A TWIN CRISIS MODEL INSPIRED BY THE ASIAN CRISIS[1]

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Introduction

In spite of undeniable long-term potential benefits both for recipient countries[3] and the world economy, the strategy of abrupt financial liberalization in presence of a fragile financial system and weak regulatory and supervision structures may entail substantial short-term risks during the capital inflows period. Apart from macroeconomic instability implying faster monetary growth, inflationary pressures or real appreciation, the recipient country is exposed to financial and banking risks in the form of credit booms and surges in asset prices. Macroeconomic and financial sector vulnerabilities become strongly interrelated and are mutually reinforcing one another, with significant effects on the real economy.

In the wake of the collapse of the Bretton Woods system in early 1970s, currency crises were often associated to banking crises. Chile in 1982, Sweden and Finland in 1992, Mexico in 1994 and, more recently, in 1997-98, South-East Asia countries were hit by a crisis taking place at the height of a capital inflow period, mainly intermediated through the domestic banking sector. These episodes were preceded by excessive credit to the private sector in presence of institutional distortions created by public explicit and implicit safety nets. They all involved fixed exchange rates as additional guarantee on the private sector liabilities and were all preceded by an abrupt rise in domestic interest rates. Nevertheless, up to the Asian crisis, the link between rapid credit expansion and currency crises had been emphasized only empirically (IMF (1997), Kaminsky and Reinhart (1999)). *What was different then about the Asian crisis ?* to justify the regained interest in international crisis models and the need for a new international financial architecture for emerging markets.

The crisis starting out in 1997 in Thailand by a series of speculative attacks on the *baht*

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[3] e.g. consumption smoothing, better response to external shocks, higher investment and growth, improved banking sector activity.

was largely unanticipated by markets. Prior to the crisis, the five crisis-hit economies (i.e. Thailand, Korea, Malaysia, Indonesia and Philippines) were seen as models of development in terms of growth. The reversal in capital flows was unprecedented in size and the crisis management required international rescue packages of unprecedented high magnitude. Finally, the crisis was accompanied by volatility spillovers effects across countries and markets.

We were not anymore in presence of a typical emerging market crisis, driven by weak macroeconomic policies contributing to the worsening of domestic fundamentals. Among the new formalizations inspired by the Asian turmoil, known as "third generation" models, we identify two major interpretations. The first one (Radelet and Sachs (1998), Chang and Velasco (2000)) highlights the financial fragility of Asian emerging countries. The crisis itself is then reduced to a speculative bank run (Diamond and Dybvig (1983)) transposed to the international context. The alternative view focuses on the ex-post worsening of domestic fundamentals due to implicit and explicit public guarantees on domestic bank liabilities (Corsetti, Pesenti and Roubini (1998), Dooley (1998), Dekle and Kletzer (2001)).

Combining bank run dynamics and fundamental factors, we aim at reconciling these two major interpretations of currency and banking crises and, at the same time, bringing in new elements for the present analysis of international financial crises. We propose a joint analysis of the exchange and international financial markets, markets characterized by multiple equilibria. However, we depart from the bank run view where the crisis likelihood is exogenously determined. In our model, the reversal in capital flows takes its origin in the ex-ante moral hazard of the private sector which finally comes to deteriorate the international liquidity ratio[4].

We formalize the link between the dynamics of the liquidity ratio (in the international capital market) and investment risk-return profile (in the exchange market) based on endogenously increasing interest rate premium. Following an external supply shock, domestic banks are refinancing the losses in international capital markets at higher interest rates. In presence of a weak regulatory framework, banks will embark on riskier projects in search of higher returns, thus amplifying the impact on the initial shock. The overall indebtedness in foreign currency increases relative to the official reserves and raises concerns about the domestic banking sector liquidity. As a consequence, interest rate premia increase endogenously, and, at the same time, the deterioration of the liquidity ratio undermines the peg credibility. The comparison of the two crisis probabilities, in the exchange market and in the international financial one, enable us to finally identify two scenarios : the banking crisis triggering the currency crisis and vice versa.

The paper is organized as follows. Section 1 presents the model set up (main salient facts and the model specifications). Section 2 depicts the dynamics of the exchange market whereas Section 3 is devoted to the dynamics of the international capital market. In Section 4 we integrate the two markets dynamics and highlight two different scenarios of twin crises. Section 5 draws the conclusions of the previous analysis in terms of policy implications. The last section concludes with some further implications.

[4] View similar to "efficient" bank runs (Gorton (1985), Chari and Jagannathan (1988)) and different from "speculative" bank runs view (Bryant (1980), Diamond and Dybvig (1983)).

1. GENERAL OVERVIEW

The East Asian financial crisis involved several interrelated phenomena. We briefly present the main stylized facts any useful formalization should replicate.

1.1 Aggravating factors

- Short-term, highly volatile, foreign capital inflows[5] intermediated by the domestic banking sector,
- Weak banking regulation exposing the financial system to shifts in market beliefs,
- Maturity and currency mismatches of private sector balance sheets,
- Excessive credit growth and deteriorating investment profitability,
- Decrease of the *Foreign Reserves to Short-Term External Liabilities* ratio[6],
- Latent macroeconomic imbalances (real appreciation, widening current account deficit, deterioration in the terms of trade),
- Public implicit and explicit safety nets of bank liabilities.

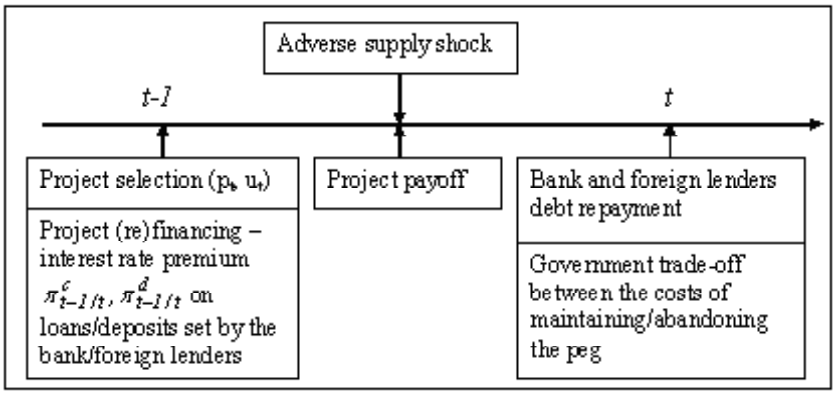

Figure 1 : Timing

1.2 General setting and main hypotheses of the model

Consider an open emerging market economy made of five types of economic actors (representative domestic firm and bank, speculators in exchange market, the government also playing the role of a Central bank, and foreign lenders). Foreign lenders'investment

[5] Compared to previous balance-of-payments crises in Latin America during the 1980s, the capital flows were of a different nature in the case of Asia. The proportion of long-term net capital flows, in particular FDI, was falling in total net private capital flows (from 11 percent in 1994 to around 7 percent in 1995 and 1996), whereas monetary capitals, highly volatile, accounted for the bulk of financing in Asia. During the inflows period, short-term loans accounted for almost half of the overall financing of the five Asian economies and reached around 70 percent prior to the crisis. Moreover, short-term external debt accounted for 20 percent of GDP in Thailand, 14 percent of GDP in Indonesia and Korea, 11 percent in Malaysia in 1996 ((IMF (1998)).

[6] As panel 1 in the Appendix shows, in 1996, the financial systems of the five Asian countries, except for Malaysia, were vulnerable to capital reversals and widespread bank run.

decisions in international capital market are based solely on the spread on domestic investment projects. We also assume perfect capital mobility between domestic and the world market and that all agents in the model are risk neutral.

Information on the private sector performance is heterogeneous across agents. Ex ante (see the timing on Figure 1), the probability distribution of investment projects is private knowledge of the domestic firm. Towards the end of the period the projects effective pay-offs are observable, not only by the contracting parties but also by speculators in the exchange market and by government. Nevertheless, there is asymmetric information, in international capital markets, between the bank and its foreign lenders. The latter have access only to information regarding macroeconomic trends, and in particular, on the evolution of the liquidity ratio which reflects the available stock of reserves relative to the outstanding amount of their claims.

1.2.1 Productive sector

The corporate sector is represented by an unique firm carrying out an investment project at the beginning of each period. From one period to another, project stochastic pay-offs maintain their binary structure but may differ in terms of risk-return. At the beginning of the period (t), the representative firm takes both investment and financing decisions. We assume that the capital accumulation in the emerging economy is entirely financed by borrowing from foreign banks in the international credit market[7].

The aggregate production function satisfies a Cobb-Douglas equation given by:

$$\tilde{X} = (A + \tilde{u}) \cdot K^{\alpha} L^{1-\alpha} \tag{1}$$

where uncertainty is introduced through a random variable $\tilde{u}$ reflecting an adverse supply shock, $\tilde{X}$ denotes the net product, A the technology parameter and K the stock of physical capital. The labour factor L is normalized to 1. The firm produces a single tradable good using non tradable inputs. The good is then sold in the world market where prices are denominated in the same foreign currency (e.g. dollar). The firm's export income is then the unique source of external revenues available to the domestic market. Moreover, we assume that the firm is not large enough to affect the interest rates or other prices at the international level. The probability distribution of project pay-offs takes the following form:

$$\tilde{X} = (A + \tilde{u})K^{\alpha} = \left\{ \begin{array}{c} (A+u)K^{\alpha} \text{ , with probability } p \\ AK^{\alpha}, \text{ with probability } 1-p \end{array} \right\} \tag{2}$$

where $\tilde{X}$ denotes the export income (in dollars) for a stock K of invested capital.

The entrepreneur has a typical "adverse incentive" behaviour depicted by Stiglitz and Weiss (1981), that is, he tends to embark on riskier projects as the credit cost increases[8].

