Exchange Rates and Monetary Policy in Emerging Market Economies

Michael B. Devereux
Hong Kong Institute for Monetary Research
University of British Columbia

and

Philip R. Lane
Trinity College Dublin

October 2000

Abstract

This paper investigates the effects of exchange rate regimes and alternative monetary policy rules for an emerging market economy that is subject to a volatile external environment in the form of shocks to world interest rates, world prices and the terms of trade. Our model allows for the economy to be subject to external financing risk-premia associated with domestic net worth. We find that the particular monetary policy rule being followed is as important as whether the exchange rate is fixed or flexible. In general, there is a case for exchange rate flexibility under all shocks, but as constraints on external financing become more important, the relative benefits of monetary rules that allow for floating exchange rates tend to diminish. The benefit of exchange rate flexibility under terms of trade disturbances is quite minor, whether or not external financing constraints are important. In application to the economy of Thailand, we find that the major shocks hitting that economy come from the terms of trade. As a result, our simulation results suggest that for Thailand, the degree of exchange rate flexibility in monetary policy is likely to have only minor consequences for output stability.

The paper was written while Devereux was visiting the Hong Kong Institute for Monetary Research during 2000. Devereux thanks the HKIMR for their hospitality. The views presented in this paper are those of the authors and do not necessarily reflect those of the Hong Kong Institute for Monetary Research, its Council of Advisors or Board of Directors.

1. Introduction

The experience of emerging market economies over the past decade has led to a re-evaluation of the choice over monetary policy stance. One part of this debate has been conducted at the level of choosing between fixed and flexible exchange rate regimes. In the crises of the 1990s, all of the worst hit countries were attempting to peg or stabilize their exchange rates in the pre-crisis period. Most commentators have suggested that the Asian and Mexican crises have completely undermined the case for pegged exchange rates in emerging markets (e.g. Sachs 1998). They argue that the stability of exchange rates led to the over-accumulation of un-hedged, foreign currency debt, which gave rise to the conditions that led to the financial crises.

But a recent series of papers have questioned the wisdom of floating exchange rates for emerging markets. Some writers, such as Calvo (1999), argue that exchange rate flexibility gives too much discretion to the monetary authority, and especially in Latin America, discretionary monetary policy has typically led to damaging episodes of inflation. The best option, under this view, is to remove discretion entirely by choosing a currency board, or outright dollarization. Other authors have focused on issues of "financial fragility" in emerging markets to argue that volatility in exchange rates may be particularly damaging in ways that would not occur in developed economies (Eichengreen and Hausmann 1999, Aghion, Bacchetta, and Banerjee 2000, Cespedes, Chang and Velasco 2000, Cook 2000, and Krugman 1999). The particular explanations vary between these authors, but the essential message is that the combination of financial market vulnerability and a high exposure to exchange rate changes via foreign currency liabilities make emerging markets very reluctant to allow exchange rates to freely fluctuate. Emerging market firms typically face a currency mismatch, having most of their liabilities denominated in foreign currency, such as US dollars, but assets mostly concentrated in local currency. Fluctuations in the exchange rate may therefore cause wide fluctuations in net worth for these firms. Moreover, in the presence of imperfections in financial markets, such fluctuations may be very damaging, since net worth plays a key role in determining the tightness of investment constraints (Bernanke and Gertler 1989, Bernanke, Gertler and Gilchrist, 1999).

This new view of the costs of exchange rate volatility ties in with recent empirical literature that suggests that de facto, most countries attempt to limit the movements of their exchange rates, even if they are following a de jure policy of floating exchange rates (Calvo and Reinhart 2000). In other work, we show that cross country evidence supports the view that part of the reluctance to tolerate exchange rate volatility is due to bilateral financial linkages between countries[1]. This broadly supports the view that exchange rate fluctuations may have negative effects working through financial markets.

The present paper take a different approach. We develop and apply a theoretical model to investigate the effects of alternative monetary policies that place greater or lesser emphasis on exchange rate stability. We agree with the view of Mishkin and Savastano (2000) that the debate needs to be broadened beyond the question of "fixed versus floating" to that of a wider discussion about the appropriate monetary policy rules that an emerging market economy should follow. Thus, while a fixed exchange rate regime

1 See Devereux and Lane (2000)

represents a clear and coherent monetary policy rule, “floating exchange rates” do not represent a rule at all, but are consistent with a large set of alternative monetary policies, some of which are more desirable than others. Thus, the most useful way to conduct the debate is to ask to what extent should an optimal monetary policy in an emerging market economy attempt to achieve exchange rate stability, and more generally, what is the appropriate target for monetary policy. Following from the experience and research literature on monetary policies in the developed world, it has been suggested that monetary authorities in emerging markets should follow an inflation targeting policy. In the study below, we will compare a range of alternative monetary rules for an emerging market, including inflation targeting, price stability, and fixed exchange rates. Our ultimate objective is to establish which of these rules has the best overall characteristics.

We then extend the theoretical model to investigate how financial market distortions affect the optimal monetary rule for an emerging market economy. Does the presence of un-hedged foreign currency denominated liabilities and net worth constraints on emerging market firms eliminate the potential benefits of exchange rate flexibility, or at the very least suggest that emerging market monetary authorities might want to shape monetary policy rules towards reducing overall exchange rate flexibility?

While our simulation model is reasonably general, in order to focus our study we apply the model to a particular emerging market economy; that of Thailand. Thailand is a good example for a number of reasons. It is widely perceived as being the catalyst for the Asian crisis of 1997-1999. Previous to this crisis, it maintained an exchange rate policy that was effectively a peg to the US dollar. In the wake of the Asian crisis, Thailand’s exposure to substantial short-term, foreign currency denominated debt became clear (Corsetti, Pesenti, and Roubini 1998). Finally, Thailand is currently in the process of switching towards a monetary policy regime of inflation targeting.

The results of our theoretical model may be summarised briefly. First, we find that the usefulness of exchange rate flexibility and alternative monetary policies depends critically upon the types of shocks that hit the economy. Shocks to a small open economy naturally divide into three types: shocks to foreign prices (or demand shocks); shocks to the world interest rate (or similarly risk-premium shocks); and shocks to the terms of trade. We find that exchange rate flexibility and alternative monetary policies are quite important in dealing with the first and second shocks. Moreover, other things being equal, exchange rate flexibility is a good thing here. But for shocks to the terms of trade, the monetary policy regime being followed is more or less secondary. The response of the economy does not depend greatly on the exchange rate regime or the monetary policy rule.

A second conclusion that we can draw is that the particular monetary rule being followed may be of equal importance to the question of whether the exchange rate is “fixed or flexible”. For instance, with shocks to foreign interest rates, a rule which puts a lot of weight on stabilizing the price level is almost equivalent to a fixed exchange rate regime, although nominally there is no exchange rate target.

A final conclusion from the theoretical model is that the distinction between fixed and floating exchange rate regimes tends to diminish, the more important are financial market distortions associated with “balance sheet constraints” and foreign currency liabilities. Exchange rate flexibility in the form of fixed rules (such as the money targeting or the inflation targeting rule) becomes less useful in insulating the economy from foreign price or interest rates shocks, relative to a fixed exchange rate, as these constraints become more important. Nevertheless, for credible parameterizations of the model, exchange rate flexibility is still desirable, even in face of these financial constraints. In fact, an optimally designed monetary policy would react to these constraints by *magnifying* real exchange rate volatility.

We go on to apply the model directly to the case of Thailand. When the model is calibrated to the shocks hitting the Thai economy, how important are alternative monetary policy rules and/or flexible relative to fixed exchange rates? Our results, perhaps surprisingly, indicate that for the structure of the Thai economy and the pattern of shocks it is subject to, there is relatively little difference between alternative monetary policy rules, even between fixed and floating exchange rates. Output volatility is only slightly higher with a pegged exchange rate than an "optimal" monetary policy rule. The reason is that historically the biggest source of shocks to the Thai economy have been terms of trade shocks. With this pattern of shocks, the exchange rate rule/monetary policy rule makes little difference. While we may conclude that from a theoretical point of view, it would be better to follow an optimal monetary rule which embodies exchange rate flexibility in Thailand, from a practical point of view, assuming the sustainability of the monetary rule being followed, there is little quantitative difference between the rules.

The paper is organized as follows. The next section develops the main elements of the model. Section 3 discusses the monetary rules, the model calibration, and shock identification within the model. Section 4 shows the effects of each type of shock separately for the specification with and without financial market constraints, and compares the models properties under all shocks to those of the economy of Thailand. Some conclusions follow.

2. Monetary Policy in A Small Open Economy

2.1 Outline of the Model

Here we describe a dynamic model of a small open economy that may be used as a vehicle for discussing some of the questions concerning monetary policy choice for small, emerging market economies. The structure is a relatively standard two sector "dependent economy" model. Two goods are produced: a domestic non-traded good and an export good, the price of which is fixed on world markets.

Three central aspects of the model are a) the existence of nominal rigidities; b) the presence of lending constraints on investment financing; and c) the requirement that all foreign liabilities be denominated in foreign currency. The first feature is of course necessary to motivate a role for the exchange rate regime at all. The specific assumption made is that the prices of non-traded goods are set by individual firms, and adjust only over time. The specification of price setting follows Calvo (1983) and Yun (1995). With respect to the lending constraints on foreign investment we follow the model of Bernanke, Gertler and Gilchrist (1999), which assumes that entrepreneurs undertake investment projects with returns that can be observed by lenders only at a cost. This leads entrepreneurs to face higher costs of external financing of investment relative to internal financing, and as a result investment depends on entrepreneurial net worth. The final feature of the model is based on the observation by Eichengreen and Hausmann

(1999), among others, noting that emerging market economies have little ability to issue external debt denominated in local currency. For instance, almost all the external debt issued by East Asian countries during the period of rapid inflows in the early 1990s was denominated in US dollars.

There are four sets of actors: consumers, production firms, entrepreneurs, and the monetary authority. In addition, of course, there is a "foreign" sector where prices of export and import goods are set, and where lending rates are determined.

2.2 Consumers

Assume that the economy is populated by a continuum of consumer/households of measure unity. We will describe the model in terms of the representative consumer. They have preferences given by

(1) $$U = E_0 \sum_{t=0}^{\infty} \beta u(C_t, H_t, \frac{M_t}{P_t}) ,$$

where C_t is a composite consumption index, H_t is labor supply, and $\frac{M_t}{P_t}$ represents real balances, with M_t being nominal money balances, and P_t being the consumer price index. Let the functional form of u be given by

$$u = \frac{1}{1-\sigma} C^{1-\sigma} + \frac{\chi}{1-\varepsilon}\left(\frac{M_t}{P_t}\right)^{1-\varepsilon} - \eta \frac{H_t^{1+\psi}}{1+\psi}$$

Composite consumption is a function of consumption of non-traded goods and traded (import) goods, where $C_t = (a^{1/\rho} C_{Nt}^{1-1/\rho} + (1-a)^{1/\rho} C_{Tt}^{1-1/\rho})^{\frac{\rho}{\rho-1}}$. The implied consumer price index is then $P = (aP_{Nt}^{1-\rho} + (1-a)P_{Mt}^{1-\rho})^{\frac{1}{1-\rho}}$. Because we wish to introduce nominal price setting in the non-traded goods sector, we need to allow for imperfect competition in that sector. In order to do this, we assume that the consumption of non-tradeable goods is differentiated as follows:

$$C_{Nt} = \left(\int_0^1 C_{Nt}(i)^{1-\lambda} di\right)^{1/(1-\lambda)},$$

where $\lambda > 1$.

We assume that consumers do not face any capital market imperfections. Therefore, the consumer can borrow directly in terms of foreign currency at a given interest rate i_t^*. The assumption of a frictionless consumer credit market is an extreme one. But the critical aspect of the financial frictions in the model below revolves around their impact on investment financing. Thus, the results of the model with respect to the properties of alternative monetary policies would be essentially unaffected by the presence of credit constraints at the consumer level.

