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Currency boards: are they as strong as they look?

Jean-Louis COMBES^a, Romain VEYRUNE^{*b}

^a CERDI, *University of Auvergne, France*

^b CERDI, *University of Auvergne, France*

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* Corresponding author. Tel : +33(0) 4-73-17-74-00; Fax: +33(0) 4-73-17-74-28
E-mail address: Romain.Veyrune@u-clermont1.fr

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Abstract

Since Krugman 1979, we know that the fixed exchange rate regimes have a propensity to fail because governments are unable to commit simple monetary rule in order to avoid divergence between base money supply and reserve variations. The currency boards (CB) propose a radical solution: an institutional rule linking base money and reserve. In this context, how to explain the failure of the Argentina CB? We test, in a co-integration model adapted for panel data, the efficiency of the CB rule to run the monetary policy. We conclude that in some situations, as Argentina bi-monetarism, the monetary policy could become inoperative.

Keywords: Currency Boards, endogenous money supply, Panel unit root test, Panel co-integration model, Argentina.

JEL Classification: C22, C23, E51, E52, F31, F32, F33.

Résumé

Depuis les travaux de Krugman nous savons que les régimes de change fixe ont une forte propension à s'effondrer. Cette faiblesse tiendrait à l'incapacité des gouvernements à respecter la règle du jeu d'un régime de change fixe : c'est-à-dire empêcher les déviations significatives entre la base monétaire et les réserves de change. Les caisses d'émission proposent une solution radicale : établir un lien institutionnel entre la base monétaire et les réserves. Dans ce contexte comment expliquer l'échec argentin ? Pour apporter un élément de réponse, nous essayons, grâce à un modèle de cointégration adapté au panel, de tester l'efficacité de la règle des CB pour conduire la politique monétaire. Les résultats de ce test nous incitent à penser que certaines situations, comme le bi-monétarisme argentin, peuvent rendre la politique monétaire des Caisses d'émission inopérante.

mots clé : Caisses d'émission, offre de monnaie endogène, test de racine unitaire en panel, modèle de co-intégration en panel, Argentine.

Introduction.

Fixed exchange rate regimes are known to have an important propensity to fail. Since Krugman (1979), we have some evidences about the monetary reasons for their failures. Krugman demonstrates that a deviation between monetary base and foreign assets conduct to the collapse of the regime. Without an institutional and clear link between the two aggregates, the fixed exchange rates suffer a fatal lack of credibility, which greatly concurs to the check of the regime. The Krugman explanation has the advantage to offer only monetary explanations to the weakness of the regime.

One way to vanish the lack of credibility of fixed exchange rates and to solidly establish the trust in the regime could be to promote a clear institutional link between monetary aggregates and foreign currency aggregates. The currency board has suggested a solution for a long time: foreign currencies as the unique counterpart of base money. Foreign currencies are a secure, liquid and always available counterpart; and the control of base money constitutes an efficient tool to regulate the money and the credit evolution. In effect, historically, few indeed no orthodox currency boards have known a failure. However, the Argentina bankruptcy and its currency board abandon recently lower the credibility of this kind of regime: Currency boards are they as strong as they look?

In order to check this assumption, we test the convergence hypothesis between base money and external position in a currency board regime with a co-integration model adapted for a panel data structure. The main idea is to check the compliance with the rule for the whole currency boards experiences in the 90's (five countries in our panel: Argentina, Bulgaria, Hong Kong, Estonia and Lithuania) and to evaluate the degree of heterogeneity of the panel. Could a country engaged in a currency board, for example Argentina, significantly deviates from the panel interpretation of the rule for a soft compliance?

We recall, in a first section, how the currency boards could improve the credibility of the fixed exchange rates in a Krugman type model and we present the reason why they may fail to achieve their mission. In a second section, we present our econometric tests.

1. The fatal death of fixed exchange regimes and currency boards.

In a currency board regime the base money supply is endogenous, and this feature greatly improves the credibility of the regime. Before explaining why the base money supply can be considered as endogenous, we recall the fundamental weakness of fixed exchange regimes as exposed by Krugman (1979). In a last step, we briefly evoke the implications of an endogenous base money supply on monetary policy.

Krugman observes frequent failures of government to maintain a fixed parity¹. This statement holds even if the government is able to get some re-fund. In that case, the government can compensate the reserve depletion and restore the confidence in order to avoid the crisis. However, this strategy is linked to the capacity of getting re-fund, and this capacity vanishes over the time².

The survival of a fixed exchange rates regime is determined by external accounts. A lack of foreign reserves implies that the monetary authorities are no longer able to comply with their obligation of converting their money in foreign currency at a fixed exchange rate. Thus, the basic rule to safeguard such a regime is to connect the domestic-inflation to the anchor-inflation, in order to avoid any competitiveness losses which compromise current account. Insofar, as excessive money issue causes inflation, the domestic money supply has to follow the anchor money supply. In case of excess inflation, the current account deficit leads to a depletion of reserve in fixed exchange system. If the country respects the rule of the game, this depletion should imply a reduction of money supply and, thus, a reduction of inflation that vanishes current account deficit and *vice versa*. Consequently, an automatic mechanism adjusts the money supply to reserve variations in order to comply with fixed exchange rate rules.