[7] As shown by La Porta et alii (1998), in most emerging countries where equity markets are underdeveloped, there is no protection of minority shareholders. Therefore, the majority shareholders demand a higher return on invested capital than they would have done if the rights of minority shareholders were protected. Equity financing is therefore more expensive than debt financing, result also emphasized by Bris and Koskinen (2001) which showed that domestic banks and firms prefer relying on debt financing rather than equity financing especially under a fixed exchange rate regime where Central Bank lacks credibility.

[8] We took here a different approach from their canonical model in which the adverse incentive is driven by credit market equilibrium considerations. The adverse incentive behavior is related to the presence of public safety nets.

Specifically, when lending interest rates charged by the bank rise, the next period projects will carry out the same return in case of failure (AK^{α}) and a higher return in case of success. The projects will then become riskier, as the probability of success is falling, but more profitable on average :

$$\tilde{u}_{t+1} = \left\{ \begin{array}{l} u_{t+1} \text{ , with probability } p_{t+1} \\ 0, \text{ with probability } 1 - p_{t+1} \end{array} \right\} \tag{3}$$

$$\mathbb{E}\left[\tilde{u}_{t+1}\right] > \mathbb{E}\left[\tilde{u}_{t}\right], u_{t+1} > u_t \text{ and } p_{t+1} < p_t$$

where (u_{t+1}, p_{t+1}) are the risk-return parameters of the project carried out the next period $(t+1)$.

As the entrepreneur has no initial endowment, at each period (t), the domestic bank lends to the firm an amount ($D_{t-1/t}$) in domestic currency and asks for debt repayment at the end of the period. The interest rate premium will then drive the project selection by the domestic firm so that the export income covers, on the average, the overall debt to the bank and enables him to earn a non-zero profit γ_e.

Let us write the firm's budget constraint at (t) :

$$\begin{aligned} \mathbb{E}\left[\tilde{X}_t\right] &= K_{t-1/t}^{\alpha}(A + u_t p_t) \geq D_{t-1/t}(1 + r_{t-1/t}^{c} + \gamma_e) \cdot E_t^{-1} = \\ &= D_{t-1/t}(1 + r^{*} + \pi_{t-1/t}^{c} + \gamma_e) \cdot e_t^{-1} \end{aligned} \tag{4}$$

where $D_{t-1/t}$ denotes the domestic currency-denominated capital lent at the beginning of (t) by the bank to the domestic firm and used by the latter to finance investment ($D_{t-1/t} = K_{t-1/t} = D = const$); $\tilde{X}_t$ the firm export revenues at the end of (t), r^{*} the risk free rate of interest, $r_{t-1/t}^{c}$ the short-term interest rate settled by the bank on its domestic currency loans to the firm at the beginning of (t) ; $\pi_{t-1/t}^{c}$ the debtor interest rate premium on bank's loans at time (t) and E_t the exchange rate (i.e. the price of foreign currency in terms of domestic currency) constant and normalized to unity under fixed exchange rates ($E_t = \overline{E} = 1$).

In the good state of the economy, the export income is high enough to pay out the debt service and yield a non-zero profit (γ_e). Whenever the project turns bad, the firm cannot reimburse the outstanding debt to the bank. The lender can only recoup (AK^{α}) that is the invested capital (K) net of liquidation costs (denoted l per unit invested[9]).

In presence of public guarantees on bank's liabilities, the interest rate premium on its loans to the private sector doesn't reflect the losses in case of project default. The evolution of the loan premium is then driven only by the premium required by foreign investors when lending to the bank and which, in turn, is conditional to the evolution of the overall banking sector liquidity. The link between the two interest rate premia lies at the core of the twin crises dynamics.

1.2.2 Domestic banking sector

The representative bank of the emerging financial sector carries out functions of both deposit and investment bank. Specifically, the bank directs foreign savings, collected in the

[9] Which can be written $l = 1 - A/K^{1-\alpha}, 0 < l < 1$

form of rollover deposits (after conversion into domestic currency by the Central Bank), to investment projects into the domestic private sector. The moral hazard induced by bailout expectations weakens its incentive and ability to assess the risk associated to the investment projects. As the bank is unaware of the project probability distribution, it requires from the firm, at each period, an amount (in domestic currency, at fixed exchange rate $E = 1$) equivalent to its debt owed to foreign lenders and accrued by its non-zero profit rate. Denote by $D^*_{t-1/t}$ the amount in foreign currency borrowed by the bank, at the beginning of (t), in the international financial market. On average, the bank employs its revenues on loans to pay the foreign lenders and make a profit, according to its balance sheet identity :

$$D_{t-1/t}(1 + r^* + \pi^c_{t-1/t}) \cdot E_t^{-1} = D^*_{t-1/t}(1 + r^* + \pi^d_{t-1/t} + \gamma_b) \tag{5}$$

where $\pi^c_{t-1/t}$ and $\pi^d_{t-1/t}$ are the bank interest rate premia on loans and respectively on deposits, r^* the risk free interest rate, $D_{t-1/t}$ the local currency-denominated debt of the domestic firm during period (t), $D^*_{t-1/t}$ the foreign currency-denominated debt of the bank in period (t) and γ_b its profit (positive and constant on average).

The domestic currency capital effectively used to investment financing ($D_{t-1/t}$) may be less or equal to ($E_t^{-1} \cdot D^*_{t-1/t}$). The gap between the two widens with the bank refinancing of past losses at a higher current interest rate premium. Whenever the project pay-offs are high enough to cover the current outstanding obligations, the following period debt will equal the effective investment. Nevertheless, in the wake of an adverse supply shock, the uncovered amount of previous period debt adds to the current debt. The evolution of the outstanding debt compared to effective investment will finally raise doubts about the overall banking system liquidity. The evolution of bank debt[10] can be written according to the state of the economy prevailing at the end of the previous period as:

$$D^*_{t/t+1} = \left\{ \begin{array}{c} D \text{ , } p_t \text{ (good state of the economy in } t) \\ D(1 + r^* + l) > D, 1 - p_t \text{ (bad state of the economy in } t) \end{array} \right\} \tag{5.i}$$

1.2.3 Speculators in the exchange market

Speculators in the exchange market are taken into account through their expectations of devaluation of domestic currency. Precisely, they anticipate that the government would abandon the peg whenever the losses in the productive sector, driven by falling asset quality, become high enough. The market expected devaluation rate for $(t + 1)$ can be written according to the project outcome in period (t) :

$$\widetilde{\mathcal{E}}^m_{t+1} = \left\{ \begin{array}{c} 0 \text{ , } p_t \text{ (project succeeds in } t) \\ \frac{E^a_{t+1} - \overline{E}}{\overline{E}}, 1 - p_t \text{ (project fails in } t) \end{array} \right\}$$

The state of the economy is known once investment and financing decisions are taken. Should the project succeed, the market wouldn't anticipate any change in the fixed parity as the current account is balanced and the firm budgetary constraint is binding ($\mathcal{E}^m_{t+1} = 0$).

[10] In a wake of an adverse shock, $D^*_{t/t+1} = D_{t/t+1} + D^*_{t-1/t}(1 + r^* + \pi^d_{t-1/t}) - D_{t-1/t}(1 - l) = D(1 + r^* + l)$ as $D_{t/t+1} = D_{t-1/t} = D = const$ and $D^*_{t-1/t} = D$ by hypothesis. Moreover $\pi^d_{t-1/t} = 0$ before the adverse supply shock occurs.

Conversely, in case of an adverse supply shock occurring at the end of (t), the expected devaluation in $(t+1)$ is such that, on average, the export outcome in the bad state of the economy (at a devaluated exchange rate) would be equal to its average outcome (at the fixed exchange rate) and enable to the firm to stay solvent :

$$K^{\alpha} \cdot \frac{E^{a}_{t+1}}{\overline{E}} = K^{\alpha} \cdot (A + u_t \cdot p_t) \tag{6}$$

where E^{a}_{t+1} is the devaluated exchange rate derived from speculators anticipations in the exchange market, which can be written $E^{a}_{t+1} = (A + u_t p_t) \cdot \overline{E}$ and, on average,

$$\mathbb{E}\left[\widetilde{\mathcal{E}}^{m}_{t+1}\right] = (1 - p_t)\frac{E^{a}_{t+1} - \overline{E}}{\overline{E}} = (1 - p_t) \cdot (A + u_t p_t - 1) \tag{6.i}$$

Recall that, on average, the firm pays back its debt towards the bank and makes non-zero profits. We can therefore write the balance sheet identity:
$K^{\alpha}_{t-1/t}(A+u_t p_t) = D_{t-1/t}(1+r^{*}+\pi^{c}_{t-1/t}+\gamma_e)\cdot E_t = D^{*}_{t-1/t}(1+r^{*}+\pi^{d}_{t-1/t}+\gamma_e+\gamma_b)\cdot E_t$
where, at time (t) effective investment equals outstanding debt ($K_{t-1/t} = D_{t-1/t} = D$). This enables us to derive $1 + u_t p_t = D^{1-\alpha}(1 + r^{*} + \pi^{c}_{t/t+1} + \gamma_e)$ and finally write the market anticipated devaluation rate $\mathbb{E}\left[\widetilde{\mathcal{E}}^{m}_{t}\right]$ as a function of the debtor interest rate premia and investment profitability:

$$\mathbb{E}\left[\widetilde{\mathcal{E}}^{m}_{t+1}\right] = (1 - p_t) \cdot \left(D^{1-\alpha}(1 + r^{*} + \pi^{c}_{t-1/t} + \gamma_e) - 1\right) \tag{6.ii}$$

which suggests that market anticipations are fuelled by riskier investment projects undertaken by the corporate sector ($\frac{\delta \mathbb{E}\left[\widetilde{\mathcal{E}}^{m}_{t+1}\right]}{\delta p_t} < 0$, $\frac{\delta E^{a}_{t+1}}{\delta p_t} < 0$).

