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# **Do currency undervaluations affect the impact of inflation on growth?**

**Florian Morvillier\***

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## 1. Introduction

Following the emergence of a trade war in the global economy, the specter of a currency war has come back to the center of the stage. In this context, the extent to which a currency is misaligned (undervalued or overvalued) is of primary importance, in particular because a competitive real exchange rate helps to promote economic development. Indeed, countries may chose to pursue a policy which aims to maintain an undervalued currency in order to achieve competitiveness gains against their main competitors, boosting thus their exports (Gala, 2008; Holtemöller and Mallick, 2013). This choice is particularly relevant for countries which have adopted an export led-growth strategy. However, such competitiveness gains are more likely to be limited to small currency undervaluations as suggested by Couharde and Sallenave (2013). Indeed, considering a large sample of developed and emerging countries, they show that undervaluations up to 18.69% are growth-enhancing, while above this threshold the reverse is true. Furthermore, Rodrik (2008) and MacDonald and Vieira (2010) highlight the benefits coming from a weak currency, whereas Nouira and Sekkat (2012) find no positive impact of undervaluations.

Falling into this strand of the literature, the aim of our paper is to investigate the impact of currency undervaluations' level on the effect of inflation on growth. This question is of particular interest as there is only scarce evidence concerning the adverse effects associated to an undervalued currency, especially the role played by its inflationist impact on economic performance. Moving to the macroeconomic effects of inflation, it is generally accepted that inflation has an overall negative impact on growth (López-Villavicencio and Mignon, 2011) and is likely to influence its dynamic through several channels (see Temple, 2000; Gillman and Kejak, 2005; for surveys). For example, considering a model of optimal growth, Gylfason and Herbertsson (2001) show that higher inflation reduces capital efficiency which affects negatively the output. Higher rates of inflation also lead to a lower return on loans and lower steady-state capital stock (Huybens and Smith, 1999). This inflation-growth nexus is likely to be influenced by real undervaluations as an undervalued currency is associated with supplementary inflation pressures (Calvo et al., 1995; Haddad and Pancaro, 2010; Chen, 2017; Grekou, 2018a) through economy overheating and an imported inflation mechanism. Thus, higher inflation rates, associated with an uncertain economic environment which reduces investment (Temple, 2000) can hamper growth significantly.

To investigate the impact of currency undervaluations on the inflation-growth relationship, we rely on a panel of 62 countries -including 18 advanced, 22 emerging and 22 developing economies- over the 1980-2015 period. Our results show that currency undervaluations reinforce the negative effect of inflation on growth, especially for emerging countries. Furthermore, this finding is shown to be robust, as it remains verified when we exclude currency crisis episodes from our sample.

Our paper contributes to the misalignments-growth literature in several ways. In addition to the aforementioned channels through which undervaluations affect growth, Grekou (2015, 2018a) shows the existence of a foreign currency debt (FCD) channel that tends to dampen the competitiveness channel for emerging and developing countries. Using a sample of developed and emerging economies,

Chen (2017) finds that undervaluing the exchange rate retards technological innovation, with a potential adverse effect on growth. Our paper highlights the existence of an alternative channel —namely, the inflation channel— through which real exchange rate undervaluations can hamper growth: as an undervalued currency is associated with supplementary inflation pressures arising from a cost-push inflation phenomenon and economy overheating, growth is thus penalized. Our paper also contributes to the literature by documenting the relevance to pursue development policies based on a strongly undervalued currency, in light of the undervaluation-inflation relationship. Our findings show that this choice is not the most relevant for emerging economies as it will be associated with a reinforcement of the inflation contractionary effect.

Our paper is organized as follows. Section 2 provides a literature review on the misalignment-growth relationship, inflation-growth nexus and the link between undervaluations and inflation. In section 3, we present the methodology and the data. Section 4 displays and discusses our econometric results and also offers robustness checks. Finally, section 5 concludes the paper.

## 2. Literature review

### 2.1. *Currency misalignments and growth*

Since the beginning of the 1990s, an important literature on the link between misalignments and growth has emerged. Constructing an index of "real exchange rate distortion", Dollar (1992) showed that the higher was this index, the lower was the GDP growth rate in a sample of 95 developing countries. More recently, Aguirre and Calderón (2005) consider a panel of 60 advanced and emerging economies. They provided evidence that misalignments were detrimental to growth, while Nour and Sekkat (2012) failed to find support for this result. Contrary to Aguirre and Calderón (2005), Razin and Collins (1997) were unable to find a significant relation between misalignments' volatility and economic growth on a sample of 93 countries. The impact of an overvalued currency is somewhat more "consensual" in the literature, with a detrimental effect on growth usually highlighted (see Razin and Collins, 1997; Gala and Lucinda, 2006; MacDonald and Vieira, 2010; among others).

Concerning the undervaluation-growth nexus, the conclusions are more mixed. Razin and Collins (1997) found that only high undervaluations were growth-enhancing whereas low, medium and very high undervaluations presented no significant relationship. Contrary to the previous findings, Aguirre and Calderón (2005) put forward a positive link between low undervaluations and growth, while large undervaluations penalize the growth rate of GDP per capita. Considering non-linear, regime switching models, Béreau et al. (2012) and Aflouk et al. (2013) show that undervaluations upon a certain threshold are growth-promoting, while weak undervaluations and overvaluations lower growth.

The literature has identified several effective transmission channels to clarify the misalignment-growth relationship. Gala (2008) highlighted the existence of two main channels to explain the positive (resp. negative) impact of undervaluations (resp. overvaluations) on growth. The first channel is known as the "capital accumulation channel" according to which an undervalued currency causes an

increase in the tradable goods prices. Then, real wages diminish, leading to a rise in profit margins. This upturn promotes investment which has a growth-enhancing effect. On the contrary, an overvalued currency impedes growth because of lower profit margins coming from lower tradable goods prices. The second channel proposed by [Gala \(2008\)](#) is the "total factor productivity" (TFP) channel. According to this view, an undervalued currency is seen as a crucial tool to promote the development of the tradable sector which is a key contributor to innovations and productivity increases. In other words, a more depreciated currency promotes exportations thanks to competitiveness gains which lead to the development of the tradable sector driving a technological change. Considering a heterogeneous panel of 72 countries, [Mbaye \(2013\)](#) was the first to properly assess the relevance of this channel. The "TFP growth channel" is validated by the author, revealing that TFP growth "induced" by the undervaluation has a significant and positive impact on growth. This finding is in line with [Rodrik \(2008\)](#) who found that the tradable sector size plays an important role in the transmission mechanism for a large panel of developed and developing countries. However, this result is invalidated by [Glüzmänn et al. \(2012\)](#) who show that undervaluations have no effect on industry share in emerging countries.

## 2.2. *Inflation-growth nexus*

From a theoretical viewpoint, as discussed briefly in the introduction, inflation can affect growth through several channels. A rise in the general price level increases the cost to hold money which encourages households to substitute money to physical capital ([Tobin, 1965](#)). Considering a monetary endogenous growth model, [Gillman and Kejak \(2005\)](#) show that inflation acts as a tax on physical capital (AK) in the case of AK models. Hence, a negative long-run Tobin effect decreasing the rate of return to capital, lower growth is evidenced. Furthermore, within the context of human capital models, a positive long-run Tobin effect which promotes growth is found ([Gillman and Kejak, 2005](#)). Inflation can also reduce deposit rates, lowering the saving ratios and thus depressing investment ([Gylfason, 1991](#); [Barro, 1995](#)). This channel is confirmed by [Fischer \(1993\)](#) showing that inflation lowers significantly productivity growth and capital accumulation.

