EXCHANGE RATE REGIME SWITCHING IN FAVORABLE PERIOD: LESSONS FROM ASIA FOR CENTRAL AND EASTERN EUROPEAN COUNTRIES

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Abstract

Uncovered operations against the currency risk are frequent in emerging countries. Using the Obstfeld 1994's model, this paper shows in which conditions an emerging country, during a favorable period, could exit from a fixed exchange rate regime (floatation) with lower costs than those that would be incurred in the case of self-fulfilling currency crisis and in the case of capital inflows controls. The banking system is explicitly introduced in the model and the banking crisis is linked with the currency crisis. Moreover, short term capital inflows controls are considered in favorable period. The non-interest bearing deposit decreases the currency risk of the banking system. This paper is a contribution to the debate about the choice of the appropriate exchange rate regime for accession countries.

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1. Introduction

The international financial liberalization in early 1990s has permitted massive short term capital inflows in emerging countries. These capital inflows are intermediated by the banking system. In Thailand, for example, banking operations have been essentially short term foreign borrowing in dollars with other international banks. They can be explained by a domestic yield superior to the foreign yield, particularly with the United States. Moreover, these operations are not covered against the currency risk (Burnside, Eichenbaum and Rebelo 1999). Thus, in case of a change in the investors’ expectations, banking crises of liquidity can occur.

These stylized facts raise the following question: Why the banking system of the emerging country did not cover its operations in foreign currency against the currency risk? Recent studies about twin crises choose the moral hazard assumption (e.g. McKinnon and Pill 1999 and McKinnon 1999). We choose the alternative assumption of the incomplete emerging financial market from Eichengreen and Hausmann (1999). Because of the risk of the exchange rate manipulation, foreign investors do not have an incentive to lend in domestic currency. Consequently, the country cannot cover its operations. Thus, the origin of the absence of covered operations is very certainly double: The non complete emerging financial market and the stability of the nominal exchange rate.

The main question of this paper is the following: How to reduce the currency risk of the banking system? We investigate the possibility for an emerging country to exit from a fixed exchange rate regime and to float the domestic currency in a favorable period so as to avoid future financial crises. With the introduction of a currency risk, this kind of regime would avoid disadvantages of a fixed exchange rate regime. This would encourage the banking system to cover against the currency risk. In reality, the exit from a fixed exchange
rate regime always happens in a turbulent period (Eichengreen 1999). It seems that the authorities never choose to float the currency while it would seem to be better to consider an exit from the exchange rate regime in a favorable context to limit economic costs (Eichengreen and Masson 1997). The question of the exit from a fixed exchange rate regime in a favorable period has not been modeled before.

The aim of a higher flexibility is to encourage the banking system to cover its operations against the currency risk. To reduce the currency risk of the banking system, we investigate a second possibility. The historical study of Bordo, Eichengreen, Klingebiel and Martinez-Peria (2001) shows that capital flow controls increase the risk of banking crisis. Several theoretical studies conclude that capital flow controls avoid self-fulfilling currency crises. Others studies conclude that capital controls are destabilizing because of private expectations. Nevertheless, capital controls are never considered in favorable period. In practice, as Reinhart and Smith (1997) show, capital outflow controls are imposed in turbulent period while capital inflow controls are introduced in favorable period. In this paper, we use the Chile experience from 1991 to 1998 and we model capital inflow controls in favorable period. The aim of short term capital inflow controls is not the modification of the structure of capital inflows. Here, the non-interest bearing deposit decreases the currency risk of the banking system. The reserve requirements decrease the absence of correspondence between the denomination of the liabilities and of the debts.

The banking system has certainly been at the center of several financial crises. Despite the enormous number of studies on self-fulfilling crises, it is surprising that the banking system has never played an essential role in the model. Currency crisis models of the “third generation” analyze twin crises. Nevertheless, optimization problem is not considered in these models. We adapt Obstfeld’s (1994) “second generation” currency crisis model with assumptions of self-fulfilling expectations and minimization of the authorities loss function. We show in which conditions an emerging country, during a favorable period, could exit from a fixed exchange rate regime with lower costs than those that would be incurred in the case of self-fulfilling currency crisis. Our contribution lies in introducing the banking system in a “second generation” currency crisis model and in linking the banking crisis of liquidity with the currency crisis.

In the second section, we introduce the banking system in the model with “escape clause”. We consider the three strategies of “endogenous exit” from a fixed exchange rate regime in turbulent period, the “early exit” (floatation) from a fixed exchange rate in favorable period and the introduction of capital controls in favorable period in the third section. We specify costs of these strategies. We also compare the costs of the possible strategies and we determine the optimal time of the exit from a fixed exchange rate regime in the same section. In the fourth section, we conclude.

2. Assumptions of the model with “endogenous exit” strategy

We make the assumption of a small open economy whose currency is pegged on a big economy. The discrete time model is composed of two sub-models, each with two periods. At the beginning, the exchange rate regime is fixed and credible. To simplify the model, we ignore the inter-temporal budget constraint of the authorities and the international reserves. The real sector, particularly the property sector, is not modeled. We assume the presence of a domestic banking system. The banking system is the intermediate of all international financial operations. A contrario, domestic investors can deposit in domestic currency or in foreign currency in the domestic banking system.
2.1. The assumption of the incomplete domestic financial market

We assume that the banking system cannot cover its operations because of the incompleteness of the domestic financial market. The domestic financial market is less attractive. As a result, the domestic banking system has difficulties to cover its operations as it cannot find foreign investors willing to buy domestic currency to sell it later against foreign currency. It is for the same reason that the banking system must borrow in foreign currency: The banking system must accept deposit in foreign currency because foreign investors do not want buy the domestic currency to avoid risk.