1.2.4 The Government/Central Bank

The emerging economy is characterized by public implicit and explicit safety nets on bank liabilities. On the average and in the good state of the economy the domestic bank is solvent. No bailout transfer from the government is anticipated in this case, and the amount collected on loans serves, after conversion in the exchange market, to reimburse foreign lenders and to earn a non-zero profit (γ_b). If the project turns bad, the bank expects government to intervene and cover the gap between its effective revenues and the revenues in the good state of the economy, that is $D^{*}_{t-1/t}(1 + r^{*} + \pi^{d}_{t-1/t}) \cdot E_t - D_{t-1/t}(1 - l)$.

The government deposit guarantee leads to moral hazard on the side of the borrower : in the wake of an adverse supply shock, the bank makes even more extensive use of its acces to international financial markets and finance overdue debt at higher rates. At each period, the overdue amount can be written as :

$$D^{*}_{t/t+1} \cdot E_{t+1} - D_{t/t+1} = \left\{ \begin{array}{c} 0 \text{ , } p_t \text{ (good state of the economy at time } t) \\ D^{*}_{t-1/t}(1 + r^{*} + \pi^{d}_{t-1/t}) \cdot E_t - D_{t-1/t}(1 - l) \text{ , } \\ 1 - p_t \text{ (bad state of the economy at time } t) \end{array} \right\} \tag{7}$$

The government deposit guarantee at time $(t+1)$, G^{i}_{t+1} is given by :

$$G^{i}_{t+1} = \left\{ \begin{array}{c} 0 \text{ , } p_t \text{ (project succeeds at time } t) \\ D(r^{*} + l), 1 - p_t \text{ (project fails at time } t) \end{array} \right\} \tag{7.i}$$

A key element of the model is the fact that in case of a bank run, foreign lenders cannot

recoup more than the stock of foreign reserves (denoted R_t) accrued by the world interest rate $(1 + r^*)$. Let $G^i_{t+1,\,nc}$ be amount of uninsured bank foreign currency-denominated debt :

$$G^i_{t+1,\,nc} = \left\{ \begin{array}{c} 0\,, p_t \\ D^*_{t-1/t}(1 + r^* + \pi^d_{t-1/t}) - R_t \cdot (1 + r^*), 1 - p_t \end{array} \right\} \qquad (7.ii)$$

The widening gap between the foreign lenders claims and the country liquid collateral lies at the root of the government's loss of credibility in the exchange market.

1.2.5 Foreign investors

At each period (t) foreign investors lend short-term capital, in foreign currency, to the domestic bank according to their expectations as to the overall liquidity of the banking sector. In presence of public deposit guarantees, they would rather lend to foreign banks than directly invest into the emerging economy.

As long as there in no adverse supply shock to the economy, loans to the emerging country are made at the world rate r^*. Such a shock occurring at the end of period t, for instance, the domestic bank cannot pay its debt to international lenders. If the latter have confidence in the country growth perspectives, they may accept to reconduct their debt for one more period, at a higher interest rate. But, whenever they start to have doubts as to the performance of the corporate sector and to the unconditional government supply of deposit guarantee, bank runs (in the form of a sudden stop) become inevitable. In such a situation, the foreign lenders share the stock of official reserves.

Let us write the evolution of official reserves which limit the ability of the government to guarantee the demand deposits of the banking system :

$$R_{t+1} = \left\{ \begin{array}{c} R_t + (D^*_{t/t+1} - D^*_{t-1/t})\,, p_t \\ R_t + (D^*_{t/t+1} - D^*_{t-1/t}) + CA_t\,, 1 - p_t \end{array} \right\} \qquad (8)$$

where R_{t+1} is the stock of reserves at the beginning of $(t+1)$ and CA_t the net exports at the end of period (t). According to the balance of payments identity, net exports (CA) equal the change in foreign reserves (ΔR) and in net capital inflows (ΔD). Foreign reserves during $(t + 1)$ are fuelled by the capital inflows to finance investment $(D^*_{t/t+1})$ and decrease with the reimbursement of previous period debt $(-D^*_{t-1/t})$. The current account balance, reflecting the export firm profitability, also impacts on the stock of foreign reserves.

We assume that the export income in the good state of the economy ensures the current account equilibrium. Therefore, in case of poor exporting performance, the stock of official reserves will be reduced accordingly. Reserves have thus a double role. On one hand, reserves represent the liquid collateral foreign lenders can recoup in case of a bank run. On the other hand, reserves are used by the Central Bank in order to defend the peg.

The behaviour of foreign lenders is captured by the following expression :

$$\text{Revenues}^*_{t+1} = \left\{ \begin{array}{c} D^*_{t/t+1} \cdot (1 + r^* + \pi^d_{t/t+1}) \cdot E^{-1}_{t+1}\,,\ p_t \\ \left\{ \begin{array}{c} \text{refinancing}: D^*_{t/t+1} \cdot (1 + r^* + \pi^d_{t/t+1}) \\ \text{liquidation}: R_{t+1} \cdot (1 + r^*) \end{array} \right\},\ 1 - p_t \end{array} \right. \qquad (9)$$

where the interest rate premium at the next period $(t+1)$ according to the state of the economy prevailing at the end of (t), is given by:

$$\widetilde{\pi}^{c}_{t/t+1} = \left\{ \begin{array}{c} \pi^{d}_{t-1/t} = 0 \text{ , } p_t \text{ (good state of the economy at } t) \\ \pi^{d}_{t/t+1} > 0, 1 - p_t \text{ (bad state of the economy at } t) \end{array} \right\} \quad (9.i)$$

The interactions between domestic bank, firm and foreign lenders enable us to connect the projects risk-return parameters to lender and debtor interest rate premia and agents profits. If the project succeeds, the firm and bank are solvent; otherwise they default on the interest rate payment and can only recoup the project liquidation value.

Recall the firm balance sheet identity (equation (4)) : $K^{\alpha}_{t/t+1}(A + u_{t+1}p_{t+1}) = = D_{t/t+1}(1 + r^* + \pi^{c}_{t/t+1} + \gamma_e) \cdot E_t = D^{*}_{t/t+1}(1 + r^* + \pi^{d}_{t/t+1} + \gamma_e + \gamma_b) \cdot E_t$. We can derive a relationship between the return (u_{t+1}) and risk (p_{t+1}) parameters of domestic projects at the beginning of period $(t+1)$:

$$p_{t+1} = \frac{D^{1-\alpha}_{t/t+1} \cdot (1 + r^* + \pi^{c}_{t/t+1} + \gamma_e) - A}{u_{t+1}} \quad (10)$$

as well as between deposit and loans interest rate premia :

$$\pi^{c}_{t/t+1} = \left\{ \begin{array}{c} \pi^{d}_{t/t+1} + \gamma_b \text{ , } p_t \text{ (good state of the economy at } t) \\ (\pi^{d}_{t/t+1} + \gamma_b)(1 + r^* + l) + (1 + r^* + \gamma_e) \cdot \\ \cdot (r^* + l), 1 - p_t \text{ (bad state of the economy at } t) \end{array} \right\} \quad (10.i)$$

Specifically, if the project succeeds at time (t), the interest rate premia on loans will only account for the bank profit ($\pi^{d}_{t/t+1} = 0$ and $\pi^{c}_{t/t+1} = \gamma_b$). In the wake on an adverse shock, the bank refinances past losses in the international financial market $D^{*}_{t/t+1} = D(1+r^*+l)$, according to equation (5.*i*), at a higher interest rate which further translates into higher interest rates on its loans to the private sector : $D(1 + r^* + \pi^{c}_{t/t+1} + \gamma_e) = D^{*}_{t/t+1}(1 + r^* + \pi^{d}_{t/t+1}) = D(1 + r^* + l) \cdot (1 + r^* + \pi^{d}_{t/t+1} + \gamma_e + \gamma_b)$

We suppose that no adverse supply shock occurs until the end of period (t) and that the current account is therefore balanced. Let us further consider the occurrence of such a shock at the end of (t) and analyse its impact on agents behaviour and markets dynamics.

2. EXCHANGE MARKET DYNAMICS

The impact of private sector performance on exchange market dynamics shows through the government loss function. In this section we present the interactions between government and speculators in the exchange market, the government trade-off between the costs of abandoning or maintaining the peg and finally compute the equilibrium solutions.

2.1 Devaluation expectations

Until the occurrence of an adverse shock, the emerging private sector is financing investment projects at rate r^* and the deposit interest rate premium is therefore zero ($\pi^{d}_{t-1/t} = 0$). *How speculators in the exchange market form their devaluation expectations in the wake of the adverse shock in period* (t) *?*

Let $D^*_{t-1/t}$ be the amount of short-term currency-denominated debt the bank borrows in international financial markets and $D^*_{t-1/t} \cdot (1 + r^*)$ the amount owed at the end of the period (t). In turn, the bank lends to the firm the equivalent in domestic currency (after conversion with the Central Bank at the current exchange rate) $D^*_{t-1/t} \cdot E_t = D_{t-1/t}$. The domestic firm finance investment with a risk-return profile given by (2) and (4) :

$$\tilde{X}_t = (A + \tilde{u}_t) D^{\alpha}_{t-1/t} = \left\{ \begin{array}{c} (A + u_t) \cdot D^{\alpha}, p_t \\ A D^{\alpha}_{t-1/t}, 1 - p_t \end{array} \right\}$$

$$A + u_t p_t = D^{1-\alpha}_{t-1/t} \cdot (1 + r^* + \pi^c_{t-1/t} + \gamma_e)$$

where probability p_t can been seen as a measure of the corporate sector profitability. With probability $(1 - p_t)$, at the end of period (t), the firm defaults on its obligations towards the bank. The latter will then borrow $D^*_{t/t+1} \cdot E_{t+1} = D(1 + r^* + l) > D$ (see equation (5.*iii)*) at a higher interest rate $(1 + r^* + \pi^d_{t/t+1})$ of which, only D is effectively invested in the emerging economy.