Considering large panels of low and middle income countries, inflation is shown to be harmful for growth ([Barro, 1995](#); [Ghosh and Phillips, 1998](#)), but this negative effect is weakened as soon as high inflation episodes are excluded ([Barro, 1995](#); [Bruno and Easterly, 1996](#)). The inflation-growth relationship is also subject to non linearities. Above different thresholds, inflation is found to be detrimental to growth ([Ghosh and Phillips, 1998](#); [Khan and Ssnhadji, 2001](#)). Considering a sample of emerging and developing economies, [Fischer \(1993\)](#) found that the higher the inflation rate, the lower the impact on growth. Furthermore, [López-Villavicencio and Mignon \(2011\)](#) showed that below a 15% threshold, inflation has a significant and positive impact on growth whereas beyond 15%, inflation hampers growth significantly.

## 2.3. *Real currency undervaluations and inflation*

Several authors argue that real currency undervaluations are likely to increase inflation through several channels ([Calvo et al., 1995](#); [Haddad and Pancaro, 2010](#); [Chen, 2017](#); [Grekou, 2018a](#)). Con-

sidering an intertemporal optimizing model with a cash-in-advance specification, [Calvo et al. \(1995\)](#) show that during episodes in which the real exchange rate is depreciated relative to its permanent steady-state level, inflation accelerates. Their model is confirmed by an empirical investigation on a sample of Latin American economies showing that real exchange rate undervaluations increase inflation. Several mechanisms have been proposed by the literature to understand the link between undervalued currencies and inflation. [Rodrik \(2008\)](#) argued that undervaluations are growth-enhancing through the expansion of the tradable sector. Such growth-enhancing impact generates an overheating in the economy ([Haddad and Pancaro, 2010](#); [Grekou, 2018a](#)), leading thus to inflation pressures. In addition, real exchange rate undervaluations also affect the economic environment faced by firms. Indeed, real undervaluations raise the cost of importing inputs and machinery ([Chen, 2017](#)) increasing the firms' costs, leading to a cost-push inflation phenomenon.

### 3. Methodology and data

#### 3.1. Methodology

##### 3.1.1. Empirical strategy

To investigate whether the inflation-growth nexus depends upon undervaluation's level, we proceed in two steps. The first one consists to apply the BMA methodology to select the relevant growth determinants. Then, variables which are identified as robust are used as controls in our growth regressions. The second step aims to investigate if undervaluations' level matters for the inflation-growth nexus. Our analysis starts by estimating the two following benchmark regressions depending on the sign of the misalignments:

$$Growth_{it} = \alpha_i + \beta_1 Inflation_{it} + \beta_2 X_{it} + \epsilon_{it}, if Mis_{it} < 0 \quad (1)$$

$$Growth_{it} = \alpha'_i + \beta'_1 Inflation_{it} + \beta'_2 X_{it} + \epsilon_{it}, if Mis_{it} > 0 \quad (2)$$

Where  $i$  denotes the country.  $\alpha_i$  and  $\alpha'_i$  are country fixed effects,  $X_{it}$  is our set of control variables.  $\epsilon_{it}$  stands for the error term and  $Mis_{it}$  is the currency misalignments for country  $i$  at year  $t$ .

Estimations of equations (1) and (2) constitute a preliminary step in our analysis allowing us to derive the linear effect of inflation on growth. In equation (1), inflation's effect during undervaluation periods is assessed, while in (2) its impact is considered for regimes of currency overvaluations. A distinction between undervaluation and overvaluation periods is also made to investigate if the first regime is more likely to affect growth through the inflation channel, which can motivate the investigation of the role played by undervaluations on the inflation-growth nexus. As can be seen from equation (1), the inflation's effect does not depend upon the undervaluations' size. Then, to assess if undervaluations' size matters for the inflation-growth nexus, we estimate the following equation:

$$Growth_{it} = \alpha_i + \beta_1 Inflation_{it} + \beta_2 Inflation_{it} * Undervaluation_{i,t-1} + \beta_3 X_{it} + \epsilon_{it} \quad (3)$$

Where  $Undervaluation_{i,t-1}$  is the lagged undervaluation, i.e the previous misalignment value for the years in which the currency is undervalued. Note that the use of lagged values is justified by the fact that there exists a delay to produce an inflationary effect of undervaluations. Compared to equation

(1), equation (3) allows us to assess if the inflation-growth nexus is affected by undervaluations' level thanks to the presence of an interaction term.

In order to tackle endogeneity inherent to growth regressions, we rely on the System Generalized Method of Moments (SGMM, [Arellano and Bover, 1995](#); [Blundell and Bond, 1998](#)) to estimate equations (1) to (3). Following [Roodman \(2006\)](#), we include temporal dummies as additional instruments, as it helps the assumption of no correlation across individuals to hold.<sup>1</sup> Furthermore, considering undervaluation episodes leads to an unbalanced panel dataset, we use forward orthogonal deviations to maximize the sample size as suggested by [Roodman \(2006\)](#). Moreover, to control for the presence of substantial heterogeneity among the different individuals of our panel, in addition to the traditional fixed and random effects estimator, we also estimate equation (3) on two sub-samples. The first sub-sample is composed of 22 emerging countries and the second one contained 24 developing countries. Using these sub-samples allows us to assess whether lagged undervaluation has different effects depending on the country type.

Finally, we check whether the previous findings are affected by the occurrence of currency crises. Indeed, such crises could influence our results as they are followed by consequent devaluations and high inflation rates ([Borensztein and De Gregorio, 1999](#)). Such devaluations can lead to an undervalued currency. They also lead to lower GDP growth rate ([Hong and Tornell, 2005](#)), which could potentially drive our results.

### 3.1.2. The Bayesian Model Averaging (BMA) methodology

It is well known that growth regressions are hampered by uncertainty arising from the selection of the relevant growth determinants ([Durlauf et al., 2008](#); [Moral-Benito, 2012](#)). To tackle this uncertainty, we rely on the BMA methodology which has been frequently used in the context of growth regressions with panel data (see [Moral-Benito, 2012](#); [Grekou, 2018a](#); among others). The starting point of the BMA approach is to consider a linear regression model as follows:

$$Y = X\beta + \epsilon \quad (4)$$

Where  $Y$  is the vector containing the values of the dependent variable,  $X$  the matrix of explanatory variables and  $\beta$  ( $q \times 1$ ) contains the parameters to be estimated;  $q$  being the number of parameters to be estimated.  $\epsilon$  stands for the error term which is i.i.d and normally distributed. Assuming that it is possible to set some components of  $\beta$  to be equal to zero, there are a total set of  $2^q$  candidates models to be estimated - indexed by  $M_j$  for  $j=1, \dots, 2^q$ . The posterior distribution given the data for  $\beta$ , calculated using  $M_j$  is computed as follows:

$$P(\beta|D) = \sum_{j=1}^{2^q} P(\beta|D, M_j)P(M_j|D) \quad (5)$$

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<sup>1</sup>The addition of such temporal dummies increases significantly the number of instruments, justifying why we do not include them in sub-sample regressions.



$P(M_j|D)$  is the posterior model probability for model  $j$ , given data  $D$ .

As can be seen from equation (5), the posterior density is a weighted average of the posterior model probabilities for all models including a given variable weighted by the posterior model probability for all models. Using Bayes rule and for a given prior model probability ( $P(M_j)$ ), the posterior model probability for model  $M_j$  is given by :

$$P(M_j|D) = \frac{P(D|M_j)P(M_j)}{\sum_{j=1}^{2^q} P(D|M_j)P(M_j)} \quad (6)$$

Using the posterior model probability, we estimate the posterior probability that a particular variable  $k$  is included in the regression and interpret it as the probability that the variable belongs to the "true" growth model. This is called the Posterior Inclusion Probability (PIP) for variable  $k$  and is computed as the sum of the posterior model probabilities for all the models including that variable :

$$PIP = P(\beta_k \neq 0|D) = \sum_{\beta_k \neq 0} P(M_j|D) \quad (7)$$

To rank the potential growth determinants according to their relevance, we refer to the classification proposed by [Raftery \(1995\)](#).<sup>2</sup> The implementation of the BMA methodology requires the specification of a prior distribution on the parameter as well as on the model space. Concerning the prior on the parameter space, we use the Risk Inflation Criterion (RIC) and the Unit Information Prior (UIP) proposed by [Fernandez et al. \(2001a\)](#). For the prior on the model space, we follow [Fernandez et al. \(2001b\)](#) and specify a uniform prior. To explore the robustness of our findings to the prior's choice, we also use alternative priors on the model space by using fixed and random priors as in [Moral-Benito \(2012\)](#).<sup>3</sup>

### 3.2. Data

#### 3.2.1. The sample of countries

We consider annual data over the period 1980-2015 for advanced (18), emerging (22) and developing (22) countries. There are two main reasons behind the selection of this sample. First, we only include countries which present prolonged episodes of undervaluations over the 1980-2015 period.<sup>4</sup> Such dynamic in real exchange rate misalignments is important to be able to track the effects of an undervalued currency. Second, our sample is also characterized by a variety of monetary policy rules, allowing us to have results independent on the chosen rule as argued by [López-Villavicencio and Mignon \(2011\)](#). A detailed description of the countries retained in our sample is available in appendix (Table 4).

