EconomiX

http://economix.fr

Document de Travail

Working Paper

2014-61

On the effectiveness of devaluations in emerging and developing countries

Carl Grekou

UMR 7235

Université de Paris Ouest Nanterre La Défense
(bâtiment G)
200, Avenue de la République
92001 NANTERRE CEDEX

Tél et Fax : 33.(0)1.40.97.59.07
Email : nasam.zaroualete@u-paris10.fr

université Paris Ouest Nanterre La Défense

On the effectiveness of devaluations in emerging and developing countries

Carl GREKOU*

Abstract

In this paper, we address the issue of devaluations' effectiveness by investigating to what extent a nominal devaluation leads to a real depreciation. Beyond the traditional factors identified by the literature, we pay particular attention to the size of the nominal devaluation and to the initial misalignment of the real exchange rate. Using a sample of 57 devaluation episodes (in 40 developing and emerging countries) and relying on panel data techniques, we evidence that the existence of a sizeable overvaluation of the real exchange rate is a prerequisite to ensure that nominal devaluations will have an expected effect in terms of real depreciations. Furthermore, our results put forward a potential nonlinear relationship between the size of the devaluation and the effectiveness of the nominal adjustment: devaluations operate more efficiently when the magnitude of the nominal adjustment is lower.

Keywords: Bayesian model averaging; Currency devaluations; Macroeconomic policies; Real exchange rates' misalignments.
JEL Classification: C1, E6, F3, F41

*EconomiX-CNRS, Université Paris Ouest Nanterre - La Défense. 200 Avenue de la République, 92001 Nanterre Cedex, France. Email: g.grekou@u-paris10.fr
I am very grateful to Cécile COUHARDE for valuable comments and suggestions. All remaining errors are mine.

1 Introduction

The evolution of the real exchange rate is a critical issue for economic stability as well as for development process in many emerging and developing countries. Here are in substance the conclusions of the sizeable literature on the impact of exchange rates (see, among others, Gosh et al., 2003; Klein and Shambaugh, 2010). That is why emerging economies and developing countries facing economic hardship —or even financial crisis— have often undertook a number of macroeconomic adjustment programs to restore "equilibrium", but, have unavoidably relied on exchange rate-based adjustment program, e.g. nominal devaluations. These nominal devaluations, whether intended or not, are expected to generate a real depreciation (improve the degree of international competitiveness) which in turn is viewed as a way to reduce macroeconomic imbalances and even to renew growth.

Unfortunately, devaluation programs, presented as the ultimate solutions, have often failed to improve the economic situation. Tackling this issue, a number of studies (Edwards, 1989; Edwards and Santaella, 1992; Kiguel, 1994; Guillaumont and Guillaumont, 1995) already put forward some prerequisite conditions for the success of a nominal devaluation, by focusing on its effectiveness, i.e. the extent to which it will lead to a real depreciation. Following this definition, the success of the devaluation, i.e. its ability to improve the macroeconomic situation of a country, will first depend upon its effectiveness.

According to this literature, the effectiveness of devaluations depends on a set of factors as the institutional environment, the exchange rate system, the wage indexation policies and more importantly, the accompanying macroeconomic policies (Edwards, 1989; Edwards and Santaella, 1992; Morrisson et al., 1993; Guillaumont and Guillaumont, 1995; inter alios). Nevertheless, except Guillaumont and Guillaumont (1995), none of those studies investigate the potential role of initial disequilibrium situation in which a devaluation is implemented and of the rate of devaluation itself. Moreover, as most of those studies are based on descriptive statistics, comparative analyses and cross-country regression analyses, they are unable to deal with causality problems among the involved variables and properly quantify the size of initial disequilibrium and of the devaluation, above which this nominal adjustment becomes effective.

The aim of this paper is to fill this gap by paying a special attention to the size of the devaluation and the initial disequilibrium situation, proxied here by the real exchange rate distortion. Accordingly, our empirical analysis is carried out in two stages. Firstly, we constitute a panel of devaluation episodes in developing and emerging countries and assess real exchange rate misalignments prior to those episodes. Secondly, relying on this panel, we assess the degree to which the movements in the nominal exchange rate are transmitted to those of the real exchange rate, in order to capture how effective are devaluations and investigate the key factors influencing this effectiveness.

From a methodological point, our contribution is threefold. Firstly, while previous studies are based on cross-section regressions, we rely on panel data techniques, adding then a time series dimension. In addition, we consider a wider sample of devaluation episodes compared to previous studies. Secondly, we conduct a robust analysis to select relevant fundamentals of real exchange rates in order to derive currency misalignments, by relying on Bayesian techniques. Finally, we extend the existing literature by evaluating the importance of the size of the devaluation and the initial misalignment of the real exchange rate in addition to the factors usually identified.

While our results confirm the importance of the macroeconomic policies implemented along with the devaluation, they also highlight the initial real exchange rate misalignment and the size of the devaluation as relevant *ex ante* effectiveness' factors. Finally, the socio-political context as well as the degree of capital account openness do not seem to have any significant impact.

The rest of the paper is organized as follows. Section 2 sets the background for our analysis and details our contribution to the existing literature. In Section 3, we present the data as well as our methodological approaches. In Section 4, we show and discuss our results. Finally, Section 5 concludes.

2 Theoretical and empirical background

2.1 On the effectiveness of nominal devaluations: lessons from the literature

Devaluations have been, for a number of countries facing crises (especially developing ones), at the core of macroeconomic adjustment programs. Indeed, this nominal exchange rate adjustment aimed at restoring equilibrium by improving the countries' international competitiveness and then their external and internal positions. However, the achievement of these objectives primarily depends on the effectiveness of the devaluation, that is, to what extent a nominal devaluation may generate a real depreciation.

Many authors, among them Edwards (1988, 1989, 1992, 1994) through noticeable contributions, have addressed this issue and highlighted the role played by the economic environment, in which devaluations are undertaken, and by the related macroeconomic policies.

Given that a devaluation aims at restoring macroeconomic equilibrium through a real depreciation, it should be implemented in situations where the real exchange rate is overvalued. Indeed, in this context, a devaluation can be an useful tool to restore macroeconomic balances since it helps avoiding the costly and lengthy process consisting in putting and keeping the domestic inflation below the international level in order to generate a real depreciation. Moreover, if price and wages movements are rigid downward, the usefulness of the devaluation is even larger. A nominal devaluation is thus particularly effective in low inflation countries —where prices and wages adjust relatively slowly— because in that case, it is more likely to affect the real exchange rate (Abbritti and Fahr, 2011). On the contrary, attempts to achieve real depreciations through repeated devaluations frequently end up with increasing inflation, although being ineffective in changing the path followed by the real exchange rate (Kiguel, 1994; Guillaumont and Guillaumont, 1995). Indeed, the effect of surprise seems essential to the effectiveness of devaluations, by avoiding rising inflationary expectations. Guillaumont and Guillaumont (1995) argue that the effectiveness of a devaluation relies on the monetary illusion, or put in another way, on an under-estimate of inflation: the more devaluation is a repetitive phenomenon, the more inflation expectations will be widespread. With inflation expectations closer to real inflation, the less effective the devaluation will be. This consideration is in line with the results evidenced by Edwards (1989) who finds for stepwise devaluations a very low rate of success.

Another strand of the literature, also in relation to initial conditions, has focused on the importance of socio-political and institutional determinants in the successfulness of adjustment programs (see among others, Cukierman, Edwards, Tabellini, 1992; Edwards and Santaella, 1992; Morrisson et al., 1993; Edwards, 1994). Evidence from this literature suggest that political stability is a key factor in the success of any adjustment program and more particularly of devaluation. Some factors such as political cycles (proximity of the elections, government turnover rates) and the socio-political unrest appear to strongly influence the implementation of fiscal adjustments and antiinflationary policies which are necessary for the success of devaluation.[1]

Regarding the macroeconomic policies accompanying a devaluation, it has been widely argued, with reasons, that macroeconomic policies following adjustment episodes play a key role (Khan and Lizondo, 1987; Edwards, 1989). Indeed, a devaluation is often implemented when the real exchange rate is considerably overvalued. These overvaluations are in most cases the result of inconsistent macroeconomic policies which cause a decline in international reserves. Expansive fiscal and/or monetary policies are often the roots, as they induce an increase of the domestic inflation rate and a deterioration of current account, thus making almost inevitable the adjustment if the situation persists.[2] However, in turmoil episodes (as the Latin American and Asian crises) speculative pressures have played an important role in triggering or bringing forward the date of the devaluations. Nonetheless, these pressures arose from the inconsistencies / uncertainties about the economic policies and therefore find their sources in deteriorating macroeconomic fundamentals. Thus, an essential step in the adjustment program seems to be the re-establishment of consistent macroeconomic policies (i.e., fiscal balance and/or financial and monetary discipline).

Furthermore, it is usually accepted that a devaluation must be accompanied by a global demand restriction policy in order to limit inflationary pressures caused by the devaluation. These inflationary pressures might have different sources. First, they could be the result of the consumers switch from imported to domestic goods, the former being more expensive (demand-pull inflation). The increase in import prices could also lead to an increase in production costs. As a result, the increased costs are transmitted to consumer prices, thus raising the general price level (cost-push inflation). Moreover, along with this global demand restriction policy, inflation indexation of wages must be abandoned in order to contain inflation.

A number of studies (see among others, Edwards, 1999, 2001; Stiglitz, 2002) also mentions the potential role played by exchange control policies in stabilizing the economy: restricting capital mobility would reduce macroeconomic instability. Moreover, for countries facing a currency crisis, controlling capital flows would give additional time to restructure their economies. In parallel, the more recent literature on capital flows

[1] Note however that, despite the important lessons drawn from these studies, it is worth noting the potentially endogenous nature of political unrest. Indeed, as pointed out by Guillaumont and Guillaumont (1995), devaluation may itself be a factor of social unrest because it reduces real wages. For Morrisson et al. (1993), social unrest are the result of the inflation generated by the devaluation itself.

[2] Naturally, a real shock (e.g. a term-of-trade shock) can also be the cause of macroeconomic imbalances.

provides complementary insights on this issue. Most of developing and emerging countries, to finance savings gaps or to promote growth and economic development, have removed financial barriers to attract external resources. The significant increase in capital inflows that has followed this financial openness has often resulted in an increasing financial vulnerability. Thus, as highlighted by some studies (Calvo et al. 1993; Lartey, 2007; Saborowski, 2009; Combes et al. 2011), these massive capital inflows have led to a real exchange rate appreciation, thanks in part to the rise in inflation. Naturally, this overvaluation situation, by undermining the competitiveness and widening current account and fiscal deficits, creates major problems for macroeconomic management. In case of sudden stops in capital flows, the fiscal position would be more problematic, making thus more difficult the fiscal adjustment needed to achieve real depreciation.[3] Exchange and capital controls policies, through their stabilizing benefits, might therefore play an important role in the successfulness of devaluation.

Those mechanisms have been illustrated by Edwards (1988) who developed a model of a small open economy with three goods (exportables, importables and nontradables) in which both real and nominal factors impact the short-run dynamics of the real exchange rate.[4] In this model, the long-run equilibrium real exchange rate —that prevailing when the economy reached both internal and external balances[5]— is a function of real variables, the *fundamentals*. These latter variables are the only ones that influence the real exchange rate in both short and long run. However, in the short-run, real exchange rate dynamics is also influenced by nominal factors. Real exchange rate dynamics can thus be captured through the following equation:

$$\Delta q_t = \beta \underbrace{(q_t^* - q_{t-1})}_{A} - \gamma \underbrace{(Z_t - Z_t^*)}_{B} + \Phi \underbrace{(e_t - e_{t-1})}_{C} - \omega \underbrace{(PMPR_t - PMPR_{t-1})}_{D} \quad (1)$$

where q_t and e_t are respectively the real and nominal exchange rates (expressed in log); q_t^* is the equilibrium real exchange rate; Z_t is an index of macroeconomic policies, and ${Z_t}^*$ is the sustainable level of macroeconomic policies. $PMPR_t$ stands for the parallel —black— market premium.[6]

[3]See Calvo (2003) and Calvo et al. (2003) for a review of literature on sudden stops.

[4]The complete model is presented in Appendix D.

[5]The internal balance is reached when the nontradables goods market clears, while the external balance is defined by the steady-state value of the net external position.

[6]The inclusion of the Parallel Market Premium comes for the assumption of a dual exchange rate system: a fixed nominal exchange rate for commercial transactions and a freely floating nominal exchange rate for financial transactions. This dual exchange rate system assumption is made to capture the fact that in most developing countries there is a parallel market for financial transactions.

Equation (1) establishes that the dynamics of real exchange rates is driven by four forces. Firstly, the term A —in equation (1)— represents the convergence process of the real exchange rate to its equilibrium level. The speed of this adjustment is captured by the coefficient β. Secondly, macroeconomic policies captured by the term B. If macroeconomic policies are inconsistent and unsustainable (i.e. $Z_t > Z_t^*$), there will be a real appreciation. The third source is related to changes in the nominal exchange rates, captured through the term C. Finally, the last force, term D, refers to the effect exerted by changes in the exchange rate parallel market premium.

Thus equation (1) aims to assess if any change in the real exchange rate (over the short to medium run) is only explained by the adjustment of the nominal exchange rate or if it also depends on the initial exchange rate distortion (term A) and on the accompanying macroeconomic policies (term B).

2.2 Improving the Edwards's model

If the empirical model developed by Edwards (1988) appropriately takes into account the initial distortion of the real exchange rate in the effectiveness of a devaluation, the link between the initial exchange rate misalignment, the devaluation rate and the inflation dynamics is however missing.