The foreign lenders risk aversion shows through higher interest rate premia required, each period, on their loans and impact the price of corporate sector financing (see equation (10.*i*)). The risk -return parameters of the project carried out at $(t+1)$ satisfy the conditions:

$$u_{t+1} > u_t \text{ and } p_{t+1} < p_t$$

$$\text{where } u_{t+1} p_{t+1} = D^{1-\alpha}_{t/t+1} \cdot (1 + r^* + \pi^c_{t/t+1} + \gamma_e) - A > u_t p_t$$

Under fixed exchange rate assorted of an exit clause, speculators in the exchange market anticipate that the Central Bank may abandon the peg in order to preserve competitiveness in international markets. Let us write a first relationship between the market anticipated devaluation rate $\mathbb{E}\left[\tilde{\mathcal{E}}^m\right]$ and projects profitability (p) as given by (6.*i*) :

$$\mathbb{E}\left[\tilde{\mathcal{E}}^m_{t+1}\right] = (1 - p_t) \cdot (A + u_t p_t - 1)$$

In turn, at the end of each period, the government makes a trade-off between two costs, namely :

- the cost of maintaining the peg (denoted by C_{fixed})
- the political cost of abandoning the peg and let the exchange rate float (C_{flex})

which can be written

$$C_{fixed} = C_{flex} \tag{11}$$

The first cost is composed of the export losses (C_x) of the corporate sector and the potential governement guarantee on bank deposits (C_g) that covers, in the bad state of the economy, the gap between the bank overall debt and the project liquidation value :

$$C_{\,fixed} = C_x + C_g = D \cdot (1 + r^* + \pi^d) - D^{\alpha}(A - u) + l \tag{11.i}$$

The defense of the fixed parity may thus prove extremely expensive for the government, especially when the deposit interest rate is high or when the probability of the good state of the economy is low. C_x is equal to the gap between the returns in the two states of the economy $(A + u_t)D^{\alpha} - AD^{\alpha} = u_t \cdot D^{\alpha}$ while C_g is given by the gap between bank outstanding debt and the amount paid by the firm :

$$C_g = D \cdot (1 + r^* + \pi^d) \cdot E_t - AD^\alpha + l \qquad (11.ii)$$

Should the government find the competitiveness loss too high and decide not to provide the implicit guarantee, he would then pay a political cost of credibility loss regarding the financial system. Let c denote this cost which verifies the condition $l < c < u$, where l is the liquidation cost and u the private sector export losses.

We note that, in the presence of a currency mismatch in the balance sheet of the domestic bank, the devaluation involves an additional cost for the distressed financial system. The cost of letting the exchange rate float can thus be written:

$$C_{flex} = c + C_{.fin} \qquad (11.iii)$$

where the cost of a devaluation for the financial system is equal to the gap between the value of bank liability (at the devaluated exchange rate $E > 1$) and that of its assets (at the initially fixes exchange rate, $\overline{E} = 1$) that is :

$$C_{.fin} = E_{t+1} \cdot D(1 + r^* + \pi^d) - AD^\alpha + l \qquad (11.iv)$$

2.2 Government trade-off

The two costs of the government ((11.*ii*) and (11.*iii*)) depending on the shadow exchange rate ($E > 1$), in a wake of an adverse shock in period (t), are represented on Figure 2 (for $\overline{E} = 1$ and $c < D^\alpha u$). Should the project succeeds, the guarantee cost, the export loss and the cost incurred by the financial systems are zero. Then, the abandon of the peg implies only a political cost, compared to a zero loss if the peg is maintained.

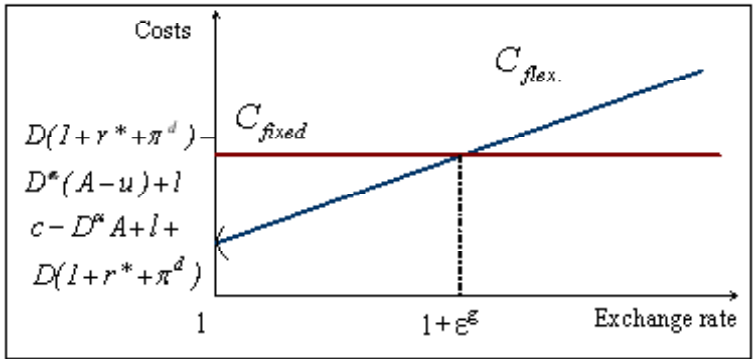

Figure 2 : Evolution of government costs of maintaining and abandoning the peg

When the shadow exchange rate reaches $(1 + \mathcal{E}^g)$, the potential loss of maintaining the peg becomes equal to the cost of abandoning it. For an exchange rate inferior to that threshold, the cost of maintaining the peg overpasses that of letting the exchange rate float. Therefore, devaluation is an optimal strategy for the government as long as the implicit exchange rate is below $(1 + \mathcal{E}^g)$. Beyond this limit, balance sheet effects (driven by foreign indebtedness) become too high compared to the current deficit and the potential deposit guarantee.

We can further write the devaluation rate implicit to the government trade-off, that is the devaluation rate for which the two costs are equal. This rate will depend on the private sector profitability :

$$1 + \mathcal{E}_t^g = \frac{uD^\alpha - c + D \cdot (1 + r^* + \pi^d)}{D \cdot (1 + r^* + \pi^d)} \tag{11.v}$$

and we can finally write a second expression of the expected devaluation rate from the government point of view :

$$\mathbb{E}\left[\widetilde{\mathcal{E}}_t^g\right] = (1 - p_t) \cdot \frac{uD^\alpha - c}{D \cdot (1 + r^* + \pi^d)}$$

The implicit devaluation rate, which is a decreasing and convex function of p, is illustrated on Figure 3 of the next section.

2.3 Equilibrium configuration

We identify a circular dynamics in the exchange market characteristic of multiple equilibria : *In a poorly regulated financial system where firms rely on debt financing only, an adverse supply shock in (t) raises the interest premium on loans to the private sector. The firm is thus encouraged to carry out riskier investment projects. The evolution of the risk-return parameters fuels the devaluation expectations in the exchange market (see relation 6.ii) through the falling probability p and raises the costs of maintaining the peg. Foreign lenders start to doubt about the government ability to fully insure their outstanding claims by the current stock of currency reserves and ask a higher risk premia on their loans, which further deteriorates investment performance p.*

The equilibrium in the exchange market is realized whenever the market anticipated exchange rate becomes equal to the optimal one, implicit to the government loss function.

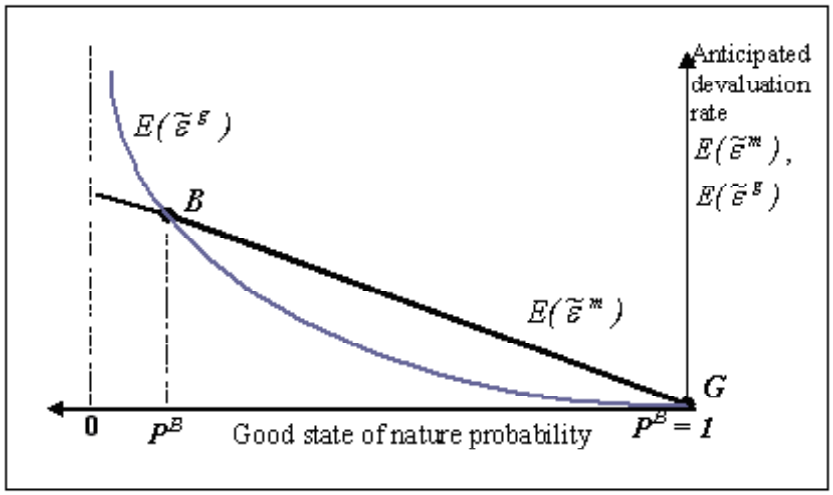

Figure 3 : Short-term dynamics of the exchange market

The solutions

$$\begin{cases} p^G = 1 \\ p^B = \frac{D(1+r^*+\pi^d) - AD^\alpha}{c + D^{2-\alpha} \cdot (1+r^*+\pi_t^d+\gamma_c+\gamma_b)(1+r^*+\pi^d) - AD(1+r^*+\pi^d)} \end{cases} \tag{12}$$

come from the equality $(1-p)\cdot up = (1-p)\cdot \frac{uD^{\alpha}-c}{D\cdot(1+r^{*}+\pi^{d})}$ and are depicted on Figure 3, where p^{G} and p^{B} denote the probabilities of the good and respectively bad equilibrium in the exchange market.

In reference to the equilibrium relationship $\mathbb{E}\left[\widetilde{\mathcal{E}}^{g}\right] = \mathbb{E}\left[\widetilde{\mathcal{E}}^{m}\right]$, we highlight, analytically as well as graphically (Figure 3), two equilibria :

- The good equilibrium (denoted by G on Figure 3), characteristic of a situation in which investment projects are financed at the world interest rate as long as an adverse shock doesn't occur. Investors have no reason to anticipate a regime switch.
- The bad equilibrium (denoted by B on Figure 3) of currency and domestic intermediation crisis, characterized by a extremely low probability that project income (after conversion to foreign currency) repay the outstanding bank foreign debt. The investment projects become extremely risky and the interest premium very high. We note that, since p is an indicator of the project overall efficiency, a currency crisis is more likely to happen when this investment efficiency is low.

The currency crisis equilibrium is reached whenever the market anticipated devaluation rate becomes equal to the devaluation rate implicit to the government trade-off between the costs of maintaining/abandoning the peg. It is the outcome of a trade-off made by the government in a context of rational expectations of agents. In the wake of an adverse productivity shock, the cost of credit increases and firms are encouraged to undertake even riskier investment projects. That makes all the more difficult for the government to defend the peg through the insurance guarantee of the corporate sector liabilities.

