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Revisiting the nexus between currency misalignments and growth in the CFA Zone

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Revisiting the nexus between currency misalignments and growth in the CFA Zone

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Abstract

In this paper, we revisit the link between currency misalignments and economic growth by taking into account the foreign currency-denominated debt dynamics (except French Franc and euro) for the CFA zone countries over the period 1985-2011. Relying on a BEER approach and using panel cointegration techniques, we first derive currency misalignments. We then estimate a panel smooth transition growth equation that allows us to observe nonlinear impacts of misalignments on both economic growth and foreign currency-denominated debt dynamics. We find that the nonlinear impact of currency misalignments on growth through the competitiveness channel is mitigated by the foreign currency-denominated debt dynamics through a valuation effect.

JEL Classification: C33, E42, F3, F43

Keywords: Currency misalignments, CFA zone, debt, economic growth, panel smooth transition regression.

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1 Introduction

A relatively abundant literature has highlighted the importance of assessing equilibrium exchange rates in order to limit, or even eliminate, the adverse impact that real exchange rate's misalignments (defined as the difference between the observed real exchange rate and its equilibrium value) may have on economies.

If until now there is no consensus in the determination of equilibrium real exchange rates (see Edwards and Savastano, 2000; Driver and Westaway, 2004), many studies, during these last few years, have sought to link currency misalignments to economic growth (Aguirre and Calderón, 2005; Gala and Lucinda, 2006; Béreau et al., 2009; MacDonald and Vieira, 2010; among others). Recent empirical studies agree that undervalued currencies usually exert a positive effect on growth. In particular, Elbadawi et al. (2009), Levy-Yeyati and Sturzenegger (2007), Rodrik (2009), Korinek and Servén (2010) state that this positive impact is channeled through respectively an increase in exports, an expansion of savings, of capital accumulation, and of investment as well as through learning-by-doing externalities in the tradables sector.

However, the generalization of these results may be questionable as impacts exerted by currency misalignments on growth have not been totally explored. In particular, very little research exists on the link between misalignments and the foreign currency-denominated debt. Indeed if a currency overvaluation can cause a competitive disadvantage, it can also reduce the external debt denominated in foreign currency. This issue is particularly accurate for the CFA zone countries. On one hand, their competitiveness depends on the variations of their anchor currency vis-à-vis third currencies; on the other hand, their revenue coming from their exports dominated by primary products incited them to be indebted in US dollars. Then, for the CFA zone countries, it can be expected that currency misalignments could impact economic growth through two antagonistic effects. For example, in case of a real overvaluation, the deterioration of their competitiveness could inhibit their growth while the decrease of their foreign currency-denominated debt (except French Franc and euro), through valuation effects, could inversely benefit to their growth. Thus, a crucial issue for these countries is to analyze how currency misalignments may be transmitted to growth not only through the competitiveness channel, but also through the channel of valuation effects. This is the purpose of this paper.

Accordingly, we implement a methodological approach in two steps. The first step consists in determining the equilibrium exchange rates of the CFA zone countries in order to derive their currency misalignments. To do so, we adopt the Behavioral Equilibrium Exchange Rate (BEER) approach (Clark and MacDonald, 1998) and use panel data econometric techniques (panel unit root tests and panel cointegration) for the determination of equilibrium exchange rates. The second step consists in estimating a growth equation which allows us to take into account the two transmission channels of misalignments to growth mentioned above. Given that competitiveness and valuation effects crucially depend on whether the real exchange rate is over or undervalued, we rely on a Panel Smooth Transition Regression (PSTR) model (González et al., 2005) in order to take into account those potential nonlinear impacts that currency misalignments may exert on growth.

Considering a panel of twelve CFA zone countries over the 1985-2011 period, our results show that currency misalignments exert a nonlinear impact on growth dynamics through two conflicting effects: a competitiveness effect and a valuation effect. More precisely, we evidence that a real undervaluation tends to boost growth through gain in competitiveness but also tends to hamper it through an increase in the foreign currency-denominated debt.

The rest of the paper is organized as follows. Section 2 is devoted to a review of literature on the linkage between growth, currency misalignments and debt dynamics. In Section 3, we present the econometrical framework. In Section 4, we present the data and discuss the results on the relationship between currency misalignments, debt and economic growth. Finally, Section 5 concludes.

2 Currency misalignments, debt and economic growth: a review of literature

2.1 Currency misalignments and growth

For developing countries and especially for sub-Saharan African (SSA) countries, the issue of currency misalignments is central to their growth process. Because of institutional weaknesses and market failures, currency misalignments may be persistent and may then cause important economic disturbances. So, it is not surprising that a considerable number of empirical works has pointed out a negative link between misalignments and economic growth in those countries.

Cavallo et al. (1990) studied the relation between real exchange rate behaviour and economic performance over a sample of less developed countries. Using two measures of misalignments (a PPP-based index and a regression-based index[1]), they highlighted the negative link between GDP growth and real exchange rate's instabilities (volatility and misalignment). Following Cavallo et al. (1990), Ghura and Grennes (1991) also investigated the relationship between indicators of macroeconomic performance and real exchange rate misalignments in sub-Saharan countries over the period 1970-1987. Their empirical results pointed out a negative link between misalignments and economic growth. According to these authors, better economic performances are usually linked to lower levels of real exchange rate misalignments.

Beyond the size of misalignments, several studies have pointed the specific adverse impact exerted by overvaluations on growth. Klau (1998) emphasized that one of the main causes of poor economic performance in the CFA zone from the mid-1980s to early 1990s, was the CFA Franc overvaluation during that period. It is in this context of important economic imbalances that the CFA devaluation occurred in 1994. This result has been reinforced by recent studies. Gala and Lucinda (2006) and Toulaboe (2006) have offered more robust evidence of the negative link between GDP growth and overvaluations by using panel data approach. More recently, Elbadawi et al. (2009) have investigated the impact of currency misalignments on economic growth and exports for 83 sub-Saharan countries over the period 1970-2004. Using a dynamic model developed initially by Elbadawi et al. (2008) to derive real exchange rate misalignments indexes[2], they also find a negative impact of overvaluation on growth as well as on export diversification and sophistication.

This relationship has been clarified by studies which emphasize possible asymmetric

[1]The authors consider the following fundamentals of real exchange rates: terms of trade, differential productivity, excess domestic credit creation, net capital inflows and the income over trade ratio.

[2]The reduced form of the real exchange rate's equation includes: terms of trade, endowment variables (natural resources and human capital), government consumption, productivity levels, foreign aid, the stock of foreign debt and taxes.

impacts of under- and overvaluations on economic growth. Razin and Collins (1997) explore the relationship between real exchange rate misalignments and economic growth for a large sample of countries and show that there are important nonlinearities in this relationship. More specifically, only a very high overvaluation appears to be associated with slower economic growth. Moderate to slightly high undervaluations, on the contrary, go hand in hand with more rapid economic growth. Aguirre and Calderón (2005) consider a panel of 60 developed and developing countries over the 1965-2003 period. To capture potential asymmetric effects of misalignments, they estimated a growth equation in which they include interaction variables.[3] Their empirical results show that an undervaluation up to 12% enhances growth, whereas an overvaluation tends to hamper it. Several studies based on regime switching models have also found a positive and significant link between undervaluation and growth, while an overvaluation above an estimated threshold negatively affects economic growth (see for instance, Béreau et al., 2009; Aflouk and Mazier, 2013; Couharde and Sallenave, 2013). These results clearly highlight the asymmetrical behaviour of over- and undervaluation. First, the wider the currency misalignment, the more negative the impact on growth is. In particular, large undervaluations seem to hamper growth dynamics while small to moderate undervaluations enhance it. Second, the impact of currency misalignments depends on their sign: a real overvaluation generally exerts a negative impact on growth while the effect of a real undervaluation is found to be positive.

2.2 The issue of transmission channels

Beyond the question of the effects of currency misalignments on growth, the issue of transmission channels at stake is also a fundamental one. However, as underlined by Gala (2008), theoretical analyses of those transmission channels through which real exchange rate levels could affect economic growth are very scarce.

