Foreign capital inflow, exchange rate dynamics and potential financial crisis

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We construct a model of capital inflow in a two-country framework. A capital-scarce country, typically a developing country with a high return on capital borrows from a capital-rich country, typically a developed country to finance domestic investment. In the process both the countries gain, raising the world welfare. This borrowing leads to appreciation of exchange rate in the developing country. When the external loan is repaid there is depreciation of exchange rate leading to costlier repayment. This is further accentuated when a bad state hits the country. This explanation of financial crisis is different from the usual theoretical explanations based on information theory, while our explanation is drawn from trade theory where worsening of terms of trade in the next period wipes out the gains of cheaper external borrowing, which is supported by several historical episodes in the empirical literature. If the exchange rate depreciation of the next period reduces the welfare of the capital importing country, even then there might be a gain in the total world welfare. However, in a situation of financial crisis, gains of international borrowing turn into total world welfare loss. We study the potential regimes of foreign exchange crisis under different parametric configurations of the model through the exchange rate dynamics.

Keywords: Exchange rate dynamics, financial crisis, foreign capital flow, portfolio choice.

Introduction

FINANCIAL and banking crises faced by many countries across the globe have often been ascribed to informational problems – adverse selection and moral hazard and spread to other countries through contagion effect. This has particularly been discussed for the Asian crisis of 1997 (refs 1 and 2). Once started in Thailand, it spread to other Asian countries via what may be called herd behaviour (see note 1). Allen and Gale[3–5] have also expressed similar views (see note 2). Mendoza *et al.*[6] has ascribed the recent global financial crisis to globalization and financial integration. Bordo and Meissner[7] analysed two phases of financial crisis across the globe – 1880 to 1913 and 1972 to 1997 (see note 3) and concluded that countries for which foreign currency debt was denominated in gold (in the first phase) or in hard currency (in the second phase) – the so-called original sin (see note 4) have been hit by financial or banking crisis or both. When the exchange rate depreciates debt servicing becomes difficult, which in turn increases the perception of default. Thus Eichengreen and Hausman[8] argue that exchange rate management is of utmost importance even if monetary and fiscal fronts are sound. This point has been further strengthened by Eichengreen *et al.*[9] and Flandreau[10]. Bussire *et al.*[11], in a theoretical model of incomplete markets have shown that exchange rate uncertainty leads to a debt structure that is more biased towards short-term debt which makes the borrowing countries more vulnerable to currency crisis.

It is evident from the studies mentioned above that financial crisis whether began due to informational problems or due to the so-called original sin, operates via exodus of foreign capital and thus accentuates the effects of crises even when they originate due to mismanagement of domestic macroeconomic policies. This has led many academics and policy makers to argue a fair degree of control on the inflow of foreign capital[12]. Bhagwati[13] and Rodrik[14] contended that capital account liberalization leading to free inflow of capital has been the root cause of financial crises and that the non-industralized countries have benefitted less than its costs. It has been observed empirically that regimes of less capital control have led to financial crisis, such as Argentina in the early 1990s (see ref. 15), Brazil during 1980s (see ref. 16) and Chile during 1980s and late 1990s (see ref. 17). The crisis has been accentuated with poor domestic macroeconomic management policies. Based on the experience of the second phase of capital decontrol in Chile, Cowan[17] has argued that the banking sector reforms leading to stricter prudential norms and absence of the provision of guarantees to the private sector led to more prudent indebtedness policies and helped avoid the severity of crisis. However, Edwards[18] has shown that there is no systematic pattern on the capital control and financial crisis.

Singapore, on the other hand, was hardly hit by the Asian financial crisis of 1997 because of, as argued by Kapur[19], its exchange rate management and less interna-

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tional exposure of its currency. A different kind of example is South Korea which had several controls over international flow of capital, but it could not avoid the crisis of 1997; in fact, it was one of the worst-hit countries[20]. After the recent financial crisis hit India, exodus of foreign capital was so high that it turned the problem of managing excess foreign exchange accumulation to hardly a comfortable foreign exchange reserve. China was not hard hit during the last global financial crisis for it has become a net exporter of capital abroad. A common element between China and India in this regard is the risk of a banking crisis that may trigger exodus of foreign currency deposit and loans from the banking system.

In recent times for various reasons capital control, whether quantitative restrictions or by way of imposing taxes on inflow of capital, is increasingly losing its potency as a policy instrument in the fast-growing developing countries, including China and India[21]. For, capital control introduces several distortions. However, post-1997 crisis in East Asia and after the recent financial crisis capital outflow from the emerging markets has been significant resulting into macroeconomic crisis and also exposed these countries to volatility of foreign capital. It is envisaged that once the turmoil of the current financial crisis settles down foreign capital will flow in from the developed countries, especially because of a low interest and low growth prospect in the developed world.

In this backdrop efficient management of capital inflow becomes extremely important. In a recent theoretical paper Marjit *et al.*[22] have shown that even without any informational problem foreign borrowing may lead to exchange rate depreciation at the time of repayment culminating into financial crisis. It is a two-period framework where borrowing in the first period leads to an appreciation of the exchange rate, but the exchange rate depreciates in the second period when the full loan is repaid along with the principal. The mechanism is drawn from the trade theory and operates via the terms of trade effect which is common in standard textbook exposition in trade theory[23,24]. The adverse impact of excessive borrowing in this framework operates via the depreciation of the exchange rate in the second period leading to a fall in welfare of the borrowing country. Policy intervention has a natural appeal in this framework; imposition of a tax on foreign capital inflow in the first period, such as Tobin's tax would help achieve the second best solution.

This article extends the model of Marjit *et al.*[22], in a number of ways. First, in respect of determination of international interest rate. In their model international interest rate is exogenously given to the borrowing country because of the small-country assumption, which is quite standard. When a typical bank in the lending country chooses its optimal level of loan supply, it does not incorporate the effect of aggregate loan supply on the international interest rate. However, when the volume of capital inflow denominated in a particular hard currency from one country to another is very large, then the assumption of a given international interest rate might not be appropriate for the borrowing country as a whole. In this context the Chinese holding of US Government securities is a good example. Second, the model of Marjit *et al.*[22] being a two-period model does not incorporate the simultaneous effects of repayment of past borrowing and current demand for foreign loans. The present article considers the borrowing and lending activities of countries for each period and repayment of previous period's borrowing and lending. In this way, the successive periods are connected. This posits the model in a multi-period framework. But these extensions come at a cost; the model becomes analytically intractable. So we resort to a numerical solution of the model and trace the dynamic path of the endogenous variables, viz. international interest rate and the exchange rate. Since repayment is made in the next period and all borrowings are pegged in hard currency, expected exchange rate plays an important role in the model. Estimation of the expected exchange rate even under the assumption of perfect foresight is difficult in this model for its nonlinear character. We have worked with a simpler though a bit rigid expectation of next period exchange rate. To see the impact of change in expectation we reworked the model ceteris paribus. This will give us some idea about the role of expected exchange rate. We also analyse the impact of changes in the values of the parameters of the model, such as attitude towards risk, on the dynamic paths of the endogenous variables.