Devaluation by "nature" has a direct inflationary effect stemming from higher import prices. With a higher degree of exchange rate pass-through, the inflationary pressures are particularly important (Ca' Zorzi et al. 2007). So, a strong exchange rate pass-through can require that the appropriate exchange rate adjustment overshoots the initial adjustment. But, as evidenced by the literature on exchange rate pass-through, movements in the exchange rate and prices do not go necessarily one to one in the short to medium run. The issue of the size of the devaluation is thus crucial for the effectiveness: on the one hand, a too large devaluation could trigger unnecessary inflationary pressures which would annihilate the expected effects; on the other hand, a too weak devaluation could fail in improving the economic situation and could thus lead to other devaluations, triggering by the way an increasingly inflation. A key issue is therefore of how sizeable the devaluation should be without endangering the economy (export revenues vs. inflation). In other words, what should be the "optimal" size of the devaluation that may maximize the benefits expected from this nominal adjustment (export revenues) without triggering inflation nor imperiling the government resources?

Guillaumont and Guillaumont (1995) also note this ambivalent relationship between the size of a devaluation and its effectiveness. They argued that devaluation, by decreasing the relative price of nontradable goods (the main one being labor), implies a reduction in the real wage. Assuming that the marginal utility of income is decreasing, a decline in the real income entails a marginal loss of utility. The latter cannot happen without encountering opposition at the social level. Thus, fiscal and monetary policies aimed at containing the nominal increase in the labor price will be even more difficult to implement if the nominal devaluation —and thus the increase in the relative price of tradable goods— is high. Hence, one can suppose that the marginal effectiveness of devaluation is decreasing, that it can be equal to zero, or even negative if the devaluation exacerbates social claims. In other words, the relationship between changes in nominal exchange rates and changes in real exchange rates is likely to be nonlinear. Following the assertion of Guillaumont and Guillaumont (1995), we take into account this potential nonlinear relationship —which can be viewed as a *saturation effect*— by including the squared value of the nominal exchange rate's variation.

Finally, in order to capture the effect of the socio-political environment, we also include a number of variables intended to reflect this context.[7] Usually a devaluation, due to its urgent nature, triggers unpopular measures (lower subsidies, increased or new taxes, reduction of the public wage bill, etc). These unpopular measures in turn generate an extremely tense political and social climate that typically ends up with unrests (strikes or public protests), contributing thus significantly to inflation (Aisen and Veiga, 2005). In such context, some governments have been "forced" to ease or even cancel the stabilization programs undertook along with the devaluation, hereby limiting the effectiveness of the nominal adjustment. The important social and political costs of devaluation have therefore led policy makers and international organizations (namely, IMF) to precede devaluation by adjustment programs —in some cases— in order to enhance the effectiveness of the former. The importance of the socio-political context is therefore noticeable and should be taken into account.

The empirical framework of Edwards can then be extended by taking into account the additional factors mentioned above:

$$\begin{aligned}\Delta q_{i,t} = \; & \beta \,(q^*_{i,t} - q_{i,t-1}) - \gamma \,(Z_{i,t} - Z^*_{i,t}) + \Phi_1 \,(e_{i,t} - e_{i,t-1}) + \Phi_2 \,(e_{i,t} - e_{i,t-1})^2 \\ & - \omega \,(PMPR_{i,t} - PMPR_{i,t-1}) + \lambda \, SP_{i,t}\end{aligned} \tag{2}$$

[7]Further details will be given in the empirical section.

where $SP_{i,t}$ is the vector containing the socio-political variables.

Then equation (2) offers the advantage of encompassing all the different factors identified by the literature that may contribute to the effectiveness of a devaluation: the initial real exchange rate's misalignment, the accompanying macroeconomic policies, the size of the devaluation including a possible saturation effect and the socio-political context.

3 Data and Econometric method

3.1 Data

3.1.1 Selecting devaluation episodes

A devaluation episode is included in our sample if it satisfies two main conditions: *(i)* the change in the nominal exchange rate must be greater or equals to 15%, and *(ii)* no devaluation has occurred during the three years preceding the selected devaluation, nor during the three following years. The threshold chosen for changes in the nominal exchange rate (i.e. at least 15%), while arbitrary, is used by most empirical studies (Edwards, 1989, 1992; Frankel and Rose, 1996; Milesi-Ferretti and Razin, 1998; Céspedes, 2005). The reason is simple: during large devaluation episodes all effects tend to be stronger and therefore easier to highlight. In addition, small devaluations frequently happen without being sufficiently far from each other. Furthermore, the selected devaluation episodes correspond to both *de jure* —official decision— and *de facto* —observed variation— devaluation rate of at least 15%. We rely on changes in the nominal effective exchange rate to identify the *de facto* devaluations[8], and on various issues of the *Annual Report on Exchange Rate Arrangements and Exchange Restrictions* (*AREAER*, International Monetary fund) as well as other sources[9] to identify the *de jure* devaluations.

Our criteria to select devaluation episodes have two main objectives. Firstly, by defining a devaluation episode based on both *de jure* and *de facto* devaluations, and on a sizeable change in the nominal effective exchange rate, we exclude from our sam-

[8]Note that since we are working with annual data, devaluations that occurred at year-end are recorded as they had occurred the following year because the most important variation of the exchange rate will be that of the following year. This choice was dictated by the data analysis.

[9]Kaminsky's currency crises database (2006), and informations from the *Historical Exchange Rate Regime* database (International Economics). This latter is available at: http://intl.econ.cuhk.edu.hk/exchange$_{r}ate_{r}egime/index.php?cid = 20$

ple unsuccessful speculative attacks that are taken into account by studies focusing on financial crises (see among others, Eichengreen, Rose and Wyplosz, 1995; Kaminsky and Reinhart, 1999). Secondly, by imposing that none devaluation has occurred during the three years prior and following the selected devaluation, we definitely focus in our analysis on the short-medium run. Our selection criteria are a bit more restrictive than those of Edwards (1989, 1992) which exclude devaluations that have occurred two years before and after the devaluation. Guillaumont and Guillaumont (1995) do not impose such a constraint and select devaluation episodes, with a criteria only relying on changes in the nominal effective exchange rate. Their analysis has then a major drawback: it does not clearly define the time horizon of devaluations' effects and therefore leads to select, for a country, several episodes that have occurred but not sufficiently remote in time to investigate their effectiveness.

Overall, our selection criteria lead to a sample of 57 devaluation episodes. This sample consists of devaluations that have occurred over the 1976-2009 period in 40 developing and emerging countries. It includes most notable Latin American currency crises (Argentina, 2002; Brazil, 1999; Mexico, 1994 and 2001; Venezuela, 2002; ...), some Asian and European crises (Philippines, 1997; Russia, 1998; Turkey, 1994 and 2001;...) and a number of devaluations that have occurred in African countries (namely the CFA Franc devaluation in 1994). Table A.2.1 in Appendix A.2 provides further details regarding the selected episodes.

3.1.2 Selected indicators

The real effective exchange rate is the dependent variable in the analysis. It is calculated as the weighted average of real bilateral exchange rates against trade partners. The devaluation is assessed by changes in the nominal effective exchange rate. We rely on those multilateral measures because they give fair pictures about the overall performance of the countries by reducing a considerable bias owing from the use of the bilateral exchange rates vis-à-vis the US dollar: indeed a country's currency could depreciate against the US dollar, while appreciating against trading partners' currencies. Both real and nominal effective exchange rates are from the Bruegel's database.

Our set of macroeconomic indicators includes a relatively small number of variables intended to reflect the economic environment as well as the macroeconomic policies implemented along with the devaluation.[10]

[10] This is deliberately done to limit endogeneity and simultaneity problems.

To capture the nature of the fiscal policy, we include the fiscal balance. This variable reflects the consistency or inconsistency of the fiscal policy implemented with the devaluation. Since an overvalued real exchange rate can be directly related to the inconsistency of the fiscal policy —i.e. important fiscal deficits—, the improvement in the fiscal balance can only be a supporting policy for the devaluation: indeed, reducing the fiscal deficit will help limit the real exchange rate's appreciation. The effectiveness of a devaluation is therefore strengthened if this latter is accompanied by a fiscal adjustment.[11] In the same vein, we take into consideration the monetary policy by including the money —and quasi-money— supply (M2) and two indexes of the domestic credit: *(i)* the domestic credit to public sector, and *(ii)* the ratio of domestic credit to public sector to total domestic credit. As in the case of fiscal policy, expensive monetary policies are expected to seriously weaken the effectiveness of devaluations.[12]

Furthermore, we take into account effects that may be exerted by possible changes in the exchange rate regime. Indeed, devaluation episodes are often followed by switch in exchange rate regimes that may impact the adjustment process of the real exchange rate or the implementation and the success of stabilization programs (Gosh et al., 2003). We consider two exchange rates regime classifications: the *de jure* and the *de facto* classifications. The *de jure* classification corresponds to the exchange rate regime officially announced by the country while the *de facto* classification reflects the country observed practices (on the basis of the exchange rate's flexibility and the existence of formal or informal commitments). We here rely on the Reinhart and Rogoff *de facto* classification (Ilzetzki et al., 2011). We also include the Chinn-Ito *kaopen* index (Chinn and Ito, 2008) in order to take into account the existence of exchange controls.[13]

Finally, in order to take into account the potential role that the socio-political context may play in devaluation's effectiveness, we add some variables capturing the political climate, e.g. repression of dissidents, political demonstrations and riots and also the electoral cycle since the proximity of election can impact the real exchange rate dynamics.[14]

[11]We do not discuss the issue of the means by which the fiscal deficits are reduced (e.g. increase in taxes, government expenditures reduction). Even if these ways of reducing the fiscal deficits have different implications regarding the real exchange rate dynamics, they always go the same direction: the reduction of the fiscal deficit limits the appreciation of the real exchange rate or even reduce the overvaluation; the only difference lies in the degree of this effect. For a discussion on fiscal deficits reduction and real exchange rate dynamics, see Khan and Lizondo (1987).

[12]The main transmission channel for the monetary policy is the inflation: an expensive monetary policy following a devaluation would accentuate inflation which in turn would erode the effect of the nominal devaluation on the real exchange rate dynamics.

[13]*kaopen* is a good proxy for restrictions on capital account transactions and current account transactions. We modified the initial scale of the index so that it is bounded between 0 and 1, the value of 1 referring to the highest financial openness.

[14]See, among others, Rogoff and Sibert (1988) and Stein and Streb (2004) for the literature on

We use the *Political violence* index —from the *Center for Systemic Peace*— to proxy the socio-political context. As an alternative proxy, we use the *Political Terror* index (from the *Political Terror Scale*) which can be seen as a global indicator encompassing both civil and political rights. Additionally, we create a dummy variable —*Conflict*— which scores 1 in case of internal conflict —armed or not— and 0 otherwise. Finally, to take into account the electoral cycle, we also create a dummy variable —*Election*— which scores 1 the year of elections, 0 otherwise.

All data are annual. Sources, definitions and calculation details are provided in Appendix A.1.

3.2 Investigating devaluation effectiveness factors

Since we are interested by the effectiveness of a devaluation in short and medium terms, we consider a time window of four years, i.e. the devaluation's year and the three following years. For each year, variables are taken in variation with respect to the year prior to the devaluation.

Before proceeding to the empirical analysis, some additional adjustments are needed. Indeed, equation (2) cannot be estimated since the equilibrium levels of real exchange rates ($q^*_{i,t}$) are unknown. These latter need to be determined in order to make equation (2) operational. This will be done in the next subsection.

Considering that real equilibrium exchange rates have been determined, the term ($q^*_{i,t} - q_{i,t-1}$) in equation (2) reflects the difference between the equilibrium real exchange rate and the lagged value of the observed real effective exchange rate. Denoting this latter Mis_{t_k-1}, and considering all the above statements, equation (2) can be then rewritten as follows:

$$\begin{aligned} \Delta q_{i,t} = \; & \alpha_i + \beta \; Mis_{i,t_k-1} + \; \gamma \; Macro_{i,t_k} + \; \Phi_1 \Delta e_{i,t_k} + \; \Phi_2 \Delta e^2_{i,t_k} \\ & + \lambda \; SP_{i,t_k} + \; \varepsilon_{i,t_k} \end{aligned} \tag{3}$$

where $\Delta q_{i,t}$ (resp. $\Delta e_{i,t}$) denotes changes in the real (resp. nominal) effective exchange rate between the year prior the devaluation and k years after the devaluation. $Macro_{i,t_k}$ is the vector containing the macroeconomic variables and SP_{i,t_k} is the vector of socio-political indicators. $t_k = 0, \ldots, 3$ indicates the considered time horizon (t_0: the devaluation's year; $t_k : 1, \ldots, 3$ year(s) after the devaluation). Finally, α_i stands for

exchange rate cycles around elections.

the country-fixed effects, and ε_{i,t_k} is an error term. Notice that we removed the Parallel Market Premium (PMPR) from the empirical equation. The reasons are mainly twofold. First, the parallel (or black) market premium is often used as a proxy for exchange rate misalignment so use both indicators is repetitive. The second motivation is related to data availability.

In its current form, equation (3) does not yet reflect completely the different mechanisms described above. Indeed, two key elements do not fit properly with equation (3). The first refers to the importance of the initial distortion of the real exchange rate. Indeed, the variable Mis_{i,t_k-1} reflects the autonomous tendency for the real exchange rate to reach its equilibrium level rather than the importance of the initial distortion. To overcome this drawback, we construct a dummy variable —$Dum_{k=0}$— which scores 1 only for the devaluation's year and then use an interaction variable between $Dum_{k=0}$ and Mis_{i,t_k-1} to fully capture the effects exerted by the initial distortions of real exchange rates: $Init.Dist_{i,t_k-1} = Dum_{k=0} * Mis_{i,t_k-1}$.

