is no fixed debt overhang. This mitigates the impact of a depreciation of the exchange rate on the domestic balance sheets. The impact of the depreciation on net export demand and firm cash flows more than offsets the effect on real indebtedness. Flexible rates dominate even though an asset price channel is not present. In our framework, however, the asset price channel is key. Since capital is non-depreciable, in the short term there is a non-variable component to borrowing needs. This raises firms' exposure to currency depreciations. Nonetheless, the contraction in asset values that occurs as interest rates rise under the fixed exchange rate regime more

[19] In the presence of loans denominated in foreign currency, the entrepreneurial net wealth and the external finance premium equations are modified as follows:

$$V_t = \left(1 + r_t^k\right) \frac{Q_{t-1}}{P_{t-1}} K_t - \left[\left(1 + \chi(\cdot)\right) \left(1 + i_{t-1}^*\right) \frac{S_t}{S_{t-1}} \frac{P_{t-1}}{P_t} \right] \frac{B_t}{P_{t-1}}$$

and

$$E_t \left\{1 + r_{t+1}^k\right\} = (1 + \chi_t(.)) E_t \left\{ (1 + i_t^*) \frac{S_{t+1}}{S_t} \frac{P_t}{P_{t+1}} \right\}$$

[20] Caballero and Krishnamurthy [11] and Schneider and Tornell [37] also emphasize the importance of the asset price channel in analyzing emerging market crises.

than offsets the benefits to the balance sheets from avoiding the currency depreciation. As a result, the contraction in investment and output is invariably larger under the fixed exchange rate regime relative to the flexible exchange rate regime.

4.3 The Korean Experience

We now turn to a quantitative exercise that is intended to capture the macroeconomic consequences of the rise in the country risk premium that occurred in Korea during its recent financial crisis. Our goal is to analyze the quantitative response of our model under such a scenario and compare the model outcome with the actual Korean data. Within the context of our model, an exogenous rise in the country risk premium introduces a wedge between domestic and foreign interest rates in the uncovered interest parity condition. Formally, it is equivalent to a shock to the foreign interest rate. As discussed above, we believe that treating the rise in the country risk premium as exogenous is a reasonable approximation of the Korean situation.[21]

We consider a 5 percentage point rise in foreign interest rates, which is in line with the rise in the risk premium that occurred in Korea during the financial crisis. We assume that the shock persists as a first-order autoregressive process with a 0.95 coefficient.[22] We consider two alternative scenarios for monetary policy. The first scenario assumes a fixed exchange rate. The second scenario assumes that the monetary authority starts out under a fixed exchange rate but abandons the fixed rate two periods after the interest rate increase.[23] To make this realistic, we assume that private agents have some expectations that the monetary authority will abandon the peg, but the actual abandonment is still a positive surprise. Specifically, we consider a hybrid model where the exchange rate is initially fixed but where policy makers are expected to abandon the fixed exchange rate with a low probability. We set the abandonment probability at $\Pi = 0.1$. Accordingly, conditional on being on the peg, the expected duration is $1/\Pi = 1/(0.1) = 10$ quarters. Thus abandoning the fixed exchange-rate regime two periods after the shock represents a positive surprise to the economy.

Figures 7A and 7B plot the response of twelve key variables under the policy of fixed

[21] Cooper and Ejarque [21] provide a model with an endogenous collapse of the banking sector applied to the Great Depression. Their model, however, does not provide an endogenous amplification of the collapse through a financial accelerator mechanism.

[22] Even after controlling for the sharp spike in the EMBI+ following the Russian crisis in 1998, it appears that the increase in the Korean spread was persistently high after the Asian crisis.

[23] As a benchmark, we also include the flexible exchange rate regime case.

exchange rates and under the policy of probabilistic abandonment. For comparison purposes, we also plot the response under flexible exchange rates. With fixed exchange rates, the 5 percentage point rise in foreign interest rates leads to a 12 percent drop in output and a 35 percent drop in investment according to the model. As expected, the financial accelerator plays an important role in this exercise – the premium on external funds rises 9 percentage points on an annual basis. As a result, the financial accelerator accounts for 50 percent of the overall drop in investment and output in this exercise. The endogenous contraction in the rate of capital utilization implies a reduction in labor productivity despite the fact that hours are falling. We also obtain a quantitatively important reduction in measured total-factor productivity in this exercise (not shown). Under the fixed rate policy, consumption spending falls by 8 percent while net exports rise by 12 percent in the period following the shock.

In this experiment, abandoning the fixed exchange rate represents good news for the economy and hence asset values. Prior to abandonment, the response of the hybrid model is very similar to the response obtained under the model with fixed exchange rates.[24] Following abandonment, the nominal and real exchange rates depreciate by 10 percent. Under the now flexible monetary policy, the nominal interest rate falls 13 percentage points, while the real interest rate drops 17 percentage points. The sudden reduction in real rates leads to an increase in asset values and a reduction in the premium on external funds. As a result, investment and output recover to levels that are close to those that would be obtained under the flexible exchange rate regime. Overall, the hybrid model implies a deep but short-lived recession, which again suggests that there are substantial gains to be obtained from a flexible exchange rate policy even if it is enacted after the onset of the crisis.

The hybrid model does well at capturing the key outcomes of the Korean experience displayed in Figures 1-3 above. In the Korean data, the drop in real GDP is 14 percent whereas the model produces a 12 percent drop in real GDP. The reduction in gross capital formation for Korea is on the order of 45 percent, again in line with, albeit somewhat larger than, the model's 35 percent response. Net exports increase by 15 percent in the data, compared with 12 percent in the model. Notably, both the data and the model imply a large reduction in imports, especially capital goods, which drives the expansion in net exports. In the data, consumption falls by 18 percent, which is somewhat more than the 8 percent

[24] Because agents expect the monetary authority to abandon eventually, expected future inflation is higher, and consequently, so is current inflation. As a result, both nominal and real interest rates rise by more under the hybrid policy, and the initial contraction is somewhat more severe.

implied by the model; because the data include durables as well as non-durables, we expect to find that the consumption data are more volatile than the model's response however.

The model also does well at capturing the productivity and utilization variables observed in Korea over this time period. The Korean data imply a 5 percent drop in labor productivity over the period December 1997 through September 1998 while the model implies a 3 percent drop in labor productivity. The magnitude of the decline in labor producivity observed in the data is probably exagerated, however, since it is based on output per worker not output per hour. As shown in figure 1, electricity consumption for the Korean economy falls 14 percent during the crisis period. In the model, capital utilization drops 11 percent. Given that oil is an imported good, we would expect some substitution away from energy towards other capital goods and inputs in the case where energy and capital show some degree of substitutability. Hence the 14 percent drop in energy is likely to overstate the decline in capital services owing to a drop in utilization rates. These results imply that variable capital utilization provides a reasonable explanation for the contraction in productivity that emerging market economies such as Korea experience in the wake of a financial crisis.

Finally, the model also does well at capturing various financial features of the Korean experience. The 9 percentage point rise in the corporate-treasury bond spread observed in the data is very close in magnitude to the response obtained by the model's external finance premium. Under fixed exchange rates, the external finance premium in the model is highly persistent. In contrast, the hybrid model does a good job of capturing the sudden reduction in the corporate-treasury bond spread following abandoment. The hybrid model also does well at mimicking both the nominal and real interest rate movements observed in the data. In particular, in the data, the (ex-post) real rate initially rises by 8 percentage points prior to abandonment, and then falls 16 percentage points following abandonment – a result that is similar to the real rate path generated by the model.[25] Consistent with this path, both the data and model exhibit a surge in inflation – on the order of 5 percentage points – following abandonment.

The financial variable that is difficult to match is the actual exchange rate movement when the monetary authority abandons the flexible exchange rate regime probabilistically.

[25] Although we don't have data on ex-ante real rates it is useful to look at the ex-post real rate as a guide. The nominal interest rate rises from 13% to 25% on an annual basis in January, 1998, before falling to 5% by September 1998. The inflation rate rises from 5% to 9% from the third quarter of 1997 to the first quarter of 1998 before falling to 6% by September of 1998. Thus, the ex-post real rate is approximately 8% in October, 1998, 16% in January, 1998 and 0% in September 1998, indicating an initial 8 percentage point rise followed by a 16 percentage point fall in the real rate.

Table 1: Welfare Loss As a Percent of Steady-State Consumption

	No Financial Accelerator	With Financial Accelerator
Flexible Rates	23.4%	25.2%
Switching Regime	25.1%	29.7%
Fixed Rates	27.5%	37.7%

The fact that quantitative macroeconomic models have difficulty matching exchange rate movements comes as no surprise however. Our model nonetheless produces a sizeable depreciation in the real exchange rate – on the order of 10 percent. As is well known, movements in the nominal exchange rate dramatically over-state movements in real exchange rates and terms of trade.[26] To the extent that our model does well at capturing the dynamic response of net exports, we are less concerned that it does not fully account for the volatility of exchange rates during this time period.

We now consider the welfare loss associated with the financial crisis. Specifically, we compute the amount of steady-state consumption that an appropriately weighted average of households and entrepreneurs would be willing to pay as a one-time payment to avoid the present discounted loss in utility associated with the crisis - corresponding to 16 quarters in these calculations. The loss incorporates the current and future forgone consumption of households and entrepreneurs as well as the gain in current and future household leisure that accompanies the crisis. Details of these calculations are available in an accompanying appendix. These results are reported in table 1. Under flexible exchange rates and in the absence of the financial accelerator, the welfare loss associated with the crisis is a one-time drop in consumption equivalent to 23.4 percent of the economy's steady-state consumption on an annual basis. With flexible rates, the addition of the financial accelerator causes a modest increase in the welfare loss. Under fixed exchange rates, the losses are more severe. Without the financial accelerator, the loss is 27.5 percent of annual consumption. With the financial accelerator, the welfare loss is equivalent to a one-time loss on the order of 37.7 percent of annual consumption. In the presence of the financial accelerator, the reduction in welfare owing to fixed relative to flexible exchange rates appears to be sizeable. The welfare loss under the switching regime model, at 29.7 percent, is substantially less than the loss

[26] As emphasized by Burstein, Eichenbaum and Rebelo [9], in the absence of a substantial non-tradeable goods sector, it would likely be difficult to match movements in the nominal exchange rate. Barth and Dinmore [4] provide further discussion of the response of real exchange rates and the terms of trade for various Asian countries during the financial crisis.

obtained under a purely fixed rate regime. This result again highlights the benefits to flexible exchange rates in this environment.