<sup>2</sup>According to [Raftery \(1995\)](#), a PIP between 0.75 and 0.95 denotes positive evidence of a regressor having an effect. A PIP between 0.95 and 0.99 denotes very strong evidence and a PIP over 0.99 indicates a decisive evidence of a regressor. More generally, a PIP over 0.50 indicates a robust variable.

<sup>3</sup>As noted by [Moral-Benito \(2015\)](#), the use of a random prior rather than a fixed one allows to reduce the sensitivity of the posterior model probabilities.

<sup>4</sup>Due to the lack of data for some developing countries, they are not included in our sample.

Unlike the common practice in the context of growth regressions, we rely on annual data rather than five-years averages for two main reasons. Firstly, as argued by [Grekou \(2018a\)](#) averaging misalignments produce "misleading time series", which could significantly affect the results. Secondly, applying this transformation to the inflation series is also problematic as it does not account for its dynamic.<sup>5</sup> Following [López-Villavicencio and Mignon \(2011\)](#), we apply a logarithmic transformation to the inflation rate. Indeed, as noticed by these authors, inflation's distribution is highly skewed. In addition, we can control for the presence of high inflation episodes which were shown to potentially drive the result of the inflation-growth nexus ([Ghosh and Phillips, 1998](#)). Specifically, we consider the following transformation:

$$inflation_{it} = \log(1 + \pi_{it})$$

Where  $\pi_{it}$  is the growth rate of the Consumer Price Index between years t-1 and t for country i.

### 3.2.2. Potential growth determinants

In this subsection, we briefly review the potential growth determinants retained to implement the BMA approach. Our set of explanatory variables aims to investigate the relevance of Solow determinants, human capital and macroeconomic variables, as well as social-political indicators for growth. We consider a set of 18 potential growth determinants. A detailed description of the definitions and sources of the different variables is available in Table 5 in appendix, together with corresponding descriptive statistics (Table 6).

#### **Solow determinants and human capital**

The Solow model (1956) constitutes a useful benchmark in the literature on growth determinants. We investigate the convergence hypothesis through the use of the initial level of real GDP per capita, proxied by the lagged real GDP per capita (in log) as in [Sallenave \(2010\)](#). This variable is considered as the only one robust growth determinant ([Durlauf et al., 2008](#)). Still in reference to [Solow \(1956\)](#), we include the population, population growth and the gross capital formation in our set of potential determinants. An increasing stock of capital should enhance economic growth ([Barro, 1991](#)), while a growing population has a negative effect. In the context of the endogenous growth theory, the role of human capital accumulation has been highlighted (see [Romer, 1986](#); among others). [Mankiw et al. \(1992\)](#) provide evidence that a rise in gross secondary school enrollment enhances economic growth. Higher level of human capital is expected to improve the path of innovations in the economy and, in turn, rises growth. We study the relevance of this determinant using the human capital index offered by PWT 9.0.<sup>6</sup> Furthermore, using the Bayesian averaging of classical estimates (BACE) methodology, [Moral-Benito \(2012\)](#) shows that the young dependency ratio exhibits a significant high PIP. Our set of determinants also includes the old dependency ratio. Following [Becker et al. \(1990\)](#), we retain the fertility rate as a potential determinant: by increasing the available labor force, a higher total birth

<sup>5</sup>Note that in the investigation of the inflation-growth nexus, it is common to use annual data (see [Ghosh and Phillips, 1998](#); [López-Villavicencio and Mignon, 2011](#); among others).

<sup>6</sup>We include the human capital index proposed by PWT 9.0 rather than the gross replacement rate arising from the WDI due to data availability.

per woman reduces the incentive to accumulate human capital. In line with [Barro and Sala-i Martin \(2004\)](#), the relevance of life expectancy is considered. [De la Croix and Licandro \(1999\)](#) argued that a low life expectancy is expected to reduce human capital accumulation because of an important discount rate factor. In addition, as people die young, the economic development is hampered by a high depreciation rate of human capital.

### **Macroeconomic and external environment**

In line with previous studies ([Barro, 1991](#); [Easterly and Rebelo, 1993](#)), we include government consumption expenditures in our set of variables. Through its distorting effects, an increase in government consumption expenditures which negatively impact savings can hamper economic growth. Furthermore, the presence of eventual distortions is proxied by the investment price level (extracted from PWT 9.0) as in [Moral-Benito \(2012\)](#). Distortions in the economy are expected to affect negatively growth ([Easterly, 1993](#)). Following [Edwards \(1998\)](#), we consider a measure of trade openness. [Edwards \(1998\)](#) argued that more opened economies experience higher total factor productivity growth, because of an increasing ability to absorb technological progress coming from more advanced economies. We also investigate the relevance of the financial development channel using the broad money to GDP ratio. [King and Levine \(1993\)](#) stressed that a more developed financial system can improve long term growth by helping to invest in high quality projects and mobilize resources for the most promising investment project. Our set of potential determinants also includes the terms of trade (TOT). Countries relying heavily on exports can be affected by a modification in their TOT ([Bleaney and Greenaway, 2001](#)). In fact, such modification creates volatility in their revenues. Moreover, [Bleaney and Greenaway \(2001\)](#) showed that a deterioration in TOT of sub-Saharan African economies significantly lowers their investment. Due to the majority of developing and emerging countries in our sample, we also consider the remittances received. By rising households' incomes, remittances can have a positive effect on consumption and also help to invest ([Pradhan et al., 2008](#)). The presence of a scarce financial system can penalize economies but personal remittances can help them to overcome this difficulty ([Giuliano and Ruiz-Arranz, 2009](#)). On a sample of developing countries, [Pradhan et al. \(2008\)](#) and [Giuliano and Ruiz-Arranz \(2009\)](#) showed that higher remittances boost growth. Finally, our last macroeconomic variable is Foreign Direct Investments (FDI) which can enhance economic growth through a technological diffusion process ([Borensztein et al., 1998](#)), especially for developing countries with a sufficient educated population.

### **Governance and institutions**

To investigate the relevance of the social-political indicators, our set of potential determinants includes political rights and civil liberties indexes, taken from the Freedom House database. The expected effect of such variables is not clear-cut in the literature. On the one hand, following ([Sirowy and Inkeles, 1990](#)) growth can be facilitated by the institution of an authoritarian regime which implements the needed policies. On the other hand, expansion of civil liberties and political rights provides an environment adequate to the innovation process with at the key a positive effect on growth. From an empirical point of view, [Barro and Lee \(1994\)](#) provide evidence of a negative effect of political freedom on growth.