The second important element to be taken into consideration is the *saturation effect*. As stated earlier, this effect implies a potential nonlinear relationship between the nominal and the real effective exchange rates. The channel through which this nonlinear effect could happen is inflation. However, the effect of a devaluation on inflation tends to be not persistent.[15] It therefore appears unlikely that the saturation effect persists over time. Put another way, the coefficient of the squared value of the nominal effective exchange rates' variations —in equation (3)— might not adequately reflects this *saturation effect*. To overcome this drawback, we introduce other time dummy variables for the three years following the devaluation and construct interaction variables between these latter and the squared values of nominal effective exchange rates' variations.

[15] A look at the data (see Figure 1 in Appendix C) reveals that in most devaluation episodes, inflation growth rate reaches peaks during the devaluation year (at most one year after the devaluation), then returns to its pre-devaluation levels no more than two years after the devaluation. Borensztein and De Gregorio (1999) studied the effect of devaluation on inflation and made the same observations. They argued that the non-persistence of the effect of devaluation on inflation is not surprising since if fundamental determinants of inflation do not change after the devaluation, the economy should return to its initial level of inflation. Note however that for some Latin America countries, the inflation path is different specifically during the debt crisis. Inflation remains higher than its pre-devaluation level, and even in some cases countries move into hyperinflation. A possible explanation may stem from the fact that these countries devalued with already high inflation rates. This is also in line with the findings of Cebotari (2013).

The equation to be estimated is then:

$$\Delta q_{i,t} = \alpha_i + \beta_1 \, Mis_{i,t_k-1} + \beta_2 \, Init.Dist_{i,t_k} + \gamma \, Macro_{i,t_k} + \lambda \, SP_{i,t_k} + \Phi_1 \Delta e_{i,t_k} + \sum_{j=0}^{3} \Phi_{2,k} \, Dum_{k=j} * \Delta e^2_{i,t_k} + \varepsilon_{i,t_k} \quad (4)$$

3.3 Assessing equilibrium exchange rates

3.3.1 The Behavioral Equilibrium Exchange Rate (BEER) approach

To derive our equilibrium exchange rate series, we rely on the Behavioral Equilibrium Exchange Rate (BEER) introduced by Clark and MacDonald (1998).[16] The aim of this approach is twofold: *(i)* to better link the behaviour of the observed real exchange rate to movements of fundamental variables; *(ii)* to allow a better determination of the equilibrium exchange rate by circumventing the drawbacks and shortcomings of the other approaches. However, equilibrium exchange rates are, by definition, unobservable. To tackle this issue, the BEER approach proposes to estimate a long-run relationship between the observed real effective exchange rate and a set of fundamentals. This estimated long-run relationship is assumed to give an assessment of the real equilibrium exchange rate. The BEER therefore relies on a modelling approach that attempts to explain the actual behaviour of the real exchange rate in terms of relevant economic variables.

There are several theoretical models underlying the BEER approach. Among them, the works of Edwards (1988), Elbadawi (1994), Hinkle and Montiel (1999) and more recently Elbadawi and Soto (2008) provided a suitable theoretical and empirical framework to investigate the factors affecting in the long run the real equilibrium exchange rate —i.e. fundamentals— in developing and emerging countries. In accordance with this literature, we first retained an initial set of 8 potential real effective exchange rate's fundamentals:[17] terms of trade *(tot)*, government spending *(gov)*, foreign direct investment *(fdi)*, net foreign assets *(nfa)*, official development aid *(oda)*, relative productivity *(rprod)*, openness *(open)*, investment *(invest)*.[18]

[16]For extensive survey on the BEER approach and related concepts (e.g. PPP, FEER, NATREX) we refer to Driver and Westaway (2005).

[17]The most common in the literature. Some real exchange rate fundamentals often mentioned have been deliberately excluded from the initial sample since they will be used for other analyses. We therefore remove them to limit collinearity and endogeneity problems.

[18]See Table A.1 in Appendix A for the variable definitions, sources and measurements.

However, given that our sample includes countries that are quite different from each other (different stage of development, specialization, etc), we may face a problem due to the heterogeneity of individuals. To avoid considerable bias namely through an arbitrary choice of the real exchange rate's fundamentals, we resort to Bayesian model averaging (BMA) to account for the multiplicity of potential models and fundamentals inherent to the BEER approach. Indeed the BMA approach provides a coherent methodology to address the issue of model uncertainty and allows then identifying the most relevant fundamentals with regard to our panel.

3.3.2 Selecting real exchange rates' fundamentals: the Bayesian Model Averaging (BMA) approach [19]

Let us consider the following relationship between the real effective exchange rate and a set of fundamentals:

$$q = \theta X + \varepsilon \qquad \varepsilon \sim N(0, \sigma^2 I) \tag{5}$$

where q is the real effective exchange rate, X represents a set of potential real effective exchange rate's fundamentals, and θ is the vector of unknown parameters to be estimated. ε is an *iid* error term.

The starting point of the BMA methodology is the finding that there are different models of real equilibrium exchange rates, each of them defined by a different combination of real exchange rate's fundamentals, and by a probability of being the "true" model. It proceeds by estimating different models from different combinations of fundamentals, and by constructing a weighted average of all of them. If we consider K fundamentals, we will have therefore 2^K possible combinations of fundamentals and thus 2^K different potential models M_j with $j = 1, \ldots, 2^K$.[20] In the Bayesian framework, a model is defined by a prior density and a likelihood function. Denoting D, the dataset available, and considering θ a function of θ^j parameters to be estimated for $j = 1, \ldots, 2^K$, the posterior density of the parameters for all the models under consideration is given by:

$$p(\theta|D) = \sum_{j=1}^{2^K} P(M_j|D)\ p(\theta|D, M_j) \tag{6}$$

[19] The BMA methodology is briefly presented in this section. For further technical details, see Hoeting et al. (1997, 1999), Fernandez et al. (2001), Sala-i-Martin et al. (2004) and Moral-Benito (2012).

[20] M_j depends of θ^j, i.e. the parameters.

Thus, the posterior density of the parameters is defined by the weighted sum of the posterior density of each considered model, with weights being their posterior model probability.

Given the prior model probability[21] $p(M_j)$, the posterior model probability is calculated using the Bayes' rule as follows:

$$P(M_j|D) = \frac{p(D|M_j)\ p(M_j)}{\sum_{j=1}^{2^K}\ p(D|M_j)\ p(M_j)} \tag{7}$$

where $p(D|M_j) = \displaystyle\int p(D|\theta^j, M_j)\ p(\theta^j|M_j)\ d\theta^j$ is the marginal (or integrated) likelihood of the data given the model M_j; $p(\theta^j|M_j)$ is the prior density of the parameter θ^j under the model M_j, $p(D|\theta^j, M_j)$ is the likelihood and $p(M_j)$ is the prior probability that M_j is the "true" model.

Following Leamer (1978), the posterior mean and variance are given by:

$$E(\theta|D) = \sum_{j=1}^{2^K} p(M_j|D)\ E(\theta|D, M_j) \tag{8}$$

$$V(\theta|D) = \sum_{j=1}^{2^K} p(M_j|D)\ V(\theta|D, M_j) + \sum_{j=1}^{2^K} p(M_j|D)\big[E(\theta|D, M_j) - E(\theta|D)\big] \tag{9}$$

One of the main advantage of the BMA, in dealing with uncertainty, is that it draws what we call *posterior inclusion probability*, i.e. the probability that a specific variable (regressor) belongs to the "true" model. The latter is calculated as the sum of the posterior model probabilities for all of the models including that variable:

$$p(\theta_h \neq 0|D) = \sum_{\theta_h \neq 0} p(M_j|D) \tag{10}$$

A fundamental distinction among the different BMA approaches is the assumption made about the priors. We here follow the Bayesian Averaging of Classical Estimates (BACE) approach proposed by Sala-i-Martin, Doppelhofer, and Miller (2004) and assume diffuse priors.[22] This latter assumption is made to reflect our ignorance about (or

[21] A prior probability for a model is a description of what is known a priori about the model to be estimated; how likely we believe the model M_j to be the "true" model.

[22] BACE combines the averaging of estimates across models, with classical ordinary least- squares (OLS) estimation which comes from the assumption of diffuse priors.

unwilling to specify) prior beliefs. Since the BACE approach as originally proposed is a cross-sectional analysis, we follow the methodology proposed by Moral-Benito (2012) for its implementation in the panel data context. For brevity, we do not report construction details of the "panel BACE" estimator. Note however that it boils down to the combination of the *Within* estimator with previous mentioned BMA methodology.

4 Results

4.1 Equilibrium exchange rates

4.1.1 BMA results: selecting the relevant fundamentals

We rely on the BACE approach to identify the relevant— with regards to our panel— real effective exchange rate's fundamentals. Given our initial set of 8 real exchange rate's fundamentals, results presented in Table 1 are the averages over 2^8 models, i.e. 256 models. As stated earlier, the relevance of each fundamental —in explaining the real effective exchange rate's dynamics— is given by the *posterior inclusion probability* (PIP). The columns "Post Mean" and "Post SD" (in Table 1) respectively indicate the estimated coefficients and standard deviations, both correspond to the averages over all models. The column "Sign Cert. Prob." — Sign Certainty Probability— indicates the probability that the coefficient sign is positive.

By setting the threshold of posterior inclusion probability at 0.5, as it is often the case, we retain, among the 8 potential fundamentals identified above, only 3 fundamentals: the terms of trade *(tot)*, the relative productivity *(rprod)* and the net foreign assets position *(nfa)*. Moreover, the signs of the coefficients appear to be robust (sign certainty probability =1) and correspond to the expected signs.

The long-run relationship to be estimated in order to assess real equilibrium exchange rates therefore links the real effective exchange rate to the terms of trade, the relative productivity and the net foreign assets position. We expect a positive relationship between the real effective exchange rate and each of those fundamentals: indeed, an increase in the relative productivity as well as an improvement in the terms of trade and the net foreign assets position are expected to appreciate the real equilibrium effective exchange rate.

Table 1 — BMA results

	PIP	Post Mean	Post SD	Sign Cert. Prob.
tot	**1.0000**	0.1791	0.0266	1.0000
invest	0.4608	0.0356	0.0127	1.0000
rprod	**0.9896**	0.0873	0.0220	1.0000
open	0.1950	0.0034	0.0125	1.0000
gov	0.0445	-0.0041	0.0254	0.0000
nfa	**0.6806**	0.0802	0.0071	1.0000
fdi	0.2635	0.0069	0.0140	1.0000
oda	0.0265	-0.0002	0.0092	0.0000

Note: The dependent variable is the real effective exchange rate. Results based on 10,000 burn-ins and 20,000 draws. Simulations made using prior diffuse and birth-death MCMC sampler.

We therefore estimate the following long-run relationship:

$$q_{i,t} = \alpha_i + \beta_1 \, rprod_{i,t} + \beta_2 \, tot_{i,t} + \beta_3 \, nfa_{i,t} + \varepsilon_{i,t} \quad (11)$$

where $i = 1, \ldots, N$ and $t = 1, \ldots, T$ respectively indicate the individual and temporal dimension of the panel. $q_{i,t}$ denotes the real effective exchange rate; α_i are the country-fixed effects and $\varepsilon_{i,t}$ is an error term.

4.1.2 Estimating equilibrium exchange rates

The first step in our empirical analysis consists in applying unit root and cointegration tests. We begin by testing the presence of unit root in our series (the real effective exchange rates and their fundamentals). To do so, we rely on the second-generation unit root tests (Choi, 2002; Pesaran, 2003) which relax the assumption of cross-sectional independence.[23]

The Choi (2002) test relies on an error-components panel model and removes the cross-section dependence by eliminating *(i)* individual effects using the Elliott, Rothenberg and Stock (1996) methodology (ERS), and *(ii)* the time trend effect by centering on the individual mean. The Pesaran (2003) CIPS test is based on Dickey-Fuller type regressions augmented with the cross-section averages of lagged levels and first differences of the individual series. Both tests are based on the null hypothesis of unit root. Results are displayed in Table B.2 in Appendix B.2, and as it can be seen, all tests conclude that the variables —*reer, rprod, tot,* and *nfa*— are integrated of order one.

We then test for the existence of a long run relationship between the real effective exchange rate and the fundamentals. To this end, we perform the Westerlund (2007)

[23]The use of these second-generation tests is validated by the cross-sectional dependence test, the CD test (Pesaran, 2004). See Table B.1 in Appendix B.1.

cointegration test which, in addition to be robust to cross-sectional dependence, allows for various form of heterogeneity.[24] As displayed in Table B.3 in Appendix B.3, results indicate that there is a cointegration relationship between the real effective exchange rate and the three identified fundamentals.

We can therefore estimate the cointegration relationship. In particular, we rely on the Pooled Mean Group (PMG; see Pesaran et al., 1999) procedure. The choice of the PMG estimator is mainly motivated by the fact that it allows a greater degree of heterogeneity among the countries —compared to other panel cointegration estimation procedures (FMOLS, DOLS)— which is particularly suitable since we are dealing with fairly heterogeneous countries. Estimation results of the long-run relationship are reported in Table 2. They are in accordance with theory and existing empirical results: an increase in the relative productivity as well as an improvement in the terms of trade and the net foreign assets lead to an appreciation of the equilibrium real exchange rate in the long-run. Furthermore, it appears from the short-run dynamic's results that only the terms of trade impact the real exchange rate in the short-run.[25]

Table 2 — PMG estimation results

	Coef.	z
Long-run dynamic		
rprod	0.132**	2.28
tot	0.358***	8.96
nfa	0.108***	2.64
Short-run dynamic		
ec.	-0.212***	-8.39
rprod	0.017	0.04
tot	-0.087**	-1.99
nfa	-0.080	-1.38
const.	0.260***	8.90

Note: ***, **, and * denote respectively significance at 1%, 5% and 10% level. Estimates over the 1975-2011 period.