Consumers revenue flows in any period come from their supply of hours of work to firms for wages W_t, transfers T_t from government, profits from firms in the non-traded sector (see below) Π_t, domestic money, less their debt repayment from last period D_t. They then obtain new loans from foreign capital markets, and use these to consume, and acquire new money balances. Their budget constraint is thus[2]:

(2) $$P_t C_t = W_t L_t + \Pi_t + S_t D_{t+1} + M_t - M_{t-1} - (1 + i_t^*) S_t D_t + T_t$$

The household will choose non-traded and traded goods to minimize expenditure conditional on total composite demand C_t. Demand for non-traded and traded goods is then

$$C_{Nt} = a\left(\frac{P_{Nt}}{P_t}\right)^{-\rho} C_t \qquad C_{Tt} = (1-a)\left(\frac{P_{Tt}}{P_t}\right)^{-\rho} C_t$$

The consumer optimum can be characterized by the following conditions.

(3) $$\frac{1}{(1+i_{t+1}^*)} C_t^{-\sigma} = E_t \beta \frac{S_{t+1}}{S_t} \frac{P_t}{P_{t+1}} C_{t+1}^{-\sigma}$$

(4) $$\frac{W_t}{P_t} = \eta C_t^{\sigma} H_t^{\psi}$$

(5) $$\left(\frac{M_t}{P_t}\right)^{-\varepsilon} = \chi C_t^{-\sigma} (1 - E_t d_{t+1}^h)$$

Equation (4) represents the Euler equation for optimal consumption. Equation (5) is the labour supply equation, while equation (6) gives the implicit money demand function. Money demand depends on domestic nominal interest rates. The domestic nominal discount factor is defined as

(6) $$d_{t+1}^h = \frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}} \frac{P_t}{P_{t+1}}.$$

The combination of (3) and (6) gives the representation of uncovered interest rate parity for this model.

2.3 Production Firms

Production is carried out by firms in the non-traded and traded goods (export) sectors. The sectors differ in their production technologies. Both types of goods are produced by combining labour and capital. Following BGG (1999), labour comes from both consumer/households and from entrepreneurs. Thus, in the non-traded sector, effective labour of firm i is defined as

$$L_{Nit} = H_{Nit}^{\Omega} H_{Nit}^{e(1-\Omega)},$$

2 Note that consumers do not receive any capital income, as all investment in this economy is done by entrepreneurs.

where H_{Nit} is employment of household labour and H^e_{Nit} is employment of entrepreneurial labour. The overall production technology for a firm in the non-traded goods sector is then

(7) $$Y_{Nit} = A_N K^{\alpha}_{Nit} L^{1-\alpha}_{Nit},$$

where A_N is a productivity parameter.

Traded goods use the production function

(8) $$Y_{Tt} = A_T K^{\gamma}_{t} L^{1-\gamma}_{Tt}$$

Firms in each sector hire labour and capital from consumers and entrepreneurs, and sell their output to consumers, entrepreneurs (for their consumption) and capital producing firms. Cost minimizing behaviour then implies the following equations

(9) $$W_t = MC_{Nt}(1-\alpha)\Omega \frac{Y_{Nit}}{H_{Nit}}$$

(10) $$W^e_{Nt} = MC_{Nt}(1-\alpha)(1-\Omega)\frac{Y_{Nit}}{H^e_{Nit}}$$

(11) $$R_{Nt} = MC_{Nt}\alpha \frac{Y_{Nit}}{K_{Nt}}$$

(12) $$W_t = P_{Xt}(1-\gamma)\Omega \frac{Y_{Tt}}{H_{Tt}}$$

(13) $$W^e_{Tt} = P_{Xt}(1-\gamma)(1-\Omega)\frac{Y_{Tt}}{H^e_{Tt}}$$

(14) $$R_{Tt} = P_{Xt}\gamma(1-\Omega)\frac{Y_{Tt}}{K_{Tt}},$$

where MC_{Nt} denotes the marginal production cost for a firm in the non-traded sector (which is common across firms). Equations (9), (10), (12) and (13) describe the optimal employment choice for firms in each sector. It is assumed that the entrepreneurial labour supply to each sector is inelastic in supply and fixed across sectors. Thus, the entrepreneurial wage differs across sectors. Equations (11) and (14) describe the optimal choice of capital. Note that the price of the traded export good is P_{Xt}. Movements in this price, relative to P_{Mt}, represent terms of trade fluctuations for the small economy.

Production of capital goods is also carried out by competitive firms who combine both traded and non-traded goods in production to produce unfinished capital goods. There are adjustment costs of investment, so that the marginal return to investment in terms of capital goods is declining in the amount of investment undertaken, relative to the current capital stock.

Capital stocks in the traded and non-traded sectors evolve according to

(15) $$K_{Tt+1} = \phi(\frac{I_{Tt}}{K_{Tt}})K_{Tt} + (1-\delta)K_{Tt}$$

(16) $$K_{Nt+1} = \phi(\frac{I_{Nt}}{K_{Nt}})K_{Nt} + (1-\delta)K_{Nt}$$

where the function ϕ satisfies $\phi' > 0$, and $\phi'' < 0$. This reflects the presence of adjustment costs of investment.

Investment in new capital requires traded and non-traded goods in the same mix as the consumer's consumption good. Thus, the price of a unit of investment, in either sector, is P_t. Competitive capital producing firms will then ensure that the price of capital sold to entrepreneurs is

(17) $$Q_{Tt} = \frac{1}{\phi'(\frac{I_{Tt}}{K_{Tt}})} P_t$$

(18) $$Q_{Nt} = \frac{1}{\phi'(\frac{I_{Nt}}{K_{Nt}})} P_t$$

2.4 Entrepreneurs

Capital is transformed by entrepreneurs and sold to the final goods sector. Following the set-up of BGG, we assume that the economy is populated by entrepreneurs who purchase capital in order to invest in individual-specific projects with random returns. Each project then produces "finished" capital which is rented to firms in each sector. The project returns are private information to the individual entrepreneur. Financing for the project is provided by foreign lenders, but subject to the credit market imperfections discussed in BGG. In particular, because project returns can be monitored by creditors only at a cost, as in Townsend (1979), external finance is more costly to entrepreneurs than internal finance. The external finance premium — the excess of the return on capital for entrepreneurs over the external cost of capital — is negatively related to the internal funds, or net worth, of entrepreneurs.

There are two groups of entrepreneurs: One group provides capital to the non-traded sector, while the other provides capital to the traded sector[3].

Entrepreneurs must borrow in foreign currency. We set this as a constraint on the types of borrowing contracts rather than deriving it endogenously. An entrepreneur j in the non-traded sector who wishes to invest K^j_{Nt+1} units of capital must pay nominal price $K^j_{Nt+1}Q_t$. Say that the entrepreneur begins with nominal net worth given by Z^j_{Nt+1}. Then she must borrow in foreign currency an amount given by

3 Since capital is quasi-specific to each sector, separating the provision of capital to the different sectors is the simplest way of handling the entrepreneurial capital supply decision.

(19) $$D^{ej}_{Nt+1} = \frac{1}{S_t}(K^j_{Nt+1}Q_t - Z^j_{Nt+1}),$$

The return to an entrepreneur in the non-traded sector is determined in part by economy-wide factors and partly by privately observed idiosyncratic shock. Let $\tilde{R}_{KNt+1}$ be the random economy-wide average return to capital in the non-traded sector. Then the return for a given entrepreneur *i* is $\omega_{Nti}\tilde{R}_{KNt+1}Q_{Nt}K^j_{Nt+1}$, where ω_{Nti} is a privately observed realization, independent of $\tilde{R}_{KNt+1}$, and i.i.d. across entrepreneurs, with expected value unity and CDF $F(\omega_{Nt})$. Lenders can observe the return to the investment at cost $\mu\omega_{Nt}\tilde{R}_{Kt+1}Q_{Nt}K^j_{Nt+1}$, where clearly $\mu < 1$. This represents a cost of bankruptcy in the model.

Given this informational environment, BGG show that the optimal contract between the lenders and borrowers is a debt contract. The contract specifies a threshold level of ω_{Nt}, $\bar{\omega}_{Nt}$, which is state-dependent, such that if $\omega_{Nt} > \bar{\omega}_{Nt}$, the borrower will repay $\bar{\omega}_{Nt}\tilde{R}_{KNt}Q_{Nt}K^j_{Nt+1}$, while if $\omega_{Nt} \leq \bar{\omega}_{Nt}$, the lender will monitor the project, and the entrepreneur will get nothing.

The optimal contract will choose the cut-off value of $\bar{\omega}_{Nt}$ and the level of capital to maximize the utility of entrepreneurs, subject to lenders receiving their desired return *Rt*. BGG show that the optimal capital choice will satisfy the equation

(20) $$E_t(\tilde{R}_{NKt+1}\frac{S_t}{S_{t+1}}) = \Psi\left(\frac{Z^j_{Nt+1}}{Q_t K^j_{Nt+1}}\right)(1+i^*_{t+1})$$

where $\Psi(1) = 1$, and $\Psi'(.) < 0$.

The contract specifies an "external finance premium" for each entrepreneur, such that the required rate of return on borrowed funds exceeds the world opportunity cost of funds. Moreover, the external finance premium depends negatively on the entrepreneur's net worth, relative to the value of capital purchases. The cost of investment funds for an entrepreneur is increasing with the amount borrowed. If net worth is large enough so that there is no requirement to borrow, then the cost of borrowed funds equals the world opportunity cost $(1+i^*_{t+1})$. But the higher borrowing relative to net worth, the higher the probability of default, and the higher the cost of funds. This dependence of the cost of funds on net worth is a critical aspect of the model and indicates that shocks to net worth, generated perhaps by a nominal exchange rate depreciation, may directly reduce investment by increasing the cost of capital. Since each entrepreneur faces the same return on capital $\tilde{R}_{NKt+1}$, equation (19) can be represented as an external finance premium depending on the average ratio of net worth to capital in the economy.

In addition to (19), the optimal contract requires that the lender receives the opportunity cost of funds, in each state of the world. This implies that the following condition holds, ex-post:

(21) $$\tilde{R}_{KNt+1}Q_t K_{Nt+1}(\bar{\omega}_{Nt}(1-F(\bar{\omega}_{Nt}))+(1-\mu)\int_0^{\bar{\omega}_{Nt}}\bar{\omega}_{Nt}f(\omega)d\omega) = \frac{S_{t+1}}{S_t}(1+i^*_{t+t})(Q_t K_{Nt+1} - Z_{Nt+1})$$

In equation (20), $f(\omega_t)$ represents the PDF for the distribution of ω. This equation implicitly determines the cut-off level of $\bar{\omega}_{Nt}$ as a function of the ex-post state of the world.

Again, following BGG, we assume that entrepreneurs are risk neutral and have uncertain lifetimes, dying with probability $(1-\vartheta)$ at the end of any given period. The entrepreneur will only consume if she will die at the end of the period. In the aggregate, with a large number of entrepreneurs in the non-traded sector, consumption will be given by

$$P_t C_t^{Ne} = (1-\vartheta)(\tilde{R}_{KNt} Q_{t-1} K_{Nt} - (1+i_t^*) S_t D_{Nt} - B_{Nt})$$

where the term inside the parentheses gives the entrepreneur's period *t* return, which includes the direct return on capital, less repayments on foreign currency borrowing, less monitoring costs undertaken by the lender, which are given by B_{Nt}[4]. Given this, average net worth for entrepreneurs in the non-traded goods sector will be

(22) $$Z_{Nt+1} = \vartheta(\tilde{R}_{KNt} Q_{t-1} K_{Nt} - (1+i_t^*) S_t D_{Nt} - B_t) + (1-\alpha)(1-\Omega) W_{Nt}^e$$

Net worth is determined by the unconsumed returns to investment plus the wages earned working in the non-traded sector. The important feature of equation (22) is that it depends negatively on the current exchange rate. By raising the value in domestic currency of the outstanding foreign-currency debt, an unanticipated devaluation will reduce the net worth of the entrepreneurial sector. From equation (19), this will raise the external finance premium, and reduce investment. This introduces a non-standard mechanism for the effects of exchange rate shocks. As stressed by Krugman (1999), Cespides, Chang and Velasco (2000), and Cook (2000), when emerging market firms have outstanding foreign currency liabilities, movements in the exchange rate can impinge directly on their investment opportunities by affecting the strength of their balance sheets.