5 Concluding Remarks

In this paper we use a small open-economy general equilibrium framework to assess the importance of financial factors in explaining the macroeconomic outcomes observed in Korea during the 1997-1998 Asian financial crisis. Our model experiments are able to match the observed drop in Korean output, investment and productivity during this time period. The financial accelerator mechanism is found to be quantitatively significant – accounting for about 50 percent of the total reduction in output. Our modeling exercises suggest that a policy of fixed exchange rates can lead to substantially higher welfare losses following a financial crisis. Abandoning the fixed exchange after the crisis has begun provides substantial gains in terms of output stabilization however. These findings suggest that a policy of flexible exchange rate targeting may provide major gains in terms of both welfare and output stabilization during crisis episodes.

References

[1] Anderson, G. and G. Moore, "A Linear Procedure for Solving Linear Perfect Foresight Models", Economics Letters 17, 1985, 247-252.

[2] Aghion, P., Bacchetta, P. and A. Banerjee, "A Simple Model of Monetary Policy and Currency Crises", European Economic Review 44, 2000, 728-738.

[3] Basu, S. and M. Kimbal, "Cyclical productivity and unobserved input variation", NBER Working Paper No 5915, 1997.

[4] Barth, M.J. and T. Dinmore, "Trade prices and volumes in East Asia through the crisis", International Finance Discussion Paper No. 643, 1999.

[5] Baxter, M. and D. Farr, "Variable Factor Utilization and International Business Cycle", NBER Working Paper No. 8392, July 2001.

[6] Bernanke, B. and M. Gertler, "Agency Costs, Net Worth, and Business Fluctuations", American Economic Review 79, 1989, 14-31.

[7] Bernanke, B., M. Gertler, and S. Gilchrist, “The Financial Accelerator in a Quantitative Business Cycle Framework”, Handbook of Macroeconomics, North Holland, 2000.

[8] Bernanke, B., Laubach, T., Mishkin, F., and A. Posen, “Inflation Targeting. Lessons from the International Experience”, Princeton University Press, 1999.

[9] Burstein, A., Eichenbaum, M. and S. Rebelo, “Why is inflation so low after large devaluations?", Northwestern University Mimeo, 2002.

[10] Burnside, C., Eichenbaum, M., and S. Rebelo, “Hedging and Financial Fragility in Fixed Exchange Rate Regimes”, European Economic Review 45, 2001, 1151-1193.

[11] Caballero, R.J. and A. Krishnamurthy, “Emerging Markets Crises: an Asset Markets Perspective”, 1999, MIT mimeo.

[12] Calvo, G., “Staggered Prices in a Utility-Maximizing Framework”, Journal of Monetary Economics 12, 1983, 383-398.

[13] Carlstrom, C. and T. S. Fuerst, “Agency Costs, Net Worth, and Business Fluctuations: a Computable General Equilibrium Analysis”, American Economic Review 87, 1997, 893-910.

[14] Cespedes, L.P., Chang, R. and A. Velasco, “Balance Sheets and Exchange Rate Policy”, NBER Working Paper No. 7840, August 2000.

[15] Chari, V.V., Kehoe, P.J., and E. McGrattan, “Can Sticky Price Models Generate Volatile and Persistent Real Exchange Rates?”, Staff Report 277, Federal Reserve Bank of Minneapolis, July 2002.

[16] Chari, V.V., Kehoe, P.J., and E. McGrattan, “Accounting for the Great Depression”, Staff Report, Federal Reserve Bank of Minneapolis, December 2002 .

[17] Clarida, R., Gali, J. and M. Gertler, “Monetary Policy Rules in Practice: Some International Evidence”, European Economic Review 42, 1998, 1033-1067.

[18] Clarida, R., Gali, J. and M. Gertler, “The Science of Monetary Policy: a New Keynesian Perspective”, Journal of Economic Literature 37, 1999, 1661-1707.

[19] Cole, H. and L. Ohanian, "Re-Examining the Contributions of Money and Banking Shocks to the U.S. Great Depression" in Ben Bernanke and Kenneth Rogoff eds,. NBER Macroeconomics Annual, Cambridge MA, MIT Press 2001.

[20] Cole, H. and L. Ohanian, "Did Monetary Forces Cause the International Great Depression", Federal Reserve Bank of Minneapolis, 2002.

[21] Cooper, R. and J. Ejarque, "Financial Intermediation and the Great Depression: A Multiple Equilibrium Interpretation", Carnegie-Rochester Series on Public Policy 43, 1995, 285-323.

[22] Eichengreen, B., "The Gold Standard and the Great Depression, 1919-1939", New York, Oxford University Press, 1992.

[23] Fuerst, T. S., "Monetary and Financial Interactions in the Business Cycle", Journal of Money, Credit, and Banking 27, 1995, 1321-1338.

[24] Gali, J. and M. Gertler, "Inflation Dynamics: a Structural Analysis", Journal of Monetary Economics 44, 1999, 195-222.

[25] Gali, J. and T. Monacelli, "Monetary Policy and Exchange Rate Volatility in a Small Open Economy", NBER Working Paper No. 8905, April 2002.

[26] Greenwood, J., Z. Hercowitz, and G. Huffman, "Investment, Capital Utilization, and the Real Business Cycle", American Economic Review 78, 1988, 402-417.

[27] Kaminsky, G.L and C.M. Reinhart, "The Twin Crises: the Causes of Banking and Balance-of-Payments Problems", American Economic Review 89, 1999, 473-500.

[28] Kiyotaki, N. and J. Moore, "Credit Cycles", Journal of Political Economy 105, 1997, 211-248.

[29] Krueger, A. and J. Yoo, "Chaebol Capitalism and the Currency-financial Crisis in Korea, NBER Conference on Currency Crises Prevention, January 2001.

[30] Mishkin, F.S., "The Causes and Propagation of Financial Instability: Lessons for Policymakers", in "Maintaining Financial Stability in a Global Economy", Federal Reserve Bank of Kansas City, 1997.

[31] Monacelli, T., "Into the Mussa Puzzle: Monetary Policy Regimes and the Real Exchange Rate in a Small Open Economy", 1999, Boston College Working Paper in Economics, No. 437.

[32] Natalucci, F.M., "Was There a Financial Accelerator Mechanism in the Asian Crisis?", 1999, New York University, mimeo.

[33] Obstfeld, M. and K. Rogoff, "The Mirage of Fixed Exchange Rates", Journal of Economic Perspectives 9, 1995, 73-96.

[34] Obstfeld, M. and K. Rogoff, "New Directions for Stochastic Open Economy Models", NBER Working Paper No. 7313, August 1999.

[35] Rebelo, S. and C. A. Vegh, "Real Effects of Exchange Rate-Based Stabilization: an Analysis of Competing Theories", NBER Working Paper No. 5197, July 1995.

[36] Schmitt-Grohe, S. and M. Uribe, "Stabilization Policy and the Costs of Dollarization", Journal of Money, Credit, and Banking 33, 2001, 482-509.

[37] Schneider, M. and A. Tornell, "Balance Sheet Effects, Bailout Guarantees and Financial Crises", mimeo, University of Rochester, 2003.

[38] Svensson, L.E.O., "Open-Economy Inflation Targeting", Journal of International Economics 50, 2000, 155-183.

[39] Taylor, J. B., "Discretion Versus Policy Rules in Practice", Carnegie-Rochester Series on Public Policy 39, 1993, 195-214.

[40] Townsend, R. M., "Optimal Contracts and Competitive Markets with Costly State Verification', Journal of Economic Theory 21, 1979, 265-293.

[41] Uribe, M., "Exchange-Rate-Based Inflation Stabilization: the Initial Real Effects of Credible Plans", Journal of Monetary Economics 39, 1997, 197-221.

Appendix

Assuming real money balance effects are negligible, we can write the household utility function at time t as

$$U_t^h = \frac{\left[(C_t)^{1-\varsigma} (1 - L_t)^{\varsigma} \right]^{1-\sigma}}{1-\sigma}$$

Since the entrepreneur utility function at time t is given by

$$U_t^e = C_t^e$$

then in steady state we have

$$U_{ss}^h = \frac{\left[(C_{ss})^{1-\varsigma} (1 - L_{ss})^{\varsigma} \right]^{1-\sigma}}{1-\sigma}$$

and

$$U_{ss}^e = C_{ss}^e$$

From equation (9), the household marginal utility of consumption at time t is given by

$$\lambda_t^h = \frac{\partial U_t^h}{\partial C_t} = (1-\phi)(C_t)^{(\sigma-1)(\phi-1)-1}(1-L_t)^{\phi(1-\sigma)}$$

while the entrepreneur marginal utility of consumption is 1.