2.2. The profit of the domestic banking system

Our fundamental assumption is that the domestic banking system, which gives loans to the property sector in domestic currency only, must borrow in foreign currency from foreign investors. This is because deposit of the domestic investors is insufficient\(^1\).

At each period \(t\), the banking system collects term deposit in domestic or foreign currency. It converts into domestic currency the part of the deposit in foreign currency with a nominal exchange rate at the uncertain \(S\). Then it lends in domestic currency to the domestic property sector. To simplify, we assume a unique domestic interest rate on deposit in domestic currency and on the loan. We assume the domestic country is dominated by a foreign country that determines its interest rate depending on its economic policy objective. The foreign interest rate is then exogenous for the domestic country. We assume that the domestic interest rate is higher than the foreign interest rate. The deposit in foreign currency is remunerated at the rate \(i^+_t + u_t\), with \(u_t\) being the risk premium\(^2\) and the deposit in domestic currency is remunerated at the rate \(i_t\).

In period \(t+1\), the property sector reimburses the loan of the previous period. The banking system converts the reimbursed loan (with interests) to foreign currency with a nominal exchange rate \(S_{t+1}\) to honor the deposit withdrawal from the bank in foreign currency.

\(D_t\) is the deposit amount in period \(t\) in foreign currency withdrawn in period \(t+1\). \((D_t S_t)\) is a part of the loan for the domestic property sector reimbursed in period \(t+1\). \(F_t\) is the deposit amount in period \(t\) in domestic currency (by domestic investors) withdrawn in period \(t+1\). We assume that the total loan is \(L_t = D_t S_t + F_t\). When there is no problem\(^3\), in period \(t+1\), there is equality between:

- The volume of the new deposit in \(t+1\) \((D_{t+1} S_{t+1} + F_{t+1})\) and the domestic loan in \(t+1\) \((L_{t+1})\);
- The reimbursement of the domestic loan of the period \(t\) \((L_t)\) and the withdrawal of the deposit of the period \(t\) \((D_t S_t + F_t)\);
- The interests from the loan \((i_t L_t)\) and interests on the deposit \([(i^+_t + u_t) D_t S_t + i_t F_t]\).

Thus, the profit of the banking system is equal to zero despite an increase in the volume of the deposit in foreign currency (and then the loan)\(^4\) at each period.

A contrario, in the case of devaluation, the two previous equalities are not possible. Thus, the liquidity risk of the banking system increases because of the rise of the deposit withdrawal cost in foreign currency.

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1 The narrowness of the domestic market justifies massive small term capital inflows.
2 In some emerging countries, as in Thailand from the 19th May 1997, domestic banks that borrow in dollars must accept a higher interest rate than the other foreign banks. We name this the Thailand premium (see Puibasset, 2003).
3 i.e. when i) the exchange rate is fixed; ii) the exchange rate regime is credible; iii) \(i^+_{t+1} = i_t\).
4 At each period, the volume of the deposit increases: The condition of the equilibrium of the balance of payments must be verified.
for the domestic banking system. In this case, we assume that the banking system cannot honor the withdrawal of the deposit: It is the banking crisis of liquidity.

The liquidity risk of the banking system increases at each period because of the increase in the volume of the uncovered operations in foreign currency against the currency risk.

To determine the profit of the domestic banking system, we compare:

- The amount of the reimbursement of the part of the loan converted in foreign currency (used to honor the deposit withdrawal in foreign currency) with the amount of the deposit withdrawal in foreign currency;
- The amount of the reimbursement of the second part of the loan with the amount of the deposit withdrawal in domestic currency.

The domestic interest rate being unique for the loan and for the deposit in domestic currency, then the profit of the second part of the operations is equal to zero.

Deposit interests in foreign currency are paid in period \( t+1 \). The first part of the profit of the banking system in period \( t+1 \) in foreign currency is determined by:

\[
n_{S,t+1} = \frac{D_i S_i(1+i_i)}{S_{t+1}} - D_i(1+i_i+u_i)
\]

This part of the profit of the banking system in period \( t+1 \) denominated in domestic currency is the following:

\[
n_{d,t+1} = D_i S_i(1+i_i) - D_i(1+i_i+u_i) S_{t+1}
\]

The profit of the banking system is dependent on the domestic and foreign interest rates, on the risk premium and on the variation of the nominal exchange rate between periods \( t \) and \( t+1 \). Under the assumption of uncovered operations, the profit decreases with the devaluation of the domestic currency \( (S_{t+1} > S_t) \).

2.3. Equilibrium of the domestic country balance of payments

At each period, the volume of the deposit in foreign currency increases. Thus, the surplus of the capital account increases while the deficit of the current account raises (because the interests amount on the deposit in foreign currency increases). Under the assumption of the fixed exchange rate, we assume that the deficit of the commercial balance \( B_i \) allows the equilibrium of the balance of payments.