The details of the contract structure and net worth dynamics in the traded goods sector are described in the identical way.

Finally, we may define the return to capital to entrepreneurs as depending on both the price of capital and the rental rate offered by firms. Thus

(23) $$R_{KNt+1} = \frac{R_{Nt+1} + (1-\delta) Q_{Nt+1}}{Q_{Nt}}$$

(24) $$R_{KTt+1} = \frac{R_{Tt+1} + (1-\delta) Q_{Tt+1}}{Q_{Tt}}$$

4 BGG show that $B_t = \mu\left[\int_0^{\bar{\omega}_t} f(\omega) d\omega\right] \tilde{R}_{KNt} Q_{t-1} K_{Nt}$.

2.5 Price setting

Firms in the non-traded goods sector set prices in advance. Following the method of Calvo (1983) and Yun (1995), assume that firms face a probability $(1-\kappa)$ in every period of altering their price, independent of how long their price has been fixed. Following standard aggregation results, the non-traded goods price follows the partial adjustment rule

(25) $$P_{Nt}^{1-\lambda} = (1-\kappa)\tilde{P}_{Nt}^{1-\lambda} + \kappa P_{Nt-1}^{1-\lambda}$$

where $\tilde{P}_{Nt}$ represents the newly set price for a firm that does adjust its price at time t.

The evolution of $\tilde{P}_{Nt}$ is then governed by (the approximation)

(26) $$\tilde{P}_{Nt} = (1-\beta\kappa)MC_{Nt} + \beta\kappa\tilde{P}_{Nt+1}.$$

2.6 Monetary policy

The determination of monetary policy will be discussed in more detail in the next section. Irrespective of the monetary policy rule being followed, the transfer T_t to consumers is determined by the rate of money growth. Thus, the public sector budget constraint requires that

(27) $$M_{t+1} = M_t + T_t$$

2.7 Equilibrium

In each period, the non-traded goods market must clear. Thus, we have

(28) $$Y_{Nt} = a\left(\frac{P_{Nt}}{P_t}\right)^{-\rho}\left(C_t + I_{Nt} + I_{Tt} + C_t^{Ne} + C_t^{Te} + B_{Nt} + B_{Tt}\right),$$

Equation (28) indicates that demand for non-traded goods comes from consumers, investment demand, consumption of entrepreneurs, and monitoring costs undertaken in each sector. In the calibration of the model, the last two categories are assumed to be very small relative to the size of the economy.

In a similar manner, we may describe the evolution of the economy's net debt, $D_t^A = D_t + D_{Nt}^e + D_{Tt}^e$, as

(29) $$\begin{aligned} S_{t+1}D_{t+1}^A &= S_tD_t(1+i_t^*) - P_{Tt}Y_{Tt} \\ &+(1-a)\left(\frac{P_{Mt}}{P_t}\right)^{-\rho}(C_t + I_{Nt} + I_{Tt} + C_t^{Ne} + C_t^{Te} + B_{Tt} + B_{Nt}) \end{aligned}$$

Labour market clearing for the household sector implies

(30) $$H_{Nt} + H_{Tt} = H_t .$$

Finally, the law of one price must hold for both exported and imported trade goods:

(31) $$P_{Mt} = S_t P^*_{Mt}$$

(32) $$P_{Xt} = S_t P^*_{Xt}$$

where P^*_{Mt} and P^*_{Xt} represent the foreign currency price of imports and exports, respectively.

The economy's equilibrium may be described as the sequence of functions given by

$C(\theta_t)$, $H(\theta_t)$, $S(\theta_t)$, $d^h(\theta_t)$, $Y_N(\theta_t)$, $Y_T(\theta_t)$, $H_N(\theta_t)$, $W^e_N(\theta_t)$, $K_N(\theta_{t-1})$, $H_T(\theta_t)$,

$W^e_T(\theta_t)$, $K_T(\theta_{t-1})$, $I_T(\theta_t)$, $I_N(\theta_t)$, $Q_T(\theta_t)$, $Q_N(\theta_t)$, $\tilde{R}_{NK}(\theta_t)$, $\tilde{R}_{TK}(\theta_t)$

$\bar{\omega}_N(\theta_t)$, $\bar{\omega}_T(\theta_t)$, $Z_N(\theta_{t-1})$, $Z_T(\theta_{t-1})$, $R_N(\theta_t)$, $R_T(\theta_t)$, $P_N(\theta_t)$, $\tilde{P}_N(\theta_t)$, $MC(\theta_t)$,

$D^A(\theta_t)$, $W(\theta_t)$, $P_M(\theta_t)$, $P_X(\theta_t)$. Here θ_t is the period t information set. This represents a system of 31 functions that correspond to the 31 equations (3)-(18), (20)-(22) and their counterparts for the export sector, (23)-(26) and (28)-(32), given the definition of entrepreneurial consumption and debt, the CPI definition, and given the definition of the shock processes (discussed below).

3. Monetary Rules and Solutions

3.1 Monetary Rules

The next critical feature of the model is the stance of the monetary authorities. We wish to explore a set of alternative monetary policy rules that emerging markets might follow. A fixed exchange rate is a simple and coherent rule. But the alternative allows a wide variety of monetary policies. To fix ideas, we explore the implications of five different monetary policy rules, listed as follows:

a) **Fixed Exchange Rate.** We assume that the fixed exchange rate is fully credible and sustainable. Our aim is to evaluate the properties of robust alternative monetary policy rules for emerging market economies. It seems clear that the performance of weak pegs has been uniformly bad. Therefore, a durable fixed exchange rate has to be associated with rigorous monetary and fiscal discipline. Therefore we might think of this regime as a currency board or a policy of dollarization.

b) **Monetary Growth Rule.** In this case, the monetary authority sets a constant growth rate of money, and interest rates are determined freely.

c) Price Stability Rule. Under this rule, the monetary authority maintains a constant (growth rate) of the consumer price index. This is a much tighter policy than what is typically known as "inflation targeting".

d) Taylor Rule/ "Inflation Targeting". Under this policy, the monetary authority sets the short-term interest rate to target the rate of domestic CPI inflation and the deviation of domestic output from its "target level", following the rule put forth by Taylor (1993). Thus, interest rates are set so that

$$i_{t+1} = \varphi_1 \pi_t + \varphi_2 y_t$$

where π_t is the domestic CPI inflation rate, and y_t is the deviation of domestic output from its natural level. Following Taylor (1993), we let $\varphi_1 = 1.5$ and $\varphi_2 = 0.5$.

The Taylor rule may be thought of as being close to an "inflation targeting" rule, although in some key respects it differs from the popular definitions of inflation targeting as in Svensson (1998), for instance.

e) Optimal Monetary Policy Rule. Under this rule, the monetary authority follows a policy of adjusting either money or interest rates to ensure that the domestic price of non-traded goods equals marginal cost. This policy follows the suggestion of King and Wolman (1999). The rule in fact ensures that the response of the economy to shocks replicates that of a fully flexible price economy. While this is an unrealistic candidate for a monetary policy rule, it offers a useful and interesting benchmark against which to compare the other rules. Moreover, in the absence of external finance constraints, this is the welfare optimising monetary policy stance for the monetary authority to follow[5].

3.2 Calibration

We now derive a solution for the model, by first calibrating and then simulating using standard linear approximation techniques. The calibration of the model is somewhat more involved than the usual "dynamic general equilibrium" framework, both because the model has two production sectors, and because it involves parameters describing the entrepreneurial sector. As discussed above, we wish to calibrate as much as feasible to the economy of Thailand, a "representative" example of an emerging market economy[6]. The benchmark parameter choices for the model are described in Table 2.

Some standard parameter values are those governing preferences. It is assumed that the intertemporal elasticity of substitution in both consumption and real balances is 0.25. The consumption intertemporal elasticity is within the range of the literature, and the equality between the two elasticities ensures that the consumption elasticity of money demand equals unity, as estimated by Mankiw and Summers (1986). The elasticity of substitution between non-traded and imported goods in consumption is an important parameter, on which there is little direct evidence. Following Stockman and Tesar (1995), we set this to unity. The elasticity of labour supply is also set to unity, following Christiano, Eichenbaum,

---

5 The model economy has two goods market deviations from the first-best: sticky prices and imperfect competition. The welfare costs of imperfect competition may be eliminated by a production subsidy to firms. This leaves price stickiness as the only welfare loss. Therefore, a monetary policy which replicates the flexible price economy is fully optimal.

6 Unless stated otherwise, all data were obtained from CEIC, courtesy of the Hong Kong Institute for Monetary Research.

and Evans (1997). In addition, the elasticity of substitution between varieties of traded goods determines the average price-cost markup in the non-traded sector. Since we have no direct evidence on markups for Thailand, we follow standard estimates from the literature in setting a 10 percent markup, so that $\lambda = 11$.

Assuming that the small economy starts out in a steady state with zero consumption growth, the world interest rate must equal the rate of time preference. We set the world interest rate equal to six percent annually, an approximate number used in the macro-RBC literature, so that at the quarterly level, this implies a value of 0.985 for β.

The factor intensity parameters are quite important in determining the dynamics of the model. Typically these types of parameters are calibrated in general equilibrium models by identifying the employment share of GDP. But since it is quite likely that this share differs across sectors, then it is necessary to obtain separate wage shares at the sectoral level. For Thailand, detailed wage data by sector is not easily available, but estimates for the wage share of value added in two sectors: Construction and Manufacturing, were obtained (averages between 1993 and 1998), and equal to .66 and 0.24 respectively. These sectors would roughly seem to correspond respectively to the non-traded and the traded (export) sectors. In addition, the total share of wages in GDP averaged between 1994 and 1998 was 52 percent. Since the estimate of the share of wages in manufacturing income is likely to be lower than for other traded goods (such as agriculture), we increase this to 30 percent. Then, setting the share of wages in non-traded to 70 percent (approximately corresponding to Construction), the model produces an overall wage share of GDP equal to 52 percent as in the data.

In combination with the other parameters of the model, the parameter α, governing the share of non-traded goods in the CPI, determines the share of non-traded goods in GDP. The corresponding figure in the data depends on the classification for non-traded goods. Following the classification followed by Giovannini et al. (1996), we found that the average share of non-traded goods in total GDP in Thailand over the period 1980-1998 was 54 percent[7]. Given the other parameters, a value of α equal to 0.55 produces this share.

To determine the degree of nominal rigidity in the model, the value κ, governing the speed of price adjustment in non-traded goods, must be chosen. Again, in the absence of direct evidence of this, we follow the available literature on the subject (e.g. Chari, Kehoe and McGratten 1998), and set $\kappa=0.75$, so that prices completely adjust after approximately four quarters. Likewise, with no direct evidence on the speed of adjustment in capital, we follow BGG in setting the ϕ function such that the elasticity of Tobin's q with respect to the investment capital ratio is 0.3. This produces an average volatility of investment close to that observed in Thai data.

7 Traded goods were defined as Agriculture, Mining and Quarrying, and Manufacturing. Non-traded goods were Electricity Gas and Water, Construction, Hotel and Retail Trade, Transport Storage and Communications, Education, and other service sectors.