3. INTERNATIONAL FINANCIAL MARKET DYNAMICS

In this section we formalise the evolution of bank foreign currency debt, compute the equilibrium solutions in presence of an infinity of foreign lenders and finally consider the case of a sole investor in order to better characterize the dynamics of the international financial market.

3.1 Capital inflows

A key hypothesis of the model is that the investment decisions by both foreign lenders and domestic banks are based on the anticipation of a government bail-out in case of a bank run at the international level. Despite weak performance of the corporate sector resulting into large shares of non performing loans, the deposit supply by domestic banks seems perfectly resilient to credit interest rates. The explanation lies within the very existence of public guarantees.

In a closed economy, if, at the end of the period, the project returns cannot pay out the outstanding debt (principal and interests) the firm must liquidate and cease activity. Conversely, in an open and poorly regulated economy, the government is likely to encourage

large-scale capital inflows. Furthermore, guaranteeing banks exposure in foreign currency results in increasing risk-taking and moral hazard risk in bank credit. The conjunction of financial liberalization and weak prudential regulation may lead to an over-indebtedness of the emerging country.

The amount of short-term debt (made of principal $D^*_{t/t+1}$ and interests) taken on by the bank in period (t) and owed in $(t+1)$ becomes ex post (see also equation (5.*i*)) :

$$Debt^*_{t/t+1} = \left\{ \begin{array}{c} D_{t/t+1} \cdot (1 + r^* + \pi^d_{t/t+1}) \cdot E^{-1}, \text{ good state of the economy in } t; \\ \left(D_{t/t+1} + D^*_{t-1/t}(1 + r^* + \pi^d_{t-1/t}) \cdot E_t - l \cdot D_{t-1/t} \right) \cdot \\ \cdot E_t^{-1} \cdot (1 + r^* + \pi^d_{t/t+1}), \text{ bad state of the economy in } t \end{array} \right\} \quad (5.ii)$$

amount that increases, in the wake of an adverse shock, compared to the invested capital ($D_{t/t+1}$). The external debt owed in period $(t+1)$ can be divided into two terms :

- actual investment in the emerging economy (depending on the investment return compared to the risk-free interest rate)
- refinancing of past losses

and be written as $\mathbb{E}\left[Debt^*_{t/t+1}\right] = D_{t/t+1} \cdot (1 + r^* + \pi^d_{t/t+1}) \cdot E^{-1} + (1 - p_t) \cdot \left(D^*_{t-1/t}(1 + r^* + \pi^d_{t-1/t}) - l \cdot D_{t/t+1} \cdot E_t^{-1} \right) \cdot (1 + r^* + \pi^d_{t/t+1})$.
One can notice that the variable part of the overall debt is fuelled by the interest rate spreads and the occurrence of adverse supply shocks. Eventually, the economy will reach a very high level of external indebtedness compared to the context of a closed economy.

3.2 Equilibrium configuration

Foreign lenders have imperfect information on investment project performance. Under a fixed exchange rate regime and in presence of public deposit guarantees, they can solely observe the evolution of their liquid collateral relative to the outstanding external debt. As long as the capital inflows are directed to the emerging countries at the international risk-free interest rate (which means that foreign lenders see domestic projects as low risk), the international liquidity ratio $\rho_t = \frac{R_t \cdot (1+r^*)}{D^*_{t-1/t}(1+r^*+\pi^d_{t-1/t})}$ is always equal or above unity ($\pi^d_{t-1/t} = 0$). The ratio starts decreasing whenever poor bank asset performance is revealed and drives foreign lenders to require a non-zero interest rate premium on their loans to the emerging country. Moreover, the liquidity ratio falls with the reserves depletion in order to finance the current account deficit. It therefore depends on both currency and credit risk incurred by the domestic private sector and can be seen as the product of two terms, one, driven by the evolution of the current account and the other, reflecting the evolution of deposit interest rate premium :

$$\rho_t = r_t \cdot \frac{(1 + r^*)}{(1 + r^* + \pi^d_{t-1/t})} \text{ where } \mathfrak{m}_t \text{ denotes the } \frac{R_t}{D^*_{t-1/t}} \text{ ratio} \quad (13)$$

We assumed that in the good state of the economy the current account was balanced.

According to the BOP identity (8), the change in reserves ($R_{t+1} - R_t$) equals net capital inflows ($D^*_{t/t+1} - D^*_{t-1/t}$) and net exports ($CA_t$). As long as an adverse shock doesn't occur and according to our hypotheses, we have $R_t = D^*_{t-1/t} = D$, $BC_t = 0$, which enables us to write the $\mathfrak{m}$ ratio in period (t) :

$$\mathfrak{m}_t = 1 = \frac{D^*_{t-1/t} + CA_t}{D^*_{t-1/t}} \tag{14.\textit{i}}$$

Let us now consider the occurrence of an adverse shock at the end of (t), resulting in a current account deficit at the beginning of $(t+1)$ of $CA_{t+1} = AD^\alpha - (A + u_t)D^\alpha = -u_t \cdot D^\alpha$. This further implies that present reserves are falling relative to the previous period stock :

$$\mathfrak{m}_{t+1} = \frac{D^*_{t/t+1} - u_t \cdot D^\alpha}{D^*_{t/t+1}} = 1 - \frac{D \cdot (1 + r^* + \gamma_e + \gamma_b) - AD^\alpha}{p_t \left[D + D(1 + r^*) - AD^\alpha\right]} \leq 1 \tag{14.\textit{ii}}$$

where $D^*_{t/t+1}$ is given by (5.*i*) and u_t by (10).

The endogeneity of the interest rate premia enables us to highlight a circular dynamics in the international financial market. Specifically, *the occurrence of an adverse supply shock deteriorates the current account, which shows through a concomitant fall in* m *and* ρ *ratios. In the light of the negative relationship between the liquidity ratio* ρ *and the interest rate required by the foreign investors on their loans, a lower ratio results in higher premia which furthermore undermines next period* ρ *ratio.*

The foreign lenders, the domestic bank and the government are the main actors in this market. The government implicitly commits to pay out the amount of accrued interests to international lenders at the risk-free interest rate (r^*). Eventually, foreign lenders with rational expectations will become aware of the limited government ability to keep this commitment credible whenever country competitiveness is at stake, and require higher interest rates on their loans to the emerging country. Rising interest rate premia will end up eroding government credibility and validate initial doubts about banking sector overall liquidity.

As showed by equation (8), government commitment to bail out the distressed bank depends on the stock of foreign reserves, as foreign investors lent in dollars to the domestic bank. At the same time, recall that foreign lenders aren't aware of the real performance of the corporate sector and what matters for them is the country's liquid collateral (i.e. the stock of foreign reserves). Suppose that they accept to lend to the emerging country as long as the stock of external reserves is higher than a subjective threshold, defined as a fraction of the outstanding debt :

$$\psi_k = P(\rho > \chi_k), k = 1, n \tag{14}$$

where ψ_k is the subjective probability of each foreign lender k that the domestic bank is liquid (i.e. the international liquidity ratio is above the subjective threshold) ; ρ is the effective *Foreign Reserves to Short-Term Debt* ratio; χ_k is the subjective threshold of ρ ratio (i.e. the lower limit below which it becomes optimal for lender k to go to the bank and ask for reimbursement).

Foreign investors take into account the evolution of ρ when lending to the emerging country. The collapse of the system is far from being foreseeable but rather uncertain. This

uncertainty will eventually lead to multiple equilibria.

Specifically, the liquidity ratio stays above unity as long as investment is financed at world risk-free interest rate and the current account is balanced. It falls below 1 with the rise in the interest rate premium and/or the widening of the current account deficit. Let us write the interest rate premium on deposits as function of ρ, embodied in lenders expectations, but also in the effective liquidity ratio characterizing the banking system. The equilibria with rational expectations for each lender will then result from the equality of the subjective and objective interest rate premia.

On one hand, the deposit risk premium results from a trade-off made by each risk neutral lender k, between a risk free investment and a loan to the domestic bank. He will take into account, not only the government deposit guarantee, but also the limited liquid collateral in case of a bank-run :

$$D^* \rightarrow D^*_{t/t+1}(1+r^*) \sim \left\{ \begin{array}{c} D^*_{t/t+1} \cdot (1+r^*+\pi^d_{t/t+1,k}) \text{ , with probability } \psi_k \\ R_{t+1} \cdot (1+r^*), \text{ with probability } (1-\psi_k) \end{array} \right.$$

From the previous relation we can derive the "individual" interest premium required by a foreign investor k $(k = 1, n)$ when lending, in period $(t+1)$, to the domestic bank, as a function of the subjective probability of bank solvency and the ρ_{t+1} ratio. We then have $D^*_{t/t+1}(1+r^*) = \psi_k \cdot D^*_{t/t+1} \cdot (1+r^*+\pi^d_{t/t+1}) + (1-\psi_k) \cdot R_{t+1} \cdot (1+r^*)$ which enables us to write

$$\pi^d_{t/t+1,k} = \frac{(1+r^*) \cdot (1-\rho_{t+1}) \cdot (1-\psi_k)}{\psi_k + (1-\psi_k) \cdot \rho_{t+1}} \tag{15}$$

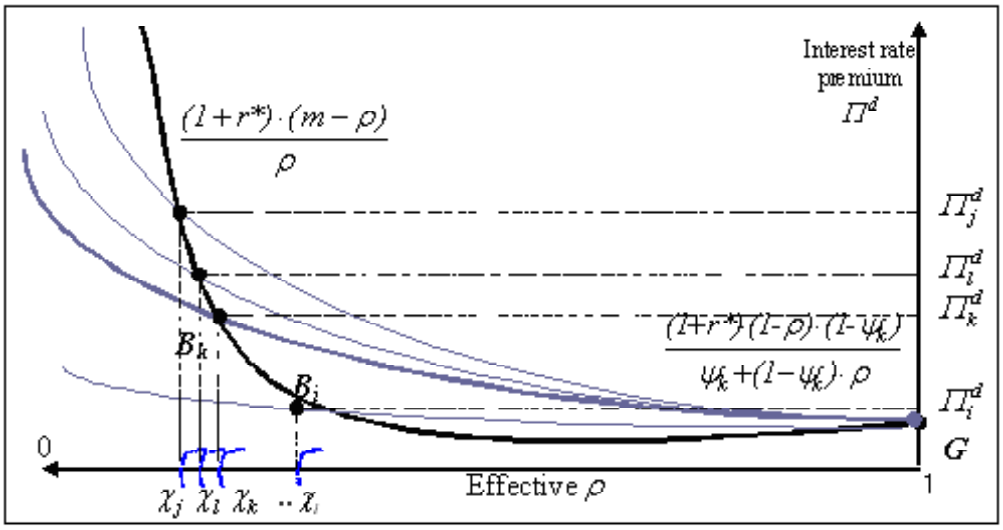

Figure 4 : Equilibrium solutions in the international financial market

This relationship is represented on Figure 4 which captures the evolution of the interest rate premium as a function of the liquidity ratio. The curve given by (π^d_k, χ_k) characterizes the behaviour of a foreign lender k. As shown by equation (15), the interest rate premium

is negatively related to the liquidity ratio (i.e. when the ratio decreases from 1 to 0_+, the interest rate premium rises from 0_+ to ∞).