Currency misalignments, $Mis_{i,t}$, are then derived from the difference between the observed real effective exchange rate ($q_{i,t}$) and its equilibrium level ($q^*_{i,t}$) which corresponds to the fitted value of $q_{i,t}$ obtained from the estimation of equation (11):

$$Mis_{i,t} = q_{i,t} - q^*_{i,t} \tag{12}$$

[24]Among the four tests that constitutes the Westerlund (2007)'s test, two are designed to test the alternative hypothesis that the panel is cointegrated as a whole while the other two test the alternative that at least one unit is cointegrated. The null of the test is that there is no cointegration.

[25]The coefficient of the error-correction term (***ec.***) — -0.212 — corresponds to half-life of approximatively 3.60 years. The half-life (HL) is the time it takes for a unit impulse to dissipate by half. It is calculated as follows: $HL = |log(0.5)/log(1-\gamma)|$ where γ is the coefficient of the error-correction term.

Figure 2 in Appendix C displays the obtained exchange rate misalignments.

4.2 The effectiveness of devaluation

In order to investigate the potential factors which allow devaluations to be effective, we first estimate equation (1) which only includes usual factors of effectiveness of devaluations. The other potential factors that we have identified are then added one-by-one till we obtain the complete model, described by equation (4). Results are displayed in Table 3. The first four columns (3.1 to 3.4) refer to the conjecture that the effectiveness of the devaluation is only due to movement in nominal exchange rates and macroeconomic policies. In the remaining columns, we respectively take into account the role played by the initial real exchange rate distortions, the effect of changes in the exchange rate regime, the magnitude of the devaluation and the importance of the socio-political context.

As it can be seen in Table 3 —and not surprisingly—, in all the regressions, a nominal devaluation generates —*ceteris paribus*— a real depreciation. But, the impact of the nominal to the real exchange rates proves to be rather weak. The associated coefficient varies between 0.121 and 0.348: in average the response of the real effective exchange rate following an infinitesimal variation of the nominal effective exchange rate is a bit more than one fifth (one third at best). This result shows the impact that may be exerted by exchange rate movements on prices and could reveal a strong exchange rate pass-through on domestic prices. From a policy viewpoint, this result might justify overshooting the initially required devaluation rate to obtain a significant depreciation of the real exchange rate.

However, this has to be balanced as the relation between the size of the devaluation and its effectiveness appears to be nonlinear. Indeed, the squared value of the devaluation rate —i.e. the change in the nominal exchange rate in the first year—, when included, has a negative sign, which is significant in all regressions but one (column 3.11). But, in most cases, coefficients become positive from the second year following the devaluation. This nonlinear effect could be explained by an immediate inflationary effect of the devaluation coupled with the delay in policy responses —after the devaluation— which may significantly erode positive effects expected from the devaluation at least during the first year. This result therefore confirms the findings of Guillaumont and Guillaumont (1995) about the existence of a *saturation effect*. However, in contrast with their results and what can be observed in advanced economies, we found that this effect happens —or is significant— only within the two years following the devaluation.

Table 3 — Investigating devaluation effectiveness factors

Dependent variable	$\Delta REER_k$						
	(3.1)	(3.2)	(3.3)	(3.4)	(3.5)	(3.6)	(3.7)
Exchange rate variables							
$\Delta NEER_k$	0.136***	0.145***	0.121***	0.187***	0.189***	0.186***	0.188***
	(5.16)	(5.03)	(5.21)	(4.01)	(4.14)	(3.76)	(3.81)
$\Delta NEER^2 * D_{k=0}$							
$\Delta NEER^2 * D_{k=1}$							
$\Delta NEER^2 * D_{k=2}$							
$\Delta NEER^2 * D_{k=3}$							
Mis_{t_k-1}	-0.022	-0.016	-0.027	-0.009	-0.029	-0.011	-0.010
	(-0.60)	(-1.61)	(-1.01)	(-0.33)	(-0.89)	(-0.34)	(-0.27)
Initial distortion					-0.072**	-0.070**	-0.073**
					(-2.23)	(-2.00)	(-2.07)
Exchange rate regime[a]						0.138***	0.162***
						(3.13)	(3.55)
Macroeconomic indicators							
Fiscal balance	-0.121	-0.210*	-0.193**	-0.148*	-0.131	-0.194**	-0.189*
	(-1.01)	(-1.64)	(-2.14)	(-1.69)	(-1.44)	(-1.99)	(-1.93)
Credit[b]		0.026**		0.146**	0.10*	0.102	0.098
		(2.28)		(2.34)	(1.66)	(1.36)	(1.31)
M2	0.005*	0.007**	0.004**	0.004**	0.004**	0.004	0.004**
	(1.84)	(2.14)	(2.10)	(2.24)	(2.12)	(2.02)	(2.03)
kaopen			0.030	0.027	0.025		0.032
			(1.12)	(1.14)	(1.17)		(1.08)
Socio-political indicators							
Political violence							
Political Terror							
Conflict							
Election							
Other							
Constant	-0.076***	-0.076**	-0.052***	-0.076***	-0.073***	-0.072***	-0.060***
	(-8.65)	(-7.91)	(-7.84)	(-6.19)	(-6.05)	(-5.56))	(-3.50)
Observations	228	224	228	224	224	224	224
R^2	0.22	0.25	0.24	0.26	0.37	0.37	0.38
Devaluation episodes	57	56	57	56	56	56	56

Notes: ***, **, and * denote respectively significance at 1%, 5% and 10%. Robust t statistics in parentheses.
a: *de facto* classification
b: Domestic credit to public sector (%GDP)

Continued on next page

Table 3 — *Continued from previous page*

Dependent variable	$\Delta REER_k$						
	(3.8)	(3.9)	(3.10)	(3.11)	(3.12)	(3.13)	(3.14)
Exchange rate variables							
$\Delta NEER_k$	0.229***	0.273***	0.258***	0.342***	0.345***	0.344***	0.348***
	(4.01)	(4.12)	(3.76)	(4.80)	(4.77)	(4.74)	(4.75)
$\Delta NEER^2 * D_{k=0}$	-0.306***	-0.260**	-0.267**	-0.121	-0.149**	-0.148**	-0.150**
	(-2.93)	(-2.35)	(-2.40)	(-1.61)	(-1.97)	(-1.98)	(1.97)
$\Delta NEER^2 * D_{k=1}$	0.000	0.038	0.029	0.145*	0.111	0.109	0.113
	(0.00)	(0.57)	(0.42)	(1.93)	(0.92)	(0.90)	(0.95)
$\Delta NEER^2 * D_{k=2}$	0.061	0.093*	0.083	0.170***	0.173***	0.172***	0.177***
	(1.32)	(1.75)	(1.52)	(2.83)	(2.85)	(2.83)	(2.88)
$\Delta NEER^2 * D_{k=3}$	0.075*	0.114**	0.104**	0.172***	0.175***	0.175***	0.177***
	(1.89)	(2.28)	(2.03)	(3.17)	(3.17)	(3.15)	(3.19)
Mis_{t_k-1}	-0.050	-0.048	-0.044	-0.045	-0.043	-0.043	-0.041
	(-1.38)	(-1.29)	(-1.17)	(-1.17)	(-1.13)	(-1.12)	(-1.09)
Initial distortion	-0.087***	-0.089***	-0.091***	-0.100***	-0.101***	-0.097***	-0.114***
	(-2.95)	(-2.95)	(3.01)	(-3.01)	(-2.99)	(-2.83)	(-3.38)
Exchange rate regime[a]	0.229***	0.273***	0.209***	0.151***	0.154***	0.155***	0.157***
	(4.01)	(4.12)	(4.68)	(3.63)	(3.53)	(3.52)	(3.60)
Macroeconomic indicators							
Fiscal balance	-0.152*	-0.166*	-0.190**	-0.202**	-0.198**	-0.201**	-0.179*
	(-1.76)	(-1.77)	(-1.97)	(-2.03)	(-1.97)	(-1.98)	(-1.78)
Credit[b]		0.021	0.018	0.018	0.060	0.045	0.067
		(0.70)	(0.60)	(0.25)	(0.21)	(0.19)	(0.83)
M2	0.002	-0.003	0.003	0.003	0.003	0.003	0.004
	(1.36)	(-1.40)	(1.38)	(1.22)	(1.23)	(1.23)	(1.44)
kaopen			0.011		0.012	0.012	0.010
			(0.19)		(0.15)	(0.15)	(0.17)
Socio-political indicators							
Political violence						0.007	
						(0.26)	
Political Terror							-0.042
							(-1.61)
Conflict				0.023**	0.024**	0.024**	0.029**
				(2.09)	(2.05)	(2.03)	(2.49)
Election				0.005	0.005	0.006	0.006
				(0.87)	(0.93)	(0.90)	(1.13)
Other							
Constant	-0.024**	-0.016	-0.017	-0.010	-0.009	-0.008	-0.008
	(-2.15)	(-1.24)	(-1.19)	(-0.74)	(-0.62)	(0.58)	(-0.56)
Observations	228	224	224	224	224	224	224
R^2	0.52	0.52	0.53	0.55	0.55	0.55	0.56
Devaluation episodes	57	56	56	56	56	56	56

Notes: ***, **, and * denote respectively significance at 1%, 5% and 10%. Robust t statistics in parentheses.
a: *de facto* classification
b: Domestic credit to public sector (%GDP)

Moreover, it also appears that the effectiveness is directly and strongly linked to the existence of an overvalued real exchange rate before the devaluation. Indeed, the coefficient associated with the initial misalignment of the real exchange rate is negative and significant in all specifications, thus suggesting that the more the real exchange rate is overvalued prior the devaluation, the more it will depreciate following the devaluation. A nominal devaluation is therefore more likely to be effective if it occurs in a context where the real exchange is considerably overvalued. The coefficient associated with the lagged value of the real exchange rate misalignment is also negative but not significant. As stated earlier, this coefficient captures the tendency for the real exchange rate to reach its long-un equilibrium level. The non-significance of this coefficient reflects therefore the persistence in real exchange rates' misalignments that can be observed in most emerging and developing countries.

Regarding macroeconomic policy variables, our results confirm the role played by prudent macroeconomic policies: fiscal deficit and/or expansionary monetary policy (high rate of growth of money and/or domestic credit) tend to erode the depreciating effect of the devaluation on the real exchange rate. In other words, as long as the governments are able to control their fiscal and monetary policies, they will significantly enhance the effectiveness of the devaluation. According to the estimates, this effect is most pronounced for the fiscal policy. Controlling for changes in the exchange rate regime, results strongly suggest that the move towards a more flexible regime after a devaluation reduces the effectiveness of the nominal adjustment.[26] The coefficients are positive and highly significant in all regressions. The causes can be found in the benefits usually attributed to fixed or pegged exchange rates. Indeed, it has been extensively argued that fixed or pegged exchange rates help in stabilizing, even reducing inflation which plays a key role in the effectiveness of devaluation. Also, by maintaining a fixed regime, countries might benefit from credibility and disciplinary of both fiscal and monetary policies which contribute to the creation of a stable internal economic environment (low inflation, low interest rates and low uncertainty on the exchange rate; see Ghosh et al., 2003). Finally, the coefficient associated with the variable *kaopen* —the *dejure* financial openness— is, for all specifications, positive but not statistically significant, This result suggests that the effectiveness of a devaluation is not affected by the degree of capital account openness.

As regards the socio-political environment, results are rather inconclusive. Indeed,

[26]For brevity, we only report the results obtained using the *de facto* classification. Results are robust to change in the exchange rate regime classification and are available upon request.

among all the indicators used, only the variable "*Conflict*" is significant and has the expected —positive— sign in all the specifications. This result suggests that in periods of conflicts, the real effective exchange rate tends to appreciate. Devaluations implemented in such periods have therefore a lower probability to be effective. This could be explained by the cost of the conflict which may place a strain on the public finances and, thus, hampers the fiscal adjustment. Coefficients of the variables "*Political violence*" and "*Election*", while correctly signed (positive), are not significant. On the contrary, the coefficient of "*Political Terror*" is negative and not significant. It is therefore difficult to draw any conclusions on the link between devaluation effectiveness and the socio-political context.[27]

4.3 How robust are these results?

To test the robustness of our results, we conduct a number of additional regressions by addressing two issues. Firstly, as our results may depend on our sample of devaluation episodes, we rely on alternative selection criteria and investigate hereafter the sensitivity of our results to the sample of devaluation episodes. Secondly, we test the robustness of our findings by performing a number of cross-sectional regressions on the different time horizons of the analysis, i.e. the year of the devaluation ($k = 0$) and the three following years ($k = 1, 2, 3$).

[27]This inconclusive result may also be due to the quality and the relevance of the indicators used which remain questionable. Also, it could be the result of our methodological choice. Indeed, if the dependent variable was the inflation rate or even the real bilateral exchange rate, the effects of the socio-political variables might have been more noticeable. One can therefore think that the use of the real effective exchange rate blurs our perception of the effects of those variables.

4.3.1 Sensitivity to the sample of devaluation episodes

Different criteria are often used in the empirical literature to select devaluation episodes. In this section, we check the robustness of our results by considering alternative selection criteria. To do so, we adopt the definition proposed by Milesi-Ferretti and Razin (1998), which, compared to our definition, adds two additional criteria: *(i)* a minimum 10 percent increase in the rate of depreciation with respect to the previous year, and *(ii)* a rate of depreciation the previous years of below 10 percent. These two additional conditions restrict our initial sample to episodes in which the exchange rate was relatively stable the year prior the devaluation — and therefore is more close to the concept of currency crises described in theoretical models. The application of these criteria reduces our sample from to 57 to 42 devaluation episodes (33 countries).[28]

Results —displayed in Table 4— confirm our previous findings which then appear robust to changes in the sample. For all the variables, we identify the same effects than the ones highlighted in Table 3. Indeed, looking at our main variables of interest, results confirm *(i)* the importance of the existence of considerable exchange rate misalignments prior to the devaluation, and *(ii)* a nonlinear relationship between the rate of devaluation and its effectiveness. Furthermore, those new results confirm that expansive macroeconomic policies tend to induce an appreciation of the real effective exchange rate, reducing therefore the effectiveness of a devaluation. Changes in the exchange rate regime toward a more flexible one also seem to alter the effectiveness of devaluations. Finally, results remain mixed regarding the importance of the socio-political context. Once again, all variables, except *Conflict*, are not significant.