Finally, we must choose the parameters governing the entrepreneurial financing sector. Four numbers must be chosen: a) the cost of bankruptcy; μ, b) the steady state capital to net worth ratio, c) the average failure rate of entrepreneurs (governed by $\bar{\omega}$, and equal to $F(\bar{\omega})$), and d) the risk-spread of entrepreneurial debt over the world asset. In turn, these numbers must imply a set of values for the elasticity of the external finance premium with respect to the net worth to capital value ratio, the variance of ω, the savings rate of the entrepreneurial sector θ, and the share of total net worth of the entrepreneurial sector generated by wage income; $\frac{W^e H^e}{Z}$. Following BGG, we assume that the distribution of $\bar{\omega}$ is lognormal, and set $F(\bar{\omega})$ =0.03, so that three percent of firms fail in every period (note that we are calibrating to the pre-crisis period). The steady state ratio of capital to net worth is chosen to roughly match the pre-Asian crisis debt to equity ratio's. Stone and Gray (1999) report that for 1996 Thailand's corporate average debt-equity ratio was just over 2.5. Since in our model capital is not equity financed there is no direct translation of this for parameter values. But it suggests that the fraction of capital financed by external borrowing should be higher than the figure of unity used by BGG. Accordingly, in our benchmark model, we set $\frac{QK}{Z}$ = 3, so that $\frac{SD}{Z}$ = 2, twice that of BGG.

Evidence on the average risk spread of internal over external finance can be obtained from the risk spreads in Eurobonds charged to Thailand. Of course, during the 1997 crisis, this spread rose dramatically (see below). But in order to calibrate the size of $R_K - R$ it is more appropriate to look at pre-crisis spreads. Figure 4 below suggests that the risk spread on corporate Thai debt was only about 100 basis points in early 1997. This is even lower than the risk spread charge to US corporations over the treasury bill rate. BGG use a value of 200 basis points. But it is widely acknowledged that the risk-spreads in East Asia were unusually low before the crisis, and had been coming down significantly since 1995 (Robinson Rojas 1998). Thus, we choose a steady state risk spread of 200 basis points, as in BGG.

The cost of bankruptcy parameter μ is chosen at 0.25. This is twice the figure used by BGG, reflecting the widely acknowledged difficulties in processing bankruptcy proceedings in Thailand (e.g. Wong, Phunsunthorn, and Sutcharitkul 1999).

Given these four steady state values, the model implies an elasticity of the external finance premium with respect to the net worth to capital ratio equal to 0.025, a savings rate of entrepreneurs of 0.9, and a variance of $\ln(\omega)$ equal to 0.05[8].

3.3 Shocks

The model implies that the economy is exposed to three types of external shocks: a) shocks to foreign prices, b) shocks to the foreign interest rate, and c) terms of trade shocks. In the model, a) is represented by equal shocks to both P^*_{Mt} and P^*_{Xt}, b) is represented by shocks to i^*_{t+1}, and c) is represented by shocks to $\frac{P^*_{Xt}}{P^*_{Mt}}$. We now discuss the measurement of these shocks for the case of Thailand in more detail. Shock a) can be measured by the movement in trade prices, evaluated in foreign currency.

8 This is much lower than the 0.28 number used in BGG, but is required by the assumption that debt to net worth is much higher in the steady state of the present model.

Figure 1 shows the unit value of Thai trade prices evaluated in US dollar terms for the period 1990-2000[9]. The series seem to indicate that trade prices in foreign currency fell significantly after the Asian crisis. Since the data-sample is quite short, unit root tests are likely to provide very little information about the behaviour of this series. Nevertheless, on the natural assumption that nominal world traded goods prices are non-stationary, we first difference the data. The resulting series were then used to compute the following regression, describing the dynamics of traded goods prices facing Thailand:

(33)
$$\Delta\widehat{P}_{XMt} = 0.55\Delta\widehat{P}_{XMt-1} + \varepsilon_t$$
$$(3.79) \qquad s.e.e. = 0.019, \; R^2 = 0.28$$

with t-statistics in parentheses. Thus, trade price shocks are highly persistent, but have relatively low volatility.

The terms of trade index for Thailand is shown in Figure 2 for the period 1984-1999. As to be expected, the terms of trade displays significantly more volatility than traded goods prices. The first difference of the terms of trade were used to compute the following regression[10]:

(34)
$$\Delta\widehat{P}_{TOTt} = 0.32\Delta\widehat{P}_{TOTt-1} + \varepsilon_t$$
$$(2.39) \qquad s.e.e. = 0.029 \qquad R^2 = 0.09$$

Terms of trade shocks are less persistent than price shocks, but significantly more volatile.

The final shock that hits the model economy is an interest rate shock. The interpretation of this shock poses some difficulty however. On the one hand, the variable i^*_{t+1} can be literally interpreted as the foreign (e.g. US) interest rate. But we might also think of the economy as being subject to a country specific risk premium, leading the “offshore” interest rate facing entrepreneurs to rise above the alternative “onshore” cost of capital for US borrowers. The data clearly identify country risk-spreads for most emerging markets. Note that this country risk premium may in principle be separate from the endogenous external finance risk premium determined by the model. Moreover, while the nature of the country risk premium is not explained within the model, it is clear that the relevant interest rate faced by the country must be the one which includes the risk spread[11]. Calvo (1999a) has argued for the use of shocks to country risk-premiums as an analytical tool to explain the very large volatility of capital flows to emerging markets in the 1990s.

In this light, we may interpret the offshore interest rate facing entrepreneurs and households in our economy as being comprised of two parts; the “onshore” interest rate in the lending country, and a “risk-spread” component.

---

9 These data were computed from unit value import and export price indices.

10 Since the sample data for the terms of trade and trade prices are non-concurrent, we cannot examine the comovement between shocks.

11 Devereux and Cook (2000) show that variations in country risk spreads can be driven by rational financial panics in a dynamic general equilibrium model.

Evidence on the risk spread for Thailand is presented in Figure 3. The top line shows the spread of the Thai prime rate over US Treasury bond yields, while the bottom line shows the spread of Thai prime over US prime. There is a very high correlation between the two risk spreads (0.98). As an estimate of u_t however these series are imperfect, because the Thai prime rate is a return on a Thai baht-denominated loan, and so there is a currency risk spread over and above the "country-risk" spread. An alternative measure of country risk, and a more accurate estimate of u_t, may be represented by the spread on Eurobonds issued by Thai corporations over and above the benchmark London rate. Figure 4 shows this spread for a single issue, for the period 1997-2000. While the spread was very low in early 1997, it increased by about 500 basis points at the end of the year, and again by around the same amount in the third quarter of 1998. However, it is also clear that the movement in the spread is quite transitory.

The risk spread on Eurobond issues is heavily dominated by the Asian financial crisis, and is likely to be significantly more stable in more "normal" times. In the absence of more evidence on this risk spread, and in light of the difficulty of using the domestic-foreign risk spread from Figure 3, we choose to employ a simple but transparent interpretation of external interest rate shocks to Thailand using the US prime rate. This gives a reasonable measure of the external cost of capital for Thai corporations in normal times. According to our model then, the effective cost of capital is the US prime adjusted for the endogenous external finance risk premium.

Accordingly, using the quarterly US prime interest rate we compute the following regression

$$\begin{aligned} i_t^* = \;& 0.006 + \; 0.91 i_{t-1}^* + \varepsilon_t \\ & (1.59) \quad (18.0) \qquad s.e.e. = 0.0038 \qquad R^2 = 0.946 \end{aligned} \tag{35}$$

Equation (35) is used to measure the extent of the interest rate shock to Thailand for the simulated model below[12].

4. External Shocks under Alternative Monetary Rules

We now examine the workings of the model in response to external shocks to foreign prices, terms of trade shocks, and shocks to the world interest rate. The response of the economy will clearly depend on the monetary rule being followed. There are three shocks, and in each case, we compare this impact of the shock with and without the investment financing constraint. In the model, this case will obtain when there is no cost of monitoring entrepreneurs, i.e. $\mu = 0$. It implies that there is no external finance premium, so that in equation (19) above, $\psi(.) = 1$. Simulations from the model are described in Figures 5-10. In each case, there is a one standard deviation — an unanticipated impulse to one of the three shocks.

12 Changes in nominal interest rates are extremely persistent, as is clear from the regression (35). This opens the question of whether we should treat interest rates as non-stationary. But our model has no way to confront a non-stationary interest rate process, at a theoretical level, since we are using the methodology of simulating around a steady state.

4.1 Price Shocks

Figures 5 and 6 illustrate the effect of a shock to the world price level, which follows the process described in the estimated equation (33) above. Thus, there is a persistent shock to the *growth rate* of world prices. Figure 5 shows the case where there are no external financing constraints, while Figure 6 illustrates the benchmark model in the presence of financing constraints.

Note that if the persistent of the world price shock was zero, then any of the monetary rules that allow for exchange rate adjustment could fully and without cost offset the world price shock, since a one-for-one nominal exchange rate depreciation would leave all real variables unchanged. This represents the classic Friedman (1953) case for exchange rate adjustment in response to a world negative demand shock. But in the presence of price shocks that are persistent, i.e. the initial rise in prices is magnified over time as in equation (33), then nominal exchange rate adjustment cannot insulate the economy from shocks. The reason is that the nominal exchange rate must be expected to rise over time, increasing nominal interest rates, and also real interest rates (because of the presence of sticky prices). The rise in the real interest rate reduces consumption, investment and output in the non-traded goods sector. Output in the traded sector rises, because the decline in non-traded output reduces real wages for traded goods firms. Thus the trade balance improves. Overall output may rise or fall. Under the optimal monetary rule (or flexible prices), output would rise, but falls for all the other rules. The movement of the real exchange rate is markedly different between the fixed exchange rate case and all other monetary rules. Under fixed exchange rates, the real exchange rate appreciates, since there is a fall in traded goods prices, sticky non-traded goods prices, and the exchange rate cannot adjust. But under all other monetary rules, there is a real depreciation, since the nominal exchange rate depreciates by *more* than the fall in world prices.

How do the monetary rules compare in terms of response to the price shock? Not surprisingly, the fixed exchange rate does the worst: it generates a higher real interest rate increase, a greater fall in consumption and output, and a real exchange rate movement in the “wrong direction”. With respect to the other rules, there is a clear ranking. The money targeting rule does quite poorly in the sense of a large rise in the real interest rate, and a large fall in output and consumption, and has characteristics almost identical to the rule which stabilizes the price level. In this case, effectively the two rules operate in a very similar way since there is no required long run adjustment in the price level, so that leaving money growth unchanged is almost equivalent to stabilizing the price level.

The Taylor Rule does better than all other rules except the “optimal rule” (which replicates a flexible price economy). The reason is that the Taylor Rule responds quickly to the fall in output by lowering nominal interest rates. Moreover, as the economy goes into deflation, nominal interest rates are lowered still more. Thus, output bounces back quickly under this rule.

Finally, note that the rankings of the rules with respect to the movements on output, consumption and real interest rates are the mirror image of the rankings with respect to the real exchange rate. The real exchange rate depreciation is greatest under the optimal rule, less so under the Taylor Rule, and even less under the money targeting rule and the price stability rule.

Figure 6 illustrates the effect of introducing external financing constraints in both sectors of the economy. The first clear effect from the figures is that the magnitude of the response to the shock is increased greatly. Under all rules, output falls by more when there is an external financing constraint. The mechanism is quite clear from the way in which the dynamics of the financing constraint works. The persistent price shock amounts to an effective interest rate increase for this small economy. This leads to a fall in investment in both sectors (although by more in the non-traded goods sector), and a fall in the price of capital for entrepreneurs. In addition, the nominal exchange rate depreciates under all but the fixed exchange rate regime. The combination of these two factors leads to a fall in net worth for the entrepreneurial sector, and a fall in investment that is greater in the presence of the financing constraints.

The presence of financing constraints does not alter the ranking of alternative monetary policies, in the sense of the response of consumption, output, or the real interest rate to the price shock. Output falls by most under a fixed exchange rate rule, and by least under the optimal rule. But the difference between the fixed exchange rate rule and the other policies are significantly lessened now. For instance, the fall in output under a fixed exchange rate is only fractionally higher with the external financing constraint. But under a monetary rule (or a price stability rule), the fall in output is 50 percent greater with the external financing constraint. The real exchange rate depreciation under the monetary targeting rule or the price stabilizing rule tends to exacerbate the negative multiplier effects of the shock, but not under the fixed exchange rate, since there is no real depreciation in that case. While in principle it is possible that the scale of the real depreciation might be so great as to reverse the rankings of monetary rules with respect to the response of the economy to the price shock, in this model that reversal does not occur. Nevertheless, it is clear that the advantage of exchange rate flexibility begins to diminish, the greater the importance of the financing constraints in the economy. In an extreme case where the elasticity of the external finance premium is increased from its benchmark value to 0.1, the response of output is almost the same for all monetary rules, except the “optimal rule”.