Define the present discounted value of the household and entrepreneur utility along the time path as

$$W_t^h = \sum_{t=1}^{k} \beta^{t-1} U_t^h$$

and

$$W_t^e = \sum_{t=1}^{k} \beta^{t-1} U_t^e$$

Finally, define the utility of the household and entrepreneur corresponding to a constant sequence of consumption and leisure as

$$W_{ss}^h = \frac{U_{ss}^h \left(1 - \beta^k\right)}{1-\beta}$$

and

$$W_{ss}^e = \frac{U_{ss}^e \left(1 - \beta^k\right)}{1-\beta}$$

Then the welfare cost of the business cycle is given by

$$\frac{\Delta C_{ss}^{tot}}{C_{ss}^{tot}} = \left[(\omega) \frac{W_t^h - W_{ss}^h}{\lambda_{ss}^h C_{ss}} + (1 - \omega) \frac{W_t^e - W_{ss}^e}{C_{ss}^e} \right]$$

where ω is the household share of total steady state consumption:

$$\omega = \frac{C_{ss}}{C_{ss} + C_{ss}^e}$$

FIGURE 1

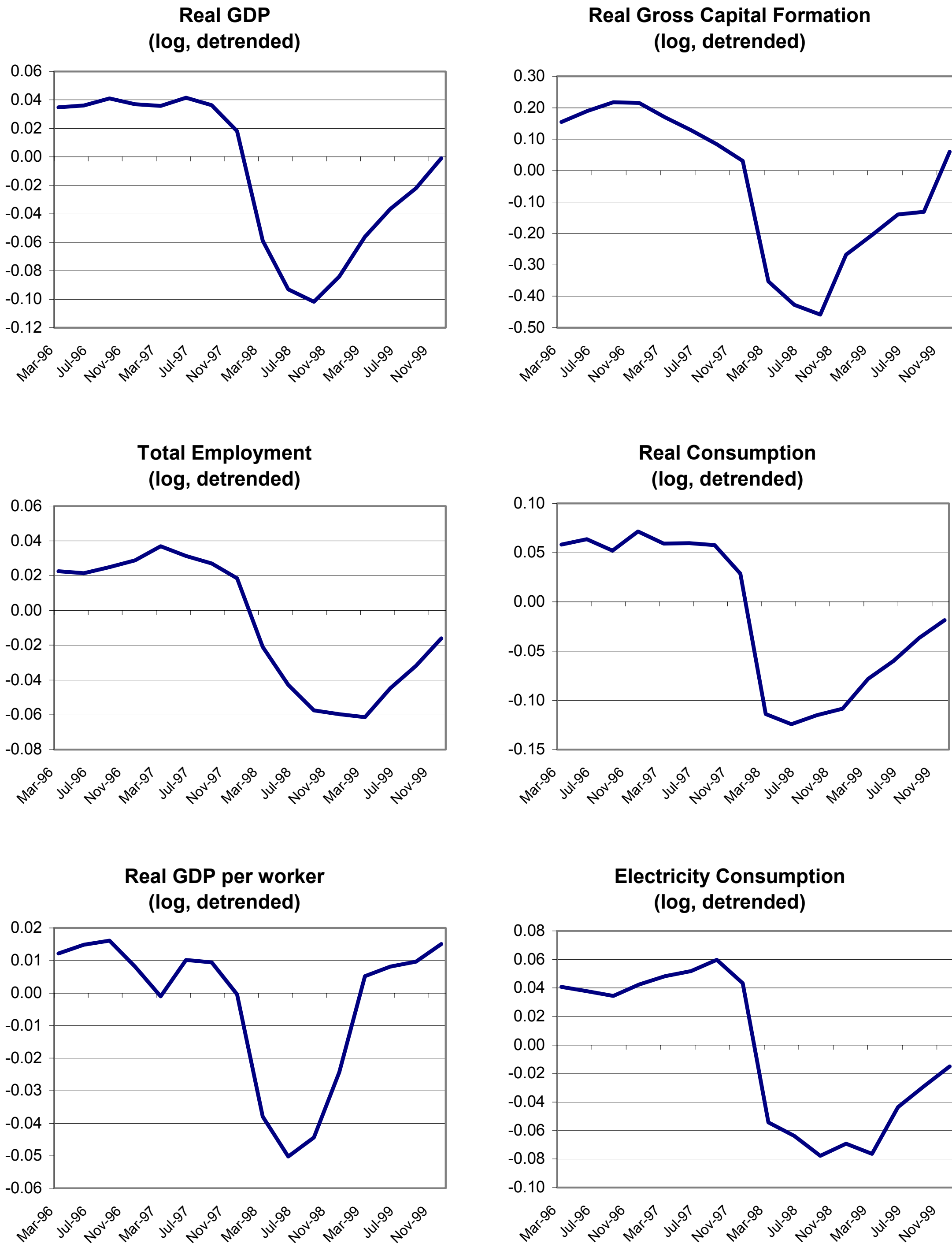
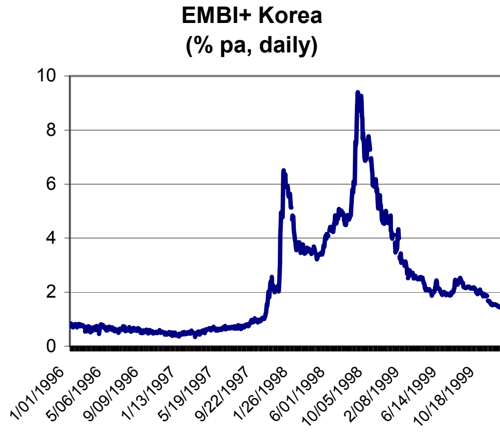
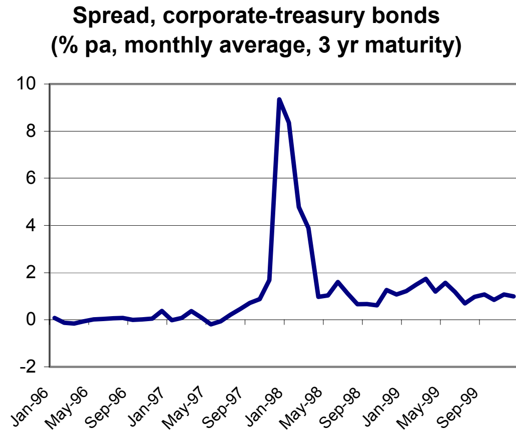
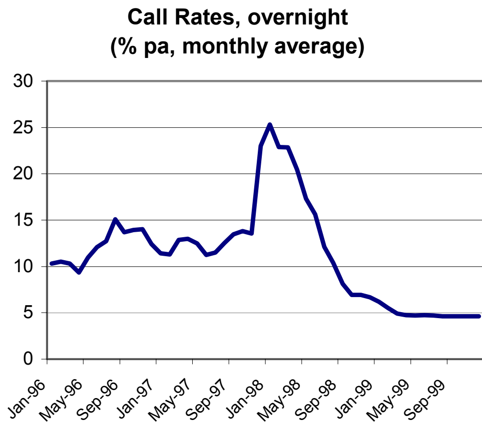
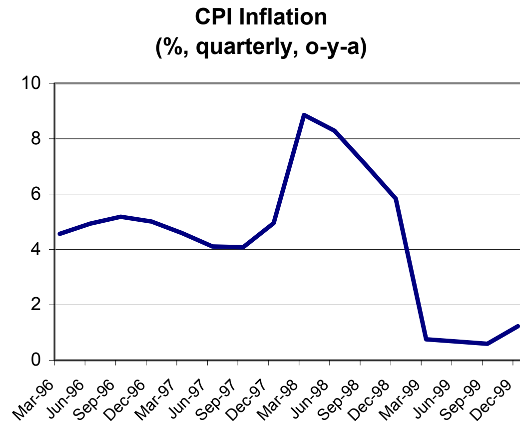