[28]See Table A.2 for details.

Table 4 — Robustness check. New sample of devaluation episodes

Dependent variable	$\Delta REER_k$						
	(4.1)	(4.2)	(4.3)	(4.4)	(4.5)	(4.6)	(4.7)
Exchange rate variables							
$\Delta NEER_k$	0.397***	0.255***	0.237***	0.558***	0.579***	0.590***	0.575***
	(7.55)	(5.77)	(4.35)	(5.15)	(5.03)	(5.13)	(5.01)
$\Delta NEER^2 * D_{k=0}$				-0.176***	-0.215**	-0.221**	-0.187***
				(-2.66)	(-2.09)	(-1.99)	(-2.78)
$\Delta NEER^2 * D_{k=1}$				0.326*	0.378*	0.373	0.365*
				(1.76)	(1.94)	(1.27)	(1.86)
$\Delta NEER^2 * D_{k=2}$				0.338***	0.369***	0.372***	0.365***
				(3.15)	(3.23)	(3.26)	(3.20)
$\Delta NEER^2 * D_{k=3}$				0.305***	0.325***	0.328***	0.323***
				(3.18)	(3.20)	(3.23)	(3.18)
Mis_{t_k-1}	-0.034	-0.023	-0.039	-0.050	-0.062	-0.071	-0.061
	(-0.62)	(-0.75)	(-1.06)	(-0.70)	(-0.55)	(-0.17)	(-0.23)
Initial distortion				-0.083***	-0.088***	-0.091***	-0.103***
				(-3.04)	(-3.35)	(-2.86)	(-3.09)
Exchange rate regime[a]			0.108**	0.128**	0.118**	0.125**	0.121**
			(1.98)	(2.44)	(2.18)	(2.31)	(2.32)
Macroeconomic indicators							
Fiscal balance	-0.193**	-0.106**	-0.138*	-0.196**	-0.185*	-0.117*	-0.196**
	(-2.23)	(-1.98)	(-1.64)	(-2.01)	(-1.68)	(-1.91)	(-1.96)
Credit[b]		0.018**	0.017*	0.057	0.053	0.056	0.053*
		(2.09)	(1.78)	(1.53)	(1.40)	(1.47)	(1.67)
M2	0.081**	0.091*	0.057	0.080*	0.066*	0.090*	0.094
	(2.44)	(1.92)	(1.56)	(1.79)	(1.66)	(1.64)	(1.59)
Socio-political indicators							
Political violence						0.034	
						(1.23)	
Political Terror							-0.032
							(-1.11)
Conflict					0.025**	0.028**	0.028**
					(2.10)	(2.33)	(2.30)
Election					0.001	0.001	0.002
					(0.18)	(0.09)	(0.24)
Other							
Constant	0.065	-0.022	-0.073***	0.010	0.025	0.041	0.032
	(1.46)	(-0.62)	(-3.19)	(0.45)	(0.57)	(0.89)	(0.71)
Observations	168	168	168	168	168	168	168
R^2	0.37	0.42	0.54	0.59	0.59	0.60	0.60
Devaluation episodes	42	42	42	42	42	42	42

Notes: ***, **, and * denote respectively significance at 1%, 5% and 10%. Robust t statistics in parentheses.
a: *de facto* classification
b: Domestic credit to public sector (%GDP)

4.3.2 Sensitivity to time windows

As previously indicated, we test the robustness of our results by performing a number of cross-sectional regressions over different time windows between the year of the devaluation and the following years. This kind of Time-Varying Parameter regressions will help us investigating the evolution of the coefficients associated with the variables over the 4 years time horizon. Indeed, due to changes in the economic environment, we may expect that the parameters are time-varying. This is specially the case of the coefficients associated with the initial distortion of the real exchange rate and the rate of devaluation. Indeed, these two latter variables may have considerable effects only during the first year of the devaluation ($k = 0$). This analysis will therefore justify, ex post, our methodological approach based on the use of dummy variables to highlight the existence of a saturation effect and the importance of the initial distortion of the real exchange rate. Results are presented in Table 5.

Here again, the results are in line with those so far obtained. In addition, they justify our methodological approach regarding the use of dummy variables. Indeed, during the year of the devaluation, we observe a negative and significant impact of the squared value of the rate of devaluation. This result therefore confirms the existence of a *saturation effect* which considerably annihilates the immediate effect of the devaluation. Our findings also suggest that overvalued real exchange rates the year before the devaluation influence the effectiveness of devaluations. The larger the initial misalignment, the more effective the depreciating effects of a devaluation on the real effective exchange rate will be. However, those two effects tend to dissipate the following years, thus revealing the importance of accompanying macroeconomic policies over time. Finally, those new results confirm the negative impact exerted by changes in the exchange rate regime towards a more flexible one and the mixed effects of the socio-political context.

All in all, our results confirm that the initial distortion of the real exchange rate, the size of the devaluation as well as the accompanying macroeconomic policies are crucial preconditions for the effectiveness of devaluations. Moreover, macroeconomic policies become increasingly important over time while the initial misalignment and the rate of devaluation only matter during the first year of the devaluation.

Table 5 — Robustness check. Cross-sectional analysis on different time windows

Dependent variable	$\Delta REER_k$											
	k=0			***k=1***			***k=2***			***k=3***		
	(5.1)	(5.2)	(5.3)	(5.4)	(5.5)	(5.6)	(5.7)	(5.8)	(5.9)	(5.10)	(5.11)	(5.12)
Exchange rate variables												
$\Delta NEER_k$	0.641***	0.252***	0.331**	0.307***	0.569**	0.657**	0.102*	0.334*	0.337*	0.116**	0.640**	0.609**
	(9.97)	(8.56)	(2.22)	(4.28)	(2.24)	(2.67)	(1.90)	(1.68)	(1.87)	(2.05)	(2.46)	(2.43)
$\Delta NEER^2$		-0.709**	-0.559**		0.357	0.403		0.221	0.234		0.479**	0.471**
		(-2.49)	(-1.98)		(1.11)	(1.31)		(1.23)	(1.27)		(2.19)	(2.17)
Mis_{t_k-1}	-0.147***	-0.140***	-0.132***	-0.067	-0.092	-0.168*	-0.052	-0.049	-0.053	-0.023	-0.051	-0.037
	(-3.67)	(-3.59)	(-3.47)	(-0.83)	(-1.03)	(-1.84)	(-0.55)	(-0.43)	(-0.44)	(-0.16)	(-0.26)	(-0.12)
Exchange rate regime[a]		0.044*	0.177**		0.238**	0.255**		0.193*	0.198		0.131**	0.173**
		(1.65)	(2.01)		(2.20)	(2.13)		(1.71)	(1.51)		(1.98)	(2.23)
Macroeconomic indicators												
Fiscal balance	-0.302*	-0.280**	-0.325*	-0.421**	-0.479*	-0.568**	-0.321**	-0.510**	-0.451*	-0.561*	-0.436*	-0.455*
	(-1.75)	(-2.03)	(-1.80)	(2.05)	(-1.77)	(-2.13)	(-2.02)	(-2.26)	(-1.66)	(-1.78)	(-1.82)	(-1.87)
Credit[b]	0.040	0.056**	0.062**	0.055	0.046	0.054	0.059*	0.089**	0.074**	0.042	0.021	0.051
	(1.52)	(2.36)	(2.45)	(1.45)	(1.06)	(1.27)	(1.89)	(2.57)	(1.98)	(1.12)	(1.40)	(0.93)
M2	0.013***	0.006	0.005	0.219*	0.124**	0.290**	0.155*	0.116	0.231*	0.322	0.162*	0.248**
	(3.63)	(1.26)	(1.19)	(1.67)	(2.13)	(2.01)	(1.73)	(1.62)	(1.86)	(1.43)	(1.73)	(1.96)
kaopen		-0.050	-0.078		0.014	0.012		0.001	-0.003		0.083	0.027
		(-0.90)	(-1.40)		(1.15)	(0.13)		(0.01)	(-0.04)		(1.15)	(0.35)
Socio-political indicators												
Political violence			0.042			0.082			0.060			0.103
			(1.37)			(1.13)			(1.02)			(1.07)
Conflict			0.013			0.017**			0.056			0.095
			(0.58)			(2.48)			(1.11)			(1.63)
Election			-0.040*			-0.055			-0.007			0.066
			(-1.64)			(-1.50)			(-0.19)			(1.61)
Other												
Constant	0.044**	0.006	0.005	-0.017	0.011	0.021	-0.065***	-0.003	-0.037	-0.076***	0.063	-0.024
	(2.63)	(0.38)	(0.35)	(-0.80)	(0.30)	(0.55)	(-2.85)	(-0.05)	(-0.80)	(-2.79)	(0.92)	(0.38)
Observations	56	56	56	56	56	56	56	56	56	56	56	56
Adj. R-squared	0.72	0.71	0.74	0.38	0.43	0.42	0.36	0.37	0.41	0.31	0.38	0.44

Notes: ***, **, and * denote respectively significance at 1%, 5% and 10%. Robust t statistics in parentheses.
a: *de facto* classification.
b: Domestic credit to public sector (%GDP)

5 Conclusion

In this paper, we have addressed the issue of the effectiveness of devaluations by paying a particular attention to the role played by the size of the nominal adjustment that is implemented and the initial distortion of the real exchange rate. To do this, we have studied the evolution of the real effective exchange rate between the year in which the devaluation occurs and the three following years, using a large sample of devaluation episodes in developing and emerging countries.

Our results indicate that the effectiveness of a devaluation depends not only on the implementation of appropriate accompanying macroeconomic policies, but also on the economic context in which the devaluation occurs and the size of the nominal adjustment. As long as governments will implement prudent policies (both fiscal and monetary), they will significantly enhance the effectiveness of a devaluation. The existence of overvalued real exchange rates preceding a devaluation is also a prerequisite to improve competitiveness after a devaluation. Finally, the size of the devaluation exerts a non-linear impact which may be considered as a saturation effect. However, this saturation effect is only effective during the two first years following the devaluation. On the contrary, we find no strong support that the effectiveness of a devaluation is related to the existence of capital / exchange controls and to the socio-political context. Finally, those results are robust to changes in the definition of devaluation episodes as well as to different time windows during which the short-medium effects of a devaluation are at stake.

Several lessons regarding economic policy might be drawn from those results. Firstly, devaluations that are not justified by considerable exchange rate misalignments and are implemented without appropriate accompanying macroeconomic policies, are likely to cause a worse situation than the existing one. Secondly, determining the "appropriate" rate of devaluation has important implications for its effectiveness. The existence of a weak pass-through between the nominal and the real exchange rates may require overshooting the initially needed rate (i.e. the one corresponding to the magnitude of the desired correction). At the same time, this weak pass-through tends to show that a too high rate of devaluation can also trigger an immediate inflationary spiral. On the other hand, a weak devaluation rate could be inefficient in improving the economic situation and could thus lead to other devaluations, triggering by the way an increasingly inflation.

For developing and emerging countries, the temptation of devaluate the currency can be strong because this exchange rate policy is often presented as the last-resort remedy to overcome economic hardship. This nominal adjustment can be also unavoidable in the event of a major financial crisis, as experienced by many emerging countries in the last decades. However, our results show that devaluations can only be effective if appropriately implemented and if some prerequisites are met. If not, this nominal exchange rate adjustment can easily become a Pandora's box —soaring inflation, increasing fiscal deficit, higher foreign currency-denominated debt to mention just a few—, thus driving countries into a downward spiral.