In the case of expectations of an increase in the exchange rate for the period \( t+1 \), investors renounce in period \( t \) to deposit in foreign currency. Thus, the country meets net capital outflows in respect of the withdrawal of the previous period deposit in foreign currency. In other words, in the absence of a new deposit in period \( t \), the currency tends to depreciate in the period \( t \). This is because of the conversion into foreign currency of the reimbursement of the domestic loan used to honor the withdrawal of the previous period deposit. Thus, there is a deficit of the capital account. If authorities choose an unchanged exchange rate, they defend the domestic currency. We will see above the domestic currency defense mechanism. In the opposite case, they can decide to devalue the domestic currency.

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5 The profit is equal to zero if the exchange rate is fixed and the regime is credible.
6 The increase of the massive short term capital inflow is then taken account.
7 In the model, international reserves and variation are ignored.
2.4. The domestic interest rate determination

As in McKinnon and Pill (1999), we assume that the domestic banking system cannot cover operations in foreign currency against the currency risk. The absence of covered operations increases the liquidity risk of the domestic banking system. When the domestic banking system borrows in foreign currency, it must pay higher interests than the foreign banking system. \( u_i \) is the risk premium required from the domestic banking system.

The uncovered interest rate parity condition is not verified. The domestic interest rate is determined by the following condition\(^8\):

\[
i = i^* + \frac{E(S_{t+1}) - S_t}{S_t} + u_i
\]

With an approximation of \( \frac{E(S_{t+1}) - S_t}{S_t} \) by \( \ln E(S_{t+1}) - \ln(S_t) \) with \( \ln(S_t) = e_t \) and \( \ln E(S_{t+1}) = E(e_{t+1}) \), we obtain:

\[
i = i^* + E(e_{t+1}) - e_t + u_i
\]

We assume the risk premium \( u_i \) is a random variable\(^9\).

2.5. Quasi-rationality assumption of the investors

We imagine the complete model is composed of two sub-models:

1) The "exit endogenous" strategy is composed of two periods 1 and 2. It takes place in turbulent period: At the time \( t_2 \), the currency crisis is produced by self-fulfilling expectations of an increase of the exchange rate;

2) The "early exit" strategy is composed of two periods 1 and 2. It takes place in favorable period: At the time \( t_1 \), before a turbulent period, the authorities decide to exit from the fixed exchange rate regime to avoid higher costs of a self-fulfilling currency crisis at the time \( t_2 \).

In the sub-model with "endogenous exit" strategy, we assume that there is no exit from the fixed exchange regime at the time \( t_1 \). Expectations are assumed quasi-rational. In the first sub-model, foreign investors are unaware that the authorities are worried by the surplus of the capital account that will become excessive in the future. Foreign investors are short-sighted: They behave as if they do not know the present sub-model.

2.6. The events chronology

At the beginning, the exchange rate is fixed and the exchange rate regime is credible. The balance of payments is in equilibrium. The banking system must honor the deposit withdrawal at the end of the period \( 1^{10} \). \( i \) is the target domestic interest rate. The events chronology is the following:

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8 We have assumed that the domestic interest rate is higher than the foreign interest rate. In the context of a fixed exchange rate regime, we must introduce a risk premium \( u_i \) variable with the time in the standard uncovered interest rate parity. Then in fixed exchange rate regime, we have: \( i_t - i^* - u_i = 0 \) with \( u_i = i_t - i^* \). If \( i_t > i^* \), then \( u_i > 0 \).

9 It can depend on the political risk, the domestic financial volatility, etc.

10 We find again these assumptions in the sub-model with the "early exit" strategy.
• Step 1: At the beginning of the period 1, foreign investors formulate their expectations about the level of the exchange rate for the end of the period 2, \( E(e_2) \). If investors do not expect an increase of the exchange rate, they continue to deposit their foreign currency in the banking system (then there is not net outflow) and the exchange rate does not depreciate;
• Step 2: Realization of the random variable \( u_1 \);
• Step 3: The authorities determine the new level of the exchange rate according to the level of the shock and the expectations.

### 2.7. The authorities arbitrage between two costs

The authorities arbitrate between two costs. The first one is dependent of the realignment. The banking system has accepted deposits in foreign currency to lend to the property sector in domestic currency. Thus, a devaluation of the domestic currency has a negative backlash because it increases the deposit withdrawal cost for the banking system. The authorities must take account of this problem in their minimization program of the costs. The higher is the devaluation, the higher is the liquidity risk of the banking system. The authorities have a fixed nominal exchange rate objective.

The second cost is dependent of the fixed exchange rate. A high interest rate is used to defend the domestic currency. In the case of expectations of an increase in the exchange rate, investors renounce to make a new deposit. They expect an increase of the liquidity risk of the domestic banking system. This is because of the increase of the deposit withdrawal cost in foreign currency — because of the increase of the exchange rate — for the domestic banking system. We have assumed that the deposit denominated in domestic currency is smaller than the volume of the deposit denominated in foreign currency. Thus, the increase of the remuneration of the domestic loan is higher than the one of the deposit withdrawal denominated in foreign currency. Thus, the increase of the domestic loan remuneration can compensate the effect of an increase of the exchange rate on the deposit withdrawal cost in foreign currency. Investors understand that the increase of the domestic interest rate can compensate the effect of an increase of the exchange rate and thus can avoid an increase of the liquidity risk. Thus, the increase of the domestic interest rate leads to the renewal of the deposit in foreign currency. This is the defense of the domestic currency mechanism. Nonetheless, the authorities deviate from the target domestic interest rate.

There is a conflict between the nominal exchange rate stability objective and the target domestic interest rate.