¹ Krugman (1979) notes that: “at a fixed exchange rate the government’s reserves gradually decline. Then at some point, generally well before gradual depletion of reserves would exhaust them; there is a sudden speculative attack that rapidly eliminates the last of reserve. The government then becomes unable to defend exchange rate any longer”

² To quote Krugman (1979) again: “it sometimes happens that the government is able to weather the crisis by calling on some kind of secondary reserves: it draws on its gold tranche or negotiates emergency loans. At this point, there is a dramatic reversal, the capital that as just flowed out returns, and the government’s reserves recover. The reprieve may only be temporary. Another crisis may occur, which will oblige the government to call on still further reserves. There may be a whole sequence of temporary speculative attacks and recoveries of confidence before the attempt to maintain fixed exchange rate is finally abandoned.”

However, in Krugman model, the government has not enough incentives to respect the basic rule of the game. Coping with external shocks or financing budget deficit incites the government to issue money without any respect of foreign reserve amount. Indeed, a time inconsistency appears between the rate of growth of base money and the obligations of fixed exchange rate regimes. Investors aware of this inconsistency do not trust the government announcements. Most traders forecast the abandon of the fixed exchange rate, i.e. potential gains in holding foreign assets. This speculative movement exhausts the central bank foreign reserve as soon as the regime becomes less credible. The speculation accelerates the end of the fixed exchange rate regime.

A legal rule can institutionalize the link between reserve and money supply, and can dismiss the government discretion. In that case, the fixed exchange rule and the anti reserve depletion mechanism can hold. Trust in the regime is guaranteed and, thus, the credibility is restored. Such an institutional fixed exchange rate regime avoids the fatal death described by Krugman. That is exactly what the currency board regime looks for. In a currency board system, the law forbids explicitly all the base money counterparts different from foreign liquid assets. In the central bank accounts the short-term liability of the bank (essentially the base money) are equal to the foreign reserve. The availability of liquid foreign assets gives a guarantee to internal and external domestic assets holders of satisfying their exchange demand at a fixed and known rate. In addition, the limited central bank counterpart regulates the base money issue. Such a regulation of an essential monetary aggregate powerfully influences the monetary policy in a low inflation bias.

In effect, the currency boards have known lasting experiments. Historically, they have been widely spread in the developing countries during the XIXth and the first part of the XXth century. At the heyday of the regime, it was in function in seventy countries around the world. They provide a stable fixed exchange rate regime and the failures have been very scarce, indeed none. Abandoned for political more than economical reasons in the 1950-60's, they have done a noticed come back in the 90's. Countries in great monetary turmoil as Argentina and Bulgaria use the rule to stabilizing quickly their economy and the results have been quite efficient. Estonia and Lithuania use the rule to issue a credible new currency the day after their independence. The new issues successfully integrated the world of the international currencies. The oldest currency board, Hong Kong, maintains the regime in order to stay a solid international financial place. In the turmoil of the 1997 Asian crisis, the Hong Kong dollar kept its exchange rate pegged with the united states dollar. At a first sight, the currency

board seems to be an efficient monetary tool for developing countries. However, recently, the Argentina bankruptcy questions the evidence of currency board monetary success: how a regime, which is supposed to handle a great quantity of foreign reserve, could let a country in foreign debt suspension of payments?

The collapse of Argentina recently lowers the credibility of currency board. In particular, it puts in doubt the truth telling of the currency board arrangement. The strength of the currency board rule is that it looks like an identity in the central bank accounts. However, the 90's currency boards are qualified as non-orthodox because they abandon certain characteristics of the genuine ancestral currency boards. The orthodox currency board had a strict definition of the rule: they could not hold foreign reserve more than 100% of the base money. They excluded the possibility widely used in new currency boards of holding excess foreign reserve in order to generate rooms to some monetary policy interventions opposite to the "currency spirit". In the present currency boards (Argentina (1991), Estonia (1992), Bulgaria (1997) and Lithuania (1994)), the law allows some regulation of credit and bank activities. However, the central bank chart generally stipulates limitations to the use of these tools. These limitations correspond to amendments of the former central bank chart empowered in order to respect the currency or convertibility acts, which are the true laws establishing the Currency Board system. The only case where the central bank chart (and its available instruments) is fully altered is the case of the Bulgarian National Bank.

The following quadrant is an extract of the Argentina laws establishing a currency board. Argentina is the oldest modern currency board, which inspired especially Estonia and Lithuania currency boards. Seven extracts from the laws establishing currency board in Estonia, Lithuania and Bulgaria are presented in Appendix A.

Argentina

The law 12.155 (May 31, 1935) empowered the Central Bank of Argentina Republic (CBAR). In effect, this law ended a "caja de conversion" composed of various monetary and banking institutions, functioning closely to a currency board, and created a centralized body functioning as a classic central bank. However, the new body kept certain autarchy, for example a great part of its capital remained private.

This organic law has been altered several times to improve the discretionary capacity of the institution and to reduce its independence. We could notice especially the decree 8.505 (1946) that nationalized the central bank, and the law 20.520 (1973), which imposes that the monetary policy have to follow the government policy. These laws also increased the discretionary abilities of the central bank.

The convertibility act (law 23.928, (1992)) completely changed the monetary authorities nature. We quote the main articles below:

Article 1: The convertibility between the austral and the United stated dollar is established at a rate of 10.000 austral per dollar. (The year after, the austral was replaced by the peso at a rate of 10.000 austral for a new peso).

Article 1bis (2001): the convertibility between the peso and the united state dollar is established at the rate of 1 United stated dollar and 1 European Union Euro.

Article 2: the CBAR shall sell the foreign exchange required for conversion operation at the rate established by Article 1.

Article 4: the freely available reserves of the CBAR in gold and foreign exchange shall always be equivalent to at least one hundred percent of the monetary base.

These three articles would suffice to establish, in effect, the currency board. However, the republic of Argentina always disposes of a central bank, whose chart (BCRA's chart, law 24,144 (1992)) stipulated :

The primary and essential mission of the Central Bank is to preserve the value of the national currency, in order to secure the function of money as value of reserve, unit of account and instrument of payment (article 3).