Appendices

A. Data appendix

A.1. Data

Table A.1 — Data sources and definitions

Variables & Definitions	Sources
Exchange rate	
Nominal Effective Exchange Rate (NEER): Weighted average of bilateral exchange rates against 67 trading partners.	Bruegel's database
Real Effective Exchange Rate (REER): Weighted average of real bilateral exchange rates against 67 trading partners.	Bruegel's database
Exchange rate regime	
***de jure* classification**	IMF
***de facto* classification**	Ilzetzki, Reinhart & Rogoff
Exchange rate fundamentals	
Terms of trades (*tot*): expressed in logarithms	WDI
Government consumption (*gov*): in percentage of GDP	WDI
Foreign direct investment (*fdi*): in percentage of GDP	WDI
Net Foreign Assets[a] **(*nfa*)**: in percentage of GDP	Lane & Milesi-Ferretti
Official Development Aid (*oda*): in percentage of GDP WDI	
Relative productivity (*rprod*): Measured by the ratio of GDP PPP per capita in the country and the weighted average GDP per capita PPP of partner countries. The weights and partners are the same than those used for the calculation of the real effective exchange rate.	
Openness (*open*)	WDI
Investment (*invest*): in percentage of GDP	WEO
Macroeconomic indicators	
Fiscal balance (*fis.bal*): in percentage of GDP	WEO
Domestic credit (*dom.cred*): in percentage of GDP Domestic credit provided to public and private sector.	IFS
Domestic credit to public sector (*cred.PS*): in percentage of GDP	IFS
Money and quasi-money (*M2*): in percentage of GDP	WDI
kaopen[b]: Financial openness measured on a zero-to-one scale, 1 being the highest financial openness degree.	Chinn & Ito
Consumer Price Index (*CPI*): expressed in logarithm	WEO
Socio-political indicators	
Political violence[b]: measured on a scale from 0 to 1, 1 being the highest degree of political violence.	Center for Systematic Peace
Political Terror[b]: bounded between 0 and 1, 0 being absence of political terror.	Political Terror Scale
Election: Scores 1 years of Presidential and/or Legislative elections, 0 otherwise. Computed using informations in *Constituency-Level Elections Archive and African Elections Database.*	
Conflict Scores 1 if the country is involved in a conflict.	Uppsala Conflict Data Program

Continued on next page

Table A.1 — *Continued from previous page*

Variables & Definitions	**Sources**
Other indicators	
GDP current US$: expressed in logarithms	WEO
GDP per capita: expressed in logarithms	WEO

Notes: a: Updated by adding current account balances in the last years where data on net foreign assets were not available. Data relative to current account balance are from WDI database.
b: We modified the original scale.
IFS: *International Financial Statistics* (International Monetary Fund)
WDI: *World Development Indicators* (World Bank)
WEO: *World Economic Outlook* (International Monetary Fund)

A.2. Devaluation episodes sample

Table A.2 — Selected countries and devaluation episodes

Country	Date	Country	Date
Asia & Pacific			
Fiji	1987, 1998*, 2009	Philippines	1997*
Latin America & Caribbean			
Argentina	2002*	Mexico	1976*, 1982*,
Brazil	1983, 1999*		1985, 1994*, 2001*
Costa Rica	1981*, 1991*	Peru	1982
Dominican Republic	1985*, 1990*, 2003*	Trinidad & Tobago	1985*, 1993*
Ecuador	1999	Uruguay	1982*, 2002*
El Salvador	1986*, 1990*	Venezuela	1995, 2002*
Jamaica	1983*		
Africa			
Benin	1994*	Kenya	1993
Burkina Faso	1994*	Madagascar	1993*
Cameroon	1994*	Mali	1994*
Central African Republic	1994*	Mauritius	1979*
Chad	1994*	Mauritania	1992*
Congo Republic	1994*	Niger	1994*
Côte d'Ivoire	1994*	Nigeria	1998*
Egypt	1979*	Senegal	1994*
Equatorial Guinea	1994*	Sierra Leone	1985
Ethiopia	1992*, 2010	Tanzania	1986*
Gabon	1994*	Togo	1994*
Ghana	2009	Zambia	1992

Note: " * " indicates the devaluation episodes retained for the robustness check.

B. Test results

B.1. Cross-sectional dependence tests

Table B.1 — Cross-sectional dependence test results

	reer	*gov*	*invest*	*fdi*	*nfa*	*oda*	*open*	*tot*	*rprod*
Pesaran (CD)'s test	45.32	4.14	13.01	56,07	99.65	34.83	34.80	9.96	56.83
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Notes: The test is based on the null of no cross-sectional dependence and is standard Normal under this null. *p.values* are given in parentheses.

B.2. Unit root tests

Table B.2 — Unit root test results

		reer	*gov*	*invest*	*fdi*	*nfa*	*oda*	*open*	*tot*	*rprod*
CIPS*	level	-2.51	-2.49	-2.50	-2.85	-2.26	-2.61	-2.14	-2.39	-2.41
		(0.13)	(0.17)	(0.13)	(0.01)	(0.60)	(0.04)	(0.03)	(0.34)	(0.28)
	1^{st} diff.	-3.05	-4.01	4.49	-4.83	-3.24	-4.70	-4.15	-3.40	-2.92
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Choi *Pm*	level	-0.91	1.17	5.17	22.93	0.37	11.00	11.02	0.23	-3.96
		(0.81)	(0.12)	(0.00)	(0.00)	(0.35)	(0.01)	(0.00)	(0.40)	(1.00)
	1^{st} diff.	42.01	42.91	53.15	51.97	44.33	52.66	53.85	35.51	34.93
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Choi *Z*	level	3.92	-1.41	-4.78	-12.88	-0.64	-7.66	-6.70	2.81	8.95
		(1.00)	(0.08)	(0.00)	(0.00)	(0.26)	(0.00)	(0.00)	(0.99)	(1.00)
	1^{st} diff.	-19.38	-20.11	-24.32	-23.85	-20.46	-23.85	-24.68	-16.61	-17.04
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Choi *L**	level	4.13	-1.19	-4.68	-15.62	-0.48	-8.51	-7.63	3.61	11.19
		(1.00)	(0.11)	(0.00)	(0.00)	(0.31)	(0.00)	(0.00)	(0.99)	(1.00)
	1^{st} diff.	-25.68	-26.77	-32.97	-32.26	-27.08	-32.49	-33.45	-22.29	-22.09
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Note: We allow for individual deterministic trends and constants for all variables except *open* (only individual intercepts). The tests are built on the null of a unit root; *p*.value in parentheses. Appropriate lag orders are determined by running auxiliary ADF test regressions for each of the cross-sectional units. We also refer to the lag order that minimizes the Schwarz criterion. Conclusions are robust to change in model's specification.

B.3. Westerlund cointegration test

Table B.3 — Westerlund cointegration test results

Specification		*reer*				
		rprod, tot, nfa				
	With constant			*With trend and constant*		
Statistic	Value	$Z-$value	$p-$value	Value	$Z-$value	$p-$value
G_t	-2.783	-3.453	0.000	-3.056	-2.391	0.008
G_a	-9.121	1.552	0.940	-9.381	4.524	1.000
P_t	-15.084	-3.522	0.000	-17.478	-3.087	0.001
P_a	-8.738	-1.153	0.125	-11.467	0.544	0.707

Note: Optimal lag and lead length determined by Akaike Information Criterion. Width of Bartlett-Kernel set to 2. Null hypothesis of no cointegration.

C. Graphs

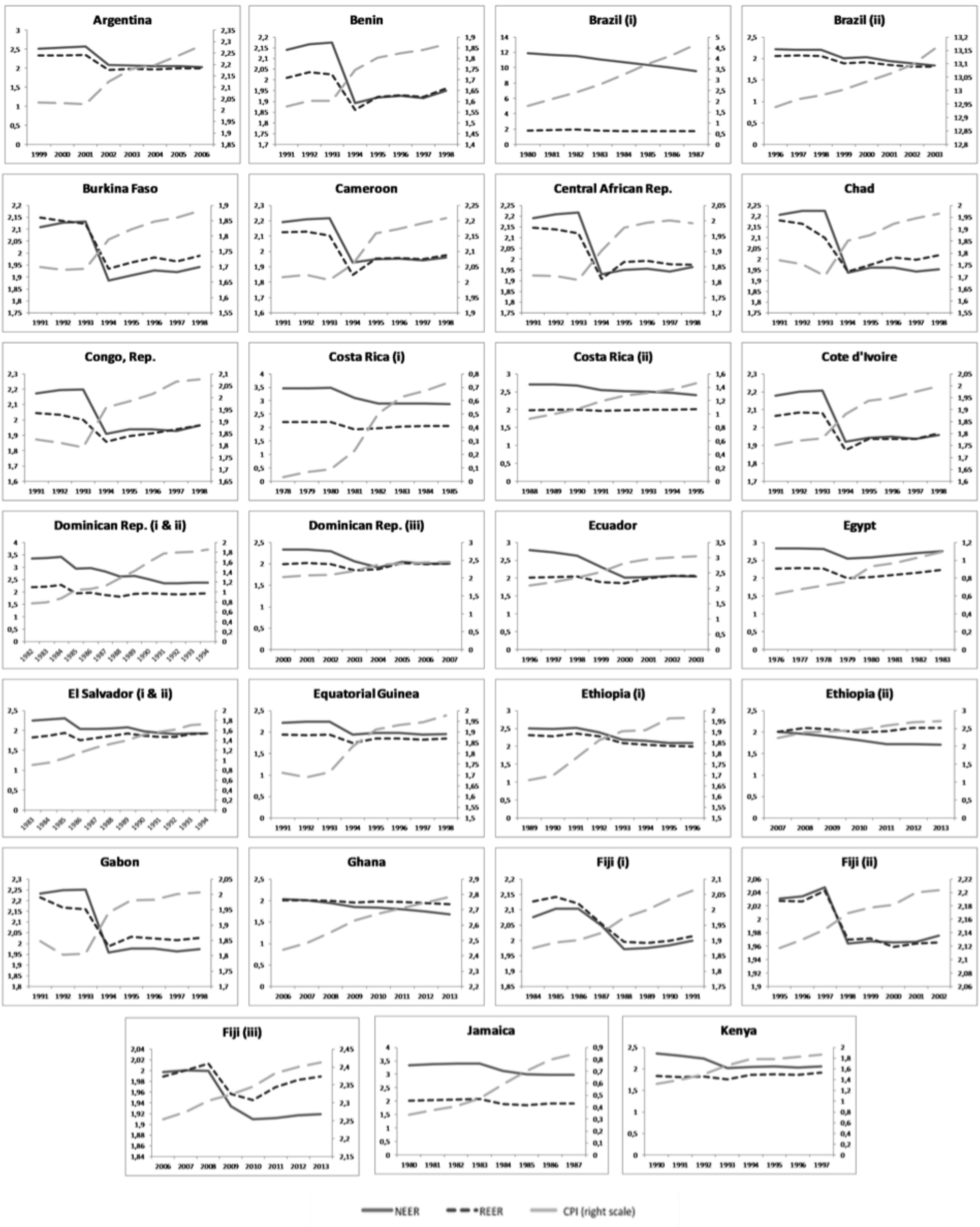

Figure 1 — Nominal and real effective exchange rates, inflation (CPI)