While the presence of financial constraints does tend to narrow the difference between rules 2-5, it also tends to increase the response of the real exchange rate to shocks, under the flexible exchange rate rules. In fact, rule 1, the optimal rule, involves much greater real exchange rate response that the other rules. This is because it actively uses monetary accommodation of the price shock. Therefore, while we observe that flexible exchange rate rules have a lesser ability to cushion the impact of price shocks under financial balance sheet constraints of these kind, this does not lead to the conclusion that real exchange rate response is not desirable. An optimal monetary policy rule would balance the positive effects of monetary expansion against the negative “balance sheet” effects of a real depreciation. The first factor will dominate, requiring greater accommodation and more real depreciation.

4.2 Interest Rate Shocks

Figure 7 illustrates the effects of shocks to the world interest rate for the small economy, in the case without financial market constraints. In some respects, the effects are the same as those for a persistent price shock, since that shock generated a change in the effective world interest rate. Consumption and investment fall, there is a real exchange rate depreciation, traded good output rises, non-traded good output falls, and there is an improvement in the trade balance. But there is an important difference between the alternative monetary rules in the response to the interest rate shock. Under the monetary targeting rule, the fall in the interest rate tends to generate a large exchange rate depreciation through the money market equilibrium. This cushions the impact of the fall in consumption and investment demand in the non-traded goods sector. As a result, non-traded goods output falls by less than it would in a fully flexible price economy (shown by the "optimal monetary policy rule"). The optimal monetary policy response to the interest rate shock would therefore be *contractionary*, dampening the real depreciation, and increasing the real interest rate. The response of overall GDP is positive under the monetary targeting rule, since the fall in non-traded goods output is dominated by the rise in traded goods output. The optimal monetary rule would actually limit the rise in output.

All the other monetary rules tend to be excessively contractionary, relative to the monetary targeting rule. As in the previous case, the contraction in output and consumption is greater under fixed exchange rates. But note that the behaviour of the economy under the price stability rule is almost the same as under fixed exchange rates. Intuitively, this is understandable. With sluggish prices in the non-traded goods sector, stabilizing the price level in response to the interest rate shock is almost the same as stabilizing the exchange rate. Figure 7 shows that the price stability rule allows for very little real exchange rate adjustment in response to the shock.

Note also that the Taylor Rule now does worse than the money targeting rule in the sense of leading to a greater fall in domestic output and consumption, a lower real depreciation, and a higher real interest rate increase. The reason is that the Taylor Rule will tend to increase nominal interest rates in response to the nominal exchange rate depreciation generated by the interest rate shock, whereas the money targeting rule has no direct response. Thus, the Taylor Rule limits the extent of the real depreciation and exacerbates the rise in the real interest rate. In fact, under the Taylor Rule, real interest rates rise by almost as much as under a fixed exchange rate. By contrast, for the price shock discussed in the last experiment, the initial inflation is much less since the CPI itself contains the deflationary impact of the shock, so the Taylor Rule involves a less contractionary monetary stance.

How does the presence of financial market friction affect the response to the interest rate shock? Figure 8 illustrates the response of the benchmark economy. The direction of response of the GDP under the monetary targeting rule is now reversed. The demand effects of the fall in consumption and investment now offset the relative price effects of the real depreciation, so that non-traded goods output falls by more than it would under fully flexible prices. As a result, overall GDP falls. The optimal monetary rule in this case would keep the response of overall GDP constant. Thus, there is an interesting distinction in the desired response of monetary policy between the economy without financial constraints and with financial constraints. In the absence of financial constraints, we would call for a contractionary stance, but in the presence of these constraints, the optimal rule involves a neutral or slightly positive stance. Equivalently, real exchange rate depreciation should be limited in the economy without financial constraints, but enhanced in the economy with constraints.

The ranking of the other monetary rules is unchanged, in terms of the response of output, consumption, the real exchange rate, the trade balance, and real interest rates. But as before, the amplitude of the response to the shock is much greater. Output and consumption fall by more under all rules, while the real exchange rate depreciation is greater. Even under fixed exchange rates, there is a much greater response in terms of output. This is because the interest rate shock directly impacts on entrepreneurial wealth, while the price shock of the previous section affects wealth only indirectly. However, it is clear from the Figure that the magnification effect of the financial friction is greater under all types of floating exchange rates than under the fixed exchange rate regime. Thus, we again reach the conclusion that the presence of financial friction narrows the gap between fixed and floating exchange rate regimes.

4.3 Terms of Trade Shocks

Figure 9 illustrates the effect of persistent negative shock to the terms of trade, measured as in equation (35). The results are quite different from those of the previous two shocks. The response of overall output depends hardly at all on the monetary policy rule. Output falls in all cases, and by roughly the same amount, even for the "optimal rule". For consumption and the real exchange rate, the ranking of the response to the shock is the same as that for price shocks. Consumption falls most under a fixed exchange rate, somewhat less for the price stability rule, which is almost equivalent to the money targeting rule, and by less still for the Taylor Rule.

The optimal rule requires a monetary expansion in the event of a terms of trade shock. In the absence of any monetary response, the income effects of the terms of trade deterioration will reduce aggregate demand and lead to a fall in output in the non-traded sector. In addition, export good output falls anyway because the terms of trade shock acts like a negative productivity shock. But in a frictionless world without any price stickiness, the fall in export goods production would reduce the demand for labour, reducing wages and increasing output in the non-traded goods sector. The increase in output of non-traded goods is associated with real depreciation and a fall in the real interest rate.

But in a sticky price environment, the fall in wages following the terms of trade shock has no direct effect on non-traded output. Non-traded output instead falls, due to the direct negative demand effects. Moreoever, the real depreciation is much less on impact, and gradually increases over time (as gradually non-traded prices start to adjust downwards). So the real interest rate rises rather than falls. Thus, all monetary rules fail to obtain the necessary movement of output in the non-traded goods sector or the movement of the real interest rate.

But an important fact to note is that the scale of all these movements is quite small relative to the size of the terms of trade shock itself. In fact, the bulk of the response to a terms of trade deterioration is felt in the immediate movement of exported goods production, and the response of other variables is quite secondary. This explains why at the aggregate level, the movement of GDP is almost independent of the form of the monetary rule being followed. In effect, the monetary policy stance is not all that important for dealing with terms of trade shocks.

How important are the balance sheet effects associated with the financial market frictions for the response to a terms of trade shock? The answer is that they are hardly important at all. Figure 10 show the effect of a terms of trade deterioration in the benchmark economy with financial market distortions. The economy with financial frictions has somewhat of a magnified response. Consumption falls by more, and output in the non-traded sector falls now even under the optimal monetary rule. But the size of these differences is small. Overall, the difference between the response of the economy to a terms of trade shock, with and without financing constraints is quite slight.

The reason for the equivalence of the two cases in the response to terms of trade shocks is the same as the reason for the ineffectiveness of monetary policy rules under this shock. The terms of trade shock does not generate a large response in either the real exchange rate or the real interest rate. Therefore, the endogenous entrepreneurial wealth effect — and the endogenous risk premium effect, is small. In addition, the terms of trade shock generates only a small response of investment, so the movement of the price of capital and entrepreneurial wealth through this channel is also small.

We may thus conclude that “balance sheet” collateral constraints are relatively unimportant for a small economy’s response to terms of trade shocks, but by the same token, the exchange rate regime is also relatively unimportant.

4.4 Volatility under All Shocks

How do alternative monetary policies rank in the presence of all shocks together? In order to do this, we simulate the model, including the three external shocks identified in the previous section, with and without the financial market constraints. Table 2 reports the results, as well as the data for Thailand[13].

The most striking feature of the Table is that, in terms of output volatility, there is very little difference between any of the monetary policy regimes. In the absence of financial constraints, under our model calibration, output volatility using the “optimal” monetary rule is three percent, while sample data, output volatility is 2.8 percent. Output volatility is higher under fixed exchange rates, but only marginally so at 3.3 percent. Monetary targeting and a price stability rule give a 3.2 and 3.1 percent output volatility, respectively, while the Taylor Rule gives the same output volatility as the optimal rule. Note however that there is a significant difference in consumption volatility. Consumption volatility is lowest under the monetary targeting rule and the optimal rule, and highest under fixed exchange rates. But relative to the Taylor Rule, or the price stability rule, consumption volatility under the fixed exchange rate regime is only slightly higher. Relative to the data, consumption volatility under all regimes is too low[14].

At the same time, we note that the fixed exchange rate regime does stabilize the real exchange rate, relative to all other regimes. Real exchange rate variability is highest under the monetary targeting regime at 2.4, while only 1.6 percent under a fixed exchange rate. For the sample period, the standard deviation of the real exchange rate is 5.1 percent, but if we leave out three observations associated with the Asian crisis, the number falls to 2.4 percent. Thus, the model is reasonably accurate on this dimension.

The effect of introducing financial market distortions is to raise output, investment, and real exchange rate variability considerably, but leave the rankings of the variabilities unchanged, relative to the case without financial market distortions. Consumption variability is essentially unchanged by financial market distortions.

---

13 The GDP data for Thailand are from March 93 to December 99. The real exchange rate is the real effective exchange rate, March 90 to March 00.

14 This is a familiar finding in the typical version of the dynamic general equilibrium model. Agents in this model will attempt to smooth consumption in response to temporary shocks.

In concluding this section, when our model is calibrated to the pattern of external shocks that have historically been predominant in the Thai economy, we find that the macroeconomic characteristics of the economy are relatively unaffected by the monetary policy rule being followed. Output volatility will be essentially unchanged by the monetary rule. This is because, historically, the dominant shocks have been the terms of trade shocks, and the exchange rate regime has little impact on the way output responds to a terms of trade shock. In welfare terms, of course, a fixed exchange rate will fare worse, because it involves a greater volatility of consumption. But the difference in consumption volatility between the fixed exchange rate and most other monetary rules is relatively small. In addition, we may conclude that the presence of financial market distortions as outlined in this and the previous section do not have major implications for the ranking of alternative monetary rules.

5. Conclusion

This paper has conducted an investigation of exchange rate regimes and alternative monetary policy rules for an emerging market economy that is subject to a volatile external environment in the form of shocks to world interest rates, world prices and the terms of trade, and when the economy is constrained by external financing risk-premia associated with domestic net worth. We saw that the particular monetary policy rule being followed is as important as whether the exchange rate is fixed or flexible. In general, there is a case for exchange rate flexibility under all shocks, but as constraints on external financing become more important, the relative benefits of monetary rules that allow for floating exchange rates tend to diminish. In addition, the benefit of exchange rate flexibility under terms of trade disturbances is quite minor, whether or not external financing constraints are important. In application to the economy of Thailand, we found a preponderance of terms of trade shocks hitting that economy. As a result, our simulation results suggest that for Thailand, the degree of exchange rate flexibility in monetary policy is likely to have only minor consequences for macroeconomic behaviour.

References

Agenor, Pierre Richard and Peter Montiel (1996), Development Macroeconomics, Princeton University Press.

Aghion, Philippe, Philippe Bacchetta, and Abhijit Banerjee (2000), "Currency Crises and Monetary Policy in an Economy with Credit Constraints," mimeo.

Backus, David, Finn E. Kydland, and Patrick J. Kehoe (1992), "International Real Business Cycles," *Journal of Political Economy*, 100, 745-75.

Bernanke, Ben, Mark Gertler and Simon Gilchrist (1999), "The Financial Accelerator in a Quantitative Business Cycle Model," in John Taylor and Michael Woodford, eds, *Handbook of Macroeconomics*, Volume 1c, North Holland.

Calvo, Guillermo (1999a), "On Dollarization," mimeo, University of Maryland.