The central bank shall not be subject to any order, suggestion or instruction given by the national executive power.

The new chart institutes the independence of the BCRA, and considerably reduced its discretionary power. However, we notice that an important number of central bank traditional prerogatives persist :

The central bank chart retains the possibility to rediscount or refinance the commercial bank in difficulties of solvency (article 17.1), but strictly limits the period and the amount per institution (article 17.2). The period is limited to 30 days and to the amount of the equity capital.

The central bank could operate certain open market operations with its excess resources (excess of foreign reserves on base money) (article 18).

The commercial banks have to fill deposit on the central bank account. The reserve requirement on these accounts is determined by the central bank. The reserve requirement of the central bank itself comes from the convertibility act (100% of the money base in foreign reserves) (article 28).

The supervision of the banking system recovers from a superintendent, mainly empowered of issuing licenses and authorizations to practice a financial activity (article 34).

The legacy of the central bank system to the currency board is important. The currency board has various tolls to regulate the credit and to supervise commercial banks. However, these tolls are available in strict bounds defined by the convertibility act. In fact, the monetary authorities are much more ruled by the Convertibility act, which fixes the resource available for the monetary authorities, than by the central bank chart, which only gives marginal capacity of action on credit.

In spite of the tight arrangement, the government and the central bank have some rooms to deviate from the strict application of the rule. The motivations to deviate for a weak government could be strong.

Even if the government is not able or unwilling to soften the rule, people themselves could worsen the rule mechanism. Indeed, the adjustment, which insures the viability of fixed exchange rate, supposes that the rule makes base money very reactive to exit/entry of foreign currency in the country. However, the change Money-currency is never instantaneous. People can hold foreign currencies (currency retention) or it can exist delays less or more important due to technical factors. The technical reasons are simply the time taken by the traders and the banking sector to effectively done the change. Which factors can influence the delays and the holding of currencies? For the delays, we could imagine that the technical reasons are quite invariant. On the contrary, the retention of currencies would be influenced by the trust in the regime and the confidence in the future of the national economy. More specifically in the case of Argentina, the monetary regime was *bi-monetarist*, the dollar and the peso were both legal tenders. By the way, Argentina shared its base money between the peso base money produced by the CB and the imported dollar base money privately managed, meanly by banks and traders. The imported base money was entirely independent from the CB rule. We could suppose that if the constraint becomes tighter, the incitement to use dollar would be higher, that to say people hold a greater part of their private local deposits in dollar. In effect, people worry by the long recession and mistrustful about their institutions used the possibility to hold deposits in dollar to protect their assets, by the way, the base money, is to say monetary

policy, become less sensitive to external account variations and the adjustment mechanism disappear. When the crisis become really critical, in order to avoid the deflation due to the shortage of liquidity, some federal bodies (federal treasuries) issue substitute base money as *patacondes* or *argentino* which contribute to make the legal base money issued by the CB less sensible, indeed rigid, to external account.

The skirting of the central bank by an important part of the private sector, as the will of the government to soften the rule, could make the regime inoperative to implement an efficient external account adjustment mechanism likely to improve the survival of fixed exchange rate. In order to test if the currency boards are as strong and honest as they look, we evaluate, in the next section, the standard currency board behavior in the group of five countries implementing this regime in the 90's. The average effective implementation of the rule is used as a benchmark to stress the experiments that significantly deviate from the CB's rule commonly used.

2. Empirical test on long run and dynamic relation between base money and external position.

In this section, we test the link previously supposed between base money supply and external reserve. The experiments of institutional monetary rule regime on a long period of time are not really numerous. So we use an unbalanced panel data structure with 5 countries (Argentina 1991-2002, Estonia 1992-2002, Lithuania 1994-2002, Bulgaria 1997-2002 and Hong-Kong 1990-2002).

Formally, we can write a long run relation between base money and external balance:

$$M0_{i,t} = \beta_i \cdot X_{i,t} + \varepsilon_{i,t} \quad (1)$$

with $X_{i,t} = C_i + \sum_{j=t0,i}^t BG_{i,j}$.

$M0_{i,t}$, is the base money at time t for the country i . It is the part of money aggregate on which the monetary authorities have a monopoly on issue. The series are provided by the international financial statistics (IFS), issue December 2001. We use the ratio between the M0

aggregate and the GNP. Such a ratio permits to have a more homogenous indicator to compare M0 variations between countries³.

$X_{i,t} = C_i + \sum_{j=t_0,i}^t BG_{i,j}$ represents the net currency balance or exterior position of the country i at time t . C_i are the foreign available reserve at the beginning of the system and $\sum_{j=t_0,i}^t BG_{i,j}$ are the cumulated overall balances $BG_{i,t}$, since the beginning of the system is in $t_{0,i}$ in each country. The data on reserves and overall balances are extracted from IFS December 2001. We use the ratio of the external position to the GNP⁴. This aggregate represents the stock of foreign assets standing in the country at each date. This evaluation of foreign assets is different from the foreign asset available for the currency board. Indeed the only a part of the stock of foreign assets belongs to the board.

ε_{it} is the usual disturbance term for the country i at time t .

β_i is the coefficient of the long term relation between base money and the stock of foreign assets. The currency board principle well defines the relation between base money and the fraction of foreign asset belonging to the board. Indeed, in a strict 100% backing rule, the coefficient linking base money and board foreign asset must be equal to 1. However, the exceptional rule-ratio manipulations and excess reserve practices are able to slightly deviate the coefficient from one. Moreover, we don't test the relation between the fractional currency board reserve and the base money, but the relation between the total external position of the country and the base money. The board handles only a fraction of the total foreign asset and doesn't clearly define the relation that we estimate. We assume thus that the relation between the two aggregate must be high, that to say close but less than 1, and strongly significant.