Rodrik (2008) argues that the relevant channel operates through the size of the tradable sector. Undervaluation has a positive effect on the relative size of the tradable sector, and especially of industrial economic activities which in turn may boost growth. For Elbadawi et al. (2009), the main channel operates through export diversification and

[3] The authors assume possible differentiated countries' behaviors depending on the size and/or the sign of their currency misalignments.

sophistication. An overvalued real exchange rate damages the manufacturing base, leads to more export concentration, and undermines the development of more sophisticated products. Gala (2008) also supports the idea that undervaluations encourage exports.[4] However, according to him, two important channels through which exchange rates levels affect growth are related to investment and technological change. A relatively undervalued currency should lead to lower real wage levels and higher profit margins and then contribute to more employment and investment by increasing capacity utilization. Also, a competitive exchange rate would help developing countries to climb the technological ladder. Gluzmann et al. (2011) suggest that undervaluation fosters growth by the channel of savings and investment rather than foreign trade dynamics: an undervalued exchange rate tends to increase the domestic saving rate and a higher saving rate in turn stimulates growth by increasing the rate of capital accumulation. However, Montiel and Servén (2008) do not support this conclusion. Drawing from standard analytical models, stylized facts on saving and real exchange rates, and existing empirical research on saving determinants, they assess the link between the real exchange rate and saving. Their main conclusion is that saving is unlikely to provide the mechanism through which the real exchange rate affects growth.

Both channels mentioned above are so far the two dominant views in the literature. But, as Montiel and Servén (2008) emphasized, the literature addressing the issue of the channel through which the real exchange rate impacts growth is in its infancy, and there is no consensus on the precise channels through which effects are generated.

Another channel, less investigated, is the impact of currency misalignments on the foreign currency-denominated debt and more particularly on the burden of these debts. Indeed, a high level of foreign currency-denominated debt can hamper growth, in particular in developing countries, through balance sheets effects (Calvo and Reinhart, 2001; Céspedes et al. 2004). The underlying mechanism is the following: a domestic currency depreciation considerably increases foreign currency-denominated debt burdens, leading thus to a decrease in firms production mainly because of corporate financial distress, absence of trade credit and increasing costs of imported inputs, goods. These balance

[4] A relatively undervalued currency may also help to avert financial crises and therefore put the economy on a more sustained development path.

sheet effects also weaken the balance sheets of banks and the government's fiscal position. On the other hand, an appreciation reduces the foreign currency-denominated debt and improves the ability to borrow in foreign currency. There is then a trade-off between competitiveness and balance sheet effects and, as argued by Craigwell et al. (2010) and Gnangnon (2012), the total effect will depend on the effectiveness of the depreciation: an exchange rate depreciation will lead to a decline of the external debt stock if the induced rise in export earnings of this depreciation is sufficiently enough to service the external debt. This problem of balance sheets effects is common to developing countries and the main reason can be found in the "original sin" according to which developing countries generally cannot borrow in their own currency (Eichengreen and Hausmann, 1999). Khan (2005) surveys the literature on the original sin by paying special attention to sub-Saharan Africa (SSA) countries and argues that due to undeveloped and relatively small size of their financial and bond markets, SSA countries (except South Africa which has a quite developed financial sector) are heavily dependent of foreign capital or aid inflows. Moreover, as emphasized by Ul Haque (2002) and Goldstein and Turner (2004), the ability to borrow abroad in domestic currency, depends not only on financial markets development but also on the credibility of national macroeconomic policies (apprehended mainly by low inflation) and on institutional factors which are usually weak in SSA countries. Therefore, for all those reasons, those countries are usually exposed to the "original sin".

Until now, the way through which these effects could happen for the CFA zone countries has not been studied. One the one hand, the CFA countries benefit from credibility that is conventionally associated to their irrevocable commitment to a fixed exchange-rate regime and guaranteed convertibility of their currency and that allows them to borrow on financial markets. As displayed in Tables A.2.1 and A.2.2 in Appendix, their foreign currency-denominated debt (except in the anchor currency) represents a significant weight (around 45% of GDP and 65% of the total public debt). On the other hand, given their peg to the euro (French Franc before 1999), fluctuations of the anchor currency against currencies of third countries should therefore have some impacts on the CFA Franc variations and then on the foreign currency-denominated debt of the CFA zone countries. Indeed, as depicted in Figure 1, variations of the CFA Franc have mirrored the anchor currency's variations (except in 1994 when the CFA Franc was devalued by 50 per cent against the French Franc).

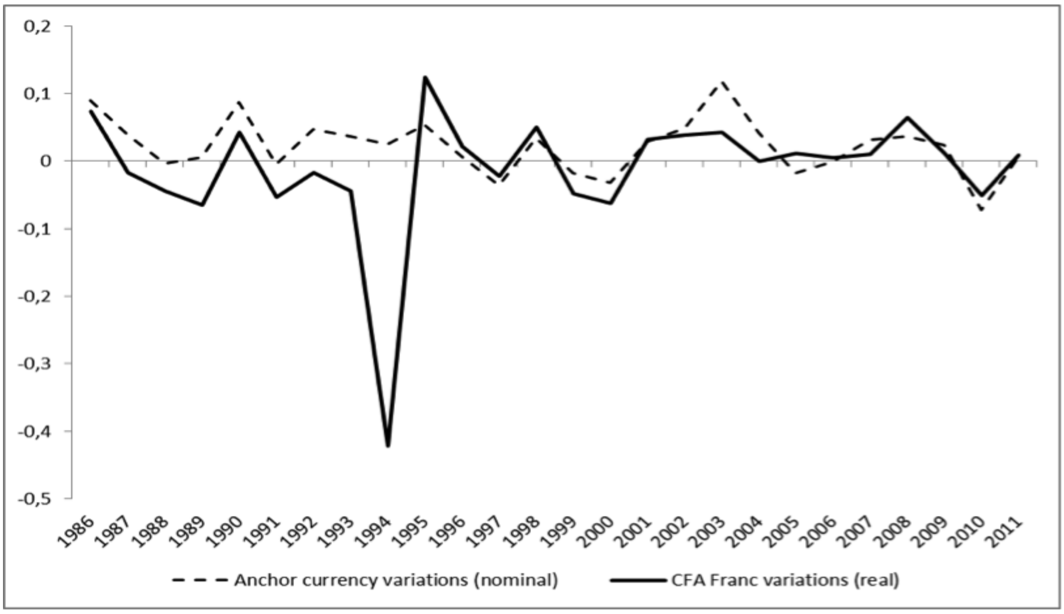

Figure 1: CFA Franc and anchor currency variations (in%)

Note: The CFA variations are those of the real effective exchange rate, those of the anchor currency correspond to the nominal effective exchange rate (euro and French Franc before 1999).

Source: Author's calculation

In particular, since 2003 with the appreciation of the euro, the issue of the interactions between the misalignment of the CFA Franc and the evolution of the anchor currency has been highlighted in several studies. Coudert et al. (2011) note that, for the CFA zone, the evolution of the anchor currency has impacted the level of misalignments, and that the CFA Franc has tended to be overvalued in periods when the euro was strong. Gnansounou and Verdier-Chouchane (2012) also evidence that the misalignment curve of the CFA Franc is closely linked to that of the euro / dollar exchange rate (except when prices of major commodities exported by each country increase). Gnimassoun (2012) who empirically studied the effect of the peg (more specifically the effects of the anchor currency misalignments within the CFA zone) found that a 1% nominal overvaluation of the French Franc (resp. euro) results in an overvaluation of the CFA Franc between 1.2% and 1.5% (resp. 0.69%). As a result, due to their exchange rate regime, the CFA countries could be confronted with two contradictory effects stemming from currency misalignments. They should reap a competitive advantage but also register an increase in their foreign currency-denominated debt in periods when their currency tends to be undervalued. Conversely, with real exchange rates overvalued, they could record a loss of competitiveness while benefiting from a decrease in their foreign currency-denominated debt. The nexus between currency misalignments and growth is then not straightforward and should be clarified by taking account those two transmission channels.

3 Econometrical framework

Relying on a BEER approach and using panel cointegration techniques, we first derive currency misalignments. We then estimate a panel smooth transition growth equation that allows us to observe nonlinear impacts of misalignments on both economic growth and foreign currency-denominated debt dynamics.

Our sample includes twelve CFA zone countries: Benin, Burkina Faso, Cote d'Ivoire, Mali, Niger, Senegal and Togo which belong to the West African Economic and Monetary Union (WAEMU); Cameroon, Central African Republic, Chad, Congo and Gabon for the Central African Economic and Monetary Community (CEMAC).[5] All data are annual and cover the period 1985-2011.