### 3. The three strategies

#### 3.1. The “endogenous exit” strategy à la Obstfeld

The authorities loss function in period 1 is the following:

\[
I_1 = \frac{\theta}{2} \left[ \frac{S_1 - S_0}{S_0} \right]^2 + \frac{1}{2} (i_1 - i)^2
\]

(5)

\(0 < \theta < 1\) is a parameter to measure the relative aversion of the authorities between the two costs of the quadratic function. \( S_0 \) is normalized to 1 and \( (S_1 - S_0) / S_0 \) is approximated by \( \ln S_1 - \ln S_0 \), i.e., by \( \ln S_1 \), then the authorities loss function in period 1 is the following:

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\[ I_1 = \frac{\theta}{2} (e_1)^2 + \frac{1}{2} (i_1 - \hat{i})^2 \]  

(6)

One condition to minimize the costs (6) in period 1 under the constraint of the condition (4) determining the domestic interest rate is that the derivative over \( e_1 \) is equal to zero:

\[ -\theta (e_1) + i_1^* + E(e_2) - e_1 + u_1 - \hat{i} = 0 \]  

(7)

\[ e_1 = \frac{i_1^* + E(e_2) + u_1 - \hat{i}}{\theta + 1} \]  

(8)

This is a maximum because the second derivative is negative: \(-\theta - 1 < 0\). The lower is the target interest rate or the higher is the shock, the higher is the exchange rate fixed by the authorities. In the case of a positive shock (the increase of the risk premium), the authorities should raise the domestic interest rate to restore the condition (4) that determines the domestic interest rate. The increase of the domestic loan remuneration let the banking system honor the deposit withdrawal in foreign currency. Nevertheless, the authorities deviate from the target domestic interest rate. Thus, the authorities choose the devaluation in the case of a positive shock.

Now, we assume additional costs and the authorities loss function in period 1 is the following:

\[ I_1 = \frac{\theta}{2} \left[ \frac{S_1 - S_0}{S_0} \right]^2 + \frac{1}{2} (i_1 - \hat{i})^2 + (k + b) Z_1 \]  

(9)

with \( Z_1 = 1 \) if devaluation, \( Z_1 = 0 \) instead. \( k \) is the cost of the loss credibility of the authorities in the case of devaluation. This is an exogenous cost. \( b \) is a disturbance cost caused by the currency crisis and by the deterioration of the fundamentals during the crisis when the devaluation produces in turbulent period. Thus, the cost of a devaluation increases in the turbulent period against the favorable period.

If the authorities maintain the fixed exchange rate, then \( e_1 = e_0 \) and \( Z_1 = 0 \). The loss function becomes

\[ I^F = \frac{\theta}{2} (e_0)^2 + \frac{1}{2} \left[ i_1^* + E(e_2) - e_0 + u_1 - \hat{i} \right]^2 \]  

(10)

If the authorities renounce to the fixed exchange rate, then \( Z_1 = 1 \). The authorities determine the exchange rate at the level (8) and the loss function becomes:

\[ I^D = \frac{\theta}{2} \left\{ i_1^* + E(e_2) + u_1 - \hat{i} \right\}^2 + \frac{1}{2} \left\{ i_1^* + E(e_2) - \left[ \frac{i_1^* + E(e_2) + u_1 - \hat{i}}{\theta + 1} \right] + u_1 - \hat{i} \right\}^2 \]  

(11)

The authorities modify the level of the exchange rate if the loss of the realignment is lower than the loss of the fixed exchange rate. The necessary and sufficient condition for the realignment would be better than the fixed exchange rate is \( I^F - I^D > 0 \):

\[ \frac{\theta}{2} \left\{ i_1^* + E(e_2) + u_1 - \hat{i} \right\}^2 + \frac{1}{2} \left\{ i_1^* + E(e_2) - \left[ \frac{i_1^* + E(e_2) + u_1 - \hat{i}}{\theta + 1} \right] + u_1 - \hat{i} \right\}^2 + \]

\[ + \frac{\theta}{2} (e_0)^2 + \frac{1}{2} (i_1^* + E(e_2) - e_0 + u_1 - \hat{i})^2 > k + b \]  

(12)
Solutions to (12) treated as an equality are the two roots \( \hat{u} \) and \( \hat{u}' \), with \( \hat{u}' < \hat{u} \). If \( u_1 > \hat{u} \), the devaluation amount \( e_1 \) is fixed at the level (8). \( \hat{u} \) is the largest shock consistent with a continuing fixed exchange rate. For \( u_1 < \hat{u}' \), there would be a revaluation, but we will not study this case.

The equation (12) shows that the level of the shock \( \hat{u} \) at which the authorities choose to devalue depends on investors' expectations. These expectations depend on the level of the shock at which the investors believe that the authorities will devalue. This circular process creates the possibility of multiple equilibria. A currency crisis can then occur while the shock is negative. In the case of expectations of an increase of the exchange rate, foreign investors do not make new deposit in foreign currency because they are worried of a liquidity banking crisis (see 2.3). Thus, capital inflows (i.e. a new deposit in foreign currency) do not compensate for the capital outflows (i.e. withdrawal of the deposit in foreign currency). This produces a depreciation of the domestic currency. This process can be corrected by the increase of the domestic interest rate only (see the mechanism in 2.7). Nevertheless, the authorities can choose not to defend the domestic currency and to devalue because of the target domestic interest rate. This is a self-fulfilling expectations process.