The model and computation of equilibria

We are considering a two-country framework, one country is labelled developed and the other underdeveloped. Typically capital flows in from the developed country to the underdeveloped country because of a higher return in the latter. So the developed country can also be called the lending country and the underdeveloped country as the borrowing country. The capital inflow to the underdeveloped country takes the form of foreign currency debt and is denominated in hard currency, such as the dollar. The debt is repaid in the next period along with the interest. If the country cannot repay in full, then it can increase its loan demand to repay previous period's borrowing. A typical bank of the underdeveloped country borrows from the domestic and international markets and lends to domestic production sector. Similarly, banks of the developed country borrow from their domestic sector and lend in the domestic market as well as in the international market. Banks of both the developed and underdeveloped country operate in a competitive environment so that individual banks have no effect on the market interest rates.

It is assumed that there are many banks in the developed country each of which raises K_t^D amount of deposits in the domestic market at an interest rate r_t^D and lends μ_t fraction in the domestic market at an interest rate R_t^D, and the rest in the international market at an interest rate R_t^*, where t denotes the time-period. There is no uncertainty for R_t^D while R_t^* is random in the sense that all of principal and interest of international loan is repaid in (t + 1)th period with probability p_t and only a part of the loan amount with probability $(1 - p_t)$. R_t^* is the contracted rate which clears the international loan market at t. Since our focus is on the foreign lending and borrowing, all other interest rates are given in this model.

Each bank is symmetric. Banks optimize their choice of portfolio; so essentially this is a portfolio choice problem with risk aversion. The profit of a typical bank in the developed country as of time t is given by

$$\pi_t^D = F_t[\mu_t(1+R_t^D)+(1-\mu_t)(1+R_t^*)\varepsilon_t]-(1+r_t^D)K_t^D,$$

where

$$\varepsilon_t = \begin{cases} 1 & \text{with probability } p_t, \\ \varepsilon_0 < 1 & \text{with probability } 1-p_t. \end{cases}$$

ε_t is the risk of the foreign lending. In the good state the principal and the interest are fully paid with probability p_t and only a part is repaid with probability $(1 - p_t)$, which might be zero in the extreme case. The funds constraint, F_t of a typical bank of the developed country is given by

$$F_t = F_{t-1}[\mu_{t-1}(1+R_{t-1}^D)+(1-\mu_{t-1})(1+R_{t-1}^*)\varepsilon_{t-1}]$$
$$-(1+r_{t-1}^D)K_{t-1}^D + K_t^D.$$

The expected profit of the bank in the current period is given by

$$E_t(\pi_t^D) = F_t[\mu_t(1+R_t^D)+(1-\mu_t)(1+R_t^*)E_t(\varepsilon_t)]$$
$$-(1+r_t^D)K_t^D,$$

where $E_t(\varepsilon_t) = p_t + \varepsilon_0(1 - p_t)$. And the variance of the profit is given by

$$V_t(\pi_t^D) = F_t^2(1-\mu_t)^2(1+R_t^*)^2V_t(\varepsilon_t),$$

where $V_t(\varepsilon_t) = p_t(1 - p_t)(1 - \varepsilon_0)^2$. E_t and V_t denote the expectation and the variance conditionally on the corresponding past information up to time t and ε_t is independent of that. We often suppress the subscript t from E_t and V_t for convenience if it is clear from the context.

We define the time t utility function of banks in the developed country bank as

$$\Omega_t^D = E_t(\pi_t^D) - \frac{\gamma}{2}V_t(\pi_t^D).$$

Banks are assumed to maximize their time t utility function each period subject to funds constraint. Given the fact that funds constraint is connected intertemporally, ideally the problem of portfolio optimization should be framed in a multi-period framework. However, if there is high degree of uncertainty, lenders may prefer to concentrate their choice problem in a shorter time horizon. We assume the shorter time horizon to be one period. Thus instead of maximizing a multi-period objective function (discounted or not), the problem of the bank boils down to a one-period problem in both the domestic and foreign countries.

Thus the problem of a typical bank of the developed country is to maximize by the choice of μ_t

$$\max_{\mu_t} \Omega_t^D \text{ subject to funds constraint.} \tag{1}$$

Solution to the above gives the optimal loan supply of banks in the developed country in the domestic and the international market.

Similarly, one can set up the problem of the banks in the underdeveloped country. Banks in the underdeveloped country are also assumed to be atomistic and operate in a competitive environment. They raise a fraction λ_t domestically in the form of bank deposits at an interest rate r_t^U and borrow the rest from the foreign source at an interest rate R_t^*. They lend to domestic firms at an interest rate R_t^U, which is repaid in the next period. There is uncertainty in the production process in the domestic sector. Thus banks in the underdeveloped country earn higher or lower depending upon the state of nature. It is assumed that r_t^U is exogenously given to the model. In reality it is determined by demand and supply of domestic credit. Total volume of deposits raised by a typical bank is assumed to be K_t^U, which is the same for all banks as they are symmetric. The profit function for the underdeveloped country bank is given by

$$\pi_t^U = \eta_t(1+R_t^U)G_t - K_t^U\left[\lambda_t(1+r_t^U)+(1-\lambda_t)(1+R_t^*)\left(\frac{e_{t+1}}{e_t}\right)\right]$$
$$+\eta_t(1+R_t^U)G_t\left(\frac{e_{t+1}}{e_t^f}-1\right)-P_t^f,$$

where

$$\eta_t = \begin{cases} 1 & \text{with probability } q_t, \\ \eta_0 < 1 & \text{with probability } 1-q_t. \end{cases}$$

Here the total funds at the disposal of each bank in the underdeveloped country is given by

$$G_t = \eta_{t-1}(1+R_{t-1}^U)G_{t-1}$$
$$-K_{t-1}^U\left[\lambda_{t-1}(1+r_{t-1}^U)+(1-\lambda_{t-1})(1+R_{t-1}^*)\left(\frac{e_t}{e_{t-1}}\right)\right]+K_t^U.$$