3.1 Derivation of real exchange rate misalignments

To derive our misalignments series, we rely on the BEER (Behavioral Equilibrium Exchange Rate) approach (Clark and MacDonald, 1998).[6] The BEER approach is based on the estimation of 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 equilibrium exchange rate. We follow the existing literature on the determination of equilibrium exchange rate in developing countries and more specifically in the CFA zone (see Abdih and Tsangarides, 2006; Roudet et al., 2007; Elbadawi et al., 2009; Couharde et al., 2011; among others) and consider the following determinants of the real

[5]Guinea-Bissau and Equatorial Guinea have been excluded from the panel. Guinea Bissau belongs to the CFA zone over the past few years. Given problems of data availability, it has not been possible to include Equatorial Guinea.

[6]For extensive surveys on the BEER and related concepts (such as PPP, CHEER, FEER, DEER, PEER, NATREX) we refer to MacDonald (2000), Edwards and Savastano (2000), and Driver and Westaway (2005).

effective exchange rate: productivity differential (*rprod*), terms of trade (*tot*), government consumption (*gov*), openness (*open*) and the net foreign assets (*nfa*).[7] We expect a positive relationship between the real effective exchange rate and these fundamentals. Indeed, an increase in the productivity differential, in government consumption and in openness as well as an improvement in the net foreign asset and the terms of trade are expected to induce an appreciation of the real effective exchange rate.

Our long-run relationship is therefore specified as follows:

$$q_{i,t} = \alpha_i + \beta_1 \ tot_{i,t} + \beta_2 \ rprod_{i,t} + \beta_3 \ open_{i,t} + \beta_4 \ gov_{i,t} + \beta_5 \ nfa_{i,t} + \epsilon_{i,t} \tag{1}$$

where $i = 1, \ldots, N$ and $t = 1, \ldots, T$ respectively indicate the individual and temporal dimensions. $q_{i,t}$ represents the real effective exchange rate; α_i are the countries fixed effects and $\epsilon_{i,t}$ is the error term.

We determine first the order of integration of each variable and then test the existence of a cointegration relationship by applying non-stationary panel methods.[8] As displayed in Appendix A.3 (Tables A.3.1 and A.3.2), results of unit root and cointegration tests confirm that our series are integrated of order 1 and cointegrated. We then proceed to the estimation of our long-run relationship.

For this purpose, the coefficients of the long-run relationship are derived by using DOLS (Mark and Sul, 2003) and PMG (Pesaran et al., 1999) estimators. The choice of these estimators is motivated by the fact that *(i)* the DOLS estimator takes into account potential endogeneities among the variables, and, *(ii)* the PMG estimator has the advantage to provide estimates not only of the long-run parameters, but also of the short-run dynamics and the speed of adjustment to equilibrium; in addition, it allows for a degree of heterogeneity. Results of both PMG and DOLS estimations are displayed in Table 1. They are in accordance with the theory: an increase in the productivity differential and in government consumption as well as an improvement in the terms of trade leads to an appreciation of the equilibrium real exchange rate in the long run, while the net foreign

[7] See Table A.1. in Appendix A for the presentation, definition and sources of the data.

[8] The use of panel data has the distinct advantage of allowing working with small sample size in the temporal dimension - as is often the case in African countries - and thus to overcome the classic problem of low power tests in small sample.

Table 1: PMG and DOLS estimation results

	PMG		DOLS	
	Coef.	z	Coef.	t
Long-run dynamic				
rprod	0.382 ***	5.94	0.363 ***	4.46
tot	0.172 ***	3.40	0.218 ***	3.76
nfa	0.058	1.41	0.078	1.22
gov	0.331 ***	6.70	0.420 ***	8.03
Short-run dynamic				
ec.	-0.311 ***	-5.90		
rprod	-0.181	-1.51		
tot	-0.116 ***	-2.93		
nfa	0.268 ***	5.36		
gov	0.090	1.23		
const.	1.262 ***	5.93		

Note: ***, **, and * denote respectively significance at 1%, 5%, and 10% level. Although PMG estimator takes into account the non-stationary nature of the variables, we deliberately excluded *open* from the short-run dynamic in order to limit the collinearity risk in the growth equation.

asset position only impacts the equilibrium exchange rate in the short-run. The coefficient of the error-correction term, -0.311, corresponds to a half-life of approximately 3.58 years. This value is a bit higher than those estimated by Gnimassoun (2012) and Couharde et al. (2013) which found a coefficient of respectively -0.26 and -0.23.

Using equation (1) estimation results, we assess equilibrium exchange rate by feeding the estimated model with the permanent components of the fundamentals. We used the Hodrick-Prescott filter to decompose our fundamentals into their temporary and permanent component. We then proceed to the determination of currency misalignments, following the three pivotal equations based methodology proposed by Elbadawi et al. (2009):

Let e_{it} be the observed real exchange rate for any given country i at time t:

$$e_{it} = \hat{\beta}' F_t^i + \hat{\epsilon}_t^i \tag{2}$$

where F_t^I and β are the vector of current fundamentals and long-run coefficients. Equation (2) expresses the log of the real effective exchange rate in terms of current fundamentals and residual terms.

Equation (3) specifies the log of the equilibrium real exchange rate:

$$\tilde{e}_{it} = \bar{e}^i + \hat{\beta}'(\tilde{F}_t^i - \bar{\tilde{F}}^i) \tag{3}$$

$\tilde{F}_t^i$ refers to the permanent components of the fundamentals and the bar over the variables indicates the mean over the time.

Misalignments series can be deduced from the difference between equations (2) and (3), *i.e* the difference between the observed values of real effective exchange rates and their equilibrium values:

$$MIS_t^i = e_t^i - \tilde{e}_t{}^i \tag{4}$$

Figures B.1 and B.2 in Appendix B display respectively the evolution of the real effective exchange rates (observed and equilibrium) and currency misalignments series for each considered country. In general, our results corroborate ones of previous studies (Gnimassoun, 2012; Couharde et al., 2013). As pointed out by Couharde et al. (2013), the CFA Franc was overvalued since the late 1980s and until the devaluation of 1994. In 1993, all countries except Togo, presented important levels of overvaluation. Benin, Burkina Faso, Cote d'Ivoire, Cameroon and Senegal have overvaluation's levels above 18%. Over the period 1990-1993, a partial decrease of misalignments can be observed, which was probably due to the structural adjustment plans in place at this time in those countries. Following the devaluation that occurred in 1994, misalignments turn, in all countries, from overvaluations to undervaluations. Nevertheless, for most of the countries, this competitiveness advantage has been reduced progressively with the introduction of the euro and more particularly to 2002 when the euro begun to appreciate against third currencies and more particularly against the US dollar. Only in some CAEMC economies (Cameroon, Republic of Congo, Chad), the appreciation of the euro has been offset by an improvement in their terms of trade and has then allowed them to record important undervaluations.

3.2 Investigating the debt channel in the misalignments-growth nexus

To investigate now the potential nonlinear effects exerted by currency misalignments on growth, we rely on a PSTR model (González et al., 2005). With this specification, González et al. (2005) proposed an extension of the Panel Threshold Regression (PTR) models (Hansen, 1999) by allowing coefficients to vary from one regime to another, depending on the value (threshold) of a transition variable. Transition from on regime to another is ensured by a transition function which allows coefficients to change smoothly.

As we expect that the impact of currency misalignments on growth is non linear and is channeled through a competitiveness effect and a valuation effect, we consider that the transition variable is the currency misalignment and that only the coefficients of the foreign-currency denominated debt variable and the misalignments series vary depending on the sign and/or the size of the currency misalignment. Thus we consider the following PSTR model:

$$\begin{aligned}\Delta y_{i,t} = \mu_i + \beta_{01} Debt_{i,t} + \beta_{02} Mis_{i,t} + [\beta_{11} Debt_{i,t} + \beta_{12} Mis_{i,t}]\ g(Mis_{i,t}; \gamma, c) \\ + \Omega_0 X_{i,t} + \ u_{i,t}\end{aligned} \tag{5}$$

for $i = 1, \ldots, N$, and $t = 1, \ldots, T$, where N and T denote the cross-section and times dimensions of the panel, respectively. $\Delta y_{i,t}$ is the dependent variable, the per capita GDP annual growth; μ_i represent the fixed individual effects; $debt_{i,t}$, is the foreign currency-denominated debt in % of GDP and $Mis_{i,t}$ is the currency misalignment. $X_{i,t}$ is a k-dimensional vector of time varying control variables, and $u_{i,t}$ is an independent and identically distributed error term.