We assume that the investors believe the authorities will devalue if the shock is higher than the threshold level \( \hat{u} \). Now, we seek the depreciation expectations given an expected threshold level \( \hat{u} \). When investors think in \( t=1 \) that \( e_2 > e_1 \), if \( u_1 > \hat{u} \), then:

\[
E(e_2) = \left[ \text{Prob}(u_1 \leq \hat{u}) \cdot E(e_2 | u_1 \leq \hat{u}) \right] + \left[ \text{Prob}(u_1 > \hat{u}) \cdot E(e_2 | u_1 > \hat{u}) \right]
\]

Under the uniformity distributed over the interval \([-\mu, \mu]\), we have:

\[
\text{Prob} \{ u_1 \leq \hat{u} \} = 1 - \frac{\mu - \hat{u}}{2\mu} = \frac{\mu + \hat{u}}{2\mu} \tag{14}
\]

\[
\text{Prob} \{ u_1 > \hat{u} \} = \frac{\mu - \hat{u}}{2\mu} \tag{15}
\]

\[
E \{ \frac{e_2}{u_1} \leq u \} = \frac{\mu + \hat{u}}{2} \tag{16}
\]

Moreover, \( E \{ \frac{e_2}{u_1} \leq u \} = e_1 = e_0 \) \tag{17}

Investors are quasi-rational, thus they know the optimization program of the authorities, then:

\[
E \{ \frac{e_2}{u_1} \leq u \} = \frac{1}{\theta + 1} \left[ i_1^* \cdot E(e_2) - \hat{u} - \frac{\mu + \hat{u}}{2} \right] \tag{18}
\]

To obtain (18), we have substituted \( u_1 \) for its value (16) in the solution (8) of the authorities optimization program. After simplifications, the equation (13) becomes:

\[
E(e_2) = \frac{1}{2\mu\theta + \mu + \hat{u}} \left[ (\theta + 1)(\mu + \hat{u}) e_0 + (\mu - \hat{u}) i_1^* - (\mu - \hat{u}) \hat{u} + \mu^2 - \hat{u}^2 \right] \tag{19}
\]

We write this value of expectations by \( \delta(\hat{u}) \).

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11 In fact, these expectations are not function of the time because the shock is not serially correlated. Nevertheless, we use the notation \( E(e_2) \).
Now, we calculate the threshold level given investors' expectations. Maintaining the fixed exchange rate is not possible. The authorities must validate investors' expectations. They consider this value of expectations (19) as given and minimize their loss function. \( \hat{\mu} \) is the largest value of the shock consistent with a fixed exchange rate and is a solution to:

\[
-\frac{\theta}{2} \left\{ \frac{i_1^* + \delta(\hat{\mu}) + \hat{\mu} - \hat{i}}{\theta + 1} \right\}^2 - \frac{1}{2} \left\{ \frac{i_1^* + \delta(\hat{\mu}) - \left[ \frac{i_1^* + \delta(\hat{\mu}) + \hat{\mu} - \hat{i}}{\theta + 1} \right] + \hat{\mu} - \hat{i}}{\theta + 1} \right\}^2 + \\
+ \frac{\theta}{2} (e_0)^2 + \frac{1}{2} \left[ i_1^* + \delta(\hat{\mu}) - e_0 + \hat{\mu} - \hat{i} \right]^2 = k + b \tag{20}
\]

We have substituted for \( E(e_2) \) in the inequality (12) transformed in an equality and \( u_1 \) by \( \hat{\mu} \). Under the quasi-rationality expectations assumption, investors' believes are "true". In equilibrium: \( \hat{\mu} = \hat{\mu} \). We substitute \( \hat{\mu} \) for \( \hat{\mu} \) in the expression (20) and we simplify:

\[
-\frac{\theta}{2(\theta + 1)} \hat{\mu}^2 + \left\{ \frac{i_1^* - \hat{i}}{\theta + 1} - \frac{\theta}{\theta + 1} \delta(\hat{\mu}) \right\} \hat{\mu} + \left\{ \frac{\theta}{2(\theta + 1)} \left[ -(i_1^*)^2 + \delta(\hat{\mu})^2 + \frac{i_1^2}{\theta} \right] \right\} + \\
+ \left\{ \frac{\theta}{\theta + 1} \left[ -i_1^* \delta(\hat{\mu}) + i_1^* d(\hat{\mu}) \right] \right\} = k + b \tag{21}
\]

Solutions to this equation (i.e. equilibria thresholds) can be obtained with a numeric simulation only.

We choose: \( \theta = 0.15 \), \( \hat{i} = 0.08 \), \( i_1^* = 0.05 \), \( e_0 = 0 \), \( \mu = 0.3 \), \( k = 0.02 \), \( b = 0.01 \). In Figure 1, we obtain equilibria thresholds \( \hat{\mu}' = -0.2 \) and \( \hat{\mu}' = +0.29 \). The associated expected exchange rates for the period 2 are \( \delta(-0.2) = 0.0814 \) (i.e. an expected depreciation for the period 2 of 8.48%) and \( \delta(+0.29) = 0.0118 \) (i.e. an expected depreciation for the period 2 of 1.19%).

The interpretation of these results is the following. If we assume that investors expect the second equilibrium threshold, then the authorities renounce to maintain the fixed exchange rate if the shock is superior to 0.29. The probability of this event is of 16.67%. Because expectations are low, the costs of the defense of the domestic currency are low. Thus, the authorities will be incited to devalue if the shock is positive only. A contrario, in the case in which the investors expect the first equilibrium threshold, the authorities renounce to maintain the fixed exchange rate if the shock is superior to \(-0.2 \). The probability of this event is 83.33%.