The unit of time is the quarter. In a first time, we test the order of integration of M0 (base money), and of the country external position, with a specific unit root test adapted for panel: Maddala and Wu (1999) based on the Elliot, Rothenberg and Stock (1996) statics. In a second time, with the Choi (2001) method, we test the co-integration hypothesis in our model. In a third time, we provide an estimation of the long run relation between base money and external position assumed in currency board regime. Finally, we highlight the short term dynamic, using the Engle Granger two steps method.

³ Annex 2: The table A.1 gives some statistical information about M0.

⁴ Annex 2: The table A.2 gives some statistical information about the exterior position.

2.1. Unit root tests.

The unit root tests in time series had been criticized because of their low power. But in maximizing the asymptotic proprieties, the panel improves significantly the power of these tests. Moreover, the panel data structure leads to some specific problems: individual heterogeneity and the cross-sectional correlation⁵.

Maddala and Wu (1999) update a test due to Fischer (1932), based on unit root test (all the unit root tests providing p-value) p-value combination. The p-value are estimated on individual series and depends on the chosen distribution of the test, here we present the p-values following a Student and a Mac Kinnon distribution. The MW statistic indicates the global significance of unit root estimations among individuals, as a classic fisher test indicates the significance of a group of variables. If the estimates of the panel are not together significant, we cannot reject the presence of a collective unit root. It is a non-parametric test; robust to different lag length and particularly well fitted for unbalanced panel. In practice, the MW method can be applied with any number of lags and any temporal or individual panel dimension. The test also relaxes the assumption of cross sectional independence. It is, thus, particularly attractive.

The MW test can be formulated as:

$$\Delta y_{i,t} = \alpha_i + \rho_i y_{i,t-1} + \sum_{j=1}^k \theta_j \Delta y_{i,t-j} + e_{i,t} \quad (2)$$

ρ_i are the unit root parameter estimated for each individuals.

The ρ_i p-values are computed to obtain the Fischer statistic⁶:

$$\text{MW stat} = -2 \sum_i^n \ln(\pi_i) \mapsto \chi^2(2n) \quad (3)$$

(π_i) are the p-value obtained by ERS test on isolated time series. The null hypothesis is the assumption of collective unit root. Indeed, the test gives the significance of the whole ρ_i . If the MW statistic reveals that the ρ_i are not together significant, we cannot reject the presence of a collective unit root in the panel.

The individual series are systematically detrended following the Elliot, Rothenberg and Stock (ERS) procedure (1996). The detrending vanishes the presence of deterministic

⁵ i.e. the overview of Banerjee (1999).

⁶ $2n$ is the degree of freedom, with n the number of individuals in the sample.

trend in individual series likely to weaken the ADF test. Our series on money and external accounts are known to be usually subject to deterministic trend. This alteration of the series greatly improves the ADF power⁷.

Table 1

ERS statistics for a MW test of panel collective unit root.

Base money	Student distribution	Mac kinnon distribution
Argentina	0.536	0.8669
Bulgaria	0.670	0.9058
Hong Kong	0.840	0.9392
Estonia	0.524	0.8607
Lithuania	0.823	0.9729
MW test	4.079	0.9640
H0 : the whole ρ_i is not different from 0		
Chi-2 Critical value 5% : 18.307		
Chi-2 Critical value 10% : 15.98		
External position	Student distribution	Mac kinnon distribution
Argentina	0.14	0.52
Bulgaria	0.30	0.70
Hong Kong	0.65	0.90
Estonia	0.71	0.91
Lithuania	0.20	0.60
MW test	11.119	3.416
H0 : the whole ρ_i is not different from 0		
Chi-2 Critical value 5% : 18.307		
Chi-2 Critical value 10% : 15.98		

This test, presented table 1, is not able to reject the null hypothesis of unit root in the time series for the two variables. The money supply and the currency balance are, thus, non-stationary on the period of time and for the group under study. The base money and the external position are not means reverting. As the ERS process eliminates the deterministic trend; we could make the assumption that the two aggregates are not stationary around a deterministic trend. The presence of unit root means that the aggregate suffers shocks non-perfectly corrected from period to period, that is to say shocks have permanent effects on the variable. It is understandable that the external position of developing countries will quite quickly change with growth and development. A country, which becomes richer, will know

⁷ Others tests as Phillips Perron are computable, however we choose to focus only on a ADF based test which is likely more illustrative of the cross sectional panel implications.

an increase of its external position. This increase will be deeply influenced by the erratic variations of the growth rate, and by the also erratic variations of the political preference for inward or outward looking development.

2.2. Co-integration test.

Choi (2001) proposes a comprehensive co-integration test. It is the extension for panel data of unit root test based on residual from the Engle Granger first step. The method consists in determining the order of integration of the estimated residual of the long run relation: ε_{it} (equation 1). It is close to the previously presented unit root MW (1999) test. It consists in a combination of residual unit root test p-values calculated for isolated time series. In effect, it follows the same procedure and the same critical value as MW (1999). It is, thus, easy to compute and presents the same advantage of the MW test. Especially, it requires few assumptions on sample and individuals nature (cross sectional heterogeneity, cross sectional independence) and has high power⁸.

The result are presented in table 2. We should admit that one time series included in our panel is quite short to report an ADF test really strong; the other time series are good enough to be reliable. The test is not able to reject the hypothesis of co-integration.