Uncertainty of η_t takes care of the risk of earnings of the underdeveloped country banks arising due to risk in the domestic production sector. e_t^f is the forward market exchange rate for one period and P_t^f is the price of the forward contract given at t. The expected profit and variance of profit functions of a typical bank of the underdeveloped country as of time t are given by

$$E_t(\pi_t^U) = E_t(\eta_t)(1+R_t^U)G_t$$

$$-K_t^U\left[\lambda_t(1+r_t^U)+(1-\lambda_t)(1+R_t^*)E_t\left(\frac{e_{t+1}}{e_t}\right)\right]$$

$$+(1+R_t^U)G_tE_t\left(\eta_t\left(\frac{e_{t+1}}{e_t^f}-1\right)\right)-P_t^f$$

$$V_t(\pi_t^U) = (1+R_t^U)^2G_t^2V_t(\eta_t)$$

$$+(K_t^U)^2(1-\lambda_t)^2(1+R_t^*)^2V_t\left(\frac{e_{t+1}}{e_t}\right)$$

$$+(1+R_t^U)^2G_t^2V_t\left(\eta_t\left(\frac{e_{t+1}}{e_t^f}-1\right)\right)$$

$$-2K_t^U(1-\lambda_t)(1+R_t^*)(1+R_t^U)G_t\text{Cov}_t\left(\eta_t,\frac{e_{t+1}}{e_t}\right)$$

$$-2K_t^U(1-\lambda_t)(1+R_t^*)(1+R_t^U)$$

$$\times G_t\text{Cov}_t\left(\frac{e_{t+1}}{e_t},\eta_t\left(\frac{e_{t+1}}{e_t^f}-1\right)\right)$$

$$+2(1+R_t^U)^2G_t^2\text{Cov}\left(\eta_t,\eta_t\left(\frac{e_{t+1}}{e_t^f}-1\right)\right).$$

The last two terms in the expected profit function are the benefit and the cost of forward transaction. If forward contracts are properly priced then marginal benefit of forward transaction equals marginal cost. This happens when the foreign exchange market is informationally efficient. When the foreign exchange market is not informationally efficient even then the results go through if the risk premium is constant or is a rising function of the level of transaction[22]. Assuming informational efficiency in the foreign exchange market we have

$$P_t^f = (1+R_t^U)G_tE_t\left(\eta_t\left(\frac{e_{t+1}}{e_t^f}-1\right)\right)$$

$$-\frac{\beta}{2}\left[(1+R_t^U)^2G_t^2V_t\left(\eta_t\left(\frac{e_{t+1}}{e_t^f}-1\right)\right)\right.$$

$$-2K_t^U(1-\lambda_t)(1+R_t^*)(1+R_t^U)G_t\text{Cov}_t\left(\eta_t,\frac{e_{t+1}}{e_t}\right)$$

$$-2K_t^U(1-\lambda_t)(1+R_t^*)(1+R_t^U)$$

$$\times G_tCov_t\left(\frac{e_{t+1}}{e_t},\eta_t\left(\frac{e_{t+1}}{e_t^f}-1\right)\right)$$

$$\left.+2(1+R_t^U)^2G_t^2\text{Cov}\left(\eta_t,\eta_t\left(\frac{e_{t+1}}{e_t^f}-1\right)\right)\right].$$

Thus, assuming a mean–variance utility function for the underdeveloped country banks we have

$$\Omega_t^U = E_t(\pi_t^U)-\frac{\beta}{2}V_t(\pi_t^U)$$

$$= E_t(\eta_t)(1+R_t^U)G_t$$

$$-K_t^U\left[\lambda_t(1+r_t^U)+(1-\lambda_t)(1+R_t^*)E_t\left(\frac{e_{t+1}}{e_t}\right)\right]$$

$$-\frac{\beta}{2}\left[(1+R_t^U)^2G_t^2V_t(\eta_t)+(K_t^U)^2\right.$$

$$\left.\times(1-\lambda_t)^2(1+R_t^*)^2V_t\left(\frac{e_{t+1}}{e_t}\right)\right].$$

The problem of the bank in the underdeveloped country is to maximize by choice of λ_t

$$\max_{\lambda_t}\Omega_t^U \text{ subject to funds constraint.} \tag{2}$$

It may be noted that the expected rate of interest on foreign loans differs between borrower and lender. For the borrower the uncertainty is in respect of the uncertainty of exchange rate, while for the lender there is no uncertainty in the exchange rate as loans are denominated in their currency. But there is uncertainty in respect of what is actually repaid to the lender in the sense that in the event of a bad state the full principal and the interest might not be repaid. This can happen for the bad state in the domestic sector of the borrowing country. In other words, p_t and q_t could be highly correlated. The maximization of eq. (1) w.r.t. μ_t yields (see note 5)

$$1-\mu_t = \frac{E_t(\varepsilon_t)(1+R_t^*)-(1+R_t^D)}{\gamma F_t(1+R_t^*)^2 V_t(\varepsilon_t)}.$$

Hence,

$$\mu_t = \frac{\gamma F_t(1+R_t^*)^2 V_t(\varepsilon_t)-[E_t(\varepsilon_t)(1+R_t^*)-(1+R_t^D)]}{\gamma F_t(1+R_t^*)^2 V_t(\varepsilon_t)}. \quad (3)$$

Accordingly, the aggregate loan supply by the developed country banks for international lending is given by

$$m^D(1-\mu_t)F_t = \frac{m^D(E_t(\varepsilon_t)(1+R_t^*)-(1+R_t^D))}{\gamma(1+R_t^*)^2 V_t(\varepsilon_t)}. \quad (4)$$

Similarly, from eq. (2) first-order condition implies

$$1-\lambda_t = \frac{(1+r_t^U)-(1+R_t^*)E_t\left(\frac{e_{t+1}}{e_t}\right)}{\beta K_t^U(1+R_t^*)^2 V_t\left(\frac{e_{t+1}}{e_t}\right)}.$$

Hence,

$$\lambda_t = \frac{\beta K_t^U(1+R_t^*)^2 V_t\left(\frac{e_{t+1}}{e_t}\right)-\left[(1+r_t^U)-(1+R_t^*)E_t\left(\frac{e_{t+1}}{e_t}\right)\right]}{\beta K_t^U(1+R_t^*)^2 V_t\left(\frac{e_{t+1}}{e_t}\right)}.$$

Then the aggregate demand for international loans of the underdeveloped country (in terms of foreign currency) is

$$\frac{m^U(1-\lambda_t)K_t^U}{e_t} = \frac{(1+r_t^U)-(1+R_t^*)E_t\left(\frac{e_{t+1}}{e_t}\right)}{\beta e_t(1+R_t^*)^2 V_t\left(\frac{e_{t+1}}{e_t}\right)}. \quad (5)$$

Equilibrium in the international loans market is obtained by equating eq. (4) with eq. (5) as given below.

$$\frac{m^D(E_t(\varepsilon_t)(1+R_t^*)-(1+R_t^D))}{\gamma(1+R_t^*)^2 V_t(\varepsilon_t)}$$

$$= \frac{(1+r_t^U)-(1+R_t^*)E_t\left(\frac{e_{t+1}}{e_t}\right)}{\beta e_t(1+R_t^*)^2 V_t\left(\frac{e_{t+1}}{e_t}\right)}. \quad (6)$$

Solving, we have equilibrium R_t^* in terms of parameters of the model and previous period values of interest rate on foreign loans and exchange rate. Plugging the equilibrium interest rate in either the demand or supply of foreign loans, we get equilibrium level of international loans in terms of, among other things, exchange rate.