On the other hand, the risk premium on deposits results from the definition of the international liquidity ratio:

$$\pi^d_{t/t+1} = \frac{(1+r^*)\cdot(\mathfrak{m}_{t+1}-\rho_{t+1})}{\rho_{t+1}} \text{ , where } \mathfrak{m}_{t+1} \leq 1 \tag{16}$$

This second relationship is also represented on Figure 4. It is worth noting that the slope of the effective risk premium equation (16) is lower, in absolute value, to the one of the risk premium equation characterizing foreign lender k (equation 15) as long as the effective liquidity ratio satisfies $\frac{m\psi_k}{(1-\psi_k)\cdot(1-m)} \leq \rho < 1$. Beyond the left limit, the risk premium $\pi^d_{t/t+1}$ decreases faster than $\pi^d_{t/t+1,k}$.

The endogeneity of the risk premium on loans brings non linearities and multiple equilibria in the dynamics of the international financial market.

Let us consider a population of foreign lenders having each one an individual threshold for the domestic bank solvability (e.g. χ_j, χ_l, χ_k or χ_i on Figure 4). We can identify multiple equilibria in the international financial market according to lenders' degree of confidence in the public guarantee and in the solvency of the domestic debtor. The equilibria correspond, on Figure 4, to the intersection points of the curves given by (15) and (16) for each lender j, l, k, i. The lender having the highest subjective threshold χ can be viewed as the most "pessimistic" one, the first to withdraw its deposit whenever the effective liquidity ratio ρ is falling from 1 through 0_+.

Let us compute the equilibrium solutions. The equilibrium liquidity ratios (ρ_k) are given by the following equation :

$$\pi^d_{,k} = \frac{(1+r^*)\cdot(1-\rho)\cdot(1-\psi_k)}{\psi_k+(1-\psi_k)\cdot\rho} = \frac{(1+r^*)\cdot(\mathfrak{m}-\rho)}{\rho}$$

$$\begin{cases} \rho^G = 1, \text{ for } \mathfrak{m}=1, \text{ good performance of the investment project,} \\ \text{balanced current account;} \\ \rho^B_k = \frac{\mathfrak{m}\cdot\psi_k}{(1-\mathfrak{m})+\mathfrak{m}\cdot\psi_k}, \text{ for } \mathfrak{m}<1, \text{ adverse supply shock,} \\ \text{current account deficit.} \end{cases}$$

where ρ^G, ρ^B_k denotes the good equilibrium and the banking crisis equilibrium for each foreign lender k. The subjective probabilities [11] are, at equilibrium :

$$\begin{cases} \psi^G = 1, \text{ no doubts about the bank's solvability} \\ \psi^B_k = \frac{(1-\mathfrak{m})\cdot\rho^B_k}{\mathfrak{m}\cdot(1-\rho^B_k)}, \text{ lender } k \text{ likelihood of a banking crisis} \end{cases}$$

where ψ^G and ψ^B_k are the probabilities assigned by lender k to the two states of the economy. We furthermore refine the triggering mechanism of the bank panic at the international level, based on the heterogeneity of these individual beliefs.

[11] ψ^B_k lies between 0 and 1 as $m > \rho^B_k > 0$.

3.3 International bank run

Let us reason from the point of view of the most "pessimistic" lender (denoted by (i) on Figure 4), that is the lender characterized by the highest threshold χ ($\chi_i = Max\{\chi_k\}$, $k = 1, n$) and thus the first not to renew his loans to the emerging country. Following him, the other lenders will do the same, and, collectively, their behaviour will lead to a liquidity dry up. The "critical" lender's action conditions the jump from one equilibrium to another in the international financial market, which can be written :

$$\psi^B = \psi_i^B \tag{17}$$

The above equality reflects the fact that the real probability of a banking run in the financial market (ψ^B) mirrors the most "pessimistic" lender's expectations (i.e. his subjective probability ψ_i^B). On Figure 4, this corresponds to agent i (where the bank run equilibrium takes place at B_i).

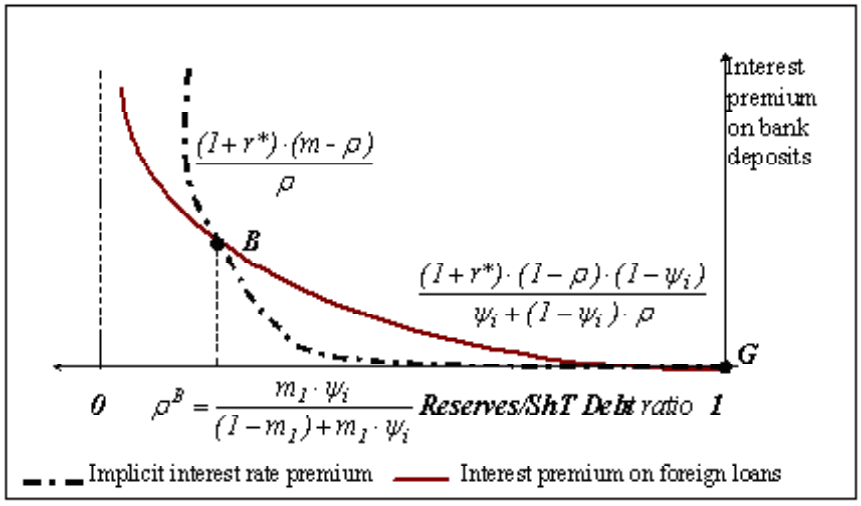

Figure 5 : The case of the most "pessimistic" lender

As soon as the effective liquidity ratio ρ reaches the threshold χ_i of the first lender doubting about the credibility of the public guarantee and the solvency of the banking sector, it becomes optimal for the rest of the population of foreign lenders as well, to adopt the same behaviour and ask for their reimbursement.
In reference to the most "pessimistic" foreign lender in the international financial market, we can identify, analytically and graphically, the existence of two equilibria :

- The good equilibrium (denoted by G on Figure 5), reflecting a context of low interest rates (r^*), no risk premium on deposits and a *Reserves to Short-term External Debt* ratio equal to unity. Foreign lending is quasi -perfectly elastic to the interest rate. As a consequence, capital flows to the emerging economy.
- The bank run equilibrium at the international level (denoted by B on Figure 5), characterized by extremely high interest rates on deposits, a rise in the risk premia

and a liquidity ratio ρ below 1. In presence of high interest premia on deposits, it becomes more and more difficult for the government to meet its commitment in case of a withdrawal of foreign currency-denominated deposits. The probability that the government would not be able to back up bank exposure is obviously higher and thus validates the interest premium which had initially fuelled the rise in interest rates.

4. JOINT ANALYSIS OF BANKING AND CURRENCY CRISES

The two multiple equilibria configurations are now connected in order to describe the timing of banking and currency crises. In this last section we put forward two different scenarios of twin crises and derive the main policy implications.

4.1 Timing of twin crises

The anticipations of devaluation formed by speculators in the exchange market are not validated as long as capital flows into the emerging country. Should an attack on the peg arise, it would immediately be offset by new capital inflows which will fuel the stock of official reserves. In the wake of an adverse supply shock at the end of (t), foreign lenders will continue to lend to the emerging country but, from this moment on, they will require a positive interest premium on their deposits with the domestic bank.

The collapse of the international credit supply occurs when the *Official Reserves to Short-Term External Debt* ratio reaches an upper bound, viewed as unsustainable by the foreign lenders. The gradual decline of the lenders'confidence in the domestic bank's solvency is shown in Figure 6.

At individual k level, suppose that ratio ρ decreases as a result of an adverse shock affecting the export return of the investment projects. Rewrite equations (15) and (16) plotted on Figure 6 :

$$\pi_k^d = \frac{(1+r^*)\cdot(1-\rho)\cdot(1-\psi_k)}{\psi_k+(1-\psi_k)\cdot\rho} = \frac{(1+r^*)\cdot(\mathfrak{m}-\rho)}{\rho}$$

As it can be seen on Figure 6, the full line curves (GB_k and $GB_{k'}$) describe the interest rate premia resulting from lender k trade-off with different subjective probabilities (ψ_k, respectively, $\psi_{k'}$). The dotted line curve describes the risk premium implicitly embodied into the effective liquidity ratio and thus not driven by individual beliefs. It is worth noting that the interest premium is decreasing with the subjective probability and the ratio ρ, as shown by the negative derivatives[12]: $\frac{\delta\pi_k^d}{\delta\psi_k} < 0$ and $\frac{\delta\pi_k^d}{\delta\rho} < 0$.
As Figure 6 and equation (14) show, the deterioration of the liquidity ratio ρ reduces the probability assigned by every foreign lender to the fact that the domestic bank could pay out its outstanding debt whenever a bank run occurs (which is visible through the decrease

[12] $\frac{\delta\pi_k^d}{\delta\psi_k} = \frac{(1+r^*)\cdot(1-\rho)\cdot(-1)}{(\psi_k+(1-\psi_k)\cdot\rho)^2} < 0$ and $\frac{\delta\pi_k^d}{\delta\rho} = \frac{(1+r^*)(1-\psi_k)\cdot(-1)}{(\psi_k+(1-\psi_k)\cdot\rho)^2} < 0$.

of the individual probability from ψ_k to $\psi_{k'}$ on Figure 6). Furthermore, in the light of equation (15), deposit interest rate premia required by foreign lenders increase.