Table 2

ADF statistics for a MW test of panel collective co-integration.

Co-integration relation residuals	ADF P value Student distribution
Argentina	0,01
Bulgaria	0,01
Hong Kong	0,13
Estonia	0,01
Lithuania	0,01
MW F-test	40,9218031
H0 : the whole ρ_i are not different from 0	
Critical value 5% : 18.307	
Critical value 10% : 15.98	

⁸ We don't apply any detrending on residual series; indeed the presence of a deterministic trend would be the sign of a co-integration failure.

Co-integration between base money and foreign assets is theoretically expected, the test supports the theoretical hypothesis. Indeed, the statistic doesn't stress the presence of unit roots in the co-integration long-run relation residuals.

2.3. Model specification: Long-term representation.

The currency board systems give us the luck to establish a clear bi-variate co-integration relation. The two integrated variables are the base money and the external position. The long run relation, Engle Granger first step, could be described in three ways as follows:

- (1) All the countries across the panel are supposed to have the same behaviors (to be the same), thus the coefficient and the intercept are homogenous between individuals, i.e equation 4.

$$M0_{i,t} = \alpha + \delta.t + \beta.X_{i,t} + \varepsilon_{i,t} \quad (4)$$

- (2) The panel is known to be heterogeneous. In such a panel, we cannot assume a perfect homogeneity in intercepts and slopes across individuals, i.e. equation 5.

$$M0_{i,t} = \alpha_i + \delta_i.t + \beta_i.X_{i,t} + \varepsilon_{i,t} \quad (5)$$

- (3) In a CB's case, the monetary authorities intervention means are ruled, we can, thus, suppose the individual behaviors to be quite homogenous and slopes to be close. Our specification, inspired from Pedroni (1995), supposes and tests the homogeneity of the slope β_i constant among countries. However, we keep the individual specific intercepts to allow for certain heterogeneity among individuals due to the great diversity of country types in our sample, except the use of CB's system. In addition, we introduce individual specific time trend in order to control for trend likely to be present in monetary aggregates. The sustainability of the exchange rate regime as exposed formerly supposes a marginal or negative time trend, that to say δ_i non significant or negative, i.e. equation 6.

$$M0_{i,t} = \alpha_i + \delta_i.t + \beta.X_{i,t} + \varepsilon_{i,t} \quad (6)$$

The following chart illustrates the chosen modelisation of the currency board rule. Three scenarios are exhibited. The first scenario assumes the convergence between base money and external account toward a stable long run relation as illustrated by B. As previously

specified, the line B has a slope positive, constant, close to one but always inferior to the unity. An intercept assumes that the base money would never be null, even if the external position is null. The panel specification allows this intercept two be different across countries, for the ease of the representation we draw only an unique intercept. The B line constitutes a boundary. Above the line, the A case, the base money/external position ratio grows at a faster rate than the long run relation, thus the monetary policy diverges from the rule and the fixed exchange rate regime becomes unsustainable. Below the B line, the ratio base money/external position grows at a rate inferior or equal to the long run relation, the regime is viable. A positive and significant deterministic time trend or a slope superior to the unity correspond to the A scenario. Non significant or negative trends and a slope equal or inferior to one correspond to the viable scenario B and C.

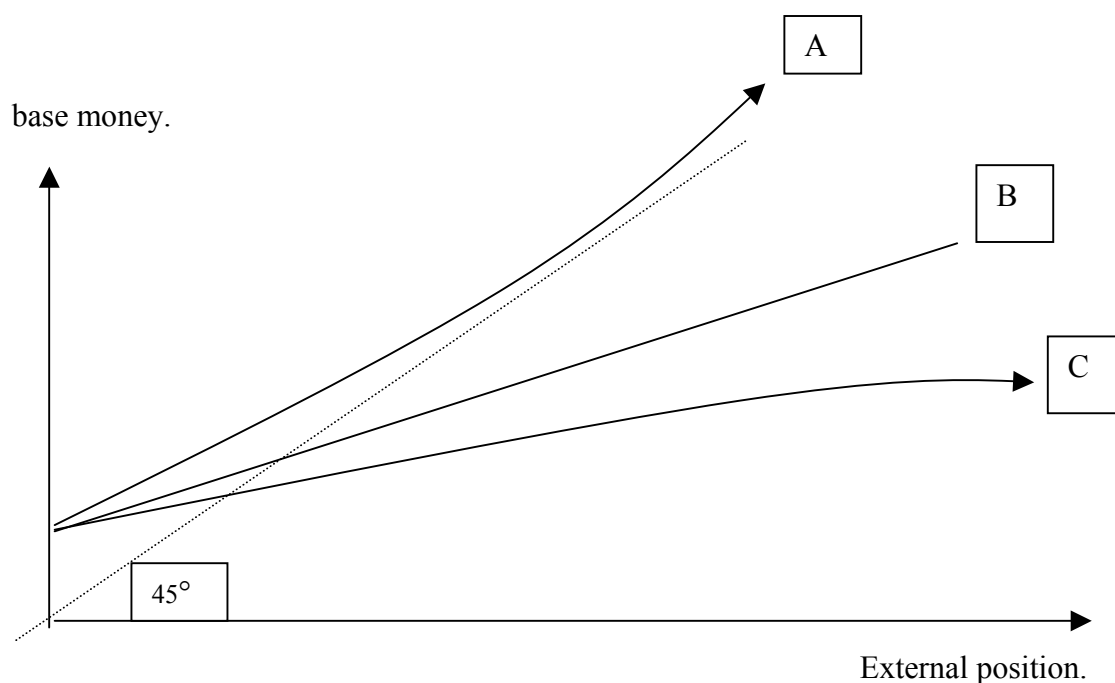


Fig. 1. Convertibility scenario in a Currency Board context.