### 3.2.3. Exchange rate misalignments

Turning now to the exchange rate misalignment series, they are extracted from the EQCHANGE database (Couharde et al., 2018). A misalignment is defined as the deviation of the Real Effective Exchange Rate (REER) from the Equilibrium Real Exchange Rate (ERER). The REER of country  $i$  in period  $t$  ( $REER_{i,t}$ ) is calculated as the weighted average of real bilateral exchange rates against each of its  $N$  trading partners  $j$  :

$$REER_{i,t} = \prod_{j=1}^N RER_{ij,t}^{w_{ij,t}} \quad (8)$$

Where  $w_{ij,t}$  is the trade-based weight associated to the partner  $j$ .<sup>7</sup>  $RER_{ij,t}$  stands for an index of the real bilateral exchange rate of the currency of country  $i$  vis-à-vis the currency of the trading partner  $j$  in period  $t$  and is given by:

$RER_{ij,t} = \frac{NER_{ij,t} * P_{i,t}}{P_{j,t}}$  with  $NER_{ij,t}$  an index of the nominal bilateral exchange rate between the currency of country  $i$  and the currency of its trade partners  $j$  in period  $t$ . The nominal exchange rate is expressed as the number of foreign currency units per domestic currency. An increase therefore corresponds to an appreciation of the domestic currency against the foreign currency.  $P_{i,t}$  and  $P_{j,t}$  stand respectively for the price index of country  $i$  and of country  $j$ . The REER is extracted from the EQCHANGE database (Couharde et al., 2018).

The literature has proposed several methodologies to estimate the ERER.<sup>8</sup> Beyond the Purchasing Power Parity (PPP) approach which presents several drawbacks,<sup>9</sup> three main theories of equilibrium exchange rates can be distinguished (Jeong et al., 2010) : a) the Fundamental Equilibrium Exchange Rate (FEER; Williamson, 1994), b) the Natural Real Exchange Rate (NATREX; Stein, 1994 ) and c) the Behavioural Equilibrium Exchange Rate (BEER; Clark and MacDonald, 1998 ).<sup>10</sup> The FEER approach defines the equilibrium exchange rate as the exchange rate ensuring “intern and extern equilibrium”. The long run NATREX equilibrium exchange rate is defined as the exchange rate which prevails in absence of speculative and cyclical factors and when the unemployment rate is at its natural level and the long term fundamentals reach their steady state. Within the BEER approach, the ERER is obtained thanks to the estimation of a long run, cointegrating relationship between the REER and its long run determinants. We can also mention the external sustainability approach proposed by the IMF (Lee et al., 2006) which consists to calculate the difference between the actual current account

<sup>7</sup>These weights are normalized so that their sum is equal to one.

<sup>8</sup>See the surveys proposed by MacDonald (2000) and Driver and Westaway (2004).

<sup>9</sup> Jeong et al. (2010) point out that this methodology is criticizable because of its simplicity. The PPP approach does not consider structural factors which can be relevant for the exchange rate dynamic. For example, MacDonald (2000) also argues that this methodology does not account for the presence of stock effects.

<sup>10</sup>It is worth noting that these approaches correspond to the same model applied to different horizons (Bénassy-Quéré et al., 2010). We can also mention the existence of the portfolio balance approach which is suitable for a sample composed of advanced economies.

balance and the balance that would stabilize the Net Foreign Asset (NFA) position of the country at some benchmark level.

In this article, we rely on the BEER framework to estimate the ERER for two main reasons. Firstly, although being based on an econometric specification, the BEER approach does not contain a normative content, as opposed to the FEER and current account sustainability approaches (Grekou, 2018b). Indeed, contrary to the BEER methodology, the implementation of the FEER approach requires assumptions about the internal and external imbalances (Couharde et al., 2018). A modification of the underlying assumptions can affect substantially the estimated ERER. Secondly, the BEER approach takes into account the stock effects through the NFA position (Couharde et al., 2018). Following Clark and MacDonald (1998) and dropping the country index, the behaviour of the actual REER can be modelled with a reduced-form equation as follows:

$$REER_t = \beta_1 Z_{1t} + \beta_2 Z_{2t} + \tau T_t + \epsilon_t \quad (9)$$

Where  $t$  denotes time.  $Z_{1t}$  (resp.  $Z_{2t}$ ) stands for fundamentals which have a long run (resp. medium term) effect on the REER.  $T_t$  is a set of variables that affect the exchange rate only in the short run and  $\epsilon_t$  is a random disturbance term.

In this equation, the REER is explained by a set of medium to long-run fundamentals as well as by transitory factors. Following Clark and MacDonald (1998) and assuming that the economy sets in the medium-long run, a first step to obtain the ERER consists in estimating the following equation:

$$REER_t = \beta_1 Z_{1t} + \beta_2 Z_{2t} + \epsilon_t \quad (10)$$

Then, the ERER, denoted  $REER^*$ , is obtained using the fitted values of the coefficients associated with the exchange rate determinants :

$$REER_t^* = \hat{\beta}_1 Z_{1t} + \hat{\beta}_2 Z_{2t} \quad (11)$$

The misalignment denoted  $mis_t$  is then given by the difference between the REER and its equilibrium level :

$$mis_t = REER_t - REER_t^* \quad (12)$$

A positive (resp. negative) misalignment implies a currency overvaluation (resp. undervaluation). Following the literature on the long-run determinants of the REER, we consider a proxy for the Balassa-Samuelson effect, the NFA position and the Terms Of Trade (TOT). Specifically, the following equation is estimated :

$$reer_{it} = \mu_i + \beta_1 rprod_{it} + \beta_2 NFA_{it} + \beta_3 tot_{it} + \epsilon_{it} \quad (13)$$

Where  $\mu_i$  stands for country-fixed effects.  $reer$  is the logarithm of the REER.  $rprod$  is the logarithm of a proxy<sup>11</sup> for the Balassa Samuelson effect.  $NFA$  denotes the Net Foreign Asset position, expressed in % of GDP.  $tot$  stands for the logarithm of the Terms Of Trade which is the ratio of the export prices

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<sup>11</sup>The proxy used is the ratio between the real GDP per capita (PPP terms) in the considered country and the trade weighted average of the PPP real GDP per capita of the trade partners.

to import prices and  $\epsilon_{it}$  is an error term.<sup>12</sup> Equation (13) is estimated relying on the Pooled Mean Group (PMG) estimator (Pesaran et al., 1999).<sup>13</sup> The PMG estimator is based on an Autoregressive Distributed Lags (ARDL) model. More precisely, we consider the following ARDL (p; q; q;...; q) specification:

$$reer_{it} = \mu_i + \sum_{j=1}^p \lambda_{ij} reer_{i,t-j} + \sum_{j=0}^q \delta'_{ij} Fundamentals_{i,t-j} + \epsilon_{it} \quad (14)$$

where  $Fundamentals_{i,t-j}$  is the  $(k \times 1)$  vector containing the real effective exchange rate fundamentals.  $\epsilon_{it}$  is an i.i.d error term. This ARDL model is estimated using the maximum likelihood methodology (Pesaran et al., 1999).

The estimation results of equation (13) are given in Table 7 in Appendix. As shown, the three long run determinants of the REER are significant and present the expected positive sign. An increase in relative productivity leads to a rise in the equilibrium exchange rate. An improvement in both the NFA position and TOT increases the equilibrium exchange rate as well. Furthermore, the error correction term is also significant at the 1% level and is negative, confirming the mean-reverting behavior of the exchange rate.

As shown by the figures in Appendix, the emergence of an undervalued currency is mainly due to a decreasing REER. Furthermore, increasing currency undervaluations generally come from a depreciation of the REER, motivating our interest to investigate how currency undervaluation affects the inflation-growth nexus. Finally, as can be seen from these figures, the EREER is only weakly volatile across countries.

## 4. Results

### 4.1. Growth determinants: A BMA approach

In this subsection, we present the results of the BMA methodology. The BMA approach is implemented using different model priors: a random, fixed and uniform prior. As previously mentioned, we consider two different parameter priors are considered: a Uniform Information Prior (UIP) and a Risk Inflation Criterion (RIC). Table 1 below displays the BMA results.