It may be noted that we have assumed deposits raised by banks, K_t^D or K_t^U in both the countries to be constant over time. There is no point in assuming a rising function of deposit rate, as the latter is given in a partial equilibrium framework. In a world of prudential regulation it is more realistic to let K_t^D or K_t^U to depend positively with accumulated funds at the beginning of the period F_{t-1} and G_{t-1} respectively. However, with the particular form of the objective function in a static framework makes no difference.

The other equilibrium condition is given by the equilibrium in the foreign exchange market. The demand for foreign exchange comprises the repayment of the previous period's foreign loan while supply has two components, viz. net exports and current period's foreign loan. We have assumed a linear net exports function

$$N_t = -N_0 + N_1 e_t, \quad \text{with } N_1 > 0.$$

Though the net exports function is linear, the coefficients N_0 and N_1 are assumed to be stochastic. Both N_0 and N_1 follow continuous uniform distribution in the interval (N_{01}, N_{02}) and (N_{11}, N_{12}). Accordingly equilibrium in the foreign exchange market is given by

$$-N_0 + N_1 e_t + \frac{m^U(1-\lambda_t)^{*\#}K_t^U}{e_t}$$

$$-\frac{m^U(1+R_{t-1}^*)^{\#}(1-\lambda_{t-1})^{\#}K_{t-1}^U}{e_{t-1}^{\#}} = 0, \quad (7)$$

where the superscript # stands for the corresponding equilibrium value, while superscript *# stands for equilibrium value given the exchange rate. It is clear from eq. (7) that a stochastic net exports function adds dynamics in the model and generates cycles in the time path of the endogenous variables. Equations (6) and (7) are solved numerically for R_t^* and e_t for 100 time points for given values of the parameters of the model and initial values of the endogenous values. Tables 1 and 2 provide the relevant parameter values and initial values. It may be noted that solution of the endogenous variables for each time point is very much dependent on the expectation of exchange rate for the next period. The conditional variance of the ratio of expected to current exchange rate is also important for the dynamics of the model. A numerical solution method can be employed for the expectation formation process and consequently variance of exchange rate under the assumption of rational expectation.

Table 1. Numerical values assigned to parameters of stochastic variables

$E(e_{t+1}/e_t)$	$E(\varepsilon_t)$	$V(\varepsilon_t)$	$V(e_{t+1}/e_t)$	η_0	$E(\eta_t)$	$V(\eta_t)$	γ	β	N_{01}	N_{02}	N_{11}	N_{12}
0.92	0.95	0.0475	0.25	0.955	0.955	0.0116	5	0.1	320	280	7	9

Table 2. Numerical values assigned to parameters, exogenous interest rates and initial values of endogenous variables

m^D	m^U	K^D	K^U	R^D	r^D	R^U	r^U	R_0^*	e_0	$G_0(=K^U)$	$F_0(=K^D)$
40	150	100	20	0.05	0.04	0.2	0.15	0.172	40	20	100

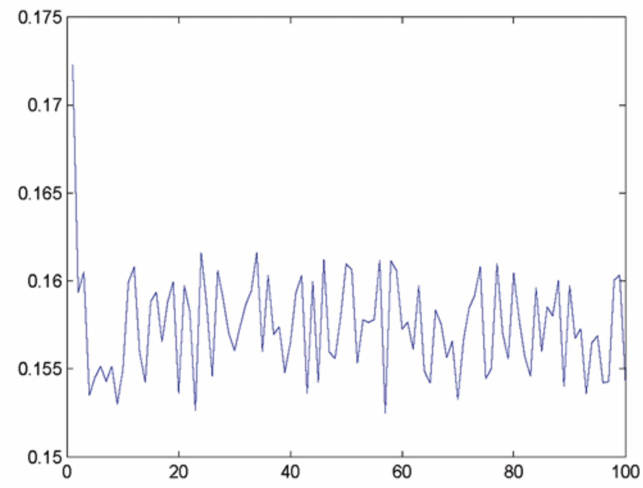

Figure 1. Interest rate on foreign loans versus time.

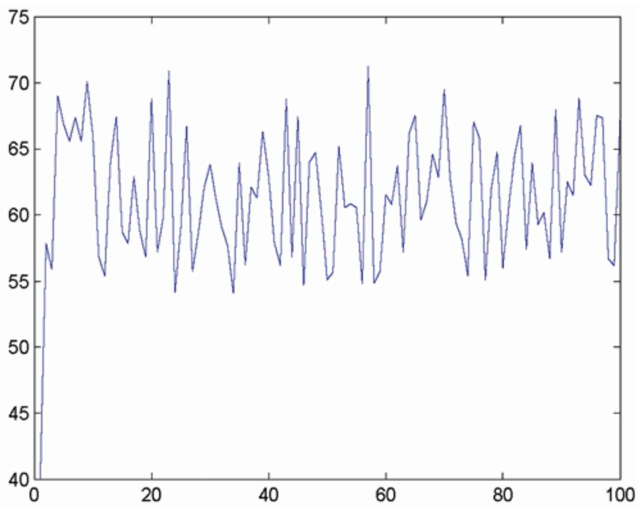

Figure 2. Exchange rate versus time.

However, as our focus in this article is to explore the possibility of financial crisis operating via repayment of foreign debt, we assume that the expected exchange rate of the next period is proportional to the current exchange rate. To gain an insight about the role of expected exchange rate we compared the dynamics of the endogenous variables for two regimes of the fixed ratio of exchange rate.

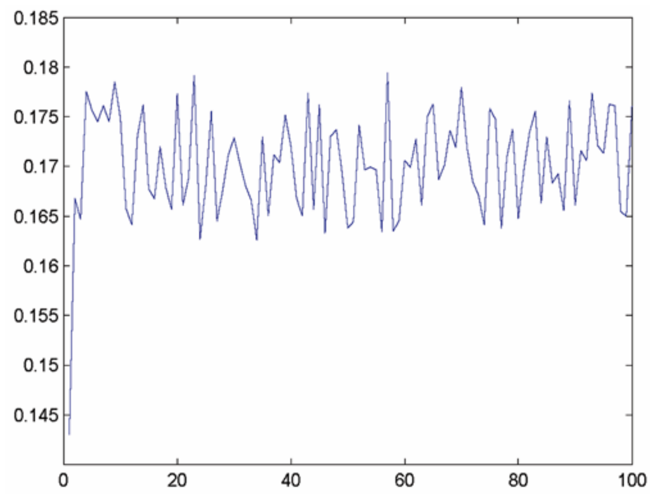

Figure 3. Proportion of foreign borrowing of underdeveloped country versus time.