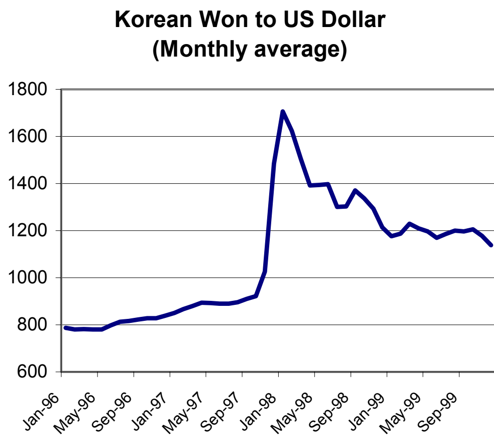
FIGURE 2











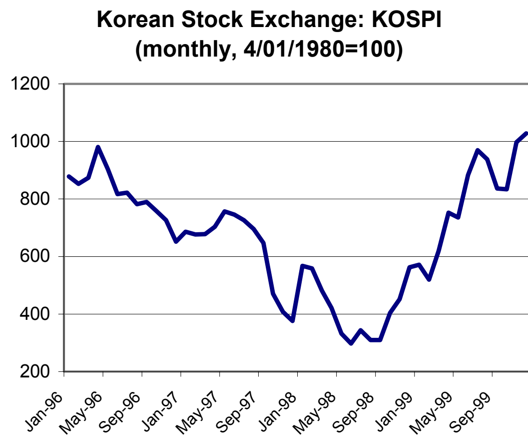


FIGURE 3

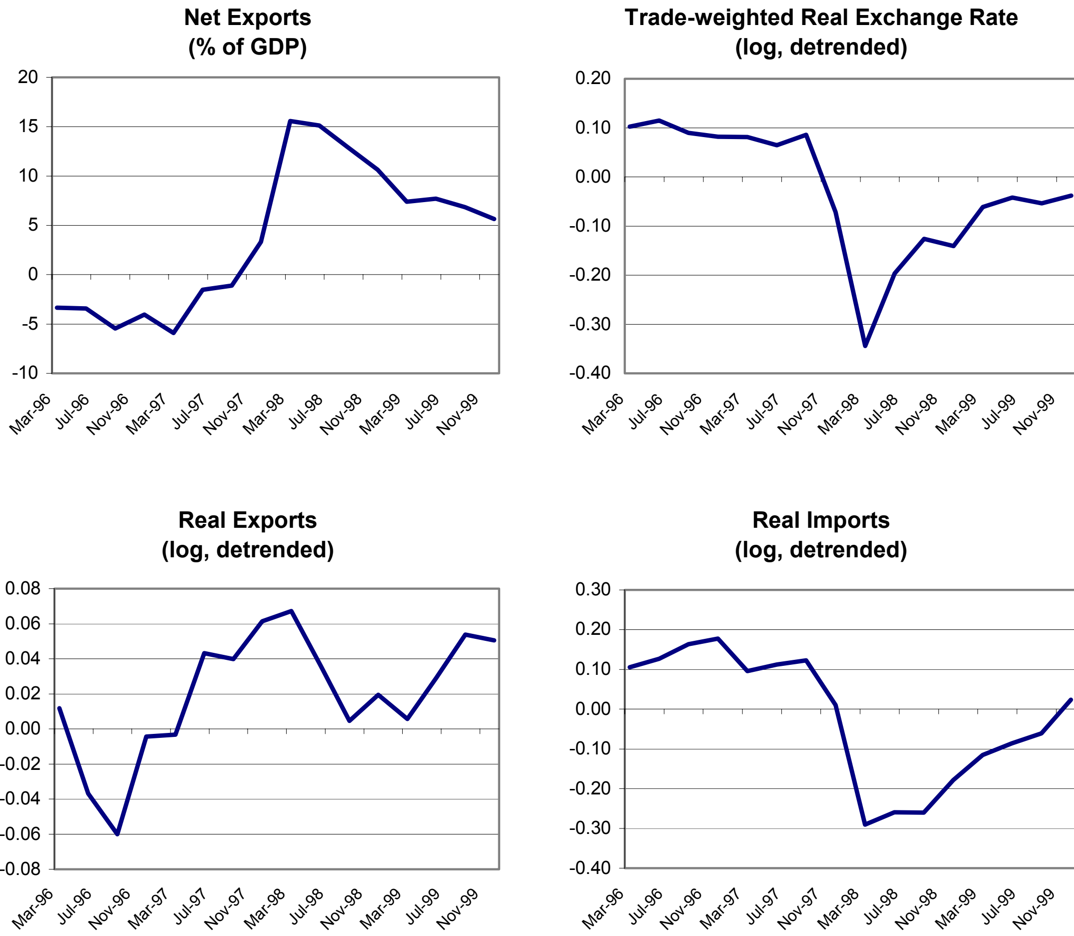


FIGURE 4 A: FOREIGN INTEREST RATE SHOCK

FIXED VS. FLEXIBLE EXCHANGE RATE

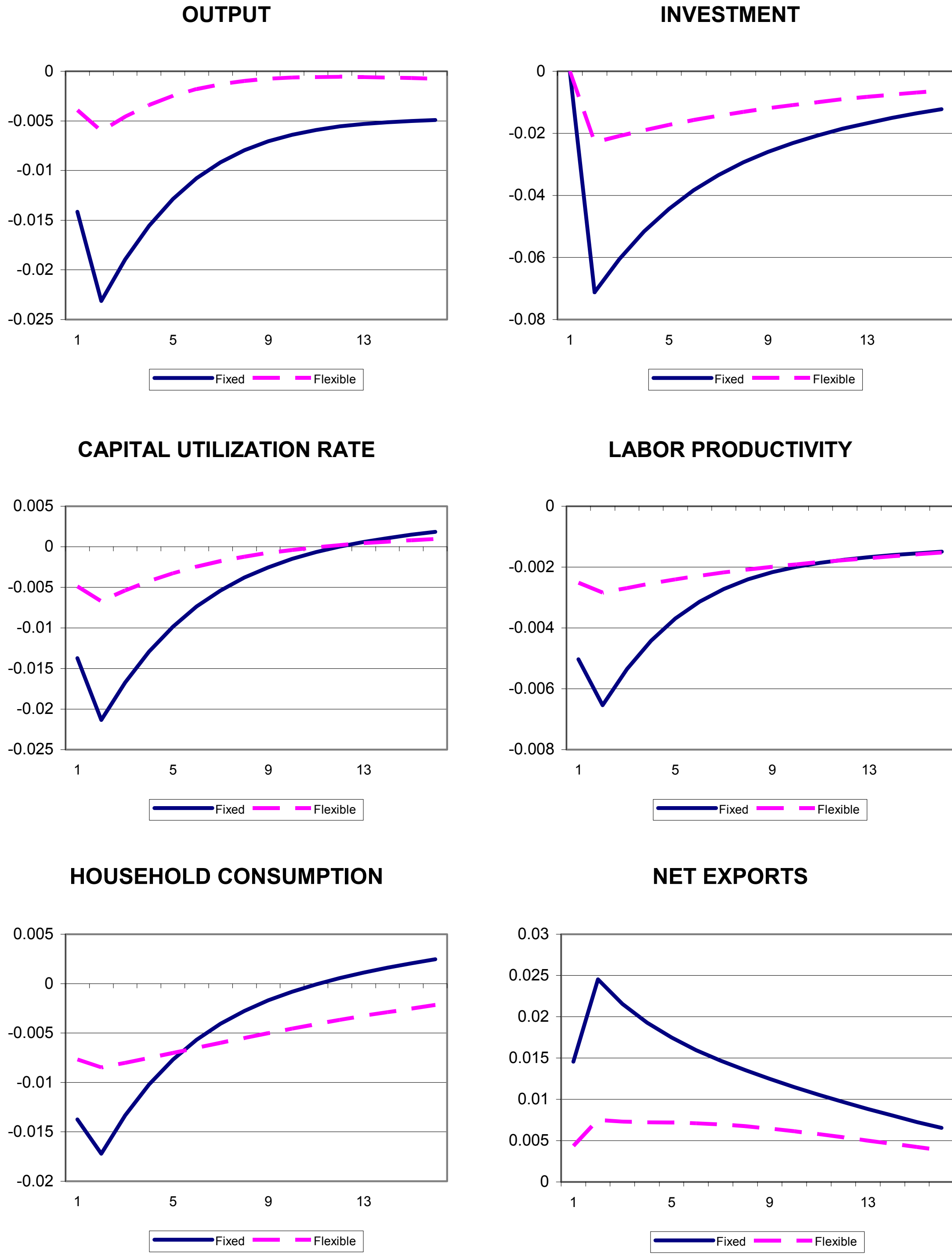


FIGURE 4 B: FOREIGN INTEREST RATE SHOCK

FIXED VS. FLEXIBLE EXCHANGE RATE (cont'd)