Calvo, Guillermo (1999b), "Fixed versus Flexible Exchange Rates," mimeo, University of Maryland.

Calvo, Guillermo (1983) "Staggered Prices in a Utility Maximizing Framework," *Journal of Monetary Economics*, 12, 383-398.

Calvo, Guillermo and Carmen Reinhart (2000), "Fear of Floating," mimeo.

Caramazza and Aziz (1998), "Fixed versus flexible: getting the exchange rate right in the 1990's," IMF Economic issues, no. 13.

Cespedes, Luis Felipe, Roberto. Chang, and Andres Velasco (2000), "Balance Sheets and Exchange Rate Policy," mimeo, Federal Reserve Bank of Atlanta.

Chang, Roberto and Andres Velasco (1998), "Financial Fragility and the Exchange Rate Regime," NBER Working Paper No. 6469.

Chang, Roberto and Andres Velasco (1999), "Liquidity Crises in Emerging Markets: Theory and Policy," Economic Research Report RR#99-14, CV Starr Center for Applied Economics, New York University, June.

Chari, V.V. Patrick J. Kehoe, and Ellen McGratten (1998) "Monetary Shocks and Real Exchange Rates in Sticky Price Models of the International Business Cycle," Federal Reserve Bank of Minneapolis Research Department Staff Report #223, February.

Christiano, Larry J, Martin Eichenbaum and Charles L.Evans (1997) "Sticky Price and Limited Participation Models of Money: A comparison," *European Economic Review* 41, 1201-1249.

Cook, David (1999) ''Monetary Policy in Emerging Markets," Hong Kong University of Science and Technology.

Eichengreen, Barry and Ricardo Hausmann (1999), "Exchange Rates and Financial Fragility," NBER Working Paper No.7418.

Frankel, Jeffrey (1999), "No Single Currency Regime is Right for All Countries or at All Times," NBER Working Paper No.7338.

Gray, F. Dale and Mark R. Stone (1999), "Corporate Balance Sheets and Macroeconomic Policy," Finance and Development, 36(3), 56-59.

Gregario, Jose De, Giovannini, Alberto, and Holger Wolf (1994), "International Evidence on Tradeables and Non-tradeables inflation," *European Economic Review*, 38, 1225-44.

Honohan, Patrick and Philip R. Lane (1999), "Pegging to the Dollar and the Euro," *International Finance*, 2(3), November, 379-410.

King, Robert G. and Alexander Wolman (1999), "What Should the Monetary Authority Do when Prices are Sticky?", in John B. Taylor Ed. Monetary Policy Rules, NBER, University of Chicago Press.

Krugman, Paul (1999), "Balance Sheets, The Transfer Problem and Financial Crises," *International Tax and Public Finance*, November, 6, 459-72.

Mankiw, N. Gregory and Lawrence Summers (1986), "Money Demand and the Effects of Fiscal Policies," *Journal of Money Credit and Banking*, 18, 415-429.

Mishkin Frederic and Miguel A. Savastano (2000), "Monetary Policy Strategies for Latin American," NBER Working Paper No.7617.

Robinson Rojas (2000), www.rrojasdatabank.org

Sachs, Jeffrey (1998), "The Causes of the Asian Crisis," mimeo.

Stockman, Alan and Linda Tesar (1995), "Tastes and Technology in a Two-Country Model of the Business Cycle: Explain International Comovements," *American Economic Review*, 85, 168-85.

Svensson, Lars (1999), "Inflation Targeting as a Monetary Policy Rule," *Journal of Monetary Economics*, 43, 607-54.

Taylor, John B. (1993), "Discretion versus policy rules in practice," Carnegie Rochester Conference Series on public policy.

Townsend, Robert M. (1979), "Optimal Contracts and Competitive Markets with Costly State Verification," *Journal of Economic Theory*, 2, 265-293.

Wong, Karen, Phunsunthorn, Chiridaka, and Tiziana Sucharitkul (1999), "Problems and Promises: the reform of Thai Bankruptcy Law in the Wake of the Asian Financial Crisis," Harvard Asia Quarterly, Winter 1999, Vol. IV, No.1, www.fas.harvard.edu/~asiactr/haq/199904/9904a004.htm

Yun, Tack (1996), "Nominal Price Rigidity, Money Supply Endogeneity, and Business Cycles," *Journal of Monetary Economics*, 37, 345-70.

Table 1: Calibration of Model

Parameter	Value	Description
σ	2	Inverse of elasticity of substitution in consumption
ε	2	Inverse of elasticity of substitution in real balances
β	0.985	Discount factor (quarterly real interest rate is $\frac{1-\beta}{\beta}$)
ρ	1.0	Elasticity of substitution between non-traded goods and import goods in consumption
η	1.0	Coefficient on labour in utility
ψ	1.0	Elasticity of labour supply
γ	0.7	Share of capital in export sector
δ	0.025	Quarterly rate of capital depreciation (same across sectors)
α	0.3	Share of capital in non-traded sector
λ	10	Elasticity of substitution between non-traded varieties
b	0.55	Share on non-traded goods in CPI
κ	0.75	Probability of non-traded firms price remaining unchanged
$-\frac{\phi''}{\phi'}\frac{I}{K}$	0.3	Elasticity of q with respect to I/K ratio (inversely related to investment adjustment costs)
$-\frac{\Psi'}{\Psi}\frac{Z}{QK}$	0.025	Elasticity of the external finance risk premium
$\frac{QK}{Z}$	3.0	Capital to net worth ratio (1 plus debt to net worth ratio)
ϑ	0.9	Aggregate savings rate of entrepreneurs
$\frac{W^e H^e}{Z}$	.01	Share of entrepreneurial net worth coming from employment income

Table 2. Moments from the model

		Data	Optimal	Money	FER	Price	Taylor
No Financial Constraints	σ_y^2	2.8	3.0	3.2	3.3	3.1	3.0
	σ_{rer}^2	5.1 (2.4*)	2.4	2.4	1.6	1.8	1.9
	σ_c^2	2.9	0.8	0.78	1.5	1.2	1.0
	σ_i^2	9.5	9.2	8.9	13.8	11.6	10.6
		Data	**Optimal**	**Money**	**FER**	**Price**	**Taylor**
Benchmark Model	σ_y^2	2.8	4.1	4.2	4.6	4.2	4.3
	σ_{rer}^2	5.1 (2.4*)	3.2	3.1	2.1	2.4	2.7
	σ_c^2	2.9	0.73	0.78	1.5	1.2	1.0
	σ_i^2	9.5	16.3	16.6	21.0	18.7	17.9

* Standard deviation of the real exchange rate if three observations from Asian crisis omitted.