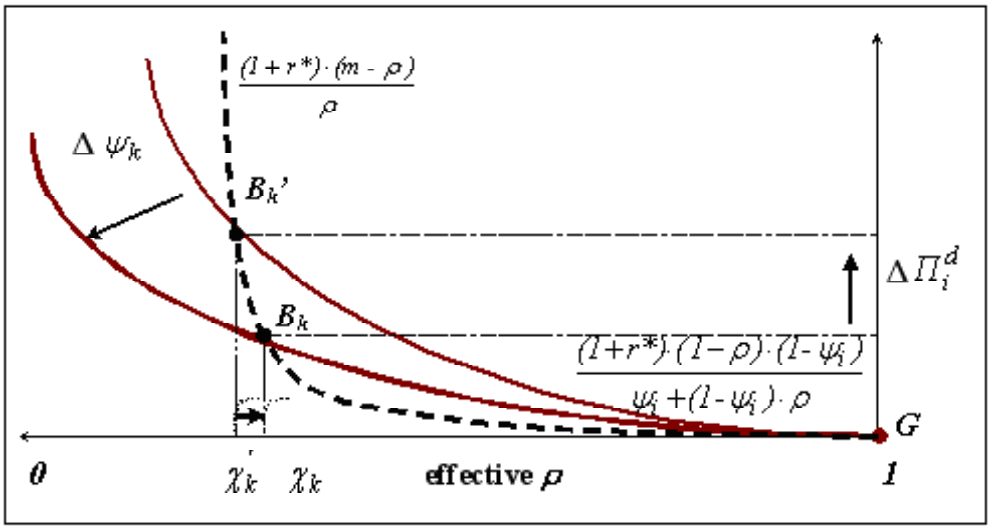

Figure 6 : Impact of foreign investors' confidence loss in the public safety net and domestic bank solvability

The previous analysis shows that, at a given moment, during the periods following the adverse shock, the economy reaches the bad equilibrium which can be either

- a currency crisis equilibrium (resulting from the dynamics of the global profitability of investment projects on the exchange market),
- a banking crisis equilibrium (resulting from the dynamics of the liquidity ratio in the international financial market).

Let us compute the project profitability p corresponding to the two crisis equilibria :

- in the exchange market : $p^B = \frac{D(1+r^*+\pi^d)-AD^\alpha}{c+D^{2-\alpha}\cdot(1+r^*+\pi^d_t+\gamma_e+\gamma_b)(1+r^*+\pi^d)-AD(1+r^*+\pi^d)}$;
- in the international financial market : an infinity of subjective probabilities ψ_k (of each foreign lender k) that the reserves are above a given fraction of the outstanding debt of the domestic bank. Each foreign lender has a minimum threshold (χ_k) for the sustainability of ratio ρ and whenever the effective ratio falls below χ_k, then, it becomes optimal, for the foreign lender k to withdraw its lending from the emerging country.

As shown in the previous section (3.3), the banking crisis equilibrium in international financial market is given by $\psi^B = \psi^B_i = \frac{(1-\mathrm{m})\cdot\rho^B}{\mathrm{m}\cdot(1-\rho^B)}$ which corresponds to the subjective probability of occurrence of a banking crisis for the most "pessimistic" foreign lender. We can then compute the probability in the exchange market corresponding to this subjective probability. To do so, rewrite the subjective probability according to equations (14) and (14.*ii*) in period $(t+1)$:

$$\psi_i^B = P\left(\tilde{\chi} < \left(1 - \frac{u_t D^\alpha}{D + D(1+r^*) - AD^\alpha}\right) \cdot \frac{(1+r^*)}{(1+r^*+\pi^d_{t/t+1})}\right) \qquad (15.i)$$

Assume that the foreign lender's individual threshold is a random variable, of continuous, strictly increasing and invertible cumulative function (denoted by F) taking values in the interval $[0, 1]$. The previous expression becomes :

$\psi_i^B = F\left[\left(1 - \frac{u_t D^\alpha}{D+D(1+r^*)-AD^\alpha}\right) \cdot \frac{(1+r^*)}{(1+r^*+\pi^d_{t/t+1})}\right]$, which enables us to write, after applying the reciprocal function and the definition of u_t (equation 10),

$u_t = \left(1 - \frac{F^{-1}(\psi_i^B)\cdot(1+r^*+\pi^d_{t/t+1})}{(1+r^*)}\right) \frac{D+D(1+r^*)-AD^\alpha}{D^\alpha} = \frac{D^{1-\alpha}\cdot(1+r^*+\gamma_e+\gamma_b)-A}{p_t}$.

Finally, we can infer the probability of the good state of the economy corresponding to the banking crisis equilibrium (ψ^M) :

$$p^{\psi^B} = \frac{(1+r^*)\left(D^{1-\alpha}\cdot(1+r^*+\gamma_e+\gamma_b) - A\right)}{\left((1+r^*) - F^{-1}(\psi_i^B)\cdot(1+r^*+\pi^d_{t/t+1})\right)(D^{1-\alpha}(2+r^*) - A)} \qquad (15.ii)$$

As project profitability, in the form of the good state probability, is decreasing from 1 à 0, we can identify two scenarios of twin crises, namely :

- When $p^{\psi^B} < p^B$, the currency crisis precedes the banking crisis.

The guarantee on the exporting firms return, implicit to the choice of the exchange rate system, generates moral hazard in domestic lending. It leads to increasing risk taking by the domestic firm, with the accumulation of large shares of non- performing loans on the asset side of the bank balance sheet. Whenever the expected devaluation reaches an upper bound, the emerging economy enters the bad equilibrium characterized by the abandon of the peg. The subsequent depreciation of the domestic currency has adverse effects on unhedged banks' balance sheets (balance sheet effects, Krugman (1999), Schneider and Tornell (2000)) due to the presence of a currency mismatch between assets and liabilities. The devaluation has then a strong adverse impact on the domestic currency value of foreign currency-denominated bank debts, and thus on its net wealth. Ultimately, the bank net wealth becomes zero, the bank ceases activity and capital flows out of the country. The stock of external reserves reaches then its lowest bound.

- When $p^{\psi^B} > p^B$, the banking crisis precedes the currency crisis.

The foreign lenders are willing to lend to the emerging country as long as its liquid collateral (i.e. the official stock of external reserves) is above a minimal threshold defined as fraction of the outstanding external debt (or, in other words, as long as the *Official Reserves to Short-Term External Debt* ratio remains above a minimum bound). When the stock of official reserves reaches a given threshold, the international lenders stop refinancing the domestic bank and require the payment of their claims. The withdrawal of international lenders amounts to a sudden reversal of foreign capital flows triggering the collapse of the exchange rate and eventually, a severe depreciation of the domestic currency.

4.2 Policy implications

Our analysis highlights several factors of vulnerability of emerging countries to financial and currency crises. Weak prudential regulation of domestic banking sector, tolerating a total lack of project selectivity and imperfect credit analysis, was at the core of the joint dynamics of currency and banking crises. Moreover, public implicit and explicit safety nets, rendered banks and foreign lenders complacent about government intervention in case of default or liquidity shortage and inevitably lead to moral hazard risks.

On one hand, the private sector undertakes riskier projects and banks refinance past losses through new loans as lending premia are going up. The rapid credit growth overexposes the private sector to exchange and interest rate risk in the wake of an adverse supply shock in international markets. In order to correct such distortions, prudential oversight of financial institutions in emerging markets could play an important part. The present regulatory framework should be adapted in order to ensure that banks are making use of more appropriate internal procedures to assess the adequacy of regulatory capital to underlying risks; that they accurately monitor the reporting of losses on their credit portfolio or that the reporting system is transparent enough to expose the bank to the market discipline.

On the other hand, one must bear in mind that, more often than not, overlending preceded overborrowing in emerging markets. The presence of domestic or international bailout guarantees induced moral hazard on the side of foreign investors who lent massively to the emerging country, at higher rates. Therefore, prudential measures should be taken as regards banks in major lending centers in order to reduce such distortions (e.g. the treatment of exchange and interest rate risks, better assessment of the corporate risk, limits on banks foreign exposure, etc).

In the light of its past bailout interventions in order to save most depositors from losses associated to a bank run, the government may find it difficult to show its determination to put an end to this practice. Any commitment not to intervene would lack credibility and drive investors to check the soundness of such a decision. Before considering extreme corrective measures like the Central Bank independence and/or the adoption of a hard peg without lender of last resort in order to restore credibility, we think that emerging countries should proceed to a reform of their deposit insurance systems. The insurance scheme should be more risk-adjusted and based on (partial) co-insurance mechanisms in order to enhance market discipline. Moreover, the deposit insurance Fund should be independent from the government in order to be able to take the best decisions[13] in terms of social welfare.

The short-term currency-denominated debt played a major part in the shock transmission between the two markets (balance sheet effects). Although maturity transformation is one of the major functions of banks, the exposition to exchange rate risk should be carefully monitored according to loans maturity.