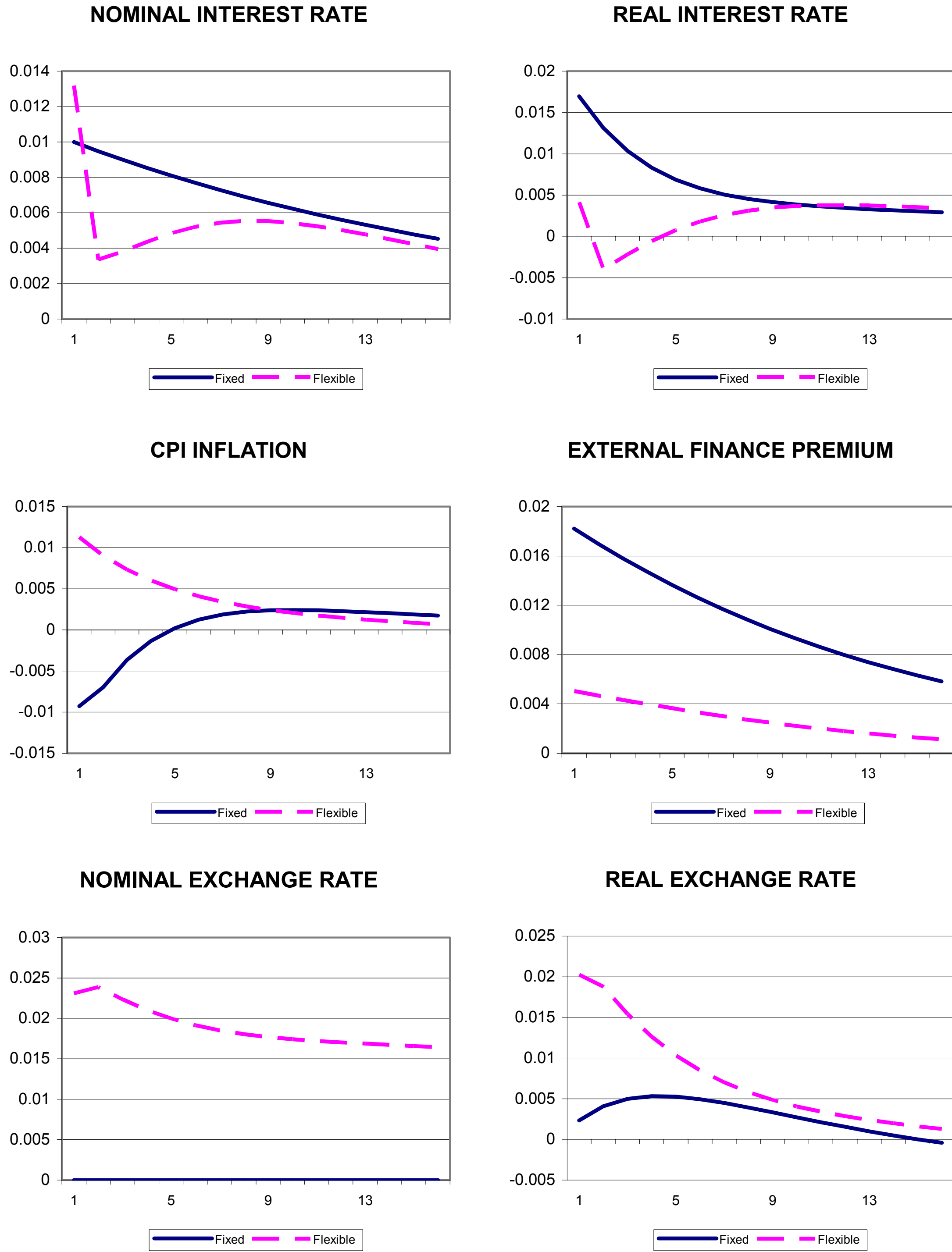


FIGURE 5: FOREIGN INTEREST RATE SHOCK

WITH VS. WITHOUT FINANCIAL ACCELERATOR

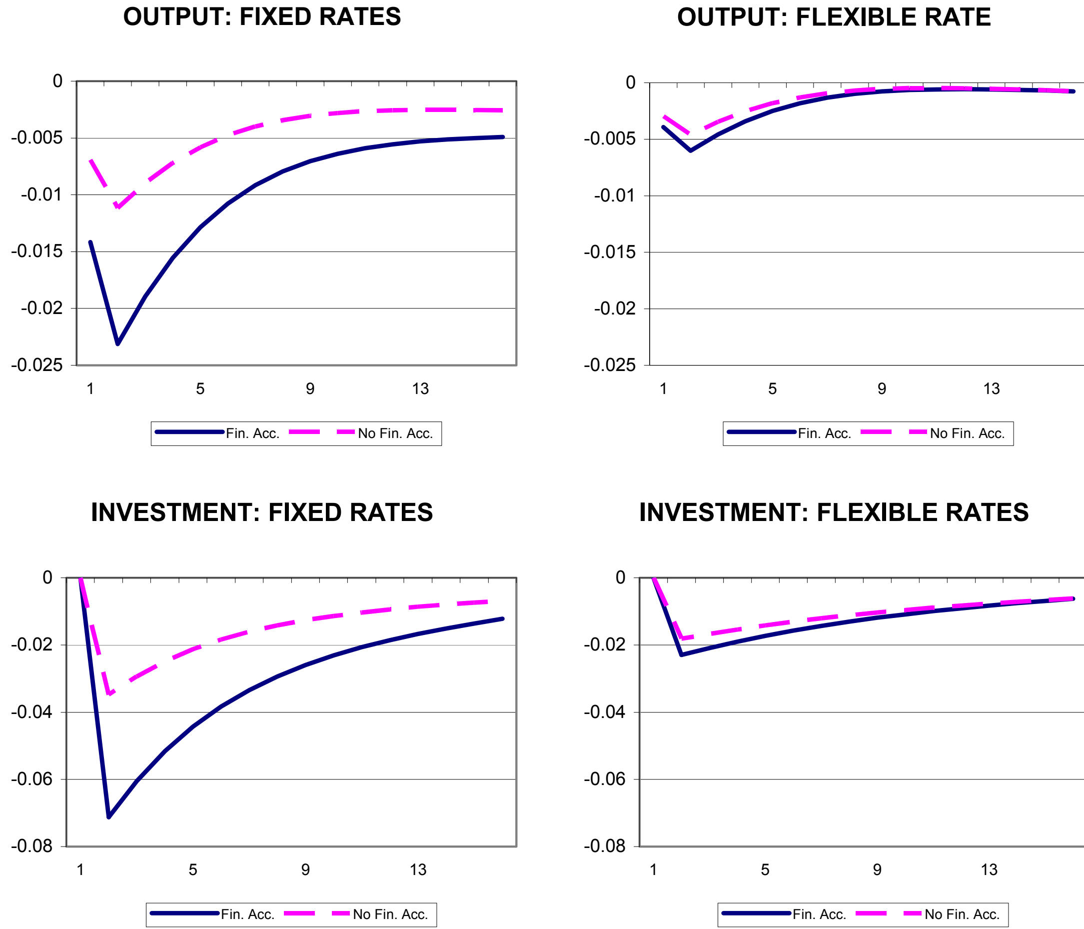
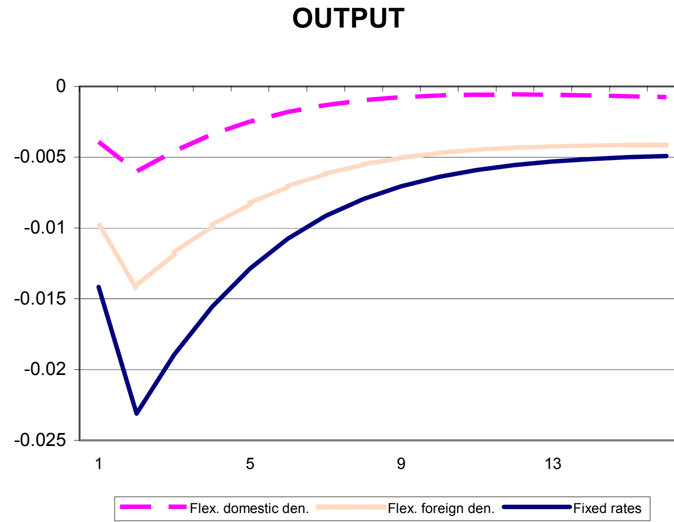


FIGURE 6: FOREIGN INTEREST RATE SHOCK

DOMESTIC VS. FOREIGN DENOMINATED DEBT



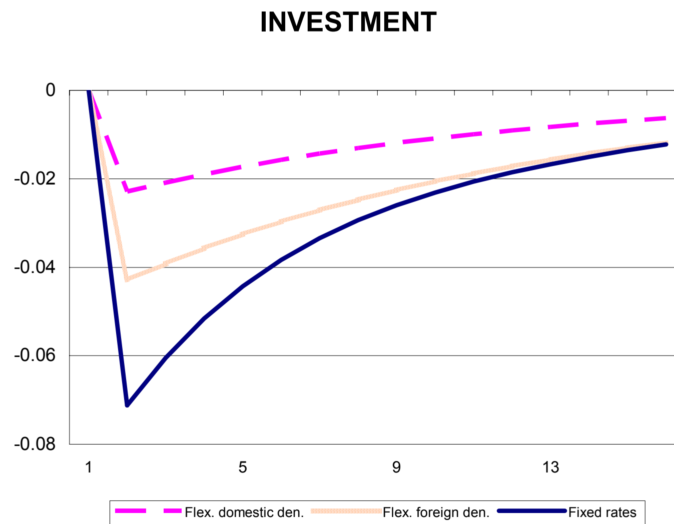


FIGURE 7A

KOREAN CRISIS EXPERIMENT

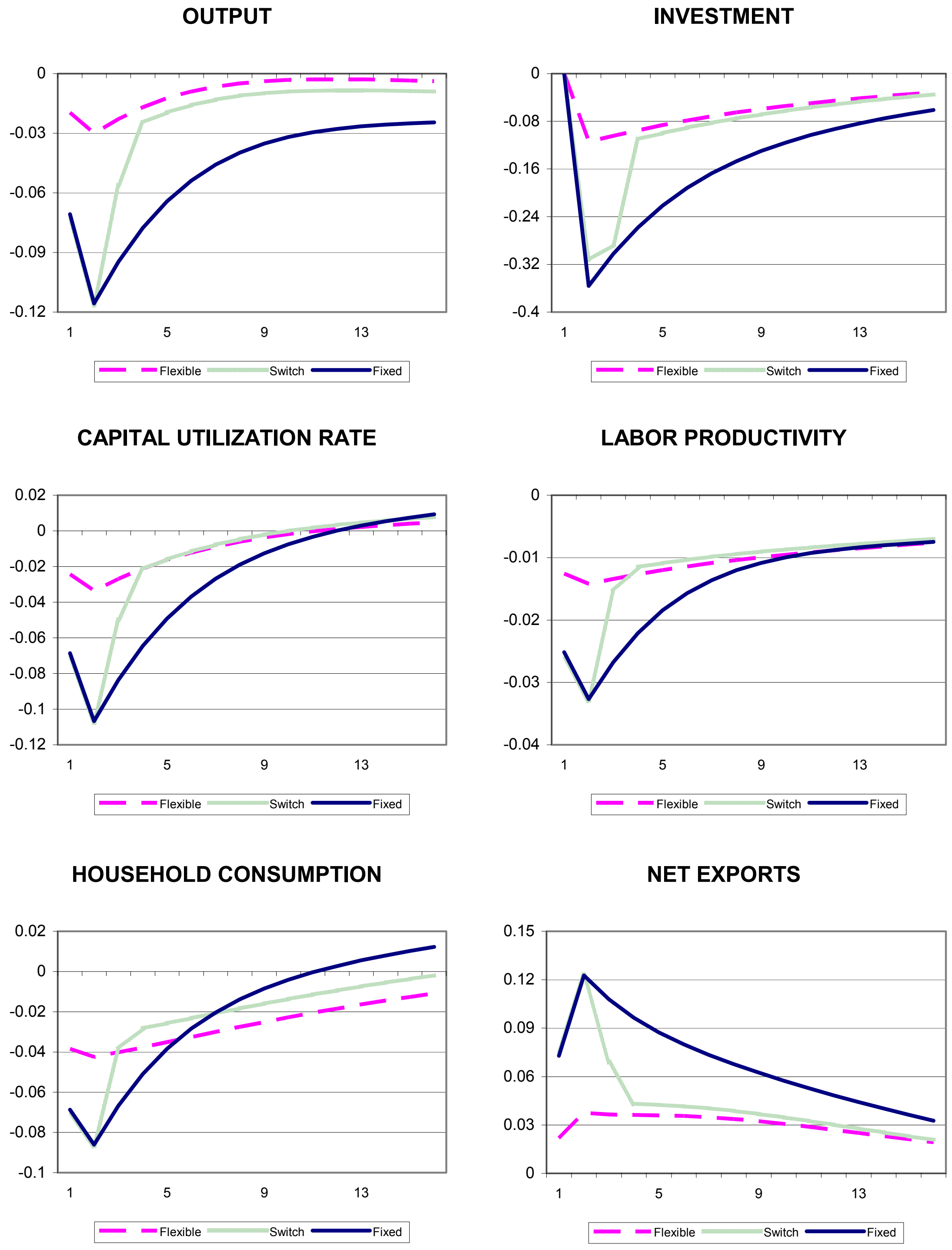
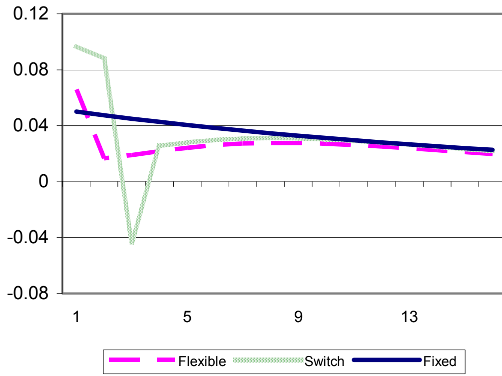
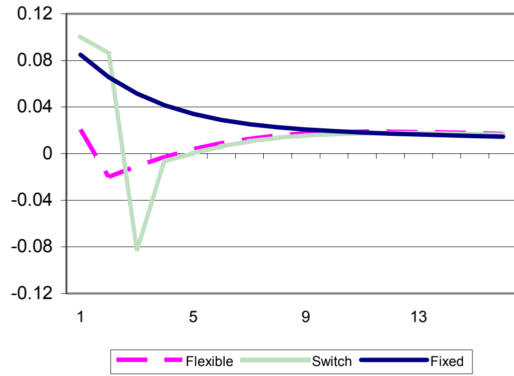
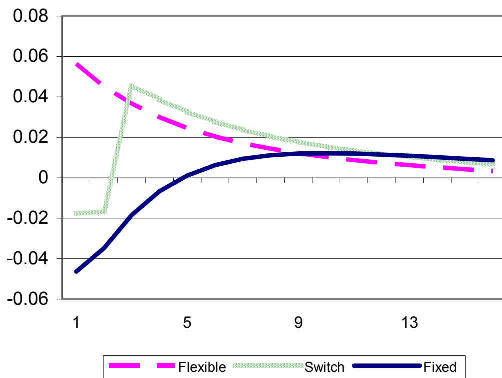