Table 3. Mean and variance of variables – initial solution set

Variable	Mean	SD	Coefficient of variation
R_t^*	0.1575	0.0029	0.000184
e_t	61.38	5.1	0.083089
$(1-\lambda_t)^{\#}$	0.1702	0.0053	0.03114
Foreign loan	8.36	0.46	0.055024

The numerical solutions of international interest rate, R_t^* and the exchange rate, e_t are computed and plotted in Figures 1 and 2. Figure 3 plots proportion of foreign borrowing of the underdeveloped country in equilibrium, $(1-\lambda_t)^{\#}$, while Figure 4 plots R_t^* and $(1-\lambda_t)^{\#}$ along with shock to net exports. It is clear from eq. (6) that R_t^* or international lending does not depend on fund flow of either country. This is because of the particular form of the objective functions of the banks of the two types of countries as well as the static nature of the objective function. When the objective of individual banks in either country is to maximize discounted sum of utilities, then even with a mean–variance utility function for each t, accumulated funds (or outstanding borrowing in case of negative value) will appear in the determination of international interest rate as well as foreign lending. However, proportion of foreign lending in equilibrium, $(1-\lambda_t)^{\#}$ is dependent on deposit raised in every period, K_t^U. It may be noted that though the model is static in nature, the consecutive periods are connected through eq. (7). A shock in net exports in any period operates via exchange rate of the current period and through eq. (7) the next period. The dynamic paths of the endogenous variables are not off steady state movement (or not off equilibrium), but how the variables move over time. The mean values of the variables reported in Table 3 can be thought of as stochastic steady state values.

The dynamics of R_t^* is achieved via the dynamics of e_t operating via the foreign exchange market. An increase in net exports lowers the exchange rate which in turn lowers the interest rate on foreign borrowing. However, the effect on $(1-\lambda_t)^{\#}$ has two components – one via exchange rate (positive) and the other via interest rate (negative). Since exchange rate decreases and interest rate increases, the net effect on proportion of foreign borrowing is negative. This is confirmed in Figure 4. The variability of interest rate is the lowest and that of exchange rate is the highest among the endogenous variables. This is observed in Figures 1 through 4 and is further confirmed by coefficient of variation from Table 3.

One important observation that may be discussed here is over-borrowing in foreign currency as in Marjit *et al.*[22]. In the present article the rising supply curve of foreign loan results in a lower level of borrowing in the international market of the underdeveloped country. The effect of the rising cost of foreign loans is incorporated in the problem through the market mechanism. This in turn reduces the need for syndicated borrowing or a tax, such as Tobin's tax on foreign borrowing.

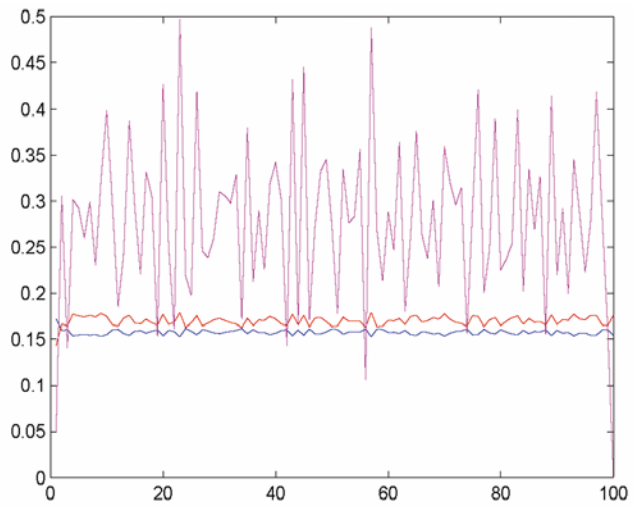

Figure 4. Variables plotted against shock to net exports. Shock (rescaled), top line; $(1-\lambda_t)^{\#}$, middle line; R_t^*, bottom line.

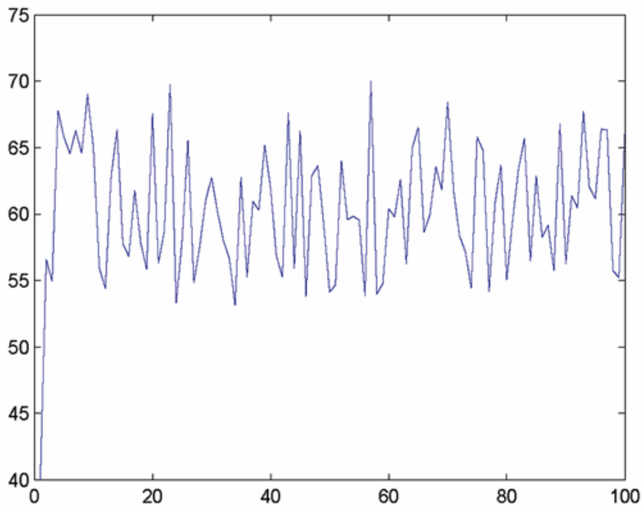

Figure 6. Exchange rate versus time – expected appreciation of e_{t+1}.

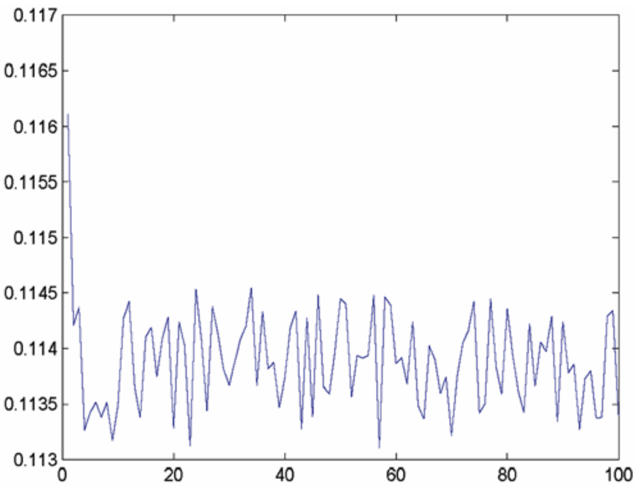

Figure 5. Interest rate on foreign loan versus time – expected appreciation of e_{t+1}.

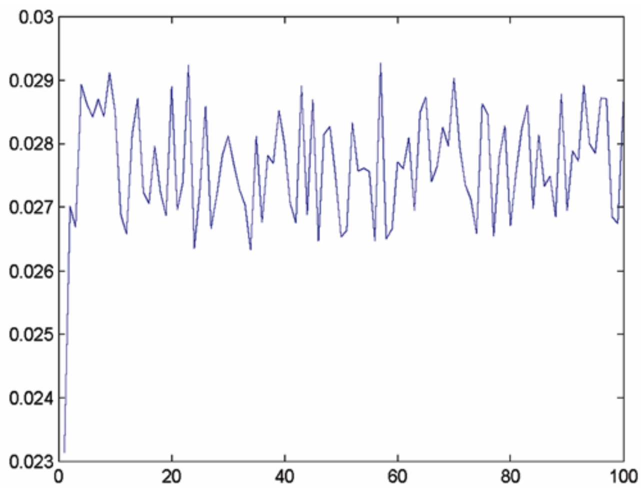

Figure 7. Proportion of foreign borrowing of underdeveloped country – expected appreciation of e_{t+1}.

Comparative dynamics

In this section we provide a comparison across dynamic paths of the endogenous variables when some of the parameters of the model are changed. In the next sub-section we consider the case of ratio of expected to current exchange rate.