Table 3

Engle Granger long-term relation. Equation 6.

Number of observation = 141			
Within estimator			
R-sq:0.93			
		Coefficient.	p-value
$X_{i,t}$		0.51	0.000
Individual time specific effect	Argentina	-0.00063	0.013
	Bulgaria	0.00283	0.026
	Hong Kong	-0.00880	0.762
	Estonia	0.00102	0.190
	Lithuania	0.00022	0.754
Constant		0.02766	0.000
(fixed effects) F(4. 130) = 2.43(0.01)			

The long run estimation fits well with the model assumption, i.e. table 3 : the slope is strongly significant, positive and inferior to one. Consequently, we conclude that it exist on the long run and across the panel a stable base money / external position relation. The estimated coefficient which sizes 0.51, indicates that the base money is undersensitive to the external position variations. Indeed, only a part of the external position are recorded in the currency board accounts, the remainder is kept by the public or by the banks. The external flux which impacts the central bank balance sheet are, thus, the lone likely to change the monetary policy, that to say to modificate the base money stock. The trends are, in a great majority of cases, no significant or negative. The lone positive significant trend concerns Bulgaria one of the shorter time series. But, in this case, we notice that the estimated trend is really low, or even marginal.

2.4. Homogenous short-term dynamic.

We think that during each period, due to various internal and external shocks, the base money will tend to deviate from its long-term relation with the country external position, defined in equation 6. However, in contrary to other monetary regimes, the CB's system forecasts an automatic mechanism to send back the base money to its long run correspondence with CB external assets (proxy of the country external position). This mechanism defines an error correction model close to that presented by Engle and Granger (EG) (1987). The EG method has often been criticized, above all it is really non-performing on small sample. It is also particularly sensitive to the presence of omitted variables. The rule-

based model may bring a correct specification moreover, the use of a fixed effects model catches the effect of individual specific and time invariant characteristics⁹.

The dynamic short run relation could be written as:

$$\Delta M0_{i,t} = a_i + b.\Delta X_{i,t} + \sigma.(\varepsilon_{i,t-1}) + e_{i,t} \quad (7)$$

b gives the dynamic between the base money supply and the overall balance. b is supposed constant across countries. σ is the coefficient of the error correction term. It gives the rate of convergence of the model to its long-term equilibrium. If σ is significantly $-1 < \sigma < 0$, the model is convergent to the long run equilibrium defined in (6). If σ is not different from 0, the model would not converge to an equilibrium. According to the Granger theorem, co-integrated variables always converge. A significant convergence coefficient σ is, thus, the indicator of a correct co-integration specification.

Table 4

Engle Granger short run dynamic. Equation 7

Number of observation =122		
Within estimator		
R-sq:0.72		
	Coef.	P-Value
$\Delta X_{i,t}$	0.44	0.000
$(\varepsilon_{i,t-1})$	-0.82	0.000
Constant	0.00053	0.74
(fixed effects) F(4,115) =2.3(0,05)		

The convergence coefficient (table 4) is strongly significant, that supports our hypothesis of co-integration and also confirms the good feature of the EG model. The rate of convergence is quite high, from a quarter to another, more than 3/4 of the divergence from the long-term equilibrium is corrected. The monetary policy will, thus, quickly react to any modification of the external position. In less than 6 months, the base money will be adjusted to its long run relation with the stock of external assets available in the country.

⁹ Others methods have been developed in the area of co-integration as for example the one step procedure or the Henry method. They both present bias consisting in lagged dependent variable endogeneity in a panel specification. Assessing respective bias of the methods, we prioritize the EG procedure.

2.5. Heterogeneous short-term dynamic.

Finally, we cross the correction error term and the country dummy variables to test for some panel heterogeneity in the error correction term σ (table 5). So we estimate the following model:

$$\Delta M0_{i,t} = a_i + b.\Delta X_{i,t} + \sigma_i.(\varepsilon_{i,t-1}) + e_{i,t} \quad (8)$$

Table 5

Error Correction Term homogeneity.

Number of observation =121

Within estimator

R-sq: 0.74

	Coefficient.	p-value
$\Delta X_{i,t}$	0.43	0.000
(ε_{t-1}) Argentina	-0.20	0.020
(ε_{t-1}) Bulgaria	-0.99	0.013
(ε_{t-1}) Hong Kong	-0.73	0.013
(ε_{t-1}) Estonia	-0.81	0.009
(ε_{t-1}) Lithuania	-1.01	0.016
Constant	0.006	0.321

In a perfect homogeneity context the entire coefficient estimated for the error correction term would have been the same. However, the individual specific effects do not seem to be perfectly neutral. In particular, Argentina significantly diverges from the other countries in the panel and reveals a less efficient convergence. This divergence can be explained by a “soft” interpretation of the rule or by the people abandon of the peso. In particular, another reflection has to be carry out about the role played by the substitutes of money issued by federal bodies at the end of the regime. They have, probably, contributed to significantly lower the sensibility of the base money to external accounts, and to lower the sensibility of money and credit to the board base money, that to say the official peso issued by the board.

In order to test further the panel heterogeneity, we implement another test. We add to the general error correction term and individual specific error correction term for each individuals.

$$\Delta M0_{i,t} = a_i + b.\Delta X_{i,t} + \sigma(\varepsilon_{i,t-1}) + \sigma_i.(\varepsilon_{i,t-1}) + e_{i,t} \quad (9)$$

We estimate the equation (9) with $\sigma_i(\varepsilon_{i,t-1})$, the country specific error correction for one country (i), and $\sigma(\varepsilon_{i,t-1})$, the general error correction term for all the panel. We repeat the process for each country of the panel. By the way, we can estimate the differential impact of each country on the panel co-integration short term relation.