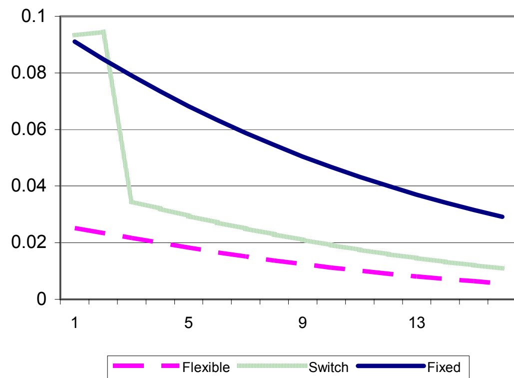
FIGURE 7B

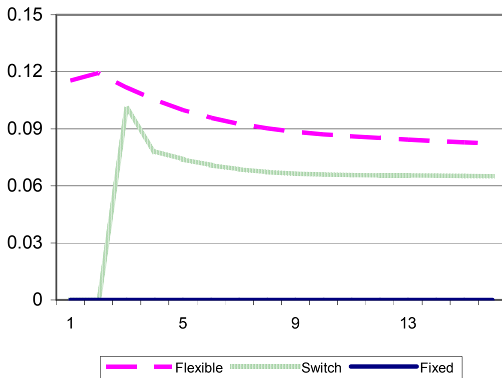
KOREAN CRISIS EXPERIMENT (cont'd)

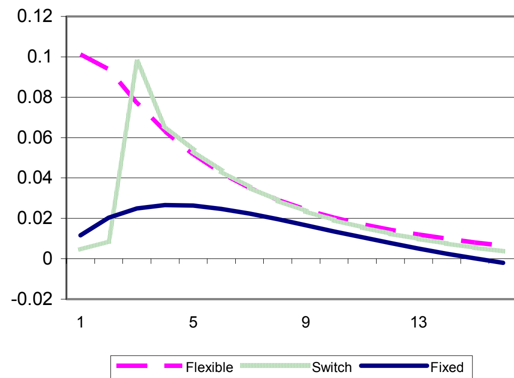












Discussion of “External constraints on monetary policy and the financial accelerator” by Mark Gertler, Simon Gilchrist and Fabio Natalucci

Philippe Bacchetta[1]

This paper is a remarkable attempt to take seriously the financial accelerator mechanism in an open economy and confront it with the data. The authors basically extend the Bernanke, Gertler and Gilchrist (2000) model to a small open economy. The two main ingredients are financially constrained entrepreneurs, introducing a financial accelerator mechanism, and sticky prices, giving a role to monetary policy and creating real exchange rate movements. Moreover, the production and investment side are carefully modelled for quantitative evaluation. Importantly, this framework allows the authors to consider different exchange rate regimes.

In my view the paper is an important step forward in the emerging literature on credit constraints in open economies. An early contribution to this literature was made by Gertler and Rogoff (1990), but this was a real two-period model. Aghion et al (1999) developed a dynamic model showing the interaction between financial constraints and real exchange rate movements, but in that model money is neutral and the exchange rate regime does not matter. In Aghion et al (2001), we introduce foreign currency liabilities and price stickiness so that monetary policy has a role, in particular during crises; however, in that framework the exchange regime has little role for large shocks, since the central bank is not able to keep the exchange rate fixed. Céspedes et al (2000) appear to be the first to find a different impact of fixed versus flexible exchange rate regimes in a dynamic financial accelerator model. However, the robustness of their result is still to be investigated. In general, much more work is required on this issue, which is why the Gertler-Gilchrist-Natalucci paper is important.

The paper has two main objectives: (1) To analyse the impact of the exchange rate regime in a financial accelerator model and (2) To reproduce the behaviour of the Korean economy during the Asian crisis. The main results from the analysis are: (1) A flexible exchange rate is better than a fixed one with a foreign interest rate shock. This traditional result is reinforced by the financial accelerator. (2) Numerical simulations can replicate the real side of the Korean economy after the crisis, in particular GDP, investment, productivity and utilisation.

Based on a natural division of labour among discussants, my comments will focus on the first element. My first concern, however, is whether it is appropriate to use the same model to look at two relatively different issues. In my view, a simpler model would be more suited to assess the impact of financial constraints on the ranking of exchange rate regimes. While it is eventually desirable to have a quantitative assessment, one needs first to understand precisely the mechanisms through which these constraints interact with the exchange rate regime and the various hypotheses that are crucial for the results.

Let me now focus on the main mechanism through which the exchange rate regime affects the response to a foreign interest rate shock. The basic idea is that under a fixed exchange rate, the central bank needs to increase the nominal domestic interest rate to maintain the value of the currency. Since prices are rigid, the real interest rate increases, which increases the debt burden and reduces the cash flow of firms. This effect is amplified by a decrease in the value of the firm. Surprisingly, the authors show that this reasoning holds even if firms borrow entirely in foreign currency.

The crucial assumptions behind this result are the flexibility of interest rates on corporate debt and the degree of rigidity of prices, in particular the degree of pass-through of the exchange rate to prices. What is important is that prices are less flexible than the interest rate on debt. For example, if prices

[1] Study Center Gerzensee and University of Lausanne. The views expressed are those of the author and not those of the BIS.

are preset for one period only (as in Aghion et al (2001), for example), this effect disappears. If firms borrow long term and have a fixed interest rate on their debt, the effect is also not present. In the model, it is assumed that firms only have one-period debt contracts, but it would be useful to know how realistic this assumption is. In the Asian crisis it is well known that most of the debt increase in the years preceding the crisis was short term, but what matters is not new debt, but total existing debt. In any case, the authors should give more attention to this aspect of the model.

The other element that deserves much more attention is the pass-through of the exchange rate to prices. While the current model appears satisfactory around steady states, it is not appropriate to deal with large currency movements. Since the authors are interested in currency crises, they should consider this aspect more seriously. A major problem in the current specification of the model is that domestically produced goods sold to both consumers and capital producers do not react when foreign retailers change their price. From equations (30) and (31), the price set by domestic retailers P^H ignores the prices set by foreign retailers P^F. Thus, if there is a large currency depreciation, P^F increases and this will increase the demand for domestic goods. However, in the current version of the model domestic retailers ignore this change in demand. The reason for the omission seems to be that the pricing behaviour is approximated around a steady state, which is not valid for large changes in the exchange rate.

Moreover, while the pass-through to domestic goods prices appears incorrect, the pass-through to foreign goods prices is also artificially low due to the assumption of Calvo pricing. The pricing strategy simply assumes that a given proportion of firms change their prices each period. With large currency movements, however, this assumption does not seem very realistic. Moreover, the Calvo pricing assumption also introduces some technical complications that are not mentioned in the paper. The fact that only a proportion of firms change prices will lead to large price differences across foreign retailers when there are large currency movements; and those retailers who do not change their prices will probably go bankrupt. One way to solve these technical problems was suggested by Calvo (1983) by introducing a “price regulation mechanism” equalising prices among foreign retailers.

To summarise, this paper is an important contribution to the literature, but it requires a better discussion of the crucial assumptions and a more careful modelling of the international dimension of the model. These improvements would definitely make the analysis more convincing. I would also encourage the authors to explore other shocks to have a broader understanding of the impact of financial constraints on the optimal exchange rate regime.

References

Aghion, P, P Bacchetta and A Banerjee (1999): “Capital markets and the instability of open economies”, *CEPR Discussion Paper*, no 2083.

Aghion, P, P Bacchetta and A Banerjee (2001): “A corporate balance-sheet approach to currency crises”, *CEPR Discussion Paper*, no 3092.

Calvo, G (1983): “Staggered contracts and exchange rate policy”, in J A Frenkel (ed) *Exchange rates and international macroeconomics*, University of Chicago Press and NBER, pp 235-52.

Céspedes, L F, R Chang and A Velasco (2000): “Balance sheets and exchange rate policy”, *NBER WP 7840*.

Gertler, M and K Rogoff (1990): “North-south lending and endogenous capital-markets inefficiencies”, *Journal of Monetary Economics*, no 26, pp 245-66.

Discussion of "External constraints on monetary policy and the financial accelerator" by Mark Gertler, Simon Gilchrist and Fabio Natalucci

Philip Lowe[1]

More than ever before financial factors are shaping the business cycle. This is true not only in those countries struggling to come to grips with recently liberalised financial systems, but also in those that have had a couple of decades to adapt. Around the globe, we have seen balance sheets expand more quickly than GDP and levels of debt rise more quickly than income. And as a result, today, economic fluctuations are more likely to have their roots in financial factors than in any other factor.