Figure 1: Thailand: Traded Goods Prices

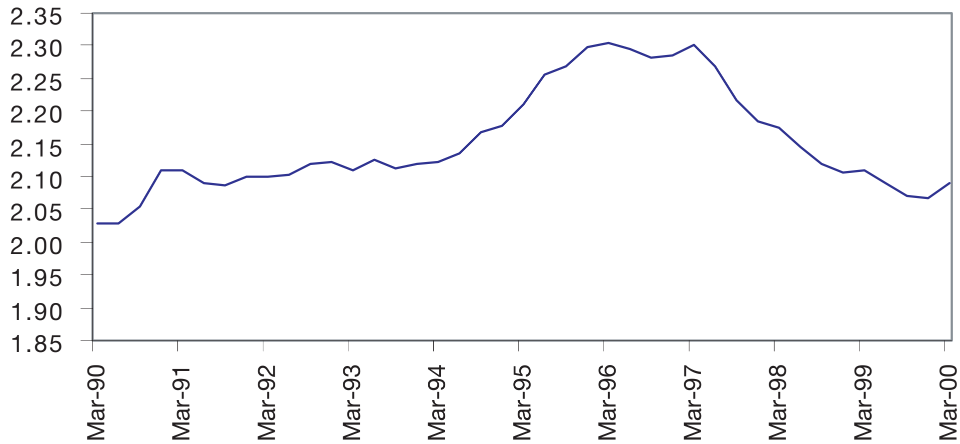

Figure 2: Thailand Terms of Trade Index

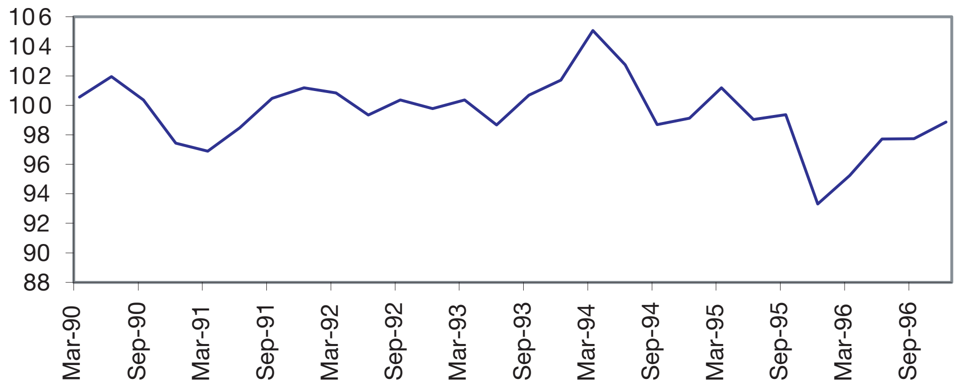

Figure 3: Thailand: Interest Spreads Prime/US Prime, Prime/USTB

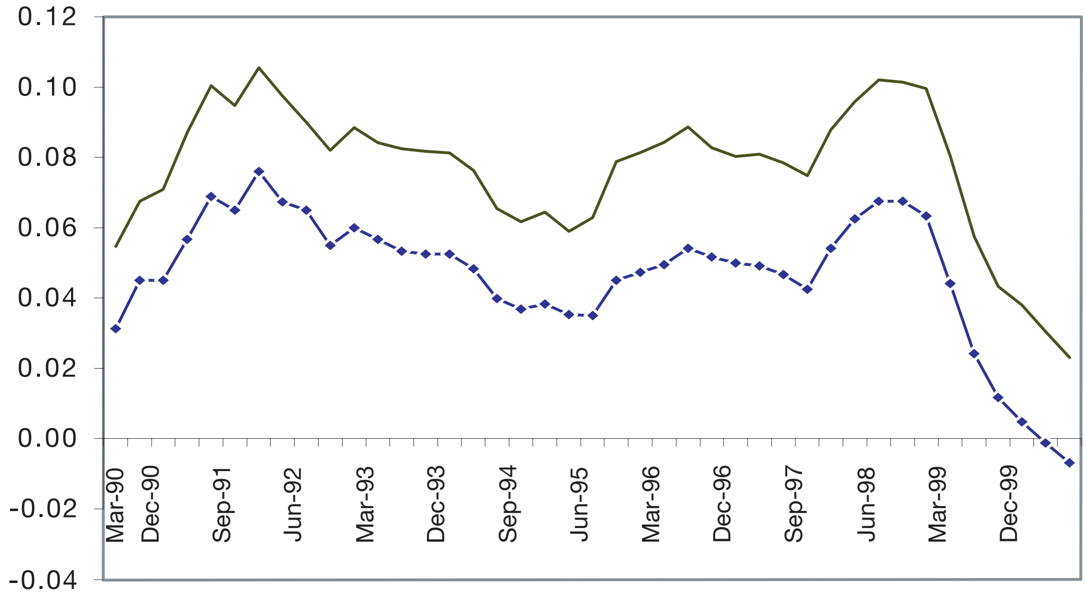

Figure 4: Spread over Benchmark Eurobond

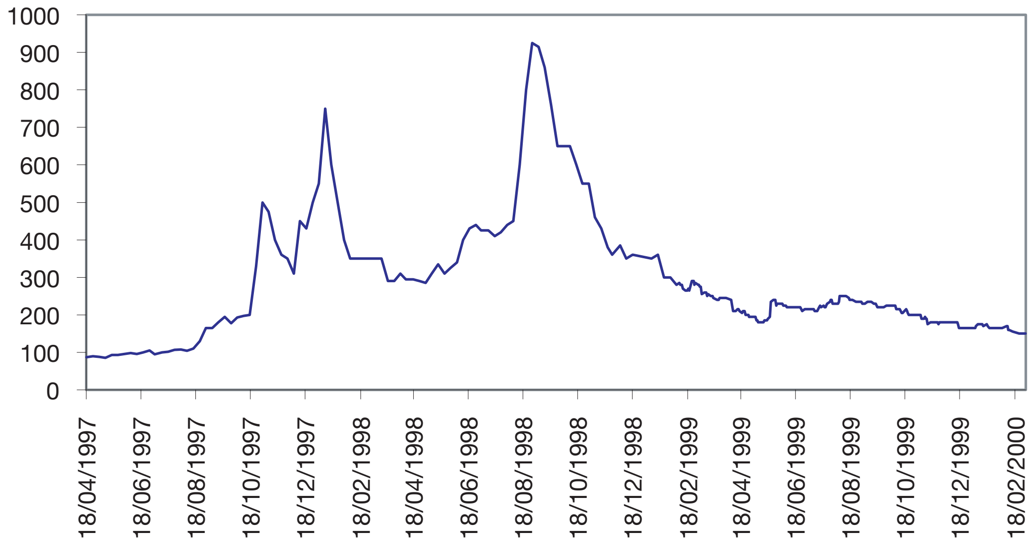

Figure 5: Foreign Price Shock
No Financial Constraint

Figure 5a: Output

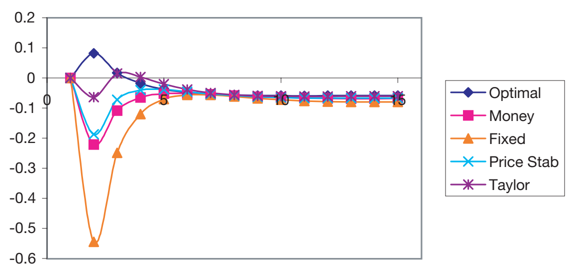

Figure 5b: Consumption

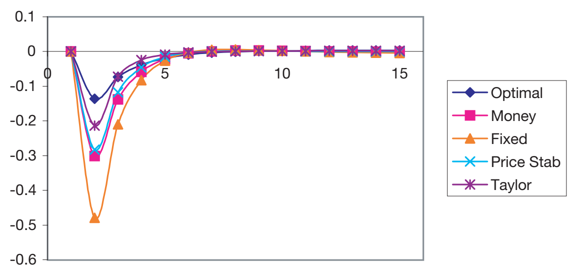

Figure 5c: Trade Balance

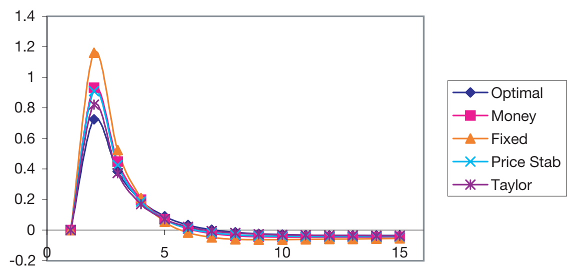

Figure 5d: Investment

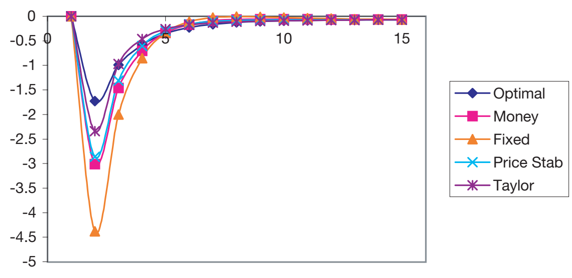

Figure 5e: Non-traded Goods

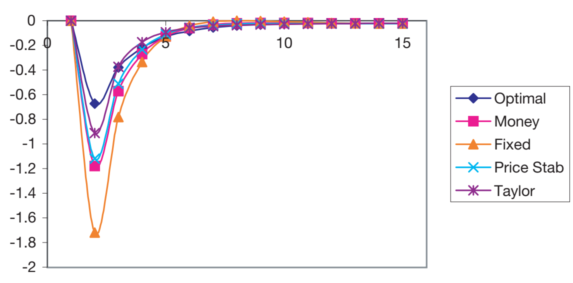

Figure 5f: Traded Goods

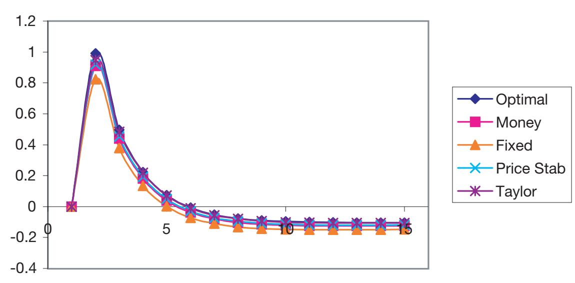

Figure 5g: Real Exchange Rate

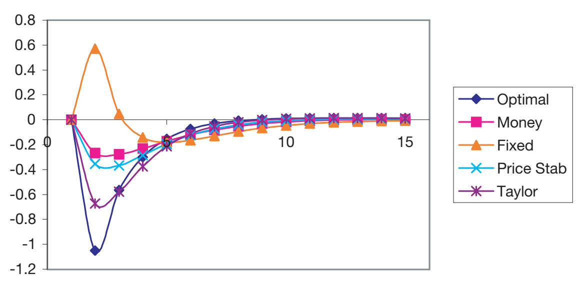

Figure 5h: Real Interest Rate

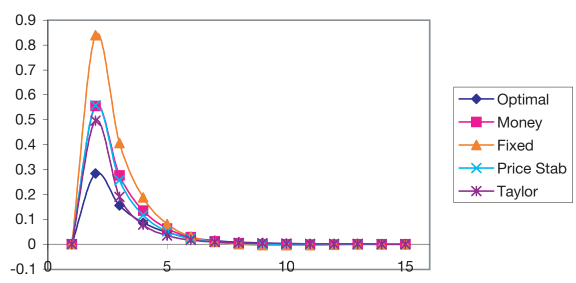

Figure 6: Foreign Price Shock
Financial constraint

Figure 6a: Output

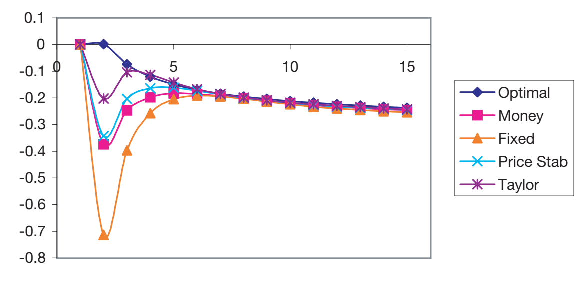

Figure 6b: Consumption

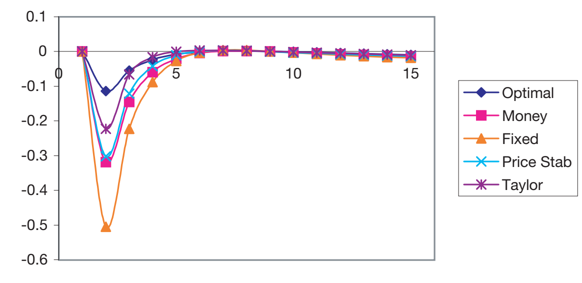

Figure 6c: Trade Balance

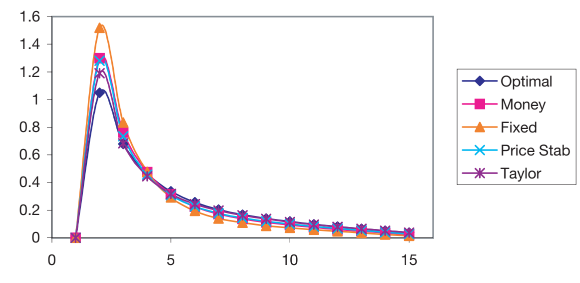

Figure 6d: Investment

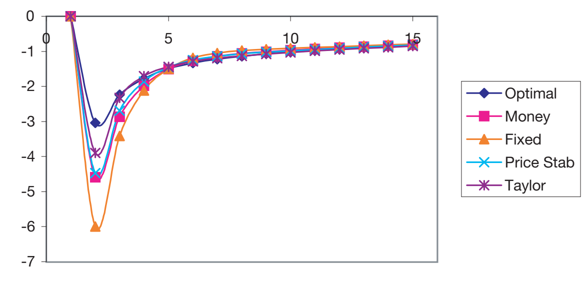

Figure 6e: Non-traded Goods

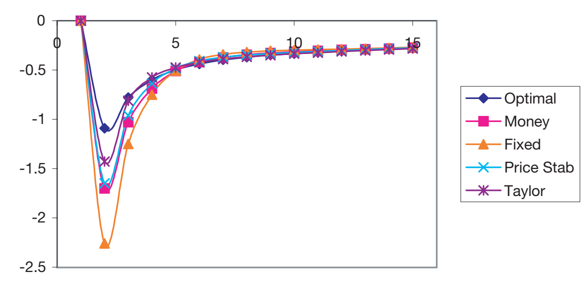

Figure 6f: Traded Goods

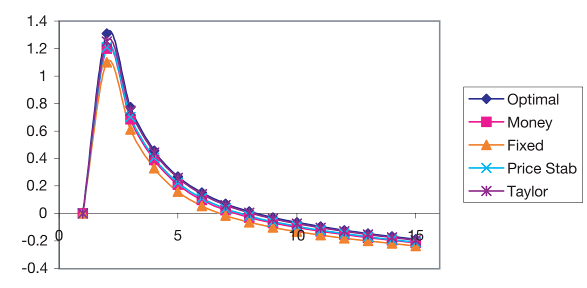

Figure 6g: Real Exchange Rate