Change in the ratio of expected to current exchange rate

As is clear from Table 1, the ratio of expected exchange rate to current exchange rate, $E(e_{t+1}/e_t)$ was assigned a value of 0.92. This implies that the expected exchange rate moves proportionately with the current exchange rate. This also means banks expect the future exchange rate to depreciate, whatever be the current exchange rate.

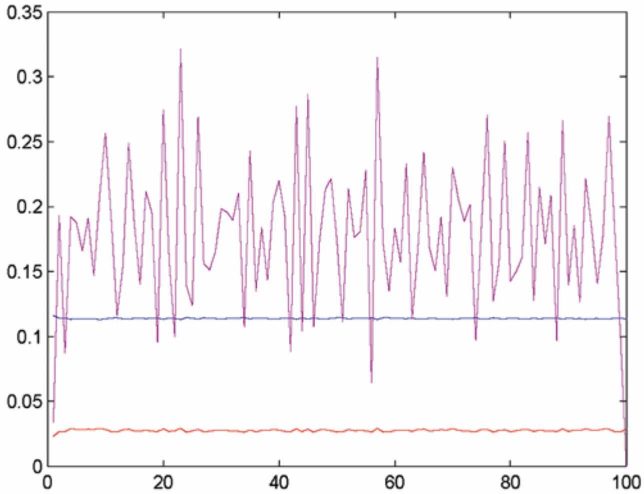

Figure 8. Variables plotted against shock to net exports – expected appreciation of e_{t+1}. Shock (rescaled), top line; R_t^*, middle line; $(1 - \lambda_t)^\#$, bottom line.

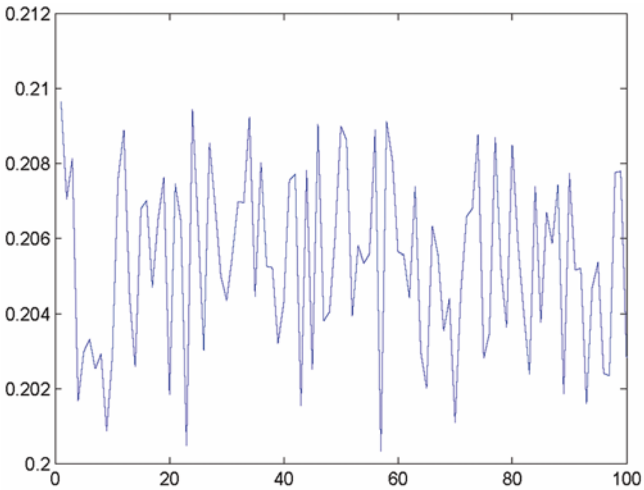

Figure 9. Interest rate on foreign loan versus time – increased γ.

That is to say even if the current exchange rate has a tendency to increase, agents expect that there will be higher foreign exchange inflow, by way of either exports or capital inflow that will more than compensate the repayment of loans. Now we consider the opposite case, i.e. if agents expect future exchange rate to increase vis-à-vis current exchange rate. The ratio of expected exchange rate to current exchange rate, $E(e_{t+1}/e_t)$ is assigned a value of 1.02. The dynamic paths of the endogenous variables are

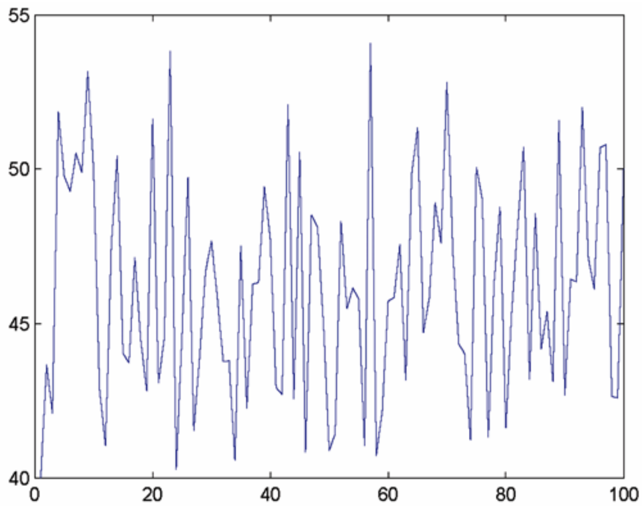

Figure 10. Exchange rate versus time – increased γ.

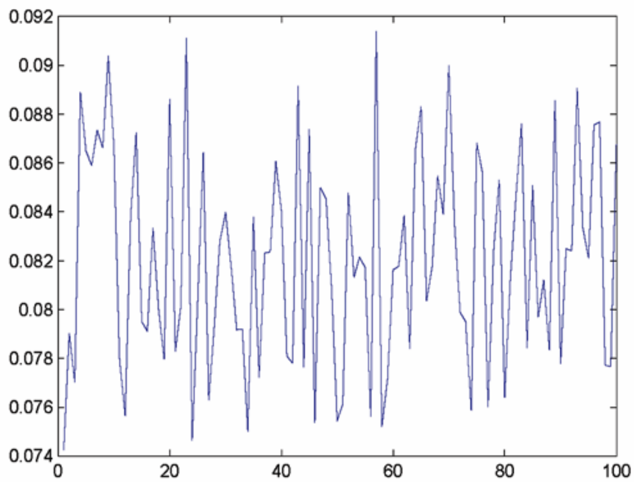

Figure 11. Proportion of foreign borrowing of underdeveloped country versus time – increased γ.

Table 4. Mean and variance of variables – change in $E(e_{t+1}/e_t)$

Variable	Mean	SD	Coefficient of variation
R_t^*	0.114	0.000453	0.003974
e_t	60.36	4.988	0.082638
$(1 - \lambda_t)^\#$	0.0277	0.000924	0.033357
Foreign loan	1.3806	0.0724	0.052441

plotted in Figures 5–8. It may be noted that we used the same realization of shock to net exports of the underdeveloped country as in the previous case. Since expected exchange rate is close to the current exchange rate, the banks expect almost no change in exchange rate in the next period. Then given the fact that borrowed amount has to be repaid along with interest, they reduce their foreign borrowing. This in turn lowers the international interest rate. Both the dynamic paths of international interest rate and proportion of foreign borrowing shift to lower bands of high and low values. The corresponding average interest rate decreases from 0.1575 (i.e. 15.75%) to 0.114 (11.4%) and average proportion of foreign borrowing from 0.1702 to 0.277. However, the variation in the latter is much more than in the former. A look at Figure 8 reveals this when compared with Figure 4. The nature of the dynamic path of the exchange rate and its variation, however, remains close to the initial solution set with mean at 60.36 and co-efficient of variation 0.0826 (Table 4). Total foreign loan drastically decreases with average being 1.3806, which is a drastic fall from the corresponding average of 8.36. However, the coefficient of variation remains close to the initial situation.