Finally, fixed exchange rate regimes often created an illusion of stability and encouraged massive capital inflows into emerging market economies. Greater exchange rate flexibility could thus provide better protection against shocks and help mitigate the debt structural

[13] in terms of prompt/least cost corrective action.

bias.

In our model, the international liquidity ratio dynamics conditions the occurrence of the banking crisis. An interesting question is then, *how to control this ratio* which lies, in our model at the heart of the boom-burst episode. *Is it through massive reserves build -up, as shows the experience of several Asian countries from 1997 onwards?* The stock of foreign reserves plays, in our model, the role of a liquid guarantee in foreign currency, the maximum amount investors can recoup in case of an bank run. Therefore, reserve accumulation is likely to lead to the same kind of distortions on both sides of the credit market. Rather than enhancing the overall stability, excessive reserve accumulation is likely to encourage dangerous forms of debt. Moreover, there is a risk that countries embark on a competitive accumulation of reserves in search of greater credibility, resulting in excessively high levels of reserves with significant effects on the economy. A better way to control the liquidity ratio at the macroeconomic level would be to reduce the overall stock of short-term debt through measures conducive to longer-term financing, like increased transparency and accountability, the development of local capital markets and better governance.

As shown in panel 1 presented in Appendix, most twin crises episodes (e.g. South-East Asia (1997-98), Ecuador (1999), Mexico (1994), Ukraine (1998), Argentina (2001)) were preceded by an abrupt drop in the international liquidity ratio as an early sign of increasing financial fragility. Moreover, the worsening of the ratio becomes a salient feature of major crisis episodes from the second half on the 1990s onwards, whatever their nature (twin crisis, standard banking or currency/debt crises). This could be explained by the increasing structural bias of external indebtedness on the private sector in emerging countries over the recent period.

CONCLUDING REMARKS : BEYOND THE ASIAN CRISIS

Our model aimed at capturing in a synthetic framework the connexions between sudden reversals in capital flows and financial sector fragility. We showed that there may be multiple equilibria in the exchange market and in the international financial one and emphasized the possible connections between currency and financial crises.

In the exchange market, currency devaluation was the outcome of the government trade-off in the presence of deposit implicit safety nets. The crisis occurs whenever the anticipated devaluation rate by the market becomes equal to the "optimal" devaluation rate of the government. In the capital market, the jump from one equilibrium to another is triggered by the evolution of the international liquidity ratio computed as the *Stock of Official Reserves to Short-Term Currency-denominated Debt* ratio. The crisis occurs whenever this falling ratio goes under the subjective level of the most "pessimistic" investor.

The dynamics of the two markets were integrated through the impact of debt and interest rate premia on international liquidity ratio as a measure of foreign investors' pledgeable income in case of a generalized dry up of short-term funds. In the wake of an adverse supply shock, the economy jumped to a bad equilibrium that may be either a currency crisis equilibrium (in the exchange market), triggered by the dynamics of investment profitability,

or a bank run equilibrium (in the international capital market), triggered by the dynamics of the liquidity ratio. The comparison of the probabilities of currency/banking crises enabled us to establish the timing of twin crises: a banking crisis could either precede or follow a currency crisis. The widening gap between the stock of official reserves of the Central Bank and the overall claims of foreign lenders showing through increases interest rate premia explained, in our model, not only the financial fragility, but also the sudden capital reversal.

The logic of banking and currency crises presented in this paper could be used to account for some recent developments in emerging countries. It focuses attention, in the current context of remarkable growth of emerging countries, on the increasing risk and volatility faced by export-driven economies. The question is then *What are the most appropriate measures in order to prevent that the rebalancing of global demand, the potential realignment of exchange rates or the tightening of monetary policy in industrial countries have disruptive effects in economies highly dependant on international prices?*

The role of banks and the quality of the regulatory framework are at the heart of the debate on the sequencing of capital account liberalization in countries that are now in the midst of a process of financial deepening and credit expansion driven by the inflows of foreign savings. We must bear in mind that capital inflows in to emerging countries in the 1990s were heavily concentrated in some main recipient countries. Prior to the Asian crisis, a dozen countries accounted for 75 percent of total inflows (World Bank (1997)). The overlending syndrome in presence of massive capital inflows and the spectre of sudden stop phenomena are a topical question again, with the dangerous accumulation of credit creation (either currency-denominated or exchange rate indexed) which finances unproductive activities like household consumption (in Central and Eastern Europe) or housing booms (in emerging Asia or in South Africa). *What lessons need to be drawn from past capital-account crises in order to preserve the stability of the international financial system?*

Our model could be extended to account for fiscal vulnerabilities (triple crises models) as public debt structure and currency composition may impact on the overall liquidity of the banking sector or the sustainability of the peg. Causality may run both ways. The potential fiscal cost of distressed banks may rise doubts about government solvency and end up in sovereign default (like in Turkey in 2001 or in Argentina in 2001-02). Higher premia on international debt, reflecting devaluation expectations, may also deteriorate government solvency through an increase of the short-term debt burden (like in Mexico in 1994-95). Conversely, doubts about the public debt sustainability may trigger a confidence crisis and the sudden reversal of capital flows. The subsequent exchange rate devaluation increases the public debt service if the debt is foreign currency-denominated and may result in a sovereign default (like in Russia in 1998).

Recent crises have proved to be more severe and had more persistent effect on growth, partly as a result of the ineffectiveness of traditional countercyclical macroeconomic policies in presence of large external mismatches. Our analysis showed that the capital flows instability during the recent crises episodes is not necessary triggered by the worsening of macroeconomic fundamentals but is rather linked to the financial and banking sector fragilities. Microeconomic distortions and macroeconomic instability

become strongly intertwined in an environment of massive capital inflows, ineffective regulation and fixed exchange rates. Therefore, apart from ensuring the coherence of macroeconomic decisions, political action should also deal with global governance, institutional change and regulation. Rather than based on direct intervention, political action should provide, in our opinion, the right incentives to the private sector.

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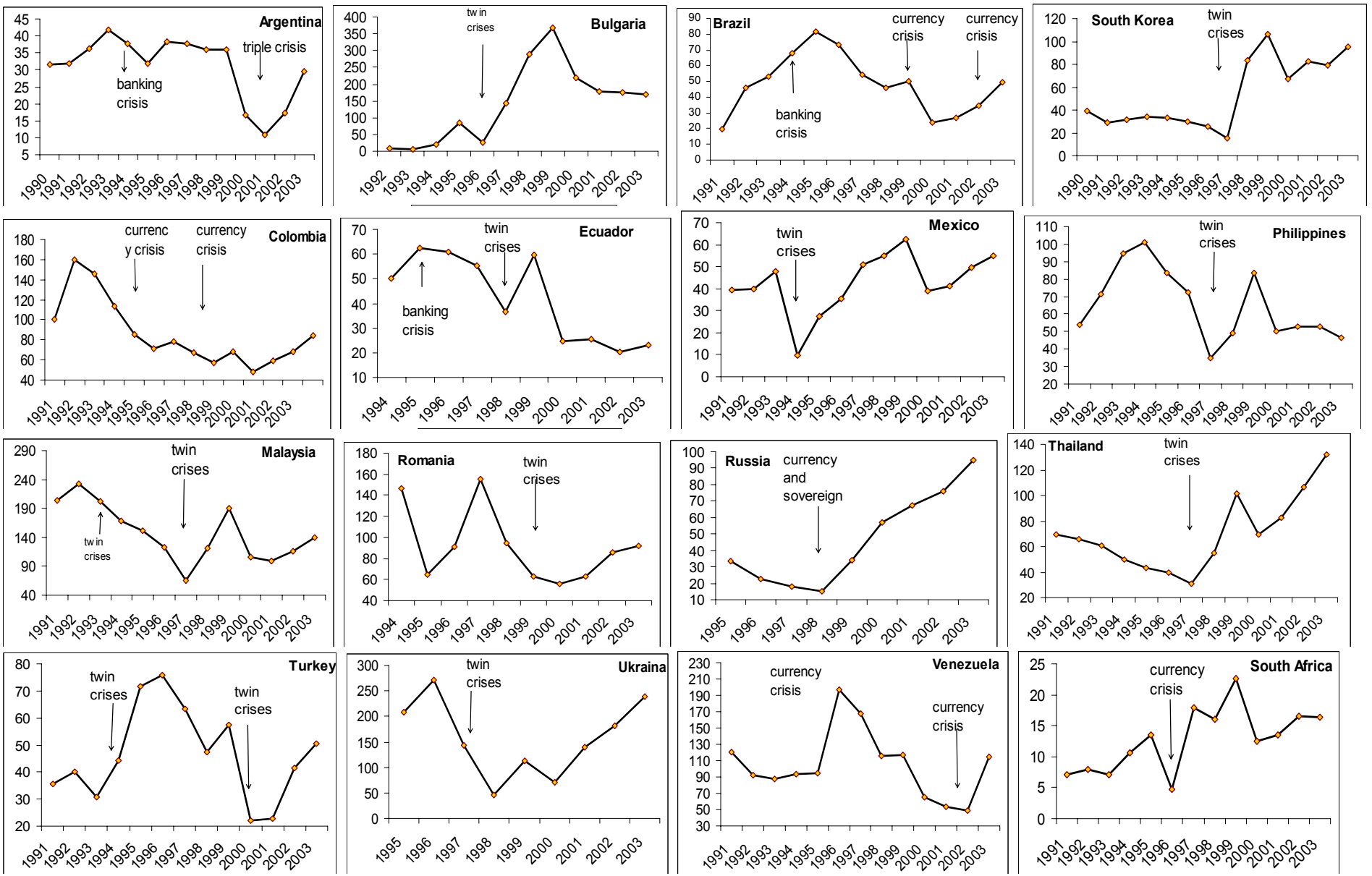

Panel 1: Evolution of the **Currency Reserves / Short Term Currency Denominated Debt** ratio in connexion with major crisis episodes in emerging countries