Why? When investors expect this first equilibrium threshold, the authorities must renounce to maintain the

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12 This corresponds to a case in which the authorities have a higher cost for the spread of the domestic interest rate from the target interest rate.

13 The target interest rate is near of the foreign interest rate.

14 This corresponds to a foreign interest rate of 5%.

15 The result is obtained with the expression (15).
fixed exchange rate because of the domestic currency defense costs. Expectations of the increase of the exchange rate are high, then the economy goes from the second equilibrium threshold to the first equilibrium threshold with an increase of the risk of the change of the exchange rate. Thus, for the first equilibrium threshold, the shock is negative. Nonetheless, because expectations of an increase of the exchange rate are high, there is a self-fulfilling currency crisis. Expectations of a variation of the exchange rate are so high that the investors fear a liquidity banking crisis and then they do not make a new deposit. This creates a net capital outflow which produces a depreciation of the domestic currency. The authorities choose a devaluation of the domestic currency instead of the increase of the interest rate to avoid the deviation from the target interest rate. In fine, the increase of the exchange rate produces a banking crisis of liquidity because of the rise of the deposit withdrawal cost for the banking system (operations are not covered). Only the realization of a very negative shock ($\hat{u} < -0.2$) would avoid both a currency crisis and a banking crisis.

**Proposition 1:** With the “endogenous exit” strategy, there are multiple equilibria. The authorities choose to devalue in period 1 if the shock $u_1$ is superior to $-0.2$. In this case, there are a currency crisis and a banking crisis of liquidity.

Sensibility test results show that the possibility of multiple equilibria is eliminated when we choose:

- $\theta$ superior to 0.17. The authorities have relatively less aversion for a higher interest rate, thus the exchange rate regime is more credible. For a value superior to 0.17 and inferior or equal to 0.45, the equilibrium is unique and the equilibrium threshold is negative. For a value superior to 0.45, there is not equilibrium;
- $\mu$ inferior to 0.3. The space of possibilities for the shock is reduced. For a value superior to 0.85, there are two positive equilibria thresholds.

### 3.2 The “early exit” strategy

The loss function of the authorities in period 1 is the following:

$$I_1 = \frac{\theta}{2} (e_1) + \frac{1}{2} (i_1 - \bar{i})^2 + kZ_1$$  

(22)

The cost of a devaluation in favorable period are lower than in a turbulent period. In the case of the turbulent period, there was a border cost in the loss function [see expression (9)]. As in the "endogenous exit" strategy, is the necessary and sufficient condition and there are two roots. If $u_1 > \hat{u}$, the devaluation amount $e_1$ is fixed at the same level (8) as in the "endogenous exit" case.

We are in a favorable period and we assume that expectations are quasi-rational. The exchange rate regime is credible. The investors expect in period 1 a fixed exchange rate for the period $2^{16}$: $E(e_2) = e_0$. The authorities consider this value of expectations as given and minimize their loss function. We obtain:

$$\frac{1}{2(\theta + 1)} \hat{u}^2 + \left[ \frac{1}{\theta + 1} (i^{*} - \bar{i}) - \frac{\theta}{\theta + 1} e_0 \right] \hat{u} +$$

$$+ \left\{ \frac{\theta}{2(\theta + 1)} \left[ -(i^{*})^2 + e_0^2 + \frac{1}{\theta} \hat{i}^2 \right] + \frac{\theta}{\theta + 1} \left[ -\frac{1}{\theta} i^{*} \hat{i} - i^{*} e_0 + e_0 \hat{i} \right] \right\} = k$$

(23)

---

16 Because in the equation (13).
We choose the same parameters as for the "endogenous exit" strategy. In the numeric simulation (Figure 2), we obtain one equilibrium threshold \( \hat{u} = -0.28 \). For this equilibrium threshold, expectations of a depreciation (in level) for the period 2 are equal to 1. In the context of a fixed exchange rate regime with adjustable parities, the authorities should have to devalue when the shock is higher than \(-0.28\). Here, we assume that the authorities take the initiative to exit from the fixed exchange rate regime if the shock is higher than \( \hat{u} \). This is to avoid costs of a future currency crisis in turbulent period.

**Proposition 2:** With the "early exit" strategy, the credibility of the authorities' policy avoids a self-fulfilling currency crisis. The authorities take the initiative to exit from the fixed exchange rate regime by floating the domestic currency when the shock \( u_1 \) is superior to \(-0.28\).

The possibility of unique equilibria is eliminated when we choose: \( \theta \) superior to 0.25 (there is not equilibrium) or \( \mu \) inferior to 0.28 (there is not equilibrium). For a value superior to 0.88, there are two equilibria thresholds.

**Proposition 3:** The "early exit" strategy in time \( t_1 \) (in favorable period) is optimal. The authorities modify the type of exchange rate regime by floating the domestic currency when the shock \( u_1 \) is superior to \(-0.28\).

**Proof:** The costs of the "early exit" strategy is lower than those of the "endogenous exit" strategy: \( k = 0.02 < b + k = 0.03 \). In the case of the change of the exchange rate regime in time \( t_1 \) we avoid the cost \( b = 0.01 \).

### 3.3. The strategy with "capital controls"

Now, we are in a favorable period and the currency is pegged on the big economy. We make the assumption that the authorities impose controls on short term inflows, as a way of preventing future currency crisis. The banking system, accepting deposit denominated in foreign currency from foreign investors, is required to make non-interest bearing deposits denominated in foreign currency at the authorities.