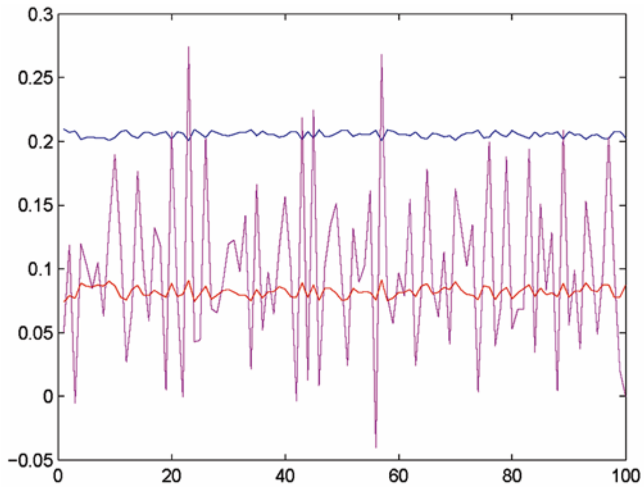

Figure 12. Variables plotted against shock to net exports – increased γ. R^*, top line; Shock (rescaled), middle line; $(1-\lambda_t)^\#$, bottom line.

Change in attitude towards risk in the developed country

As another exercise in comparative dynamics we consider the case of a change in parameter of the variance in the utility function of the banks of the developed country. Variance in the utility function captures risk of the expected profit. An increased value of the parameter γ implies decrease in utility for the same level of variance of profit. An increased γ has a negative impact on the supply of foreign loans by the lending country. As a result international interest rate increases at all time points. This in turn reduces foreign borrowing both at levels as well as proportions. With a shock to net exports remaining the same, the net effect of a reduction in foreign loan and its repayment of previous period's loan leads to a reduction in exchange rate. We change the value of γ from 5 to 15. A comparison of Figures 9–12 with Figures 1–4 reveals that the dynamic path of the

Table 5. Mean and variance of variables – increased γ

Variable	Mean	SD	Coefficient of variation
R_t^*	0.205	0.0024	0.011707
e_t	46.21	3.61	0.078122
$(1-\lambda_t)^\#$	0.0821	0.0044	0.053593
Foreign loan	5.34	0.1282	0.024007

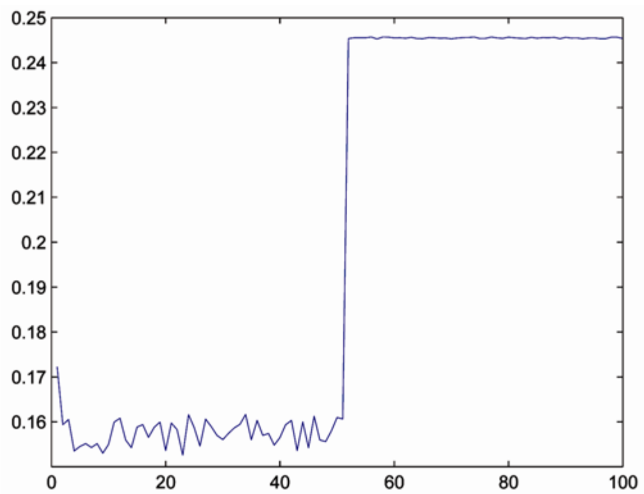

Figure 13. R_t^* versus time: shooting up of international interest rate – shock to expected repayment.

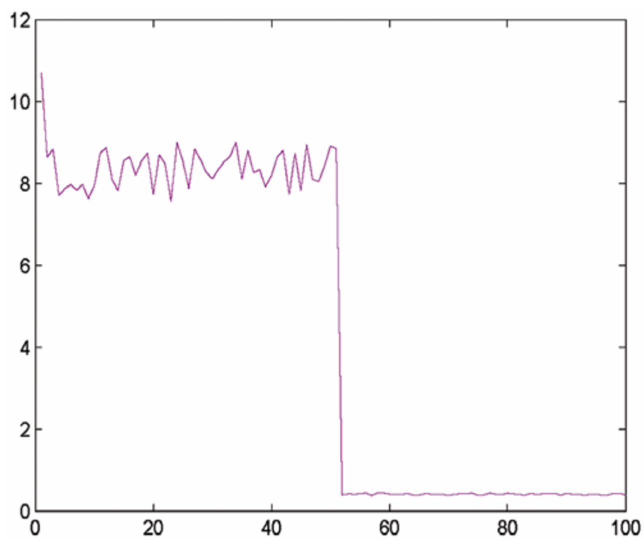

Figure 14. Foreign loan versus time: sudden fall in foreign loans – shock to expected repayment.

endogenous variables follows the above observations for all time points. The dynamics of the endogenous variables now shows more fluctuations with sharper spikes than with lower risk parameter. The average values of the endogenous variables are reported in Table 5. A notable difference from earlier case is that variation of proportion of foreign loan is now higher than foreign loan in level.

Financial crisis

Now we turn to the possibility of financial crisis that may occur in this model. Usually in this kind of model financial crisis refers to sudden stop of foreign capital inflow. This can happen for a variety of reasons – both from domestic as well as foreign sources. It can be easily shown that a sudden fall in net exports or a rise in expected exchange rate for the next period compared to the current period may raise the international interest rate to such a level that proportion of foreign borrowing and total foreign borrowing of the underdeveloped country may not have a positive solution. Even if there exists a positive solution, interest rate on foreign borrowing might shoot up to such a high level that the repayment would become extremely difficult. A positive surplus (G_t) may turn negative. The detailed analysis on the possibility of crisis due to a change in the expected exchange rate is akin to the analysis in the section on the ratio of expected to current exchange rate. An important source of financial crisis emanating from the domestic sector of the borrowing country is the under-performance of the production sector (a very low realization of η_t). As a result the borrowing country cannot generate enough surplus and consequently cannot repay foreign loans (and also domestic loan), and has to rollover foreign debt. The result is a rise in the interest rate which in turn makes repayment in future more difficult and/or in the extreme situation denied of foreign loan. In this model, as we have adopted a simple structure it cannot be shown explicitly (see note 6). Similar result can however be shown in terms of expectation of repayment of foreign loans by the lending country banks. The latter implies a fall in $E_t(\varepsilon_t)$.

Let us consider the initial equilibrium as described by Figures 1–4. Now let there be a sudden fall in $E_t(\varepsilon_t)$ from time-period $t = 51$. This can happen if the lending country banks revise their belief on the basis of the realizations of η_t.

A very high correlation between p_t and q_t justifies this. This immediately leads to shooting up of the international interest rate R_t^* from around 15% to more than 24% (Figure 13) and reduces the foreign borrowing to less than 0.5 from around 9 (Figure 14), which is an eighteen-fold drop. The percentage of foreign borrowing also shows similar behaviour. As a matter of fact, one can show that for sufficiently low value of expected repayment the percentage of foreign borrowing (and total foreign borrowing) can very well be zero, which corresponds to the case of sudden stop. It can also become negative, which implies a capital outflow. This has many repercussions on the domestic sector of the borrowing country. The most notable among them is the rise in the domestic interest rates reducing overall investment. As we have restricted our analysis to partial equilibrium, this article cannot address them in full. However, there is no change in the dynamic path of exchange rate.