Among our initial dataset of 18 potential growth determinants, six variables emerge as robust, e.g having a PIP over 0.50. As expected, we find strong support for the conditional convergence hypothesis as the real initial GDP per capita (PC) presents a PIP nearly equals to 1. This result is in line with Durlauf et al. (2008) and is not affected by a change in the model or parameter space. Furthermore, our results point out that the fertility rate constitutes a relevant growth determinant. As in Moral-Benito (2012) and Grekou (2018a), government consumption expenditures belong to the robust growth determinants. In line with the Solow-Swan model, capital accumulation is shown to

<sup>12</sup>Data sources of each series are described in Couharde et al. (2017).

<sup>13</sup>Compared to the DOLS procedure, the PMG estimator allows for heterogeneity among countries in the short-run dynamics.

Table 1: Posterior Inclusion Probabilities

Model prior	Random	Random	Fixed	Fixed	Uniform
Parameter prior	UIP	RIC	UIP	RIC	
	Posterior	Inclusion	Probability		
Variable					
Gross fixed capital	<b>1.000<sup>a</sup></b>	<b>1.000<sup>a</sup></b>	<b>1.000<sup>a</sup></b>	<b>1.000<sup>a</sup></b>	<b>1.000<sup>a</sup></b>
Government consumption	<b>1.000<sup>a</sup></b>	<b>1.000<sup>a</sup></b>	<b>1.000<sup>a</sup></b>	<b>1.000<sup>a</sup></b>	<b>1.000<sup>a</sup></b>
Real initial GDP PC	<b>0.998<sup>a</sup></b>	<b>0.998<sup>a</sup></b>	<b>0.998<sup>a</sup></b>	<b>0.996<sup>a</sup></b>	<b>0.998<sup>a</sup></b>
Fertility	<b>0.993<sup>a</sup></b>	<b>0.996<sup>a</sup></b>	<b>0.992<sup>a</sup></b>	<b>0.993<sup>a</sup></b>	<b>0.993<sup>a</sup></b>
Terms Of Trade	<b>0.809<sup>b</sup></b>	<b>0.797<sup>b</sup></b>	<b>0.736</b>	<b>0.737</b>	<b>0.799<sup>b</sup></b>
Human capital	<b>0.564</b>	<b>0.563</b>	0.495	0.495	<b>0.573</b>
FDI	0.313	0.322	0.206	0.212	0.319
Openness	0.251	0.248	0.167	0.167	0.252
Price level of investment	0.184	0.193	0.099	0.101	0.190
Old dependency ratio	0.166	0.165	0.104	0.098	0.162
Remittances	0.151	0.154	0.080	0.081	0.150
Young dependency ratio	0.140	0.143	0.084	0.083	0.135
Civil liberties	0.140	0.128	0.073	0.074	0.132
Life expectancy	0.132	0.136	0.078	0.070	0.141
Political rights	0.131	0.127	0.072	0.070	0.128
Broad money	0.131	0.122	0.072	0.068	0.131
Population growth	0.124	0.125	0.069	0.070	0.121
Population	0.114	0.116	0.070	0.063	0.117

Note: The results are based on 100.000 burn-ins and 200.000 draws. Simulations made using birth-death MCMC sampler. "<sup>a</sup>" denotes a PIP over 0.99 denotes and decive evidence of a regressor. "<sup>b</sup>" indicates a PIP between 0.75 and 0.95 denoting a positive evidence of a regressor having an effect. RIC=Risk Inflation Criterion. UIP= Unit Information Prior. Use of the BMS (Zeugner and Feldkircher, 2015) package.

have a strong influence on growth, while population and population growth do not belong to the set of selected variables. For our sample of countries, the BMA approach also shows that terms of trade constitute a relevant determinant. This result can be explained by the presence of countries which rely heavily on export revenues to sustain their growth (Australia, Brazil, China, Indonesia and New-Zealand among others). Finally, we also find evidence of the relevance of the human capital index in the growth process. However, among our set of six variables this determinant seems to be the less relevant one. Under some priors, human capital can not be seen as a robust determinant because of a PIP below 0.50. Furthermore, we do not find strong support for the socio-political indicators, nor for other macroeconomic and demographic variables.

#### 4.2. Undervaluations and the inflation-growth nexus

Our empirical investigation starts by the estimation of equations (1) and (2). These estimations allow us (i) to assess whether the inflation-growth nexus depends on the sign of the currency misalignment, and (ii) to derive the linear effect of inflation on growth for undervaluation periods. The results are displayed in Table 2 below. Let us discuss the results concerning our control variables. In at least one regression, all our control variables are significant and present the expected sign. More specifically, in line with the convergence hypothesis, a higher level of initial real GDP PC is associated



with a lower growth.

Table 2: Benchmark regressions

	FE (2.1)	RE (2.2)	SGMM (2.3)	FE (2.4)	RE (2.5)	SGMM (2.6)
Real initial GDP PC	-3.233*** (1.057)	-1.395*** (0.366)	-0.349 (0.958)	-3.491** (1.390)	-1.868*** (0.349)	-3.518*** (1.296)
Inflation	-0.466** (0.207)	-0.480*** (0.166)	-0.760*** (0.279)	-0.414 (0.269)	-0.249 (0.193)	-0.576 (0.403)
Gross fixed capital	0.139*** (0.0385)	0.117*** (0.0269)	0.210*** (0.0648)	0.227*** (0.0520)	0.223*** (0.0334)	0.297*** (0.0605)
Government consumption	-0.378*** (0.0926)	-0.218*** (0.0468)	-0.399*** (0.100)	-0.330*** (0.121)	-0.153*** (0.0457)	-0.0867 (0.166)
Human capital	3.206 (2.088)	0.731 (0.489)	-1.583 (1.620)	2.762 (1.690)	1.433*** (0.527)	3.046 (2.588)
Terms Of Trade	0.922 (0.757)	1.040 (0.642)	1.613* (0.973)	1.708 (1.030)	1.010* (0.596)	0.823 (1.305)
Fertility	-1.033* (0.519)	-1.080*** (0.212)	-1.530*** (0.496)	-1.246*** (0.346)	-1.107*** (0.210)	-1.475 (1.087)
Constant	25.70*** (7.304)	13.03*** (4.186)	8.492 (9.358)	23.16* (12.68)	11.51** (4.987)	22.58* (13.20)
No. countries/No. observations	62/1002	62/1002	62/1002	61/785	61/785	61/785
Undervaluations episodes	YES	YES	YES	NO	NO	NO
Overvaluations episodes	NO	NO	NO	YES	YES	YES
AR(1)			0.000			0.000
AR(2)			0.060			0.062
Hansen			0.221			0.183
Time series dummies			YES			YES
No. instruments			49			49

Note: \*\*\*, \*\*, and \* denote the levels of statistical significance at 1, 5, and 10%. FE: Fixed effects, RE: Random Effects, SGMM: System General Method of Moments. Robust standard errors are reported in parentheses: robust clustered (resp. Windmeijer correction) standard errors for FE (resp. for two-step SGMM). In the SGMM, all the variables are treated as endogenous. Use of forward orthogonal deviations.

Furthermore, we find support in favor of the capital accumulation channel as a rise in the level of physical capital enhances growth. Indeed, following a 1% increase in the gross fixed capital formation, growth improves from 0.117% to 0.297%. As Barro (1991) and Easterly and Rebelo (1993), we show that government consumption expenditures hamper significantly growth. This negative effect ranges from a low of 0.153% to a maximum of 0.399%. As suggested by Becker et al. (1990), growth is also negatively correlated with the fertility rate. By reducing the incentive to accumulate human capital, more births per woman reduce growth. Finally, among our different regressions, human capital and the TOT are only weakly significant. This result is expected as these determinants exhibit the lower PIP, illustrating their small explanatory power. Considering regression in column (2.5), an improvement in countries' TOT and a higher level of human capital enhance growth.