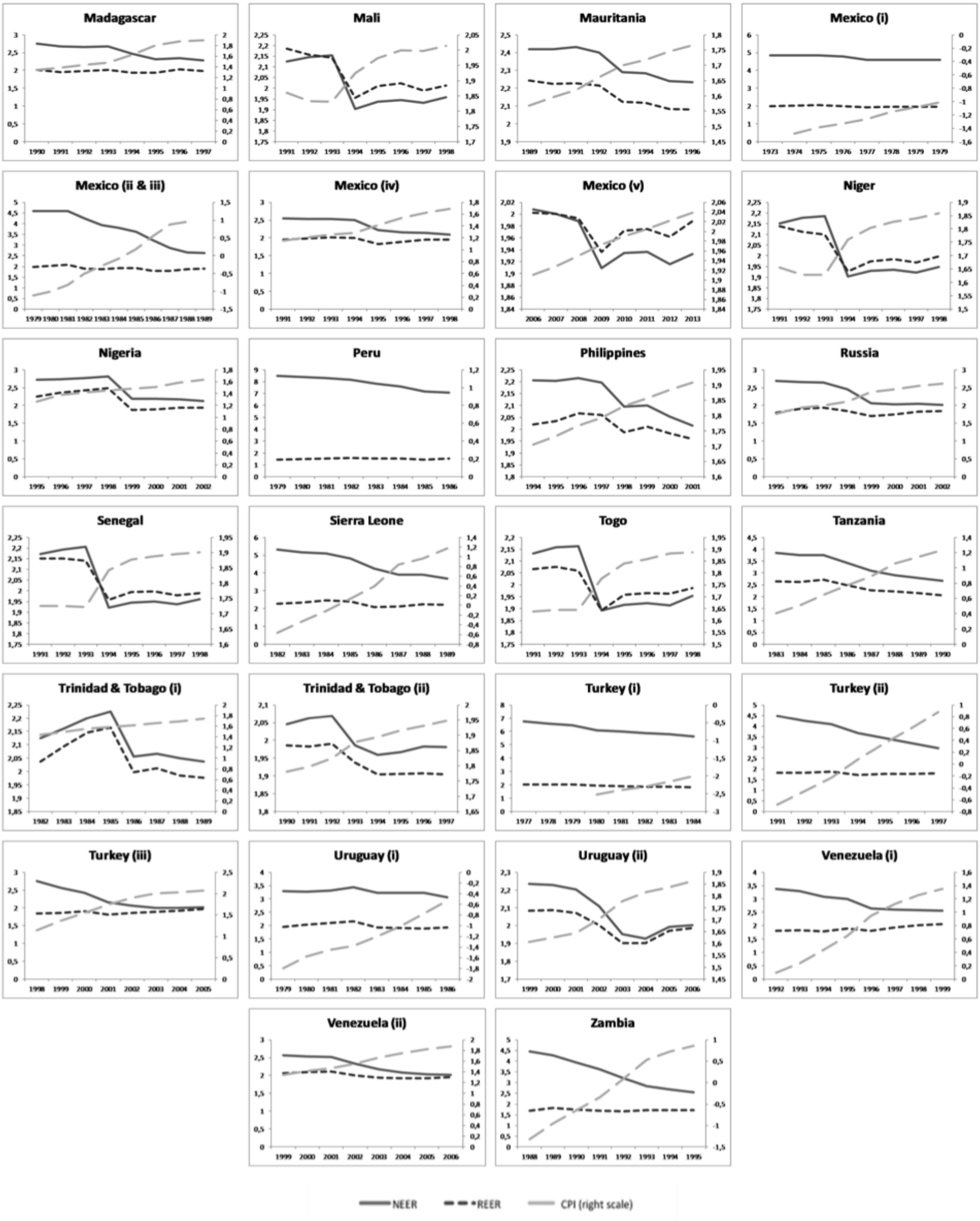

Figure 1 — *Continued.*

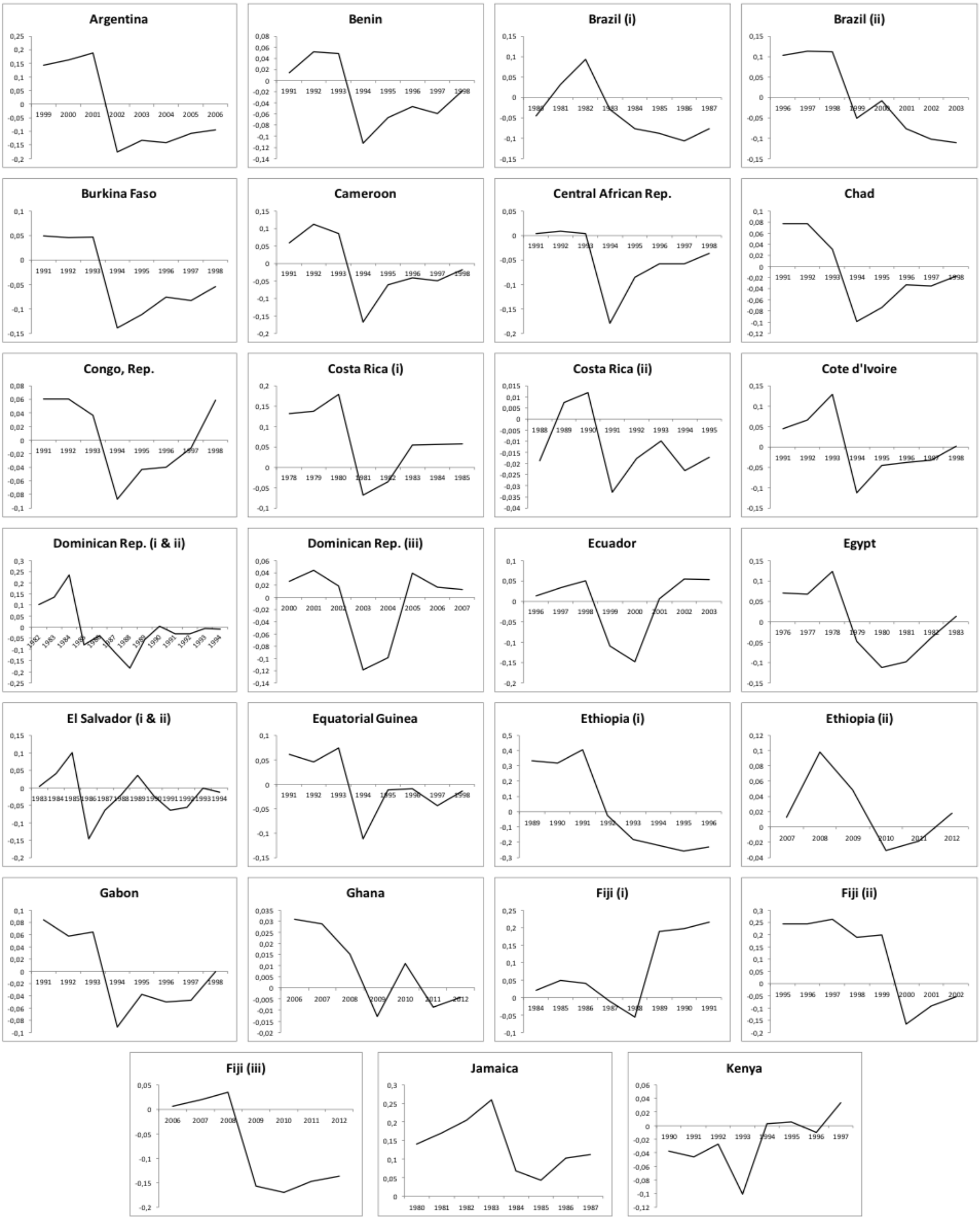

Figure 2 — Exchange rate misalignments

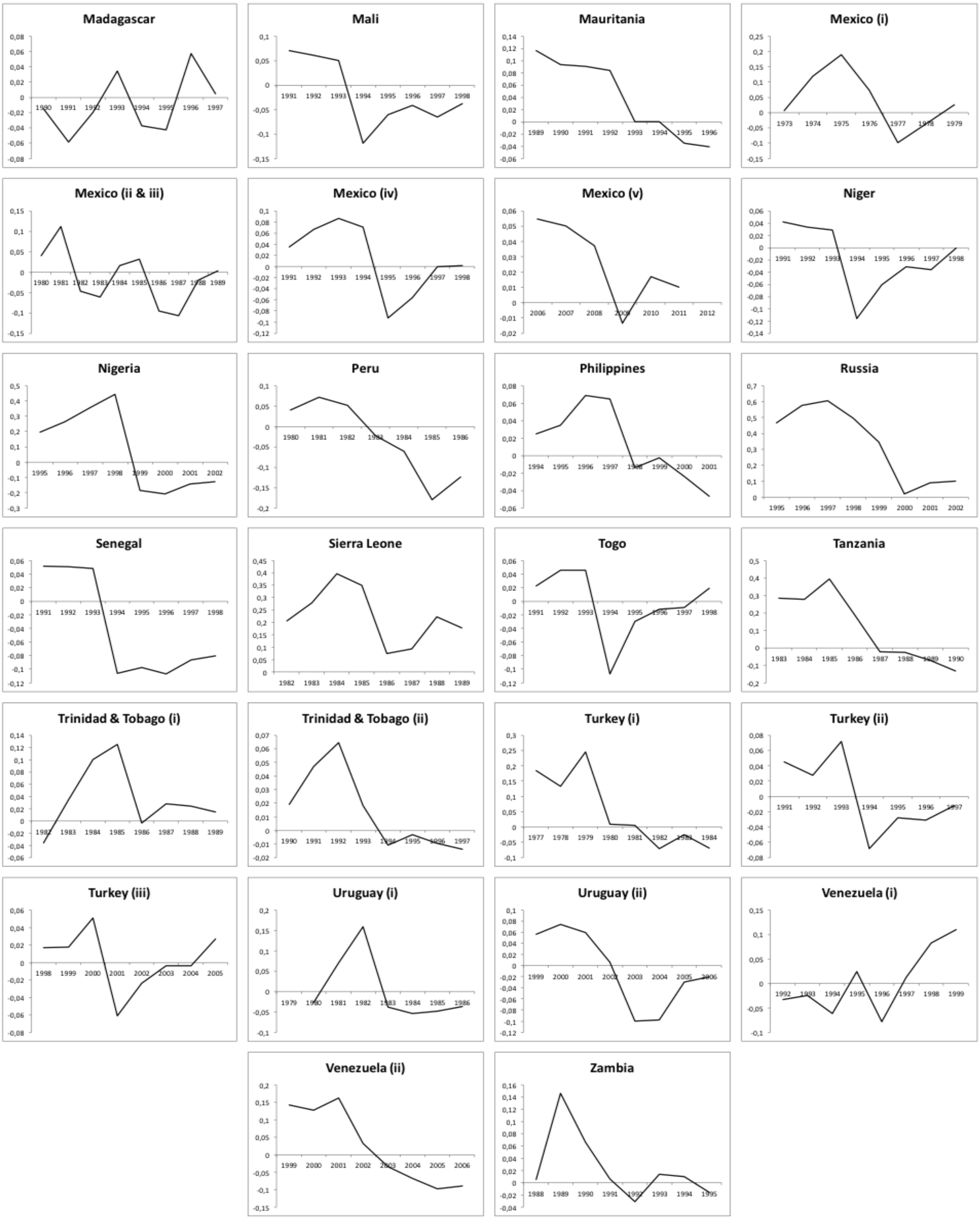

Figure 2 — *Continued.*

D. A theoretical model for the real exchange rate dynamics (Edwards, 1988)

The model presented in this section is a dynamic model of real exchange rate (RER) behavior in developing countries, developed by Edwards (1988). This model serves as theoretical background for our analysis. The model attempts to analyze the forces behind real exchange rate behavior in the developing countries and particularly addresses the issue of the importance of monetary and real variables in the process of real exchange rate determination in both the short and long runs. The model allows for both real and nominal factors to play a role in the short run. However, in the long run, only the real factors —the "fundamentals"— influence the equilibrium real exchange rate.

The model considers a small open economy with three goods: exportables, importables, and nontradables. It is assumed that there is a government sector and a dual nominal exchange rate system. The country produces exportable (X) and nontradable (N) goods and consumes the importable (M) and the nontradable. Nationals of the country hold a stock of domestic money (M) and foreign money (F). In addition, it is assumed that the private sector has inherited a stock of foreign money $(\tilde{F})$. The government consumes importables and nontradables, and uses nondistortionary taxes and domestic credit creation to finance its expenditures.

The dual exchange rate system is characterized by a fixed nominal exchange rate for commercial transactions (E) and a freely floating nominal exchange rate (δ) for financial transactions. This level takes whatever level is required to achieve asset market equilibrium. This assumption of a dual exchange rate system is made as a way of capturing the fact that in most developing countries there is a parallel market for financial transactions. It is assumed that there is a tariff on imports (r) and that, in the tradition of international trade theory, its proceeds are handed back to the public in a nondistortionary way. It is assumed that the price of exportables in terms of foreign currency is fixed and equal to unity (P_x^*). Finally, it is assumed that there is perfect foresight.

The model is given by equations (D.1) through (D.16).

Portofolio decisions

$$A = M + \delta F \tag{D.1}$$

$$a = m + \rho F \quad where \quad a = A/E; \; m = M/E; \; \rho = \delta/E \tag{D.2}$$

$$m = \sigma(\dot{\delta}/\delta)\ \rho F; \quad \sigma^{'} < 0 \tag{D.3}$$

$$\dot{F} = 0 \tag{D.4}$$

Demand side

$$P_M = EP_M^* + r\ ; \quad e_X = E/P_N\ ; \quad e_M = P_M/P_N\ ; \quad e_M^* = (P_M^* E)/P_N \tag{D.5}$$

$$C_M = C_M(e_M, a)\ ; \ \frac{\partial C_M}{\partial e_M} < 0 \quad \frac{\partial C_M}{\partial a} > 0 \tag{D.6}$$

$$C_N = C_N(e_M, a)\ ; \ \frac{\partial C_N}{\partial e_M} > 0 \quad \frac{\partial C_N}{\partial a} > 0 \tag{D.7}$$

Supply side

$$Q_X = Q_X(e_X)\ ; \ \frac{\partial Q_X}{\partial e_X} > 0 \tag{D.8}$$

$$Q_N = Q_N(e_X)\ ; \ \frac{\partial Q_N}{\partial e_N} < 0 \tag{D.9}$$

Government sector

$$G = P_N G_N + \ EP_M^* G_M \tag{D.10}$$

$$\frac{EP_M^* G_M}{G} = \lambda \tag{D.11}$$

$$G = t + \dot{D} \tag{D.12}$$

External sector

$$CA = Q_X(e_X) - P_M^* C_M(e_M, a) - \ P_M^* G_M \tag{D.13}$$

$$\dot{R} = CA \tag{D.14}$$

$$\dot{M} = \dot{D} + E\ \dot{R} \tag{D.15}$$

$$G = t + \dot{D} \tag{D.16}$$

Equation (D.1) defines total assets (A) in domestic currency as the sum of domestic money (M) plus foreign money (F) times the free market nominal exchange rate. Equation (D.2) defines the real assets in terms of exportable good, where E is the (fixed) commercial rate, $\rho = \delta/E$ is the spread between the free (δ) and commercial (E) nominal exchange rates. Equation (D.3) is the portofolio composition equation and establishes that the desired ratio of real domestic money to foreign money is a negative function of the expected rate of depreciation of the free rate δ. Since perfect foresight is assumed, in (D.3) expected depreciation has been replaced by the actual rate of depreciation. Equation (D.4) establishes that there is no capital mobility and that no commercial transactions are subject to the financial rate δ.[29] It is assumed, however, that this economy has inherited a positive stock of foreign money, so that $F_0 > 0$.

Equations (D.5) through (D.9) summarize the demand and supply sides. e_X and e_M are the (domestic) relative prices of exportables and importables with respect to nontradables. Notice that e_M includes the tariff on imports. e_M^*, on the other hand, is defined as the relative price of importables to nontradables that excludes the tariff. Naturally, e_M is the relevant price for consumption and production decisions. Demand for nontradable and importable goods depend on the relative price of importables and on the level of real assets; supply functions, on the other hand, depend on the price of exportables relative to nontradables. Equations (D.10) and (D.11) summarize the government sector, where G_M and G_N are consumption of M and N respectively. It is convenient to express real government consumption in terms of exportables as:

$$g = g_M + g_N \tag{D.10b}$$

where $g = G/E$, and $g_n = G_N PN/E$. Equation (D.11) defines the ration of government consumption on importable goods as λ. Equation (D.12) is the government budget constraint and says that government consumption has to be financed via nondistortionary taxes (t) and domestic credit creation ($\dot{D}$). Notice, however, that under fixed nominal commercial rates a positive rate of credit growth ($\dot{D} > 0$) is not sustainable. Stationary equilibrium, then, is achieved when $G = t$ and $\dot{D} = 0$. If, however, a crawling peg is assumed for the commercial rate (i.e. $(\dot{E}/E)$, it is possible to have a positive $\dot{D}$ consistent with the rate of crawl.

Equations (D.13) through (D.16) summarize the external sector. Equation (D.13) defines the current account in foreign currency as the difference between output of exportables Q_X and total (private plus public sector) consumption of importables. Equation (D.14) establishes that in this model, with no capital mobility and freely determined financial rate, the balance of payments ($\dot{R}$) is identical to the current account, where R is the stock of international reserves held by the central bank expressed in foreign currency. It is assumed that initially there is a positive stock of international reserves (R_0). Equation (D.15) provides the link between changes in international reserves, changes in domestic credit and changes in the domestic stock of money. Finally, the model is closed with equation (D.16) which is the definition of the real exchange rate as the relative price of tradables to nontradables. Notice that this definition of RER excludes the tariff

[29]Later, the assumption of no capital mobility is relaxed; it is assumed that the government is not subject to capital controls, and that there are some capital flows in and out of the country.

on imports. This is done because most empirical measures of RER exclude import tariff or taxes.