Table 6

Country specific effect.

fixed effect estimation		
	Panel ECT	Country specific ECT
Argentina	-0,92**	0,7**
Bulgaria	-0,79**	-0,2
Hong Kong	-0,84**	0,12
Estonia	-0,81**	0,0014
Lithuania	-0,72**	-0,46**

The error correction term is significant for any control; that confirms the coherence of our currency boards panel. However, we notice two groups of countries. On one hand, Estonia, Bulgaria and Hong Kong for which the control is not significant, that means that these three countries have not specific effect different from the remainder of the panel. In particular Estonia appears to be the currency board standard of the panel. Its control specific makes absolutely no changes. In another hand, Lithuania and Argentina significantly break the homogeneity of the panel. Lithuania converges toward the long-term equilibrium quicker than the remainder of the panel (40% quicker). On the contrary Argentina converge much more slowly toward the equilibrium than the rest of the group. This divergence reveals a "soft" implementation of the rule likely to disrupt the regime.

3. Conclusion.

Our tests conclude that the currency board regime permits, in most of case, a rapid convergence between base money and external account. This convergence had been stressed as the condition of viable fixed exchange rate regime. In addition, the behaviors of the currency board regimes are quite close. The monetary policy of all countries, honestly adopting a currency board, converges toward the same result.

However, some divergences are empirically noted. Government and board keep some rooms likely to tighten or to soften the constraint imposed by the rule. In addition, the regime stays dependent from the trust of people and of the state good governance. In the majority of cases no significant deviations in opposite to the rule are noticed. The lone case, which exhibits a clear deviation from the rule, is the case of Argentina. The Argentinean case is a relevant example of board's limits. Indeed, Argentina did not seem able to accept the currency board constraints. Some internal characteristics make the internal cost, in terms of unemployment for example especially high and painful. Consequently, the government and the board used all rooms available to soften the rule. People used to handle dollar and peso, both national legal tender, accumulated dollar position out of the rule regulation. At the end of the system, symptomatic of the government no cooperation, some federal bodies issued notes as central bank money substitute. These issues contributed to ended the system.

Appendix A

Laws and Acts ruling monetary authorities in some CB regime.

Estonia

The first Estonian central bank born with the first Estonian national independence in 1919. It was an active body disposing of great discretionary powers. However, in order to permit fixed exchange rate with the German mark, it reforms its status to approach a currency board system based on a gold standard (1926). With the soviet invasion the bank of Estonia lost its independence (1938), and finally disappeared (1946). In the last years of soviet occupation (1988-1991), a kind of pre-liberalization made emerge some commercial banking activities and increased the foreign trade. To cope with the central government incapacity, the local authority begun to empower quasi-monetary authorities and to imagine the development of local commercial banks and of national money. When the transition period begun, the entire ex-soviet republic known recession and hyperinflation. On the base of the primitive monetary authorities already created, the Estonian government decided to empower a currency board to avoid a predictable monetary crisis. The Estonian bank got back the gold reserve of the old Estonian CB of 1926 hidden in England; it also sold to private sector a part of the public patrimonial. These resources were used to constitute the foreign reserve of the bank. The Currency act (1992) established the exchange rate of the Estonian *kroon* with the Deutsche mark and now with the Euro. It also specified a foreign reserve requirement of 100% of the base money.

As in the case of Argentina, the act on currency established the currency board system. The law on the central bank of the republic of Estonia, established the common tool available for a traditional central bank to pursue its activities under the limitation of the Currency Act:

The law forecasts rediscount, reserves requirement and deposit on CB account (article 9).

The law forecasts a body in charges of the commercial banks supervision (article 17), that means issuing and revoking bank licenses.

The law stipulated the independence of the central bank from the all-public bodies (article 1 and article 3), and specified clearly its mission: the bank of Estonia regulates the currency circulation in respect with the currency act.

Lithuania.

The first central bank of Lithuania was empowered by the constituent assembly in 1922. Its destine follows the destine of the Estonia central bank, after the soviet invasion all the banks were nationalized and the central bank disappeared. The independence process is close of the process followed by Estonia. The local authorities created the embryo of monetary authorities to overcome the central government incapacity (1988-1990). After the independence, the Lithuania case is more unconventional; they empowered first a complete central bank (1991). This central bank issued a provisional currency, the *Talonas* (1992), highly inflated and non-convertible. In 1994, the monetary authorities issued a new currency the *litas* ruled by the “law of the republic of Lithuania on the credibility of the *Litas*”, which in fact installed a currency board.

The “law on credibility of the *litas*” (n°1-407(1994)) explicitly specifies that :

Article 1: the *Litas* put into circulation by the CB is fully covered by gold and foreign exchange reserves of the CB.

Article 2: the amount of *Litas* in circulation does not exceed the foreign exchange reserve.

Article 3: the official exchange rate of the *litas* shall be established against the currency chosen as anchor. Only in extraordinary circumstance, the central bank in coordination with the government may change the official exchange rate.

This formulation is one of the more explicit and strict encounters in currency board system definition. The central bank chart (n°99-1957 and n°28-890 (1994)), however, mainly inspired from the first version of (1994) is close to the chart of a classical independent central bank.

We find the disposal for central bank independence (article 3).