Moving to the impact of inflation on growth, we find that its effect depends on the sign of the cur-



rency misalignments. Undervaluation periods present evidence of a contractionary inflation's effect (columns 2.1-2.3), while there is no significant effect under overvaluation periods (columns 2.4-2.6). This result can be explained by a significantly higher mean inflation for undervaluation periods than for overvaluation ones as confirmed by the mean difference test (see Table 9 in Appendix). All in all, our preliminary analysis shows the presence of a contractionary inflationist effect during undervaluation episodes, motivating the investigation of the role of real exchange rate undervaluations on the inflation-growth nexus. To this end, we estimate equation (3) including our interaction variable. The corresponding results are displayed in Table 3.

Table 3: Regression for the interaction variable

	FE	RE	S.GMM	S.GMM
	(3.1)	(3.2)	(3.3)	(3.4)
Real initial GDP PC	-3.387*** (1.011)	-1.281*** (0.362)	2.828 (2.291)	-0.734 (0.905)
Inflation	-0.636*** (0.219)	-0.689*** (0.182)	-1.113*** (0.400)	-0.825*** (0.272)
Inflation*Undervaluation <sub>i,t-1</sub>	-0.0128*** (0.00306)	-0.0129*** (0.00298)	-0.0248*** (0.00894)	-0.0170*** (0.00560)
Gross fixed capital	0.132*** (0.0393)	0.111*** (0.0275)	0.183** (0.0885)	0.172*** (0.0617)
Government consumption	-0.373*** (0.0901)	-0.218*** (0.0428)	-0.371** (0.151)	-0.319*** (0.104)
Human capital	3.387 (2.039)	0.697 (0.461)	-6.255* (3.300)	-1.869 (1.435)
Terms Of Trade	0.767 (0.764)	0.838 (0.627)	6.811*** (2.502)	1.520 (1.100)
Fertility	-0.908* (0.508)	-1.030*** (0.214)	-1.064 (1.004)	-1.858*** (0.538)
Constant	26.95*** (7.436)	12.99*** (4.038)	-34.58 (26.55)	13.64 (9.644)
No. countries/ No. observations	62/1001	62/1001	62/1001	62/1001
AR(1)			0.000	0.000
AR(2)			0.069	0.062
Hansen			0.085	0.235
Time series dummies			NO	YES
No. instruments			17	51

\*\*\*, \*\*, and \* denote the levels of statistical significance at 1, 5, and 10%. FE: Fixed effects, RE: Random Effects, SGMM: System General Method of Moments. Robust standard errors are reported in parentheses: robust clustered (resp. Windmeijer correction) standard errors for FE (resp. for two-step SGMM). In the SGMM, all the variables are treated as endogenous. Use of forward orthogonal deviations. The different sub-samples of countries are displayed in Table 4 (EME: emerging countries, DE: developing countries.)

As previously, our results show the presence of a contractionary effect of inflation (columns 3.1-3.4). More interestingly, our estimations provide evidence that, in addition to this negative effect, the inflation's effect also depends on the lagged undervaluations' level. Indeed, as shown in Table 3, the interaction term is significantly negative. In other words, the higher the lagged undervaluation, the higher the negative effect of inflation on growth. More precisely, the effect of inflation on growth

derivated from equation (3) is given by :

$$\frac{\partial Growth_{it}}{\partial inflation_{it}} = \beta_1 + \beta_2 * Undervaluation_{i,t-1} \quad (15)$$

Substituting  $\beta_1$  and  $\beta_2$  by their estimated values obtained from column (3.4) in Table 3, we get :

$$\frac{\partial Growth_{it}}{\partial inflation_{it}} = -0.825 - 0.0170 * Undervaluation_{i,t-1} \quad (16)$$

Finally, assuming that undervaluation is at its median value, we have :

$$\frac{\partial Growth_{it}}{\partial inflation_{it}} = -0.825 - 0.0170 * 11.74 = -1.024 \quad (17)$$

We remark that a non negligible part of the negative effect of inflation is conveyed through a higher undervaluation level. An undervalued currency affects the inflation-growth nexus through the emergence of supplementary inflation pressures. As discussed previously, this inflation arises from a cost-push inflation phenomenon and an economy overheating. As a result of these real undervaluations, the economy is affected by additionnal macroeconomic volatility which reinforces the contractionary effect of inflation on growth. The origin behind the increase of real undervaluations' size constitutes an important factor in the analysis as it conditions the inflationary effect. This effect is more likely to be important if undervaluations are led by a nominal depreciation rather than a rise in the equilibrium exchange rates. Thus, the source of real undervaluations' increase constitutes a key factor which could affect undervaluations' effect on the inflation-growth nexus.

As previously mentioned, we also consider sub-sample regressions (Table 8 in Appendix). The first sub-sample is composed of emerging economies, and the second one of developing countries. In our sub-sample analysis, we omit developed countries as developing and emerging economies are more likely to manipulate and keep their currency undervalued than developed economies (Couharde and Sallenave, 2013), especially China (see Bhattarai and Mallick, 2013; for this issue). Thus, it is more interesting to focus on these two groups of economies to be able to draw relevant policy recommendations. Two other reasons justify this sub-sample analysis. Firstly, as argued above, such decomposition allows us to limit heterogeneity arising from our sample. Secondly and more interestingly, countries setting at different stages of development show different tolerance degrees to inflation (López-Villavicencio and Mignon, 2011) which could affect our findings.

Let us first discuss results concerning inflation. We find evidence of a negative inflation-growth nexus for emerging countries, while inflation does not hamper growth for developing economies. This result can be understood in light of two main explanations. The first one states that developing countries present a higher tolerance to inflation than emerging countries (López-Villavicencio and Mignon, 2011). In other words, due to the predominance of the Balassa-Samuelson effect for these countries, they can bear higher inflation as it occurs in response to a catching-up process. The second explanation lies in the presence of lower inflation in developing countries than in emerging ones. Indeed, as shown by the results in Table 10 in appendix, as soon as high inflation episodes are excluded,

mean inflation is significantly higher in emerging countries than in developing ones. This lower inflation originates from the presence of countries with a fixed Exchange Rate Regime (ERR), especially CFA zone countries. Indeed, countries which pegged their currencies present significantly lower inflation rates (Ghosh et al., 1997). This lower inflation rate can also explain the non significance of this relationship as for developing countries, inflation negatively impacts growth as soon as a threshold equals to 11-12% is reached (Khan and Ssnhadji, 2001).

Our estimations also show a significantly negative interaction term for emerging countries, while for developing ones the inflation-growth nexus does not depend upon lagged undervaluations. This result is discussed in light of the three following explanations: length of undervaluation periods, level of undervaluations and inflationary environment. First of all, we examine if the non significance of the interaction term for the developing economies can be relied to the length of undervaluation periods. In order to generate supplementary inflationary pressures a sizable length of undervaluation is expected. In fact, it is important because such long undervaluation periods can arise from a depreciated currency which is source of inflation. Our test, available in Table 10 in appendix, infirms this hypothesis as the mean length of undervaluation periods is significantly higher in developing economies than in emerging ones.

Let us now verify if the fact that inflation does not depend upon lagged undervaluations can be explained by the level of undervaluations. In order to generate potential inflationary pressures, undervaluations should be sizable assuming that they were caused by important currency depreciations. This explanation is supported by our test showing that emerging countries have a statistically significant higher mean undervaluation than developing ones at the 5% level (see Table 10 in appendix). These higher undervaluation episodes are likely to generate inflation, which can affect negatively growth as suggested by the significance and negative sign of our interaction variable. Hence, it explained why inflation depends upon undervaluation's level for emerging countries.

Turning to the inflationary environment, it plays a key role in the context of the Exchange Rate Pass Through to prices (ERPT) as argued by López-Villavicencio and Mignon (2017). The inflationary environment can be more propice to a high ERPT for emerging countries than for developing ones (see Mallick and Marques, 2008, 2016; for applications on emerging economies), explaining our previous findings. In fact, higher inflation rate translates into higher ERPT (see Taylor, 2000; Choudhri and Hakura, 2006; López-Villavicencio and Mignon, 2017). In other words, lower is the inflation rate lower is the ERPT, meaning that an undervalued currency is more likely to produce inflation pressures if the environment is inflationary. Hence, a possible explanation for the fact that the negative effect of inflation depends on the lagged undervaluation for emerging countries but not for developing ones is the difference in the inflationary environment. It is supported by our findings showing that mean inflation is significantly higher in emerging countries than in developing ones (Table 10 in appendix).