According to this specification, debt and currency misalignment coefficients are allowed to vary depending on the level of currency misalignment. PSTR models being regime switching models in which the transition from one regime to the other is smooth rather than discrete, the change in the estimated value of coefficients is smooth and gradual.
$g(Mis_{i,t}; \gamma, c)$ is the transition function normalized to be bounded between 0 and 1 which,

following Gonzalez et al. (2005), can be specified as follows:

$$g(Mis_{it};\gamma,c)=\left[1+exp\left(-\gamma\prod_{j=1}^{m}(Mis_{i,t}-c_j)\right)\right]^{-1} with\ \gamma>0 \text{ and } c_1\leq c_2\leq\ldots\leq c_m \tag{6}$$

where γ is the slope parameter determining the smoothness of the transition, $Mis_{i,t}$ the transition variable and c_j the threshold parameters.
With $m = 1$ and $\gamma \to \infty$, the PSTR model is equivalent to the two-regime Panel Threshold Regression (PTR) model (see Hansen, 1999). Indeed, the higher the slope parameter, the more abrupt the regime shift; the extreme case being when $\gamma \to \infty$. For any value of m and when $\gamma \to 0$, the model collapses into a homogenous (linear) panel regression model with fixed effects. As González et al. (2005) emphasized, any nonlinearity can be captured with $m = 1$ (the transition function is logistic) or $m = 2$ (the transition function is logistic quadratic). For $m = 1$, the nonlinearity implies two extreme regimes associated with high and low values of the currency misalignment relative to its threshold. For $m = 2$, the nonlinearity implies two transition points which delimitate an intermediate regime in which the dynamic is different compared to the one followed by the two extreme regimes.

We follow the three steps methodology proposed by González et al. (2005). The first step (model specification) consists of *(i)* testing the homogeneity of the model against the PSTR alternative and *(ii)* choose the appropriate transition function (order of m) as well as the appropriate transition variable. The second, estimation step relies on the use of nonlinear least squares to obtain the parameter estimates, once the data have been demeaned. The third and last stage is devoted to the application of misspecification tests in order to ensure the validity of the PSTR model: parameter constancy and no remaining heterogeneity. The latter test is useful for determining the number of transitions in the model.

4 Data and estimation results

4.1 Data

The dependent variable in our analysis is the per capita GDP annual growth. Turning to the other variables, misalignments series come from estimates of the previous section. Following the literature on growth in developing countries (see Barro, 1991; Barro and Sala-I-Martin, 1995; Mirestean and Tsangarides, 2009; among others), but paying a special attention to African countries (Tsangarides, 2012), we consider the following control variables. In accordance with the neoclassical theory, we first retain two variables: *(i)* human capital development through life expectancy, and *(ii)* population through population growth rates.[9] We also consider macroeconomic variables such as: *(iii)* government consumption (measured in percentage of GDP), *(iv)* inflation rates, *(v)* investment (in percentage of GDP) and *(vi)* external debt service (public and publicly guaranteed, as percentage of GDP); variables regarding the trade regime: *(vii)* openness and *(viii)* terms of trade. Finally, we include a measure of the external environment through *(ix)* the ratio aid to GDP.[10]

Finally, regarding the foreign currency-denominated debt, we report in Appendix A.2, details of its calculation. Given the purpose of our study, the "debt" variable to be considered is the foreign currency-denominated debt. Indeed, we expect that misalignments will impact the foreign currency-denominated debt through valuation effects. To take into account this mechanism, we then should strictly consider the foreign currency-denominated debt (except the French Franc- and euro-denominated debt) and not the external debt converted into foreign currency. We therefore built our variable of interest using the external debt stocks, public and publicly guaranteed (PPG) as percentage of GDP and its currency composition (in euro and French Franc).[11]

The unit root tests results of the variables are reported in Table A.3 in Appendix A. Our results show that *debt*, investment (*invest*), terms of trade (*tot*) and life expectancy (*life*), appear to be integrated of order one (I(1)) while, population growth (*pop*), govern-

[9]We could also take into account the gross secondary-school enrollment according to the literature (see Barro (1991) among others) but this variable is not available for all countries of our sample.

[10]See Table A.1. in Appendix A for the presentation, definition and sources of the data.

[11]Because of data availability, we use this variable which must then be considered as a proxy of the foreign currency-denominated debt.

ment expenditure (*gov*), inflation (*inflation*), external debt service (*debt service*) and aid (*aid*) are stationary processes (I(0)) at 5% confidence level.

The estimation relies on annual rather than 5-years averaged data, unlike in many estimations of growth equation. Indeed, even if this method presents the advantage to remove business cycles effects from the growth rate, it is costly in observations. We therefore opt for a relatively high number of degrees of freedom by using annual data. Also, unlike usual works on growth, we do not include the initial position of the economy (initial level of real GDP per capita) since it is difficult to deal with an endogeneity issue in a nonlinear panel.

4.2 Results

Before estimating of our PSTR model, we start by testing the null hypothesis of linearity (testing homogeneity). In particular, we test whether the response of growth is different, depending on the size and the sign of the real exchange rate misalignment, identified here as the threshold variable.

As stated in the methodology section, the PSTR model can be reduced to a homogenous form model by imposing either $H_0 : \gamma = 0$ or $H_0^{'} : \beta_1 = 0$ (see equations 5 and 6). A way to test the linearity assumption could therefore consist in testing for these last two assumptions. However, these tests are nonstandard because under either null hypothesis the PSTR model contains unidentified nuisance parameters. Indeed, c (the location parameter) is not identified under both null hypotheses, while this is the case for β_1 under H_0 and for γ under $H_0^{'}$. Following Luukonnen et al. (1988), González et al. (2005) proposed to the null hypothesis of $H_0 : \gamma = 0$ by replacing the transition function by its first-order Taylor expansion around $\gamma = 0$. After reparameterization, this test simply amounts to test a constrained model against an unconstrained model.

In Table 2, are reported respectively in the first and in the second lines the results of this test and of the no remaining heterogeneity test. As indicated by González et al. (2005), in addition to be a misspecification test, the latter test is a useful tool for determining the number of transitions in the model.

Table 2: Homogeneity and no remaining heterogeneity tests results

			$LM_{\chi} stat$	$LM_F stat$	Pseudo LRT
H_0 : Linearity	vs.	H_1 : PSTR model	6.871	3.340	6.962
$r = 0$		$r = 1$	(0.032)	(0.037)	(0.030)
H_0 : No remaining		H_1 : Heterogeneity	7.504	1.819	7.603
heterogeneity	vs.		(0.111)	(0.125)	(0.107)
$r = 1$		$r = 2$			

Note: We reported tests results for our most significant specification (see Table 3 for more details). r denotes the number of transition.

Results reported in Table 2 show that the null hypothesis of linearity can be rejected at the 5% significance level. The impact of real exchange rate misalignments on growth is then nonlinear. Moreover, the results indicate a two-regime model associated with the sign of misalignments (we do not reject the null hypothesis of no remaining heterogeneity). Thus we proceed with estimating our PSTR model (equation 5).

The estimation stage consists in eliminating the individual effects by removing individual-specific means and then apply Nonlinear Least Squares (NLS) to the transformed data. Parameter estimates are reported in Table 3.

Table 3: Estimated PSTR model[12]

Threshold:	$c = -0.075329$			
Smoothness:	$\gamma = 189.479$			
	g(.)=0		**g(.)=1**	
	β_0	t-stat	β_1	t-stat
Misalignment	0.032*	1.667	-0.087*	-1.791
Debt	-0.226***	-2.597	0.151*	1.817
Investment	0.162***	4.197		
Government spending	-0.236***	-2.765		
Population growth	-0.844***	-2.726		
Life expectancy	0.021**	2.197		
Aid	0.072**	2.030		

Note: ***, **, and * denote significance at 1%, 5%, and 10% level respectively.

Our results show a nonlinear impact exerted by currency misalignments. The estimated threshold value, -0.0753, delimits the two following regimes. A first regime associated with "$g(.) = 0$" corresponds to undervalued currencies (undervaluation higher than

[12]Some of the variables have been excluded from the final estimation since they were not significant.

7.53%). In this case, the estimated coefficients are those reported in column "$g(.) = 0$". The second regime, related to "$g(.) = 1$", refers to real exchange rates overvalued or slightly undervalued (*i.e.* less than 7.53%). In this case, the estimated coefficients of the variables subject to nonlinearities (currency misalignments and the foreign currency-denominated debt) are defined by the sum of the estimates in columns "$g(.) = 0$" and "$g(.) = 1$". With the high value of the slope parameter, the transition between the two regimes is quite abrupt, as depicted by the transition function displayed in Figure B.3 in Appendix B.