Next we consider a sudden drop in the parameter of the variance term in the objective function of the lending country, γ from time-period $t = 51$. An increased γ means the lending country banks attach more importance to riskiness of loans. The international interest rate, R_t^* shoots up from around 15% to more than 20% (Figure 15)

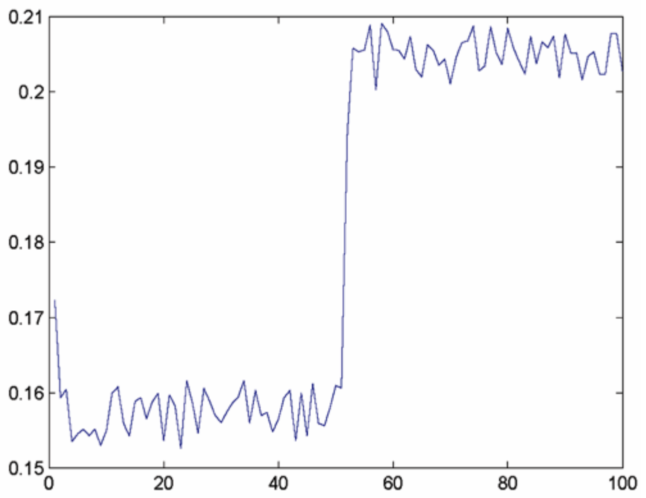

Figure 15. R_t^* versus time: international interest rate – increased risk of borrowing-country loans.

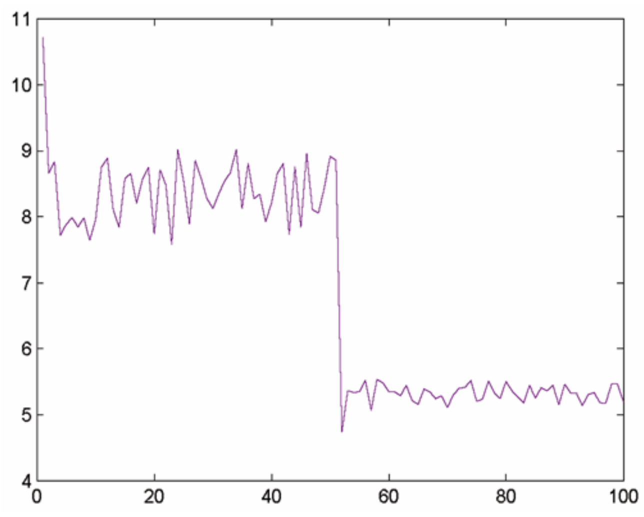

Figure 16. Foreign loan versus time: foreign loan – increased risk of borrowing-country loans.

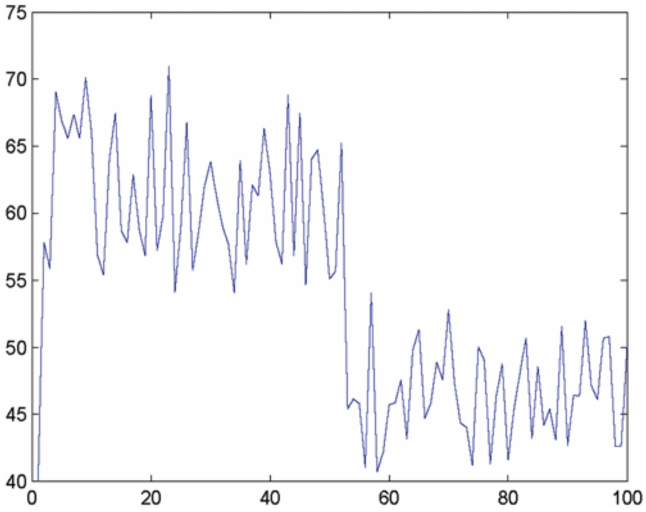

Figure 17. e_t versus time: exchange rate – increased risk of borrowing-country loans.

and foreign borrowing decreases (Figure 16) from a level of 8 to 5 (and similarly, the percentage of foreign loans). The nature of crisis remains the same as in the previous case, except that in this case, there is a shift in the dynamic path of the exchange rate (Figure 17) which actually decreases (see note 7). The latter implies lower export earnings. In such a situation borrowing countries are often forced to intervene by releasing foreign currency reserves.

Conclusion

The article considers the problem of foreign borrowing in a developing country perspective when the borrowing country has significant market power so that the standard assumption of a given international rate does not hold anymore. The foreign borrowing is pegged in hard currency so that the current borrowing is an inflow of foreign exchange and the repayment of previous period's borrowing is an outflow of the foreign exchange. The equilibrium in the foreign exchange market connects consecutive periods' borrowing of foreign loans and this is the source of dynamics in the model. Foreign borrowing being pegged in hard currency, the so-called original sin, adverse shock in net exports or an increase in the expected exchange rate may trigger financial crisis when the underdeveloped country cannot borrow for prohibitive international interest rate or cannot repay. Financial crises can also occur in this model due to fall in expected repayment of foreign loans in the form of extremely high interest rate and very low foreign borrowing or even sudden stop of foreign loans which replicates the case of under-performance of the domestic sector of the borrowing country. A change in the attitude towards riskiness of loans in the lending country can also generate crisis of similar nature.

In this article the framework of static optimization is employed to derive the demand and supply of loans by lending and borrowing countries. It is appropriate to address the portfolio choice problem in a dynamic framework whence more intricate issues, such as the impact of outstanding loans of developing country banks on current borrowing can be properly addressed. This in turn introduces another kind of dynamics in the model. However, with a mean–variance utility function it is a difficult exercise and beyond the scope of this article. Another issue of concern is the fixed ratio of expected to current exchange rate and consequently the variance of the ratio. Such an assumption introduces a rigid expectation formation process. This can be replaced by rational expectation of the next period exchange rate. However, even with perfect foresight the computation is difficult. The present authors are currently working on a research study that will address both these issues.

Notes

1. Discussed by Banerjee[25] in general terms for asset markets. Similar behaviour has been termed as mob psychology or mass hysteria by Kindleberger[26].
2. The recent financial crisis of 2007 that originated in the banking sector in the US can be ascribed more to a shift from traditional banking practices than to informational problems (see Brunnermeier[27], Duffie[28] and Gorton[29]).
3. The first of these two periods is when globalization of trade and finance occurred the most.
4. The term was coined by Eichengreen and Hausmann[8].
5. It may be readily verified that the second-order condition of maximization is easily satisfied.
6. This happens because G_t cancels from the loan demand function. However, a modified objective function or a dynamic programming approach can take care of this. We have dealt with this issue in another paper.
7. In this case foreign borrowing never actually becomes zero or negative however large γ is, it only approaches zero.

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