#### 4.3. Robustness checks

Given the long time span of our panel data set, countries were hit by several currency crisis episodes. More specifically, our sample contains economies belonging to the CFA zone which were hit by a crisis in 1994 due to a modification in parity. Furthermore, there are also Asian economies affected by currency crises in 1997-1998. The presence of such events can impact our previous findings in several ways. Firstly, one symptom inherent to currency crises is the presence of large currency overvaluations (Kaminsky and Reinhart, 1999) which are then followed by a sharp devaluation leading generally to an undervalued currency. These crises can affect our results as they are followed by lower GDP growth (Hong and Tornell, 2005) in the three years following the collapse. Moreover, the years following these crises are characterized by higher inflation because of the devaluations (Borenstein and De Gregorio, 1999; Mallick, 2005). This higher inflation rate could lower economic growth by penalizing the investment rate in the economy (see Hong and Tornell, 2005). All in all, our results can be impacted by the currency crises.

In order to check the robustness of our results to the presence of currency crisis episodes, we use the database proposed by Laeven and Valencia (2013). A detailed description of the different episodes of currency crises is available in Table 12 in appendix. We control for the currency crises by creating a dummy variable which is equal to 1 during the year of the currency crisis and the following two years, 0 otherwise.<sup>14</sup> As soon as the dummy variable is equal to one, we exclude these observations from our sample. The results are displayed in Table 11 in appendix. As expected, the exclusion of episodes of currency crises from our sample leads to weaken the significance for inflation. More precisely, considering columns (3.4) (Table 3) and (6.4) (Table 11), inflation becomes significant at the 10 % level and the interaction term is still significantly negative. Hence, as previously, an increase in the lagged undervaluation leads to an intensification of the negative effect of inflation on growth. Our results are thus robust to the presence of currency crises.

## 5. Conclusion

Our paper aims to offer a new perspective on the role played by undervaluations on growth. While it is generally admitted that undervaluations have a growth-enhancing effect (Rodrik, 2008; MacDonald and Vieira, 2010), we put into perspective these potential gains by considering the impact of undervaluations on the inflation-growth nexus.

After having selected the relevant growth determinants using the BMA approach, we show that the higher the undervaluation, the higher the negative impact of inflation on growth. In other words, undervaluations reinforce the negative effect of inflation because of the development of substantial inflation pressures coming from imported inflation and the emergence of an overheating in the economy. Considering sub-sample regressions, we show that this finding holds only for emerging countries, but not for developing economies. This result is explained in light of undervaluations' level and

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<sup>14</sup>We control for 2 years after the currency crisis due to lasting effects.

the inflationary environment. Emerging countries present a statistically significantly higher mean undervaluation than developing ones. Moreover, the former also show an inflationary environment more propice to a high ERPT than the latter. Finally, the reinforcement of the contractionary effect of inflation through higher undervaluations is robust to the exclusion of currency crises.

In light of our results, several economic policy recommendations can be drawn. Beside the potential gains coming from an undervalued currency, we observe a reinforcement of the contractionary effect of inflation. Hence, countries which base, to a certain extent, their development policy on an undervalued currency have to weigh the pros and cons of such choice. Indeed, on the one hand, undervaluations can have a growth-enhancing effect through the competitiveness channel. But, on the other hand, their inflationary effect accentuates the negative effect of inflation on growth. Our results show that such recommendation is particularly relevant for emerging countries operating under a flexible exchange rate regime, rather than for developing economies. Thus, emerging economies have to manage properly their exchange rate in order to avoid subsequent currencies' undervaluations, which can have adverse effects on their growth performance. This risk is less pronounced in the case of a fixed exchange rate regime as they are more prone to overvaluations than economies adopting a flexible regime ([Coudert and Couharde, 2009](#)).

Finally, it is worth mentioning that although the volatility of misalignments has been identified as a relevant growth determinant (see [Aguirre and Calderón, 2005](#); among others), its effective transmission channel received only few considerations. Hence, a fruitful extension of our analysis for future research would be to investigate these channels. To this end, it would be particularly relevant to account for the exchange rate regime as, as emphasized by [Holtemöller and Mallick \(2013\)](#), the higher the flexibility of the exchange rate regime, the lower the misalignment.

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# Appendix

## 6. Data appendix

Table 4: List of countries (62)

Advanced countries	Emerging countries	Developing countries
Australia	Algeria	Bangladesh
Belgium	Argentina	Bolivia
Canada	Brazil	Cameroon
China Hong Kong SAR	Chile	Central African Republic
France	China	Congo
Germany	Colombia	Costa Rica
Greece	Côte d'Ivoire	Ethiopia
Ireland	Ecuador	Gabon
Israel	Egypt	Ghana
Korea Republic	Guatemala	Honduras
Netherlands	India	Madagascar
New Zealand	Indonesia	Mauritania
Norway	Jordan	Mozambique
Singapore	Kenya	Niger
Spain	Malaysia	Nigeria
Sweden	Mexico	Panama
United Kingdom	Morocco	Paraguay
USA	Philippines	Senegal
	Thailand	South Africa
	Tunisia	Sri Lanka
	Turkey	Togo
	Venezuela	Trinidad and Tobago

Table 5: Variables' definitions and sources

Variables	Definitions	Sources	Expected sign
<b>Dependent variable</b>			
Growth	GDP per capita growth (annual %)	WDI	
<b>Solow determinants, human capital</b>			
Fertility	total (births per woman)	WDI	-
Gross fixed capital	Gross fixed capital formation (% of GDP)	WDI	+
Human capital	Human capital	P.W.T 9.0	+
Life expectancy	Life expectancy at birth (total years), expressed in logarithm	WDI	-
Old dependency ratio	Population over 65 years old divided by the working age population	WDI	-/+
Population	Total population (expressed in logarithm)	WDI	-
Population growth	Population growth	WDI	-
Real initial GDP PC	Lagged real GDP per capita (expressed in logarithm)	WDI	-
Young dependency ratio	Population under 15 years old divided by the working age population	WDI	-
<b>Macroeconomic variables</b>			
FDI	Foreign direct investment, net inflows (% of GDP)	WDI	+
Government consumption	General government final consumption expenditure (% of GDP)	WDI	-
M2GDP	Broad money (% of GDP)	WDI	+
Openness	Exports plus Imports (% GDP)	WDI	+
Price level of investment	Price level of capital formation, price level of USA GDPo in 2011=100	P.W.T 9.0	-
Remittances	Personal remittances, received (% of GDP)	WDI	+
Terms Of Trade	Net barter terms of trade index (2000 = 100), expressed in logarithm	WDI	+
<b>Socio-political indicators</b>			
Civil liberties	Civil liberties; measured on a scale from 1 to 7, 7 being the lowest level of freedom.	Freedom House	-/+
Political rights	Political rights; measured on a scale from 1 to 7, 1 being the highest degree of freedom.	Freedom House	-/+
<b>Other variables</b>			
Inflation	Growth rate of Consumer Price Index (CPI)	WDI and USDA	-
Misalignment exchange rate	Measure of misalignment using a BEER approach	EQCHANGE (Couharde et al., 2018).	