Looking first at the control variables, all coefficients have the expected sign and are statistically significant. Investment, through its positive impact on capital accumulation, increases economic growth. Moreover this variable is one of the most significant growth determinants (the coefficient has the highest t-statistic) as emphasized by Tsangarides (2012). Life expectancy and aid flows also appear to be positively correlated with growth. Conversely, government consumption and the population growth hamper growth. The negative sign of government spending seems to confirm the growing consensus that consistent and increasing government presence in an economy can hinder economic growth, especially in developing countries (Rodrik, 2008; Berg and Miao, 2010; MacDonald and Vieira, 2010).[13] In accordance with the Solow model, the population growth coefficient is also negative and significant. An increase of 1% in the population growth leads to a 0.84 decrease of the annual GDP per capita growth.

Let us turn now to our two main variables of interest. First, regarding the impact of currency misalignments on growth, we evidence a nonlinear effect depending on whether real exchange rates are strongly undervalued (more than 7.3%) or not. In the first regime (regime of strong undervaluation), the coefficient associated with the real exchange rate misalignment is positive: beyond a threshold of 7.3%, a real undervaluation has a positive impact on growth. The coefficient is equal to 0.032, meaning that, other things being equal, an undervaluation of the real exchange rate of 10% contributes for an increase in

[13] Another explanation is provided by Barro (1991) who argued that government consumption introduces distortions, such as high tax rates, but does not provides an offsetting stimulus to investment and growth. Economic growth and prosperity should therefore be higher in a context dominated by private enterprises and free market. Others works on the CFA zone confirm this results pointing the lack of complementary between the public and private investment (see Nubukpo (2007) for a review of literature).

GDP per capita growth about 0.32%. Conversely, in the second regime corresponding to real exchange rates slightly undervalued or overvalued, the impact of currency misalignments is negative (-0.055).[14] Our results are then in line with the bulk of the literature in this area that tends to evidence a positive effect on growth exerted by real undervaluations and an hampered one induced by real overvaluations.

Turning finally to the impact exerted by the foreign currency-denominated debt on growth, results confirm our prediction that it depends on the sign of currency misalignments. Indeed, in the first regime (*i.e.* in the undervaluation regime), the impact of the foreign currency-denominated debt on growth is negative: an increase of 1% in the foreign currency-denominated debt causes, *ceteris paribus*, a 0.226% decrease in the GDP per capita growth. Nevertheless, this negative impact tends to decrease in the second regime (the coefficient is equal to -0.075), meaning that the lower the real undervaluation is, the lower the negative effect of the foreign currency-denominated debt on growth will be.

Overall our findings show that growth dynamics in the CFA zone countries is nonlinearly impacted by currency misalignments through two conflicting channels: a competitiveness channel and a debt channel. A real undervaluation boosts growth by improving competitiveness while, in the same time, tends to hamper it by increasing the foreign currency denominated debt.

4.3 Robustness check

To test the robustness of our results, we conduct a number of additional regressions. First, as currency misalignments estimates are often controversial, we estimate the previous PSTR model by considering an alternative measure of misalignments. Accordingly, we rely on an alternative equilibrium exchange rate approach, the Atheoretical Permanent Equilibrium Exchange Rate (APEER) approach, as Aghion et al. (2009) and Béreau et al. (2009). This approach consists in filtering the real effective exchange rate using a Hodrick-Prescott filter and considers the currency misalignment as the cyclical components of the series. We report in Table 4, the results of the PSTR model estimated with

[14] $\beta_0 + \beta_1 = 0.032 - 0.087 = -0.055$

those alternative misalignment series.

Table 4: Robustness check

Threshold:	$c = -0.1259$			
Smoothness:	$\gamma = 63.6197$			
	g(.)=0		**g(.)=1**	
	β_0	t-stat	β_1	t-stat
Misalignment	0.037***	4.58	-0.109**	-2.19
Debt	-0.301*	-1.85	0.176*	1.68
Investment	0.034***	5.18		
Government spending	-0.157**	-2.01		
Population growth	-0.874**	-1.97		
Life expectancy	0.051**	2.15		
Aid	0.061	1.05		

Note: ***, **, and * denote significance at 1%, 5%, and 10% level respectively.

As one can note, the results go hand in hand with those of Table 3. The estimates of our growth determinants are more or less similar. More important, the results confirm the robustness of our previous findings on nonlinearities exerted by currency misalignments. When real exchange rates are strongly undervalued (more than 12.6%), economic growth is both boosted by a competitiveness channel and hampered by the negative impact of the foreign currency-denominated debt. Conversely, slight undervalued or overvalued real exchange rates tend to reduce economic growth while the negative impact exerted by the foreign currency-denominated debt is diminishing.

Finally, as the CFA zone countries (except Gabon) have benefited from debt relief initiatives (namely the Heavily Indebted Poor Countries, HIPC, initiative) during the 2000s, we run additional regressions in order to control for this initiative which in most cases has resulted in a decrease in the external debt.[15] Indeed, the aim of this initiative is to ensure that no poor country faces a debt burden it cannot manage, to reduce to sustainable levels the external debt burdens. In his implementation, the HIPC initiative appears more like a poverty reduction / development initiative as countries must meet specific criteria, establish and implement keys reforms to benefit from debt reliefs.[16] The debt relief (after the completion point) and especially the external debt service reduction (between the decision point and the completion point) should thereby enable to fight

[15]See Table A.2.3 in Appendix A.2 for further details.

[16]See the IMF Factsheet "Debt Relief Under the Heavily Indebted Poor Countries (HIPC) Initiative" for more details. http://www.imf.org/external/np/exr/facts/hipc.htm

more effectively against poverty by allocating more resources to social spending (heath and education). The HIPC initiative can then be seen as a transfer of resources from the external debt service to social spending (in others words, an official development assistance). Accordingly, in order to control for the HIPC effects, we have added both external debt service and government consumption as explanatory variables in our initial growth equation. We have also introduced different dummy variables and interaction variables[17] to control for these effects and also to take into account changes in the macroeconomic policies in place at this time. Further details regarding these dummy variables are reported in Table A.1. Results[18] show that dummy variables are not significant, meaning that the impact of currency misalignments on the foreign currency-denominated debt - growth relationship has not been affected by the HIPC initiative.

5 Conclusion

The aim of this article was to evaluate, for the CFA zone countries, the effects of real exchange rate's misalignments on growth, by distinguishing different transmission channels. More precisely, the baseline idea was to look at whether the relationship between currency misalignment and growth could be mitigated when taking into account the foreign currency-denominated debt.

Relying on a BEER approach to derive currency misalignments, and using a panel smooth transition model, we first confirmed the existence of nonlinearities in the relationship between currency misalignments and growth. We found a positive and significant relationship between undervalued real exchange rates and economic growth. On the contrary, real overvaluation negatively affects growth. In that sense, our study is in accordance with the existing literature on this subject.

But our analysis goes further by taking account not only a competitiveness channel but also a debt channel - through valuation effects - in the nonlinear relationship between currency misalignments and growth. Indeed, we have evidenced that, in the regime of undervaluation, the foreign-currency denominated debt exerts a negative impact on growth, while this impacts tends to diminish when the undervaluation decreases. We

[17] Interactions between the dummies and the debt stock.

[18] Available upon request to the author.

have interpreted this finding as a valuation effect reflecting the tendency of the foreign currency-denominated debt to rise with a real undervaluation. Moreover our results have proved to be robust to an alternative measure of currency misalignments and after controlling for the potential impact of the HIPC initiative.

From this perspective, our findings give a more nuanced vision of the relationship between misalignments and growth than the traditional one. Indeed, if they highlight the importance of an appropriate level of the real exchange rate, they also show that the effects of currency misalignments on economic growth are not straightforward. Currency misalignments affect growth through different transmission channels which have not yet been fully identified even if a consensus seems to emerge around some of them (i.e. export, industry, investment, capital accumulation). Undertaking studies on additional transmission channels through which misalignments can impact growth could then help in refining estimates and in drawing more nuanced conclusions regarding economic policy.

Thus, for the CFA zone countries, it seems that the positive impact of a real undervaluation on economic growth can be effective only if the improved export performance, induced by competitiveness gains, can offset the increase in the foreign currency value of the debt or if the path of the foreign currency-denominated debt is sufficiently sustainable in order to limit negative valuation effects.