All this is forcing us to rethink how the world works. First, private-sector spending is becoming more sensitive to changes in asset prices and, possibly, interest rates. Second, the macroeconomy seems more susceptible to asset price misalignments and associated misperceptions of risk. And third, we have come to realise that changes in the structure of balance sheets can act as a powerful accelerator to the business cycle.

It is this third dimension of this changing world that the paper by Gertler et al addresses. Over the past decade the first two authors have been instrumental in giving us the tools to model and analyse the effects of debt and asset prices on the evolution of the business cycle. Their basic line of reasoning is well known but let me repeat it here. An adverse shock materialises and forces output and asset prices to fall. Lower asset prices mean borrowers have less collateral and, as a result, the cost of external finance increases. In turn, the higher cost of funding amplifies the initial shock.

The modelling of these effects has been important in shaping our views on how this new world works. And this paper helps us on this journey by extending some of their earlier work to an open economy. In so doing it helps explain the depth of the recession in Korea in the late 1990s.

I enjoyed the paper very much and have little to quibble about. The modelling is elegant and it is easy to see how the various pieces fit together. Whether or not one agrees with the exact assumptions made, and the calibrated value of the parameters, is not really that important here. What is important is the story. And the story is basically right.

It is right to conclude that financial factors played an important role in Korea. The cost of external finance, when finance was available, did increase dramatically, and this undoubtedly compounded the crisis.

It is right to conclude that output is more stable under a floating rate regime in response to a foreign interest rate shock. And this is doubly true when one takes the financial accelerator into account. As a small aside though, I am not so sure that inflation will be less stable under a floating regime. In practice, this must depend upon the extent of exchange rate pass-through, and of late, this has been a lot less than many people thought.

And it is right to conclude that a fall in the exchange rate is more costly for output if companies borrow unhedged in foreign currency. What I am not so sure about here is whether companies would borrow in such a way if the currency were floating. It is arguable that the amount of currency exposure that companies and financial institutions run is endogenous to the currency regime. And indeed I think this was the case in Korea.

So there is much that is right in this paper and I said I agree with its general thrust. In the remainder of my time, therefore, then let me touch on two questions.

The first is whether the financial crisis in Korea is really best thought of, as we are invited to do in this paper, as an endogenous response to a large unanticipated increase in the risk premium.

---

[1] Reserve Bank of Australia. The views expressed are those of the author and not those of the BIS.

And the second question is whether we can do anything to lessen the power of the financial accelerator.

Unanticipated increase in the risk premium?

The thought experiment that we are asked to do by the authors is to consider an unanticipated increase of 5 percentage points in the Korean risk premium. The authors argue that this is appropriate given that: “the evidence suggests that capital outflows and the subsequent collapse in bank lending occurred for reasons that were largely exogenous to Korea’s economic situation at the time” (p 3).

I am not so sure that I agree with this assessment. Certainly, the problems in Thailand and Indonesia were exogenous to Korea. But why did Korea get hit so badly? One reason is that it was in the wrong neighbourhood at the time that the fight broke out. But I think to conclude this would be to miss an important point. And that is that the financial structure in Korea had become very vulnerable. You can get an idea of this from the following two graphs.[2] The first shows debt-equity ratios in the manufacturing industry in Korea, Japan and the United States. Clearly, Korean firms were highly indebted and their level of debt was trending up before the crisis. The history of directed lending and government support had encouraged excessive risk taking and banks were providing debt finance in situations where in other countries they would not have done so. The corporate sector was labouring under a mountain of debt that elsewhere would have been considered reckless.

The second graph shows Korea’s short-term external liabilities. These liabilities increased dramatically in the mid 1990s in response to the lifting of controls. The result was a large maturity mismatch, as Korean financial institutions used these borrowed funds to provide long-term financing. Often too, there were large currency mismatches as well. With an exchange rate moving in a very narrow range and underdeveloped capital markets, there was limited ability and incentive to hedge.

To add to the list of vulnerabilities was a relatively weak banking system, with poor internal controls and a supervisory structure that had not kept adequate pace with the changes in the financial landscape.

The point here is that Korea was vulnerable. Risk had been mis-assessed by domestic institutions and the international investment community alike. Balance sheets had moved into dangerous territory. When the problems developed in Thailand and Indonesia, investors got a glimpse of what could go wrong, and in the process we went from a world in which risk was being underestimated to one in which was it was being overestimated.

Given the vulnerabilities in Korea it is not surprising that, at least with hindsight, problems developed and the financial accelerator had such a strong effect. To a significant extent the crisis was not exogenous, but rather endogenous with respect to its financial structure.

The Korean experience points to two aspects of what can loosely be called the financial accelerator that are not captured in the model or the discussion in the paper. The first is the endogeneity of perceptions of risk. The second is the issue of liquidity.

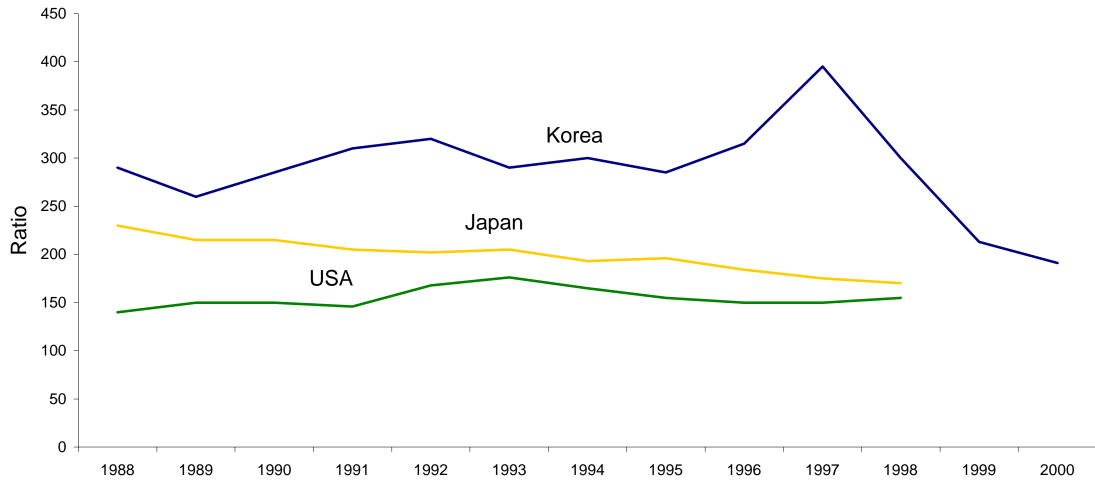
Attitudes to risk do not seem to be exogenous. Rather they seem to be endogenous to developments in the economy and financial markets. They also appear to be unduly procyclical. When things were going well, investors pointed to the strong growth record of Korea and the strength that it derived from its large, vertically integrated, conglomerates. When things started to go astray, the same world looked quite different. The growth record was forgotten. What were previously seen as advantages quickly came to be seen as disadvantages. And imbalances that had been there all along, waiting in the wings, moved rapidly to centre stage.

While these changes in risk perceptions took place in Korea on a dramatic scale, more generally they seem endemic to the world we live in. And they can act just as powerfully as an accelerant of business cycles as can the movement in balance sheets discussed in the paper by Mark, Simon, and Fabio. When things are going well perceptions of risk decline, adding fuel to the boom. And then when things are going poorly everything seems incredibly riskier.

---

[2] Both graphs have been taken from Chopra et al (2002).

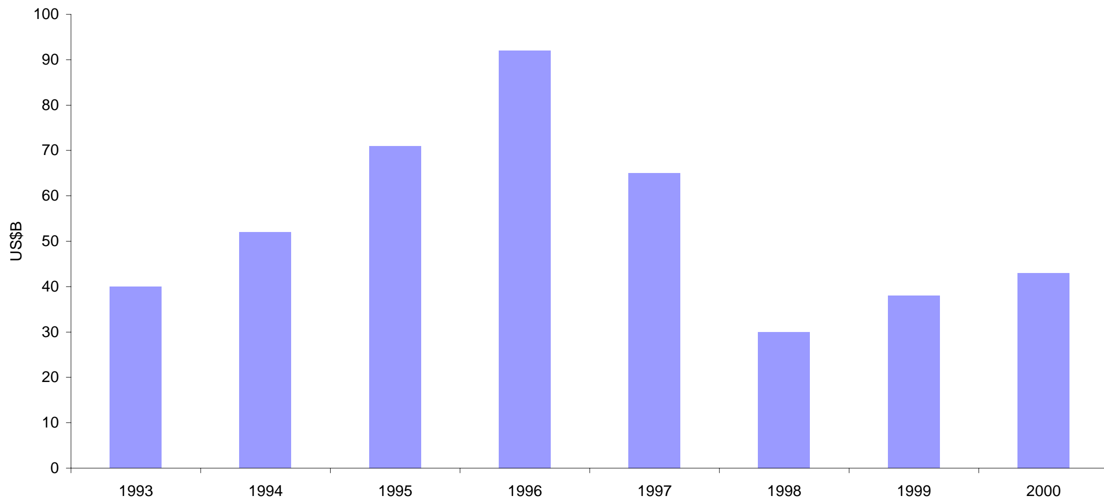
Manufacturing debt-equity ratios



Source: Chopra et al (2002).

Modelling such changes in risk perceptions is difficult. We are not fully sure why they occur, although recent behavioural work has given us some clues. Our intuition as economists is often that these changes probably are not rationale. So we often steer away from them, particularly when writing down models. But I suspect they are an important part of the story and there is work to be done here.

Korea: short-term external debt



Source: Chopora et al (2002).

As I said, the other aspect of Korea's experience with the financial accelerator that I would like to draw attention to is the role of liquidity. A common view, and one that I think has some merit, is that the Korean crisis, at least initially was one of liquidity, rather than concerns about solvency. While the two concepts are closely related, an important reason for the increase in Korean risk was the fear that the Korean banks would not be able to roll over their short-term debt. While this does not undermine the basic story of the paper, it does make it a little more complicated. While the value of net equity is an important driver of the external premium, so too can be the structure of the assets and liabilities.

Can we take some accelerant away?