\( R_t \) is the rate of the reserve requirements in period \( t \) (the time of the deposit in foreign currency made by foreign investors). The banking system is forced to deposit a proportion of the foreign investors' deposit at the authorities. The required deposit in foreign currency is then returned, at zero rate, to the banking system when foreign investors withdraw the deposit. In other words, a part of the deposit is remunerated and the proportion of the deposit at the authorities is unremunerated. If \( (i^{*} + u_t) \) is the remuneration of the deposit in period \( t \) and withdrew in period \( t+1 \), then the link between the rate of the reserve requirements and the implicit rate of the tax \( r_t \) is the following:

\[
r_t = R_t (i^{*} + u_t)
\]

(24)

The reserve requirements have a negative effect on the remuneration of the banking deposit. To
determine the profit of the domestic banking system, we compare the amount of the reimbursement of the part of the loan converted in foreign currency (used for honoring the deposit withdrawal in foreign currency) with the amount of the deposit withdrawal in foreign currency. The profit of the banking system in period \( t+1 \) denominated in foreign currency is determined by:

\[
\eta_{S, t+1} = \frac{(D_i - R_i D_i) S_i (1+i_1^*)}{S_{t+1}} + R_i D_i - D_i (1 + i_1^* + u_i)
\]  

(25)

\( D_i \) is the amount of the deposit denominated in foreign currency in period \( t \) and withdrawn in period \( t+1 \). \((D_i - R_i D_i) S_i\) is the proportion of the deposit for the domestic property sector, reimbursed in period \( t+1 \). The profit of the banking system in period \( t+1 \) denominated in domestic currency becomes:

\[
\eta_{d, t+1} = (D_i - R_i D_i) S_i (1+i_1^*) + R_i D_i S_{t+1} - D_i (1+i_1^* + u_i) S_{t+1}
\]  

(26)

The profit of the banking system is dependent on the variation of the nominal exchange rate between periods \( t \) and \( t+1 \). The profit decreases with the devaluation of the domestic currency \((S_{t+1}>S_i)\). Without the reserve requirements, the profit of the banking system denominated in domestic currency in period \( t+1 \) is determined by the expression (2). The variation of the profit because of reserve requirements is the following:

\[
\eta_{d, t+1} - \eta'_{d, t+1} = R_i D_i \left[ S_i (1+i_1^*) - S_{t+1} \right]
\]  

(27)

The variation of the profit is explained by the decrease of the domestic loan quantity. With the reserve requirements, the condition (4) that determines the domestic interest rate is modified. It can be written as (see Edwards 1998):

\[
i_1 = i_1^* + \frac{E(S_{t+1}) - S_i}{S_i} + u_i + r_i
\]  

(28)

We know that \( r_i = R_i (i_1^* + u_i) \). With a logarithmic approximation of the variation of the exchange rate, we obtain:

\[
i_1 = (1+R_i) i_1^* + E(e_{t+1}) - e_i + (1+R_i) u_i
\]  

(29)

The equality (29) shows that the value of \( i_1 \) is dependent on the reserve requirements \( R_i \). The authorities raise the domestic interest rate in the case of reserve requirements. The expression (27) of the variation of the banking system profit after the imposition of the capital controls must be modified. In the expression (26), \( i_1 \) is substituted by \( i_1 + R_i (i_1^* + u_i) \). The variation of the profit becomes:

\[
\eta_{d, t+1} - \eta'_{d, t+1} = R_i D_i \left[ S_i (1 + i_1 + (R_i - 1) (i_1^* + u_i)) - S_{t+1} \right]
\]  

(30)

The variation of the banking system profit is lower than in the case without increase of the domestic interest rate by the authorities. The rise of the domestic interest rate induces a higher domestic loan remuneration. Thus, it compensates for the loss produced by the decrease of the loan quantity after the imposition of the reserve requirements.

The reserve requirements decrease the proportion of the deposit denominated in foreign currency used
to the domestic loan. By diminishing mechanically the proportion of the liabilities denominated in domestic currency (the deposit of domestic investors), the reserve requirements decrease the absence of correspondence between the denomination of the liabilities and of the debts. Thus, the capital inflow controls allow to achieve the banking system currency risk decrease objective.

In the above events chronology, the Step 4 only is modified as the following: The authorities determine the rate of the reserve requirements according to the level of the shock and the expectations.

The authorities loss function in period 1 is the following:

\[ l_1 = \theta \left( \frac{e_1}{2} \right)^2 + \frac{1}{2} \left( i_1 - i \right)^2 + (s + k) Y_1 \]  \( (31) \)

with \( Y_1 = 1 \) if capital control and \( Y_1 = 0 \) instead. \( s \) is an “inter-temporal cost” caused by capital controls incurring later than the shock and will be economic costs. We make the assumption that \( k \) is the cost of the loss credibility of the authorities in the case of capital controls. One condition to minimize the costs (31) in period 1 under the constraint of the condition (29) determining the level of the domestic interest rate is that the derivative over \( R_1 \) is equal to zero:

\[ \left[ - (1+R_1) i_1^* - E(e_2) + e_1 - (1+R_1) u_1 + i \right] (i_1^* + u_1) = 0 \text{ or} \]  \( (32) \)

\[ R_1 = \frac{i_1^* - E(e_2) + e_1 - u_1 + i}{i_1^* + u_1} \]  \( (33) \)

The lower is the target interest rate or the higher is the level of the shock, the lower is the rate of the reserve requirements fixed by the authorities (and then the implicit rate of the tax \( r_1 \) decreases). Instead of devaluing the domestic currency in the case of a positive shock, the authorities decrease the reserve requirements in the context of fixed exchange rate regime.