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Appendix

A. Data appendix

A.1. Data description

Table A.1: Data description

Variables	Source
Real effective exchange rate (*reer*) Calculated as a weighted average of real bilateral exchange rates against each partner: $reer_i = \sum_{j=1, j \neq i}^{m} w_{i,j} \ (s_{j\$} - p_j - (s_{i,\$} - p_i))$ where $s_{j\$}$ (resp. $s_{i\$}$) is the currency j (resp. i)'s bilateral exchange rate. p_j (resp. p_i) is the country j (resp. i)'s consumer price index (CPI). The variables are taken in logarithms. W_{ij} is the weight of the currency j in the country i's real effective exchange rate and m the number of trading partners.[19]	OECD, WEO, WDI
The productivity differential (*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 are the same than those used for the calculation of the real effective exchange rate. $rprod_{i,t} = \frac{GDP\ PPP_{per\ capita\ i,t}}{\sum_{j=1, j \neq i}^{m} GDP\ PPP_{per\ capita\ j,t}}$	WDI
Net Foreign Assets* (*nfa*): in percentage of GDP	Lane and Milesi-Ferretti
Life expectancy at birth (*life*): expressed in logarithms	WDI
Population growth rate (*pop*)	WDI
Inflation rate (*inflation*)	WEO
Investment (*invest*): in percentage of GDP	WEO
External debt service (*PPG debt serv*): in percentage of GDP	WDI
Government consumption (*gov*): in percentage of GDP	WDI
Openness (*open*): in percentage of GDP	WDI
Terms of trades (*tot*): expressed in logarithms	WDI
Aid (*aid*): in percentage of GDP	WDI
Per capita GDP annual growth	WEO
Dummy variables Debt break (*debt_ break*): scores 1 for the break's year in the PPG debt dynamics HIPC initiative: *HIPC_ strict*: scores 1 (0 otherwise) from the decision point year till the completion point year; *HIPC*: scores 1 (0 otherwise) from the decision point year till the end of the studied period	

Note: *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.
WDI: World Development Indicators (World Bank
WEO: World Economic Outlook (International Monetary Fund)

A.2. Debt

Variable *debt* in our analysis required particular attention. We built it using the external debt stocks, public and publicly guaranteed (PPG) and his currency composition (in euro and French franc). Both data are from the WDI World Bank database. The public and publicly guaranteed debt comprises long-term external obligations of public debtors, including the national government, political subdivisions (or an agency of either), and autonomous public bodies, and external obligations of private debtors that are guaranteed for repayment by a public entity. Once the series extracted, we multiplied the PPG debt stock by his foreign currency composition (more specifically, we used the euro and french franc composition). This allow us to have the stock of PPG debt denominated in foreign currency (but expressed in current $US).

We then reported it to the GDP (also expressed in current $US) in order to have the stock of PPG debt (denominated in foreign currency; except french Franc and euro) as a percentage of GDP. The formula used is as follows:

$$Debt_{i,t} = \frac{stock\ PPG_{i,t} \times [1 - (\%french\ Franc_{i,t} + \%euro_{i,t})]}{GDP_{i,t}}$$

Table A.2.1: PPG debt currency composition (in %)

	U.S. Dollars	Pound Sterling	Swiss Franc	Japanese Yen	Deutsche Mark	Other currencies*
Benin	41.02	0.61	...	2.15	0.23	21.88
Burkina Faso	48.07	0.39	...	...	0.06	17.74
Central African Rep.	50.79	0.08	2.45	0.57	0.55	9.53
Cameroon	15.41	1.9	0.82	0.53	15.35	7.01
Chad	53.01	0.05	...	...	0.88	16.97
Cote d'Ivoire	32.43	0.74	1.02	1.15	3.76	6.06
Congo, Rep.	29.44	5.01	0.33	0.19	2.63	13.38
Gabon	21.34	4.92	0.49	0.78	7.98	8.53
Mali	27.22	1.57	2.04	1.95	0.46	27.44
Niger	38.5	1.02	0.45	2.42	0.17	23.4
Senegal	38.4	0.2	0.5	2.38	2.5	21.82
Togo	47.3	1.6	8.84	4.16	2.02	6.79

Note: Values reported correspond to averages over the sample. Data are from the WDI database.
* : Except French Franc and euro.
"..." denotes missing value.
Source: Author's calculations

[19] We follow Couharde et al. (2011) and consider only the top ten trading partners for each country (weights are given in the paper).

Table A.2.2: CFA zone countries external debt stocks, public and publicy guaranteed (in foreign currencies)

	Benin	**Burkina Faso**	**Central Africa**	**Cote d'Ivoire**	**Cameroon**	**Congo Rep.**	**Gabon**	**Mali**	**Niger**	**Senegal**	**Chad**	**Togo**	**Average**
1985	0.574	0.202	0.221	0.54	0.196	0.585	0.155	0.658	0.243	0.487	0.164	0.797	0.402
	(0.82)	(0.63)	(0.55)	(0.56)	(0.72)	(0.3)	(0.46)	(0.57)	(0.37)	(0.59)	(0.7)	(0.65)	(0.58)
1986	0.516	0.196	0.235	0.564	0.196	0.806	0.218	0.616	0.212	0.428	0.178	0.647	0.401
	(0.8)	(0.63)	(0.56)	(0.59)	(0.7)	(0.46)	(0.57)	(0.61)	(0.35)	(0.57)	(0.76)	(0.68)	(0.61)
1987	0.524	0.209	0.284	0.611	0.196	0.765	0.301	0.633	0.22	0.444	0.198	0.636	0.418
	(0.78)	(0.61)	(0.55)	(0.58)	(0.68)	(0.44)	(0.38)	(0.61)	(0.36)	(0.57)	(0.73)	(0.67)	(0.58)
1988	0.504	0.197	0.303	0.562	0.21	0.81	0.274	0.641	0.248	0.437	0.183	0.574	0.412
	(0.78)	(0.61)	(0.58)	(0.58)	(0.71)	(0.48)	(0.36)	(0.61)	(0.4)	(0.56)	(0.68)	(0.72)	(0.59)
1989	0.493	0.212	0.34	0.593	0.274	0.73	0.293	0.635	0.277	0.41	0.228	0.606	0.424
	(0.58)	(0.74)	(0.63)	(0.57)	(0.7)	(0.46)	(0.38)	(0.59)	(0.5)	(0.61)	(0.78)	(0.85)	(0.62)
1990	0.418	0.201	0.377	0.611	0.324	0.718	0.239	0.611	0.29	0.385	0.244	0.578	0.416
	(0.56)	(0.7)	(0.81)	(0.56)	(0.7)	(0.44)	(0.39)	(0.68)	(0.51)	(0.61)	(0.75)	(0.83)	(0.63)
1991	0.403	0.228	0.461	0.665	0.301	0.726	0.275	0.657	0.289	0.381	0.273	0.616	0.439
	(0.55)	(0.71)	(0.78)	(0.56)	(0.61)	(0.46)	(0.4)	(0.7)	(0.51)	(0.6)	(0.69)	(0.85)	(0.62)
1992	0.511	0.332	0.461	0.62	0.359	0.662	0.255	0.66	0.308	0.379	0.29	0.582	0.454
	(0.76)	(0.93)	(0.77)	(0.53)	(0.59)	(0.45)	(0.39)	(0.65)	(0.54)	(0.61)	(0.6)	(0.83)	(0.61)
1993	0.402	0.375	0.538	0.608	0.292	1.194	0.33	0.729	0.482	0.419	0.406	0.797	0.458
	(0.57)	(0.82)	(0.78)	(0.52)	(0.49)	(0.73)	(0.51)	(0.71)	(0.8)	(0.64)	(0.69)	(0.88)	(0.67)
1994	0.615	0.51	0.893	0.828	0.577	1.429	0.462	1.121	0.537	0.652	0.564	1.087	0.773
	(0.61)	(0.98)	(0.86)	(0.55)	(0.56)	. . .	(0.46)	(0.9)	(0.62)	(0.69)	(0.77)	(0.89)	(0.70)
1995	0.494	0.446	0.723	0.659	0.702	1.196	0.422	0.869	0.467	0.546	0.511	0.903	0.662
	(0.65)	(0.81)	(0.87)	(0.54)	(0.62)	. . .	(0.46)	(0.84)	(0.57)	(0.68)	(0.77)	(0.9)	(0.70)
1996	0.46	0.432	0.757	0.573	0.621	0.981	0.374	0.841	0.464	0.532	0.516	0.826	0.615
	(0.67)	(0.84)	(0.82)	(0.53)	(0.63)	(0.46)	(0.47)	(0.82)	(0.6)	(0.69)	(0.79)	(0.88)	(0.68)
1997	0.464	0.45	0.765	0.648	0.605	1.042	0.377	0.886	0.512	0.595	0.543	0.76	0.637
	(0.68)	(0.83)	(0.86)	(0.64)	(0.64)	(0.47)	(0.49)	(0.84)	(0.61)	(0.71)	(0.8)	(0.9)	(0.71)
1998	0.46	0.444	0.792	0.609	0.672	1.224	0.465	0.89	0.508	0.604	0.52	0.783	0.664
	(0.7)	(0.83)	(0.9)	(0.63)	(0.66)	(0.46)	(0.47)	(0.88)	(0.64)	(0.73)	(0.81)	(0.8)	(0.71)
1999	0.464	0.433	0.779	0.572	0.589	0.989	0.399	0.91	0.548	0.575	0.632	0.77	0.638