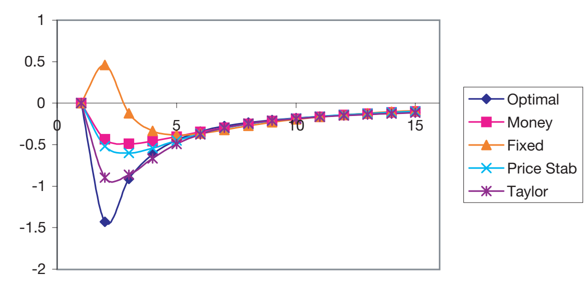

Figure 6h: Real Interest Rate

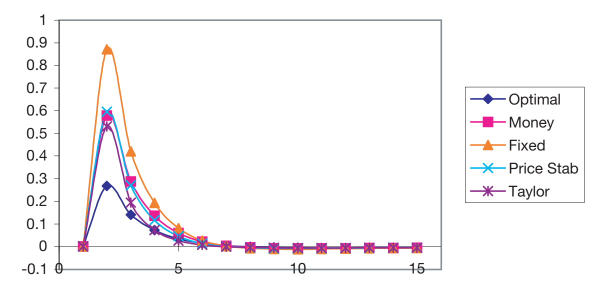

Figure 7: Interest Rate Shock
No financial constraint

Figure 7a: Output

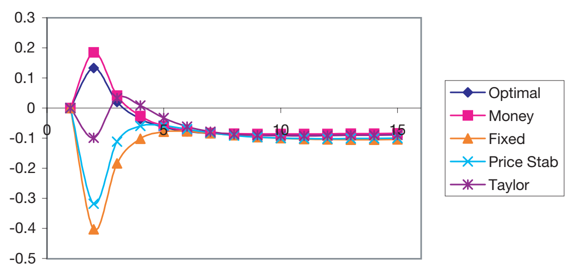

Figure 7b: Consumption

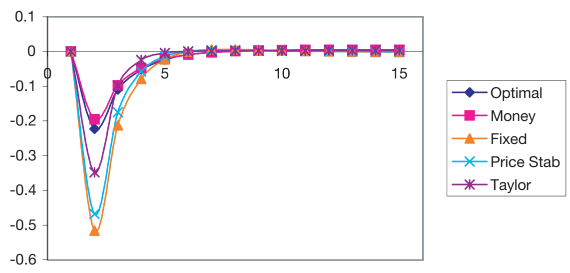

Figure 7c: Trade Balance

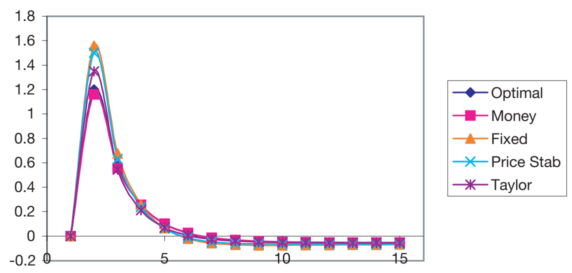

Figure 7d: Investment

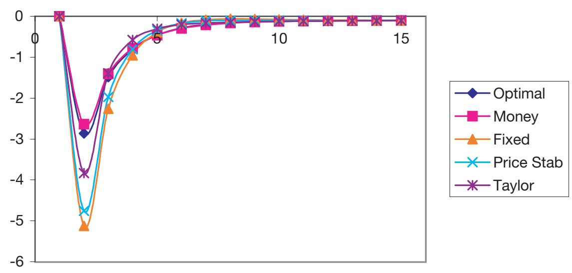

Figure 7e: Non-traded Goods

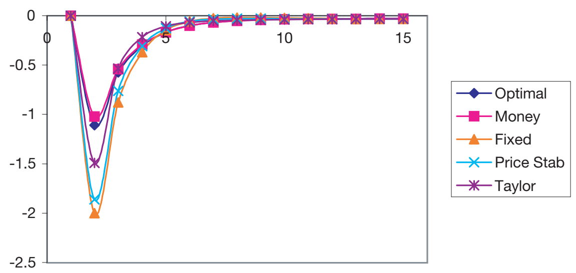

Figure 7f: Traded Goods

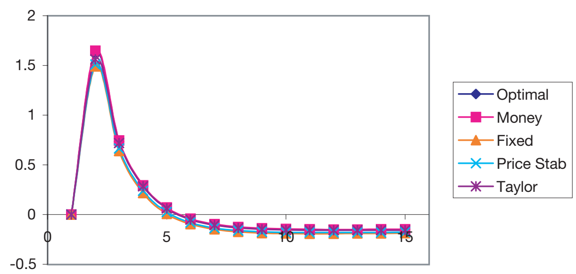

Figure 7g: Real Exchange Rate

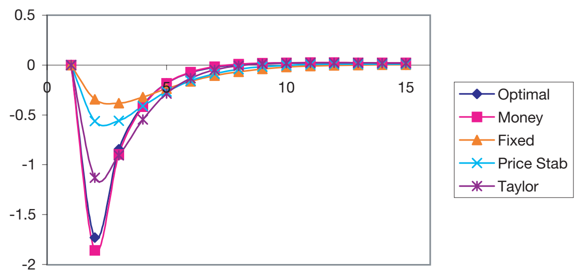

Figure 7h: Real Interest Rate

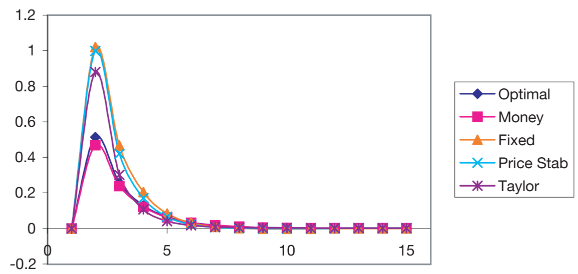

Figure 8: Interest Rate Shock
Financial constraint

Figure 8a: Output

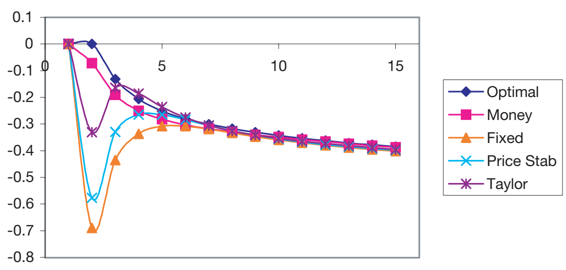

Figure 8b: Consumption

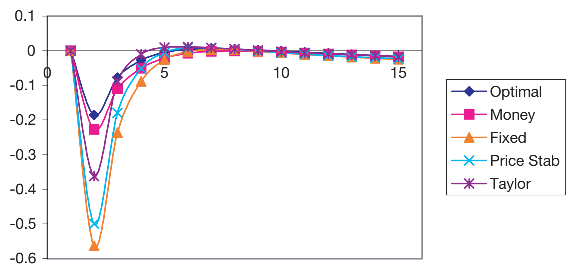

Figure 8c: Trade Balance

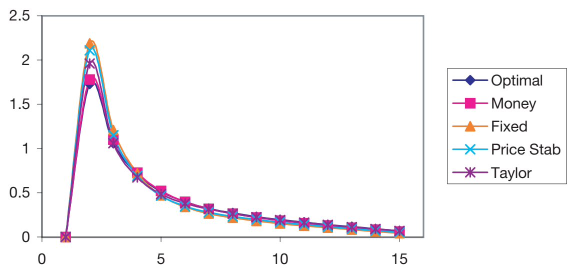

Figure 8d: Investment

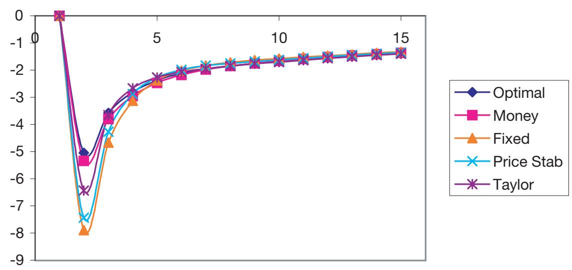

Figure 8e: Non-traded Goods

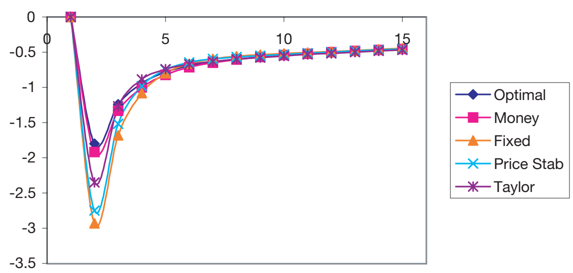

Figure 8f: Traded Goods

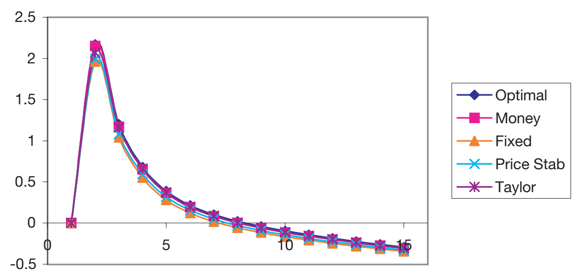

Figure 8g: Real Exchange Rate

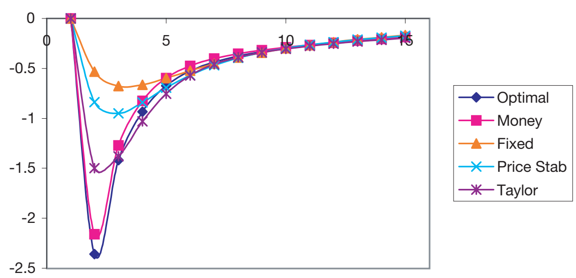

Figure 8h: Real Interest Rate

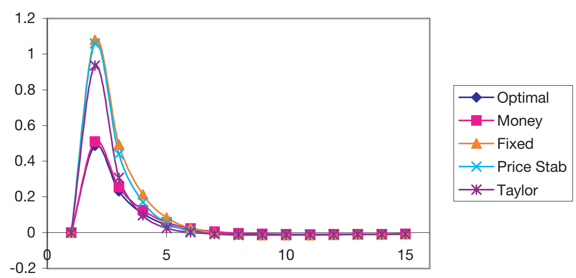

Figure 9: Terms of Trade Shock
No financial constraint

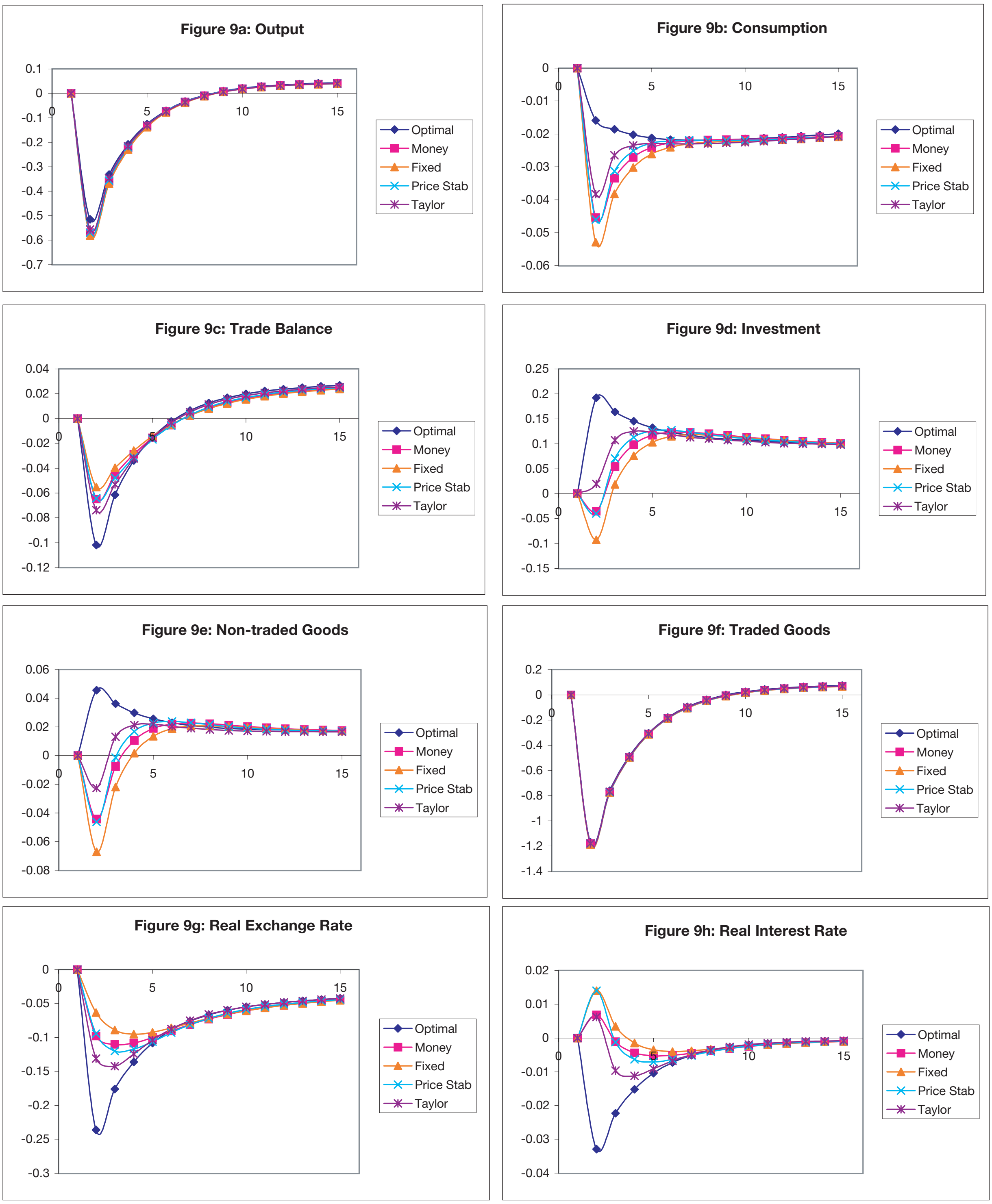

Figure 10: Terms of Trade Shock
Financial constraint