If the authorities maintain the fixed exchange rate and do not introduce restrictions on capital inflows, then \( R_1 = 0 \), \( e_1 = e_0 \) and \( Y_1 = 0 \) and the loss of the authorities becomes:

\[ l = \frac{\theta}{2} \left( e_0 \right)^2 + \frac{1}{2} \left[ i_1^* + E(e_2) - e_0 + u_1 - i \right]^2 \]

If the authorities introduce restrictions on capital inflows and maintain the fixed exchange rate, then \( R_1 \) is determined by (33) and \( Y_1 = 1 \). The authorities choose the level of the reserve requirements as in the expression (33) and the loss of the authorities becomes:

\[ l^c = \frac{\theta}{2} \left( e_0 \right)^2 + (s + k) \]  \( (34) \)

The authorities introduce restrictions on capital inflows if the loss induced is lower than the loss induced by the absence of capital controls. The necessary and sufficient condition for the introduction of restrictions on capital inflows is \( 1 - l^c > 0 \). If \( u_1 < \hat{u} \), then the authorities introduce restrictions on capital inflows and the rate of the reserve requirements \( R_1 \) is determined by the expression (33). We are in a favorable period and we make the assumption that the expectations are quasi-rational. The exchange rate is fixed and the
exchange rate regime is credible. The investors expect in period 1 a fixed exchange rate for the period 2: \( E(e_2) = e_0 \). The authorities consider this value of expectations as given and minimize their loss function. The authorities can impose restrictions on capital inflows only if there are no expectations of higher exchange rate. We obtain:

\[
\frac{1}{2} \dot{u}^2 + (i_1^* - i) \dot{u} + \left[ \frac{1}{2} (i_1^* - i)^2 \right] = s + k \tag{35}
\]

We choose the same values as for the two above strategies and \( s \) is equal to 0.018. We obtain one equilibrium threshold \( \hat{u} = -0.24 \) (see Figure 3). For this equilibrium threshold, the exchange rate level expected is equal to 1. Here, the authorities impose restrictions on capital inflows to decrease the currency risk of the banking system if the shock is lower than \( \hat{u} \).

**Proposition 4:** The currency is pegged on the big country and the authorities introduce restrictions on capital inflows in period 1 — with reserve requirements, at zero rate, at the authorities — if the shock \( u_1 \) is lower than -0.24.

Sensibility test results show that the possibility of unique equilibria is eliminated when we choose \( \mu \) inferior to 0.3 (there is not equilibrium) or for a value superior to 0.3 (there are two equilibria thresholds).

**Proposition 5:** The authorities choice between the “early exit” strategy and the “capital controls” strategy depends on the value of the cost induced by restrictions on capital inflows \( s \). Here, the “early exit” strategy is optimal.

Proof: For a given capital controls cost \( s = 0.018 \), the global cost induced by restrictions on capital inflows is higher than the cost induced by the “early exit” from a fixed exchange rate regime:

1) In the two cases, we avoid the same disturbance cost \( b \) induced by the future currency crisis in turbulent period;

2) The cost of the “early exit” strategy is lower than the cost of the “capital controls” strategy: \( k = 0.02 < s + k = 0.038 \). The authorities avoid a surplus cost of 0.018 in comparison with the “capital controls” strategy.

4. Concluding remarks

This paper shows that the “early exit” strategy is optimal. The exchange rate regime credibility avoids a self-fulfilling currency crisis and a banking crisis of liquidity. Costs of the exit from the fixed exchange rate regime are lower than in the “endogenous exit” and “capital controls” strategies. Nevertheless, there are two risks. The first one is the loss of the authorities’ credibility after the floating currency. The second risk is the effects of floating the currency on the banking system. The authorities would face a new dilemma:

1) Here, we find again the traditional incompatibility between an independent monetary policy and an international capital mobility with a fixed exchange rate regime. Breaking from the “Impossible Trinity” by floating the currency, will the authorities reach their aim of decreasing the liquidity risk of the banking
system? The following question thus arises: What will happen after the change of the exchange rate regime? Will operations be covered? The rise of the volatility of the exchange rate should incite the banking system to cover its operations against the currency risk. This was the main aim of the creating a floating exchange rate regime. Nevertheless, it is possible only if we do not assume the incomplete domestic financial market; 2) The volatility of the exchange rate could have disastrous consequences on the banking system that finances loans in domestic currency with foreign currency. This could produce a banking crisis of liquidity. Avoiding a currency crisis by a destabilization of the domestic banking system does not seem the best solution.

To avoid the last pitfall, the solution would be perhaps that the authorities choose an intermediate exchange rate regime.

Beaumont, Coker, Iakovou and Van Elkan (2000) show that there is a strong likelihood that inflows will increase for transition economies wishing to join the European Union. Nevertheless, in order to join the euro area, countries should remove capital controls. Consequently, these countries should choose the appropriate exchange rate regime in the context of volatile flows. Moreover, fixed exchange rate regime discourages hedging. To conclude, fixed exchange rate regime, capital controls and a floating exchange rate regime are not appropriate solutions for accession countries.

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