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Table A.2.2 – *Continued from previous page*

	Benin	**Burkina Faso**	**Central Africa**	**Cote d'Ivoire**	**Cameroon**	**Congo Rep.**	**Gabon**	**Mali**	**Niger**	**Senegal**	**Chad**	**Togo**	**Average**
	(0.72)	(0.83)	(0.9)	(0.64)	(0.64)	(0.43)	(0.49)	(0.88)	(0.65)	(0.74)	(0.83)	(0.83)	(0.72)
2000	0.484	0.457	0.864	0.653	0.661	0.705	0.439	0.947	0.632	0.605	0.691	0.896	0.669
	(0.74)	(0.85)	(0.96)	(0.66)	(0.72)	(0.43)	(0.57)	(0.9)	(0.71)	...	(0.83)	(0.87)	(0.75)
2001	0.471	0.445	0.798	0.545	0.313	0.705	0.352	0.842	0.559	0.525	0.552	0.754	0.572
	(0.73)	(0.84)	(0.79)	(0.59)	(0.34)	(0.36)	(0.41)	(0.92)	(0.66)	(0.74)	(0.81)	(0.69)	(0.63)
2002	0.467	0.423	0.948	0.542	0.286	0.666	0.339	0.542	0.6	0.529	0.555	0.747	0.561
	(0.74)	(0.87)	(0.98)	(0.61)	(0.33)	(0.37)	(0.39)	(0.88)	(0.68)	(0.78)	(0.81)	(0.7)	(0.63)
2003	0.361	0.367	0.766	0.481	0.241	0.596	0.152	0.49	0.55	0.454	0.493	0.727	0.478
	(0.7)	(0.82)	(0.79)	(0.6)	(0.4)	(0.29)	(0.2)	(0.90)	(0.79)	(0.83)	(0.82)	(0.67)	(0.63)
2004	0.352	0.359	0.712	0.33	0.158	0.732	0.227	0.462	0.519	0.388	0.333	0.664	0.442
	(0.74)	(0.78)	(0.65)	(0.39)	(0.26)	(0.37)	(0.35)	(0.87)	(0.88)	(0.82)	(0.83)	(0.67)	(0.61)
2005	0.317	0.336	0.63	0.293	0.125	0.569	0.216	0.49	0.467	0.359	0.272	0.552	0.385
	(0.75)	(0.76)	(0.61)	(0.34)	(0.24)	(0.53)	(0.4)	(0.93)	(0.9)	(0.79)	(0.81)	(0.67)	(0.64)
2006	0.119	0.16	0.569	0.29	0.029	0.476	0.198	0.203	0.157	0.16	0.257	0.562	0.269
	(0.69)	(0.71)	(0.58)	(0.34)	(0.18)	(0.48)	(0.47)	(0.95)	(0.82)	(0.73)	(0.87)	(0.62)	(0.57)
2007	0.13	0.174	0.492	0.261	0.028	0.363	0.146	0.207	0.158	0.159	0.236	0.516	0.242
	...	(0.79)	(0.6)	(0.35)	(0.24)	(0.37)	(0.34)	(0.95)	(0.85)	(0.68)	(0.91)	(0.48)	(0.57)
2008	0.124	0.158	0.406	0.199	0.029	0.274	0.104	0.192	0.152	0.149	0.197	0.393	0.198
	(0.46)	(0.67)	(0.53)	(0.26)	(0.31)	(0.4)	(0.5)	(0.89)	(0.92)	(0.62)	(0.84)	(0.44)	(0.54)
2009	0.14	0.181	0.139	0.201	0.035	0.287	0.14	0.216	0.167	0.19	0.234	0.399	0.194
	(0.51)	(0.69)	(0.37)	(0.3)	(0.33)	(0.5)	(0.53)	(0.89)	(0.83)	(0.56)	(0.77)	(0.54)	(0.57)
2010	0,152	0,185	0,143	0,163	0,044	0,171	0,110	0,233	0,172	0,199	0,194	0,293	0.171
	(0,51)	(0,68)	(0,36)	(0,25)	(0,36)	(0,72)	(0,44)	(0,79)	(0,98)	(0,56)	(0,75)	(0,60)	(0,58)
2011	0,148	0,174	0,118	0,182	0,041	0,139	0,094	0,228	0,169	0,207	0,156	0,089	0.145
	(0,50)	(0,60)	(0,32)	(0,27)	(0,30)	(0,62)	(0,45)	(0,74)	(1,02)	(0,51)	(0,58)	(0,19)	(0,51)
Average	0,391	0,308	0,538	0,496	0,300	0,724	0,272	0,615	0,369	0,415	0,356	0,650	0.452
	(0,66)	(0,77)	(0,70)	(0,50)	(0,51)	(0,46)	(0,43)	(0,83)	(0,70)	(0,66)	(0,77)	(0,71)	(0,64)

Note: Values reported correspond to the ratio of the external debt stocks, public and publicly guaranteed in foreign currencies (except French Franc and euro) to GDP. Numbers in parenthesis are the share of the PPG in the total public debt. Data on total public debt are from the IMF Historical Public Debt Database. "..." denotes missing value.

Source: Author's calculations

Table A.2.3: HIPC initiative in the CFA zone countries (key dates and debt reduction)

Countries	Decision point – completion point	Debt reduction (long-term reduction)	Break in the FCD debt
Benin	July 2000 - March 2003	265 million $US, NPV 1998	2006
Burkina Faso	July 2000 – April 2002	552.6 million $US , NPV 2001	2006
Cameroon	October 2000- May 2006	1.27 billion $US, NPV 1999	2006
Central African Rep.	September 2007 - June 2009	578.2 million $US, NPV 2006	2009
Chad	May 2001 –	170.1 million $US, NPV 2000	–
Congo, Rep	March 2006 - January 2010	1.575 billion $US, NPV 2004	–
Cote d'Ivoire	March 2009 - June 2012	3004.9 million $US, NPV 2007	–
Gabon	Not eligible		
Mali	September 2000 - March 2003	417 million $US, NPV 1998	2006
Niger	December 2000 - April 2004	520.6 million $US, NPV 1999	2006
Senegal	June 2000 – April 2004	488 million $US, NPV 1998	2006
Togo	November 2008 – December 2010	282 million $US, NPV 2007	2011

Note: NPV stands for Net Present Value. FCD debt: foreign currency-denominated debt

Source: Informations on the HIPC initiative are from the African Development Bank