Usual credit regulation : limited rediscount (article 26) and open market (article 29)

Usual bank supervision limited to the issue of licenses and to the imposition of prudential ratio. (article 46)

One of the main originality of this chart is that the law initially established that the bank of Lithuania determines and announces the official *litas* exchange (article 31) rate. The law on the *litas* credibility fixes the exchange rate, but also let to the central bank the ability to change the nominal exchange rate in “extraordinary circumstances”.

Bulgaria.

The Bulgarian central bank has been empowered by the newly autonomous from Turkish sultan kingdom of Bulgaria, with the help of the Russian tsarist administration in 1879. After some unsuccessful first experiment a new law establish the Bulgarian National Bank, ancestor of the present central bank (1885). This body was state owned and could lend to the government. The institution known several crisis and hardly staid on the gold standard. The first world wars imposed the emission of necessity notes, quickly inflated. The great depression pushed the monetary authorities to vanish the classic standards (as gold) and a law (1937) increases the BNB dependence on the state.

During the communist period, the BNB was dependent of the communist party. In contrary to the Estonian and the Lithuanian case, the local authorities did not prepare the transition. In 1991, a law fully restores the BNB in modern central bank prerogatives. In 1992, a law on bank and credit activity is empowered.

However, the transition problem deeply affected the monetary policy and the banking sector. The system established in 1991 seems not able to cope with inflation and bank failure. (Bad loans). After the tragic hyperinflation of 1996-1997, the BNB had been reformed as a currency board: the exchange rate is fixed with the deutsche mark, thus, the Euro. The BNB became independent and not allowed lending to the government. The lender at last resort of the monetary authorities has been strictly ruled.

The Bulgarian case is one of the last CB's experience, the new BNB law inspired by its predecessors and well prepared, is one of the most relevant CB's Act:

The same law include :

- The main objective of the institution that is contributed to the maintenance of the stability of the national currency (article 2)
- The independence of the institution (article 12)
- The currency board principle (article 28, 29, 30)
- The relation with the government (chapter 7).

The law also precise the relation with the bank in the chapter 6. The chapter 6 is almost the last one, relatively short and elusive, it gives to the institution some means of credit regulation (reserves requirement article 42).

The Bulgarian central bank chart is less ambiguous than the former three. It explicitly includes the currency board principle in the chart and explicitly limits the bank regulation on credit and financial activities. In the three previous case, more (Lithuania) or less (Argentina, Estonia), a new law (currency, convertibility or credibility act) restraints the central bank objectives and capacity without so clear modification of its chart. The government uses this mean to make easier the exit from a currency board system: they just have to make void the currency act and let the central bank use all the tools conserved (but not used) in they ambiguous charts.

Appendix BDescription of variables M0 and external position

Table B.1

M0¹⁰

Countries	Period (quarterly)	Number of observations	Means	Standard deviations
Argentina	1991q2 – 2001q3	41	0.05	0.0075
Bulgaria	1997q1 – 2001q4	18	0.11.	0.037
Hong Kong	1996q4 – 2001q4	24	0.105	0.045
Estonia	1992q3 – 2001q3	36	0.12	0.026
Lithuania	1994q2 – 2001q4	28	0.084	0.011

Table B.2

Exterior position¹¹

Countries	Period (quarterly)	Number of observations	Means	Standard deviations
Argentina	1991q2 – 2001q3	40	0.06	0.024
Bulgaria	1997q1 – 2001q4	16	0.082	0.037
Hong Kong	1996q4 – 2001q4	40	0.0402	0.088
Estonia	1992q3 – 2001q3	33	0.145	0.027
Lithuania	1994q2 – 2001q4	28	0.11	0.018

¹⁰ sources : IFS December 2001.¹¹ sources : IFS December 2001.

Appendix C

List of present Currency board (2000)¹²

COUNTRIES	EMPOWERMENT DATES.	ANCHOR	OFFICIAL COVERAGE	EFFECTIVE COVERAGE
Argentina	1991	1 Peso = 1 dollar (EU)	100% (M0*)	139% M0, 23% M2
Barbuda	1965	Dollar US	60% (M0*)	86% M0, 12% M2
Bermudas	1915	1 Bermudas pounds = 1 dollar EU	100% (M0*)	?
Bosnia-Herzegovina	1997	1 mark BZ = 1 DM (0.5 Euro)	100% (M0*)	?
Brunei	1952	1 Brunei dollar = 1 dollar de Singapore	100% (M0*)	?
Bulgaria	1997	1 lev = 1 DM (0.5 Euro)	100% (M0*)	148% M0, 54% M2
Djibouti	1949	177.72 Dj franc = 1 Dollar (EU)	100% (M0*)	?
Estonia	1992	8 Kroon = 1DM (0.5 Euro)	100% (M0*)	122% M0, 47% M2
Gibraltar	1927	1 Gibraltar pounds = 1 sterling	100% (M0*)	?
Hong Kong	1983	7.8 Dollar HK = 1 dollar (EU)	100% (M0*)	110% M0
Caymans Isles	1972	1 Caymans island dollar = 1,2 Dollar (EU)	100% (M0*)	?
Faeroe Isles	1940	1 crown Faeroe = 1 Danish crown	100% (M0*)	?
Lithuania	1994	1994-1997: 4 litai = 1 dollar 1997-2001: 4 litai = 1 Euro.	100% (M0*)	112% M0, 51% M2
Falklands	1899	1 Falklands pounds = 1 sterling pounds	100% (M0*)	?

* The aggregate M0 is the money issued by the central bank.

¹² Sources: IFS IMF February 2001, Schuler (2000). The effective coverage ratio are calculated by Ghosh, Gulde et Wolf (2000)

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