The second issue that I would like to touch on is can we do things to take some of the power out of the financial accelerator?

Here the answer is yes.

Financial systems with large maturity mismatches, unhedged currency positions, and an excessive reliance on the banking sector for financial intermediation seem more prone to have an unfortunate experience with the financial accelerator. So too do systems in which risk is not priced properly, because of either underdeveloped credit assessment skills or government interference.

So part of the answer is to get the basics of the financial structure financial regulation right. If this is not done, the potential for booms and busts in the financial sector is greatly increased. But I suspect that even if the financial structure meets all today's best practice standards, this is still not enough. Even under the best of today's systems, we still are likely to find ourselves thinking from time to time that developments in the financial sector are having a first-order undesirable effect on economic outcomes. While such situations might occur only rarely, we cannot rule out things going wrong even if we have good prudential supervision and low inflation.

If this is right, is there more that could be done?

Here the answer is a tentative yes.

The financial acceleration of business cycles is likely to be at its most powerful, at least in the upward direction, during periods of rapid increases in indebtedness and increases in asset prices. The experience of the past two decades is that such episodes can ultimately end in costly economic contractions, compounded by financial strains.

One response then is to contain the development of financial imbalances during the upswing of the business cycle. Another would be to increase the defences in the financial system against the endogenous swing in risk preference. The aim of such responses would be to take some of the financial accelerant out of the business cycle. In Australia, we are all too familiar with the need to backburn to destroy material that acts as an accelerant to the bushfires that occasionally do so much damage to the landscape and people's homes. Some backburning to contain the financial accelerator might also be appropriate from time to time.

But how should this be done? One option is monetary policy. If we can identify financial imbalances that are likely to cause problems - which I think we have some chance of doing - then monetary policy can be used to help contain those imbalances. Usually, this would be by increasing interest rates by more than suggested by a strict inflation-targeting regime in a boom characterised by strong increases in credit and asset prices. It would be consistent with medium-term inflation stability and avoiding unnecessarily large swings in output generated by the build up and unwinding of financial imbalances. It is also consistent with the long cherished central bank values of pre-emptiveness and long horizons.

Clearly, though, such a response is not without its risks. But so too is doing nothing. Good policy making is about balancing those risks. And as financial factors come increasingly to shape business cycles, we need to think more seriously about how the balance of risks has changed. Living in an open economy, like the stylised one in this paper, just makes this task more important!

So to finish, let me repeat two main points. The first is that while movements in balance sheets can act as an accelerator, so too can endogenous changes in perceptions of risk. And the second is that if we are to live happily in a world of liberalised and international financial markets and institutions we need to find ways of containing the amount of accelerant the financial sector can deliver. Monetary policy might have a role to play here.

Thank you.

Reference

Chopra, A, K Kang, M Karasulu, H Liang, H Ma and A Richards (2002): "From crisis to recovery in Korea: strategy, achievements, and lessons", in Coe, D and S-J Kim, *Korean crisis and recovery*, International Monetary Fund and the Korean Institute for International Economic Policy, Washington DC.

Discussion of "External constraints on monetary policy and the financial accelerator" by Mark Gertler, Simon Gilchrist and Fabio Natalucci

V V Chari[1]

My deepest apologies for not being able to deliver these remarks in person. I am sure that Phillippe will deliver these comments with elan and will suppress errors in my comments. This paper is a first class demonstration of the best of modern macroeconomics. We have moved well beyond quasi-religious discussions of the meaning of involuntary unemployment to a detailed examination of the quantitative role of various mechanisms to generate and propagate fluctuations. All the discussion is now about the size of capital's share, the elasticity of labour supply, the intertemporal elasticity of substitution in consumption, the size of bankruptcy costs and so on. Macroeconomists are miles ahead of our colleagues in other subdisciplines in the profession and I think it useful to use this fine paper as a way of patting ourselves collectively on the back.

But a discussant's job is to be ornery about even a fine paper. Let me begin with some comments that are intended to improve the presentation and exposition of the paper.

(1) The key shock in the paper is a rise in the foreign interest rate, which the authors correctly think of as a rise in the risk premium. But this connection can and should be made much more explicit. One suggestion is to think about a country-specific tax on borrowing and lending. With such a tax, the domestic interest rate would have to be replaced by the after-tax interest rate in the model. A change in the tax is then equivalent to a rise in the foreign interest rate. One interpretation of such a tax is the possibility of expropriation of assets by the government. A rise in the expropriation probability could be interpreted as a tax.

(2) In a paper that is allegedly about international events, it is surprising to see no reference to the current account or the trade balance. The paper desperately needs to incorporate figures both for the data and the models. My conjecture is that the current account for the model might well be close to that in the data. The reasoning is simple. Consider a model without any of the frictions emphasised by the authors. In such a model, a rise in the foreign interest rate would lead to an outflow of capital and thus a current account surplus. The frictions in the authors' model do not seem likely to impede this basic force.

(3) It is disappointing and surprising that no data on the price level or the inflation rate is reported in this version of the paper. Most of the models in the paper seem to generate a small decline in the inflation rate upon impact. My impression of the data is that it shows a modest rise in inflation following the Korean crisis.

(4) It would be useful to report data on consumption as well, as a way of comparing models and data. My understanding of the data is that consumption falls sharply. My conjecture is that consumption in the model changes relatively little. This conjecture is based upon the kind of work that Backus, Kehoe and Kydland and others have done, which suggests that international models produce much more consumption smoothing than we see in the data.

Let me turn to more substantive issues.

(5) In work with Ellen McGrattan and Pat Kehoe, I have emphasised that with complete markets relative consumptions across countries are determined solely by the real exchange rate. This implication is wildly counterfactual. To take Korea as a simple example, models with conventional measures of risk aversion would imply a change in relative consumption between Korea and the United States of the order of 30 to 40% following the crisis. Ellen, Pat and I found that incomplete markets did not quantitatively change this central feature of the data. We think that only if we

[1] University of Minnesota. The views expressed are those of the author and not those of the BIS.

understand this puzzle will we be able to make progress on a quantitative analysis of financial crisis. One way of thinking about this result is that Gertler, Gilchrist and Natalucci get a miniscule change in the real exchange rate, compared to the 100% movement in the real exchange rate seen in the data. They shrug their shoulders at the failure of their model to reproduce the large movements in the real exchange rate. There is no doubt in my mind that observers call the crisis severe precisely because they saw a gigantic movement in the real exchange rate.

A final misgiving about a central ingredient of this model. This comment really applies to Bernanke, Gertler and Gilchrist, upon which this paper is based. These authors have an economy with risk neutral agents called entrepreneurs and risk averse agents called households. They claim that an optimal contract in the presence of aggregate risk has the return paid by entrepreneurs to be a constant, independent of the current aggregate shock. I have trouble understanding this result. Surely, entrepreneurs should and would provide insurance to households against aggregate shocks. One way of providing such insurance is to provide a high return to households when their income from other sources is low and a low return when their income from other sources is high. My own guess is that if they allowed the return to households to be state contingent, then aggregate shocks would have no effects on the decisions of households and would be absorbed entirely by entrepreneurs. Before we push this intriguing financial accelerator mechanism much further, I think it would be wise to make sure that we get the microeconomics right. It would be hard, but quite feasible, to allow entrepreneurs to be risk averse as well.

My apologies again for not being there in person. But I did want to say: Mark, Simon and Fabio - you guys have written a fine paper which I liked a lot. And I hope that my suggestions on exposition and presentation will make the next revision even better.

Recent BIS Working Papers

No	Title	Author
138 September 2003	Public and private information in monetary policy models	Jeffery D Amato and Hyun Song Shin
137 September 2003	The Great Depression as a credit boom gone wrong	Barry Eichengreen and Kris Mitchener
136 September 2003	The price level, relative prices and economic stability: aspects of the interwar debate	David Laidler
135 September 2003	Currency crises and the informational role of interest rates	Nikola A Tarashev
134 September 2003	The cost of barriers to entry: evidence from the market for corporate euro bond underwriting	João A C Santos and Kostas Tsatsaronis
133 September 2003	How good is the BankScope database? A cross-validation exercise with correction factors for market concentration measures	Kaushik Bhattacharya
132 July 2003	Developing country economic structure and the pricing of syndicated credits	Yener Altunbaş and Blaise Gadanecz
131 March 2003	Optimal supervisory policies and depositor-preference laws	Henri Pagès and João A C Santos
130 February 2003	Living with flexible exchange rates: issues and recent experience in inflation targeting emerging market economies	Corrinne Ho and Robert N McCauley
129 February 2003	Are credit ratings procyclical?	Jeffery D Amato and Craig H Furfine
128 February 2003	Towards a macroprudential framework for financial supervision and regulation?	Claudio Borio
127 January 2003	A tale of two perspectives: old or new challenges for monetary policy?	Claudio Borio, William English and Andrew Filardo
126 January 2003	A survey of cyclical effects in credit risk measurement models	Linda Allen and Anthony Saunders
125 January 2003	The institutional memory hypothesis and the procyclicality of bank lending behaviour	Allen N Berger and Gregory F Udell
124 January 2003	Credit constraints, financial liberalisation and twin crises	Haibin Zhu
123 January 2003	Communication and monetary policy	Jeffery D Amato, Stephen Morris and Hyun Song Shin
122 January 2003	Positive feedback trading under stress: Evidence from the US Treasury securities market	Benjamin H Cohen and Hyun Song Shin
121 November 2002	Implications of habit formation for optimal monetary policy	Jeffery D Amato and Thomas Laubach
120 October 2002	Changes in market functioning and central bank policy: an overview of the issues	Marvin J Barth III, Eli M Remolona and Philip D Wooldridge
119 September 2002	A VAR analysis of the effects of monetary policy in East Asia	Ben S C Fung
118 September 2002	Should banks be diversified? Evidence from individual bank loan portfolios	Viral V Acharya, Iftekhar Hasan and Anthony Saunders
117 September 2002	Internal rating, the business cycle and capital requirements: some evidence from an emerging market economy	Miguel A Segoviano and Philip Lowe