A.3. Panel unit root and cointegration tests results

Table A.3.1: Unit root tests results

		gdp	***debt***	***pop***	***invest***	***inflation***	***gov***	***aid***	***life***	***reer***	***rprod***	***open***	***nfa***	***tot***	***debt serv***
CIPS*	level	-2.68	-2.18	-2.01	-2.42	-5.17	-2.38	-2.56	-1.95	- 2.15	- 1.88	- 2.53	- 2.36	- 1.90	-2.61
		(0.13)	(0.61)	(0.78)	(0.34)	(0.01)	(0.04)	(0.21)	(0.83)	(0.66)	(0.91)	(0.20)	(0.39)	(0.90)	(0.01)
	1st diff.	-3.66	-2.60	-2.83	-3.96	-5.90	-2.61	-4.46	-3.06	- 4.43	- 3.44	- 3.87	- 3.80	- 3.62	-4.06
		(0.01)	(0.01)	(0.05)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Choi *Pm*	level	21.07	-0.91	9.10	1.41	13.26	5.45	5.60	0.73	-2.23	- 2.12	4.31	- 1.44	0.21	5.72
		(0.00)	(0.82)	(0.00)	(0.07)	(0.00)	(0.00)	(0.00)	(0.23)	(0.98)	(0.98)	(0.00)	(0.92)	(0.41)	(0.00)
	1st diff.	22.97	20.43	16.15	23.79	28.44	27.24	20.01	4.38	21.10	13.32	25.45	26.39	19.40	27.12
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Choi *Z*	level	-9.85	2.15	-3.65	-1.72	-8.06	-3.48	-2.68	2.08	2.37	3.04	- 3.55	1.90	0.16	-3.13
		(0.00)	(0.98)	(0.00)	(0.04)	(0.00)	(0.00)	(0.00)	(0.98)	(0.99)	(0.99)	(0.00)	(0.97)	(0.56)	(0.00)
	1st diff.	-10.71	-10.41	-7.55	-11.40	-12.88	-12.52	-9.69	-1.31	- 10.86	- 7.34	- 12.12	- 12.31	- 10.32	-12.48
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.09)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Choi *L**	level	-13.09	2.96	-4.65	-1.61	-9.18	-3.97	-2.51	3.31	2.22	3.33	- 3.65	2.29	0.14	-3.91
		(0.00)	(0.99)	(0.00)	(0.05)	(0.00)	(0.00)	(0.00)	(0.99)	(0.98)	(0.99)	(0.00)	(0.98)	(0.55)	(0.00)
	1st diff.	-14.36	-13.16	-9.29	-15.01	-17.59	-16.93	-12.65	-2.04	- 13.61	- 8.99	- 16.01	- 16.51	- 12.66	-16.86
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(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 *debt, GDP percap, life and pop (only individual intercepts). p.values are given in parentheses. Appropriate lag orders are determined by running auxiliary ADF test regressions for each of the cross-sections units. We also referred to the lag order that minimizes the Schwarz criterion. Conclusions are robust to change in model's specifications.*

Table A.3.2: Westerlund cointegration test results

Specification		***reer*** ***rprod, tot, nfa, gov***		
Statistic	Value	Z-value	p-value	Robust p-value
Gt	-2.515	-3.180	0.001	0.010
Ga	-9.452	-1.644	0.050	0.030
Pt	-7.708	-2.114	0.017	0.098
Pa	-7.580	-2.922	0.002	0.023

Note: Optimal lag and lead length determined by Akaike Information Criterion. Width of Bartlett-Kernel window set to 3. We only allow for a constant in the cointegration relationship. Robust p.values obtained after 800 bootstraps.

B. Graphs appendix

Figure B.1: REER vs. ERER

Note: An increase (resp. decrease) of the real effective exchange rate indicates an appreciation (resp. depreciation).

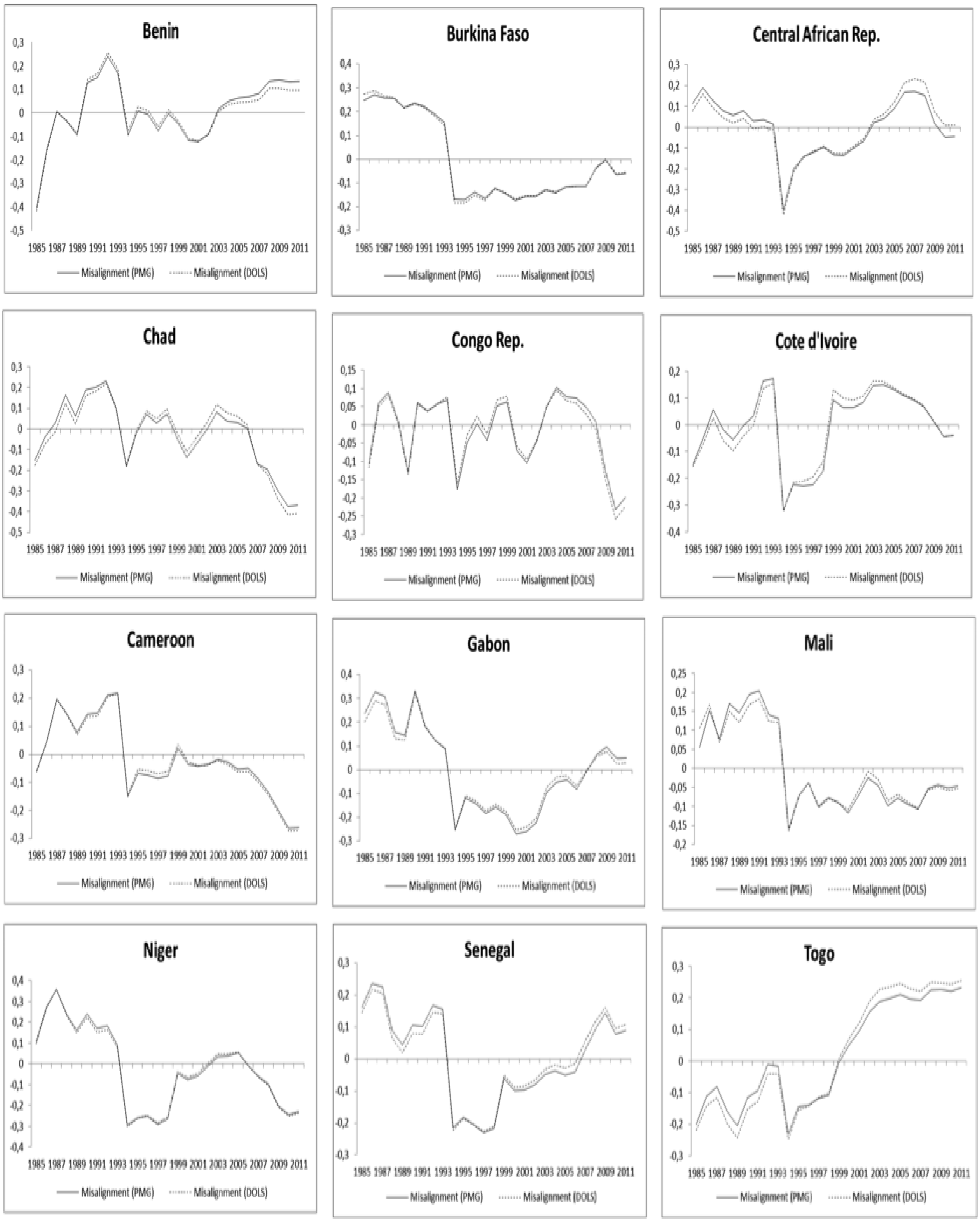

Figure B.2: Real exchange rate misalignment

Note: A positive (resp. negative) value corresponds to an overvaluation (resp. undervaluation)

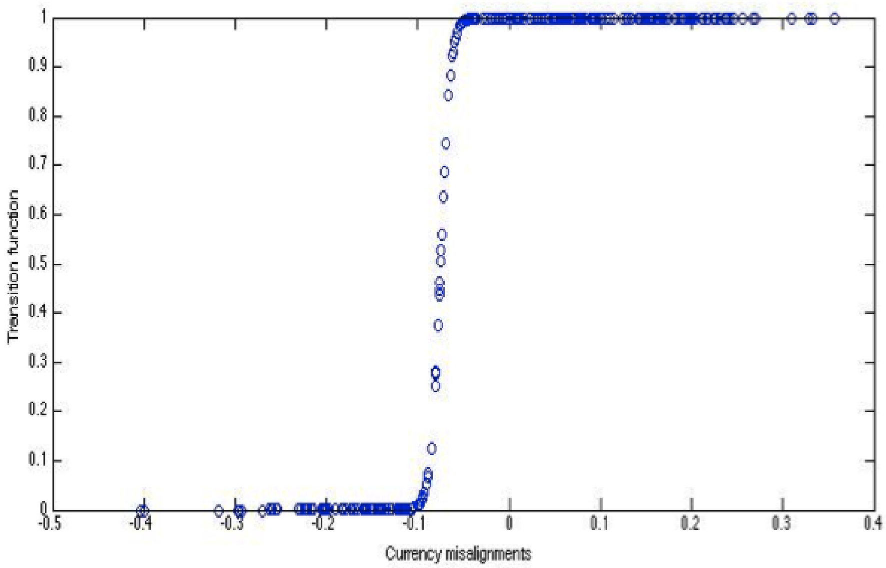

Figure B.3: Estimated transition function of the PSTR model

Note: Each circle represents an observation.