Long run sustainable equilibrium is attained when the nontradable goods market and the external sector (current account and balance of payments) are simultaneously in equilibrium. Due to the assumption tight exchange controls, the external sector long run sustainable equilibrium implies that the current account is in equilibrium in every period. In the short and even medium run, however, there can be departures from this equilibrium. This, of course, will result in the accumulation or decumulation of international reserves. A steady state is attained when the following four conditions hold simultaneously: *(i)* the nontradables market clears; *(ii)* the external sector is in equilibrium $\dot{R} = 0 = CA = \dot{m}$; *(iii)* fiscal policy is sustainable $G = t$; and *(iv)* portofolio equilibrium holds. The real exchange rate prevailing under these steady state conditions is the long run equilibrium real exchange rate.

The nontradable goods market clears when:

$$C_N(e_M, a) + G_N = Q_N(e_X) \tag{D.17}$$

Notice that $G_N = e_X g_N$, where g_N is the real government consumption of N in terms of exportable goods. From (D.17) it is possible to express the equilibrium price of nontradables as a function of a, g_N, P_M^* and r.

$$P_N = v(a, g_N, P_M^*, r) \quad where \quad \frac{\partial v}{\partial a} > 0; \ \frac{\partial v}{\partial g_N} > 0; \ \frac{\partial v}{\partial P_M*} > 0; \ \frac{\partial v}{\partial r} > 0 \tag{D.18}$$

Notice that since the real value of total assets (a), is an endogenous variable we have to investigate how changes in g_N, P_M^* and r affect real wealth (a) before solving for P_N.

Since the nominal exchange rate for commercial transactions is fixed, $(\dot{\delta}/\delta)$ in the portofolio equilibrium condition —equation (D.3)— can be substituted by the rate of change of the spread $(\dot{\rho}/\rho)$. Thus, we can write $m/\rho F = \sigma(\dot{\rho}/\rho)$. Inverting this equation and solving for $\dot{\rho}$ we obtain:

$$\dot{\rho} = \rho L\big(\frac{m}{\rho F}\big); \qquad L^{'}(.) < 0 \tag{D.19}$$

Equation (D.19) indicates that the higher the spread the lower the expectations of further increases of the free rate, and thus, the higher the amount of (real) domestic money the public is willing to hold.

From equations (D.10), (D.12), (D.13), (D.14), and (D.15), the following expression for $\dot{m}$ can be derived:

$$\dot{m} = Q_X(e) - C_M(e, a) + g_N - t/E \tag{D.20}$$

Equilibrium of the external sector requires that $\dot{m}$.

After the steady state values of ρ and m are determined, equation (D.18) can be used to find, for the corresponding values of g_N, P_M^* and r, the long run equilibrium price of tradables. Equation (D.16) can then be used to find the long run equilibrium real exchange rate:

$$e_{LR} = v(m_0 + \ \rho_0 F_0,\ g_N,\ r_0,\ P_{M_0}^*) \tag{D.21}$$

As can be seen from equation (D.21) the long run equilibrium real exchange rate is a function of real variables only —the so-called fundamentals. Whenever there are changes in these variables, there will be changes in the equilibrium RER. In the short run, however, changes in monetary variables, such as D, $\dot{D}$ and E will also affect the RER.

The model has four important implications. First, in the short run real exchange rate movements will respond to both real and monetary disturbances. Second, in the long run equilibrium real exchange rate movements will depend on real variables only. Third, inconsistently expansive macroeconomic policies will generate, in the short run, an overvaluation. Fourth, nominal devaluations will only have a lasting effect on the equilibrium RER if they are undertaken from a situation of overvaluation and if they are accompanied by "appropriate" macroeconomic policies.

The following equation for the dynamics of RER behavior captures the points made by the model:

$$\begin{aligned} \Delta log e_t = \ & \theta(log e_t^* \ - \ log e_{t-1}) - \lambda(Z_t - Z_t^*) \ + \ \Phi(log E_t - log E_{t-1}) \\ & -\psi(PMPR_t - PMPR_{t-1}) \end{aligned} \tag{D.22}$$

where e_t is the actual RER; e_t^* is the equilibrium real exchange rate, in turn a function of the fundamentals; Z_t is an index of macroeconomic policies (i.e. the rate of growth of domestic credit); Z_t^* is the sustainable level of the macroeconomic policies (i.e. rate of increase of demand for domestic money); E_t is the nominal exchange rate; $PMPR_t$ is the spread in the parallel market for foreign exchange.

References

Abbritti M., Fahr S. (2011), "Macroeconomic implications of downward wage rigidities", European Central Bank Working paper 1321.

Aisen A., Veiga F.J. (2005), "Does Political Instability Lead to Higher Inflation? A Panel Data Analysis", IMF Working Paper 05/49.

Borensztein E., De Gregorio J. (1999), "Devaluation and Inflation after Currency Crises". http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.202.925rep=rep1type=pdf

Burstein A., Eichenbaum M., Rebelo S. (2004), "Large Devaluations and the Real Exchange Rate", NBER Working Papers 10986, National Bureau of Economic Research, Inc.

Ca' Zorzi M., Hahn E., Sanchez M. (2007), "Exchange rate pass-through in emerging markets", European Central Bank, working Paper N°739, March.

Calvo G., Leiderman L., Reinhart C. (1993), "Capital Inflows and Real Exchange Rate Appreciation in Latin America: The Role of External Factors", IMF Staff Papers, Vol. 40(1), pp. 108–51.

Calvo G. (2003), "Explaining sudden stops, growth collapse and BOP crises: the case of distortionary output taxes", NBER Working Paper 9864.

Calvo G., Izquierdo A., Talvi E. (2003), "Sudden Stops, the Real Exchange Rate and Fiscal Sustainability: Argentina's Lessons", NBER Working Papers 9828.

Cebotari A. (2013), "Can Active Exchange Rate Policies Be Effective in Small States?", International Monetary Fund. http://www.imf.org/external/np/seminars/eng/2013/caribbean/pdf/aliona-cebotari.pdf

Céspedes L.F. (2005), "Financial frictions and real devaluations", Central Bank Of Chile, Working Paper N° 318, May.

Chinn M.D., Ito H. (2008), "A new measure of financial openness", *Journal of Comparative Policy Analysis* 10(3), 309–322.

Choi I. (2002), "Combination Unit Root Tests for Cross-Sectionally Correlated Panels", Mimeo, Hong Kong University of Science and Technology.

Clark P., MacDonald R. (1998), "Exchange rates and economic fundamentals: A methodological comparison of BERRs and FEERs", IMF Working Paper WP98/67.

Combes J-L., Kinda T., Plane P. (2011), "Capital Flows, Exchange Rate Flexibility, and the Real Exchange Rate", IMF Working paper 11/9.

Cukierman A., Edwards S., Tabellini G. (1992), "Seigniorage and Political Instability", *American Economic Review*, 82, 537-555.

De Hoyos R.E., Sarafidis V. (2006), "Testing for cross-sectional dependence in panel-data models", *The Stata Journal* 6, Number 4, pp. 482–496.

Driver R.L., Westaway P.F. (2004), "Concepts of equilibrium exchange rates", Bank of England, Working Paper 248.

Edwards S. (1988), "Real and monetary determinants of real exchange rate behavior: Theory and evidence from developing countries", *Journal of Development Economics* vol. 29(3), pages 311-341, November.

Edwards S. (1989), "Exchange Controls, Devaluations, and Real Exchange Rates: The Latin American Experience", *Economic Development and Cultural Change*, University of Chicago Press, vol. 37(3), pages 457-94, April.

Edwards S. (1994), "Macroeconomic Stabilization in Latin America: Recent Experience and Some Sequencing Issues", NBER Working Papers 4697, National Bureau of Economic Research, Inc.

Edwards S. (1999), "How Effective Are Capital Controls?", *Journal of Economic Perspectives*, American Economic Association, vol. 13(4), pages 65-84, Fall.

Edwards S. (2001), "Exchange Rate Regimes, Capital Flows and Crisis Prevention", NBER Working Papers 8529, National Bureau of Economic Research, Inc.

Edwards S., Santaella J. (1992), "Devaluation Controversies in the Developing Countries: Lessons From the Bretton Woods Era", NBER Working Papers 4047, National Bureau of Economic Research, Inc.

Eichengreen B., Rose A., Wyplosz C. (1995), “Exchange Market Mayhem. The Antecedents and Aftermath of Speculative Attacks”, *Economic Policy*, 21, October, 249-312.

Elbadawi I. (1994), "Estimating Long-Run Equilibrium Real Exchange Rates", in J. Williamson (ed.), *Estimating Equilibrium Exchange Rates*, Washington, D.C.: Institute for International Economics.

Elbadawi I., Soto R. (2008), "Theory and empirics of real exchange rates in developing countries”, Documentos de trabajo 324, Instituto de Economica, Pontificia Universidad Católica de Chile.

Elliot G., Rothenberg T.J., Stock J.H. (1996), "Efficient Tests for an Autoregressive Unit Root", *Econometrica*, 64, 813-836.

Fernandez C., Ley E., Steel M. (2001), "Model uncertainty in cross-country growth regressions", *Journal of Applied Econometrics* 16(5), 563–576.

Frankel J., Rose A. (1996), "Currency Crashes in Emerging Markets: An Empirical Treatment", *Journal of International Economics*, November, 41(3-4), pp. 351-366.

Ghosh A., Gulde A.M., Wolf H. (2003), "*Exchange Rate Regimes: Choices and Consequences*", Cambridge MA: MIT Press.

Guillaumont P., Guillaumont S.J. (1995), "De la dépréciation nominale à la dépréciation réelle : les facteurs d’effectivité des dévaluations dans les pays africains", *Revue Économique*, Programme National Persée, vol. 46(3), pp. 751-762.

Hinkle L., Montiel P. (1999), "*Exchange Rate Misalignment: Concepts and Measurement for Developing Countries*", Oxford: Oxford University Press.

Hoeting J.A., Madigan D., Raftery A.E. (1997), "Bayesian model averaging for linear regression models", *Journal of the American Statistical Association*, 92(437), pp. 179-191.

Hoeting J.A., Madigan D., Raftery A.E., Volinsky C.T. (1999), "Bayesian model averaging: a tutorial", *Statistical Science* 14:382-401.

International Monetary Fund (2014), "Staff Guidance Note on the Fund’s Engagement with Small Developing States", Policy Paper.

Ilzetzki I., Reinhardt C., Rogoff K. (2011), "The country chronologies and background material to Exchange Rate Arrangements into the 21st Century: Will the Anchor Currency Hold?"

Kamin S. (1988), “Devaluation, External Balance, and Macroeconomic Performance: A Look at the Numbers”, *Princeton Studies in International Finance* No.62, International Economics Section, Princeton University.

Kaminsky G. (2006), "Currency Crises: Are They All the Same?", *Journal of International Money and Finance*, Vol. 25, 503-527.

Kaminsky G., Reinhart C. M. (1999), "The Twin Crises: The Causes of Banking and Balance-of-Payments Problems", *American Economic Review*, 89, 3, pp. 473-500.

Khan M.S., Lizondo J.S. (1987), "Devaluation, Fiscal Deficits, and the Real Exchange Rate", *The World Bank Economic Review*, Vol. 1, No. 2, pp.357-374.

Kiguel M. (1994), "Exchange Rate Policy, the Real Exchange Rate, and Inflation: Lessons from Latin America", *Cuadernos de economia* 31 (93) : 229-249.

Klein M.W., Shambaugh J.C. (2010), "*Exchange Rate Regimes in the Modern Era*", Cambridge MA: MIT Press.

Lartey E. (2007), "Capital Inflows and the Real Exchange Rate: An Empirical Study of Sub-Saharan Africa", *Journal of International Trade Economic Development*, Vol. 16, No. 3, pp. 337–57.

Leamer E. (1978), "*Specification Searches: Ad Hoc Inference with Nonexperimental Data*", New York: John Wiley Sons.

Milesi-Ferretti G.M., Razin A. (1998), "Current Account Reversals and Currency Crises: Empirical Regularities", NBER Working paper No. 6620, June.

Moral-Benito E. (2012), "Determinants of Economic Growth: A Bayesian Panel Data Approach", *The Review of Economics and Statistics* vol. 94(2), pages 566-579, May.

Morrisson C., Lafay J.D., Dessus S. (1993), "La faisabilité politique de l'ajustement dans les pays africains", Document technique n°88, Paris, OCDE, Centre de Développement.

Pesaran M., Shin Y., Smith R.P. (1999), "Pooled Mean Group Estimation of Dynamic Heterogeneous Panels", *Journal of the American Statistical Association* 94(446), 621–634.

Pesaran H.M. (2003), "A Simple Panel Unit Root Test in the Presence of Cross Section Dependence", Mimeo, University of Southern California.

Pesaran M.H. (2004), "General diagnostic tests for cross section dependence in panels", University of Cambridge, Faculty of Economics, Cambridge Working Papers in Economics No. 0435.

Rodrik D. (2008), "The real exchange rate and economic growth", *Brookings Papers on Economic Activity*, Vol. 2, pp. 365–412.

Rogoff K., Sibert A. (1988), "Elections and Macroeconomic Policy Cycles", *Review of Economic Studies* vol. 55(1), pages 1-16, January.

Saborowski C. (2009), "Capital Inflows and the Real Exchange Rate: Can Financial Development Cure the Dutch Disease?", IMF Working Paper 09/20 (Washington: International Monetary Fund).

Sala-i-Martin X., Doppelhofer G., Miller R. (2004), "Determinants of long-term growth: A Bayesian averaging of classical estimates (BACE) approach", *American Economic Review* 94(4), 813–835.

Stein E.H., Streb J.M. (2004), "Elections and the timing of devaluations", *Journal of International Economics* vol. 63(1), pages 119-145, May.

Stiglitz J. (2002), "*Globalization and its discontents*", W.W. Norton, New York.

Westerlund J. (2007), "Testing for error correction in panel data", *Oxford Bulletin of Economics and Statistics* 69: 709–748.