Note: WDI: World Development indicators. USDA : United States Department of Agricultural. PWT : Penn World Table

## 7. Additional results

Table 6: Descriptive statistics

Variable	Observations	Standard deviation	Mean	Min	Max
Broad money	1814	37,42	45,01	3,81	362,86
Civil liberties	2186	1,71	3,38	1,00	7,00
Fertility rate	2232	1,75	3,42	0,90	7,89
Foreign direct investment	2172	5,71	3,09	-10,08	87,44
GDP	2231	14247,26	14112,38	354,28	80892,06
Growth	2228	4,18	1,76	-36,83	30,36
Government consumption	2174	5,23	15,04	2,98	45,30
Gross fixed capital formation	2212	8,03	22,95	0,00	61,47
Human capital	2232	0,71	2,27	1,02	3,73
Inflation	2220	281,53	24,63	-29,81	11749,64
Life expectancy	2162	11,48	64,43	35,00	84,28
Misalignment	2217	29,47	0,04	-170,28	269,85
Open	2183	57,54	75,21	6,32	442,62
Population	2170	198,54	70,63	0,73	1369,44
Population growth	2266	1,97	1,06	-4,03	7,51
Old dependency ratio	2232	4,59	6,99	1,93	21,12
Young dependency ratio	2232	10,28	32,54	11,06	50,22
Political rights	2186	2,02	3,28	1,00	7,00
Price level investment	2170	0,27	0,57	0,05	2,47
Remittances	1431	3,55	2,08	0,00	24,90
Terms of trade	1938	40,90	114,11	21,40	357,58

Source: Author's calculations.

Table 7: Equilibrium exchange rates estimation

Dependent variable : $\Delta \text{reer}$	
	Coef.
Long run dynamic	
rprod	0.0740*** (0.0209)
NFA	0.0432*** (0.00569)
tot	0.419*** (0.0307)
Short-run dynamic	
ec	-0.185*** (0.0165)
$\Delta \text{rprod}$	0.189 (0.123)
$\Delta \text{NFA}$	0.0553** (0.0237)
$\Delta \text{tot}$	0.419*** (0.0307)

Standard errors in parentheses, \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .  
 "e.c." denotes the error-correction term. Cointegration relationship estimated relying on the PMG estimator. Source: [Couharde et al. \(2017\)](#).

### 7.1. Sub-sample regressions

Table 8: Sub-sample regressions

	FE (5.1)	RE (5.2)	S.GMM (5.3)	FE (5.4)	RE (5.5)	S.GMM (5.6)
Real initial GDP PC	-4.829*** (1.226)	-2.152*** (0.524)	-3.393*** (0.959)	-1.053** (1.711)	7.050 (0.411)	7.051 (4.445)
Inflation	-1.045*** (0.300)	-0.842*** (0.244)	-0.673* (0.390)	-0.134 (0.319)	-0.250 (0.239)	-2.655 (3.327)
Inflation*Undervaluation <sub>i,t-1</sub>	-0.0164*** (0.00357)	-0.0190*** (0.00360)	-0.0153*** (0.00491)	-0.00745 (0.00535)	-0.00994** (0.00497)	-0.0164 (0.0191)
Gross fixed capital	0.330*** (0.0686)	0.207*** (0.0449)	0.215*** (0.0603)	0.0465 (0.0310)	0.0613** (0.0299)	0.101 (0.319)
Government consumption	-0.452*** (0.132)	-0.258*** (0.0591)	-0.154 (0.124)	-0.268** (0.120)	-0.183** (0.0715)	-1.404** (0.600)
Human capital	4.324 (3.600)	0.615 (0.804)	1.772 (2.443)	3.862 (3.663)	1.011 (0.901)	-14.20 (9.251)
Terms Of Trade	-0.690 (1.138)	0.414 (0.746)	-0.712 (2.137)	0.728 (0.939)	1.632* (0.901)	9.322 (7.882)
Fertility	-1.002 (0.890)	-1.075*** (0.271)	-1.409** (0.613)	-0.739 (0.780)	-0.675** (0.321)	-0.921 (2.111)
Constant	42.07*** (8.104)	21.20*** (7.509)	34.37*** (13.13)	11.11 (9.154)	4.828 (4.612)	-47.72 (36.27)
No. countries / No. observations	22/425	22/425	22/425	22/413	22/413	22/413
Sub-samples	EME	EME	EME	DE	DE	DE
AR(1)			0.006			0.013
AR(2)			0.427			0.225
Hansen			0.473			0.466
Time series dummies			NO			NO
No. instruments			25			17

Note: \*\*\*, \*\*, and \* denote the levels of statistical significance at 1, 5, and 10%. FE: Fixed effects, RE: Random Effects, SGMM: System General Method of Moments. Robust standard errors are reported in parentheses: robust clustered (resp. Windmeijer correction) standard errors for FE (resp. for two-step SGMM). In the SGMM, all the variables are treated as endogenous. Use of forward orthogonal deviations. The different sub-samples of countries are displayed in Table 4 (EME: emerging countries, DE: developing countries.)

## 7.2. Tests

Table 9: Tests of difference in mean between undervaluations and overvaluations

Alternative Hypothesis	P-value difference mean inflation
Difference <0	0.000***
Difference=0	0.000***
Difference>0	1.000

Note: \*\*\*, \*\*, \* indicates rejection of the null hypothesis respectively at the 1%, 5% and 10% level in favor of the alternative hypothesis. Welch for unequal variances is used. Mozambique and high inflation episodes are excluded (inflation >100%).

Source: Author's calculations.

Table 10: Tests of difference in mean between emerging and developing countries

Alternative Hypothesis	P-value difference mean duration of undervaluations' periods	P-value difference mean undervaluation	P-value difference mean inflation
Difference <0	0.000***	0.957	0.999
Difference=0	0.000***	0.087*	0.001***
Difference>0	1.000	0.0428**	0.000***

Note: \*\*\*, \*\*, \* indicates rejection of the null hypothesis respectively at the 1%, 5% and 10% level in favor of the alternative hypothesis. Welch for unequal variances is used. Mozambique and high inflation episodes are excluded (inflation >100%) as the latter tend to increase mean inflation for emerging countries. Absolute value of the undervaluations used.

Source: Author's calculations.

### 7.3. Robustness checks

Table 11: Robustness checks

	Dependent Variable: GDP PC growth rate			
	FE (6.1)	RE (6.2)	S.GMM (6.3)	S.GMM (6.4)
Real initial GDP PC	-3.006*** (0.947)	-1.078*** (0.359)	1.143 (1.032)	-0.313 (0.908)
Inflation	-0.499** (0.212)	-0.431** (0.174)	-1.260*** (0.438)	-0.636* (0.377)
Inflation*Undervaluation <sub>i,t-1</sub>	-0.00994*** (0.00360)	-0.00959*** (0.00338)	-0.0126*** (0.00484)	-0.0185*** (0.00545)
Gross fixed capital	0.112*** (0.0350)	0.0968*** (0.0268)	0.0598 (0.0472)	0.105** (0.0424)
Government consumption	-0.372*** (0.0918)	-0.218*** (0.0453)	-0.253** (0.113)	-0.360*** (0.0900)
Human capital	2.332 (1.813)	0.311 (0.409)	-4.867*** (1.816)	-1.938 (1.640)
Terms Of Trade	0.752 (0.856)	0.778 (0.731)	0.427 (1.196)	-0.275 (1.140)
Fertility	-0.954* (0.482)	-1.135*** (0.225)	-1.687*** (0.497)	-1.775*** (0.484)
Constant	26.57*** (7.571)	12.78*** (4.250)	11.00 (10.37)	19.93** (9.611)
No. countries/ No. observations	62/918	62/918	62/918	62/918
AR(1)			0.000	0.000
AR(2)			0.071	0.047
Hansen			0.714	0.252
Time series dummies			NO	YES
No. instruments			25	51

Note: \*\*\*, \*\*, and \* denote the levels of statistical significance at 1, 5, and 10%. FE: Fixed effects, RE: Random Effects, SGMM: System General Method of Moments. Robust standard errors are reported in parentheses: robust clustered (resp. Windmeijer correction) standard errors for FE (resp. for two-step SGMM). In the SGMM, all the variables are treated as endogeneous. Use of forward orthogonal deviations.

## 8. Currency crisis episodes

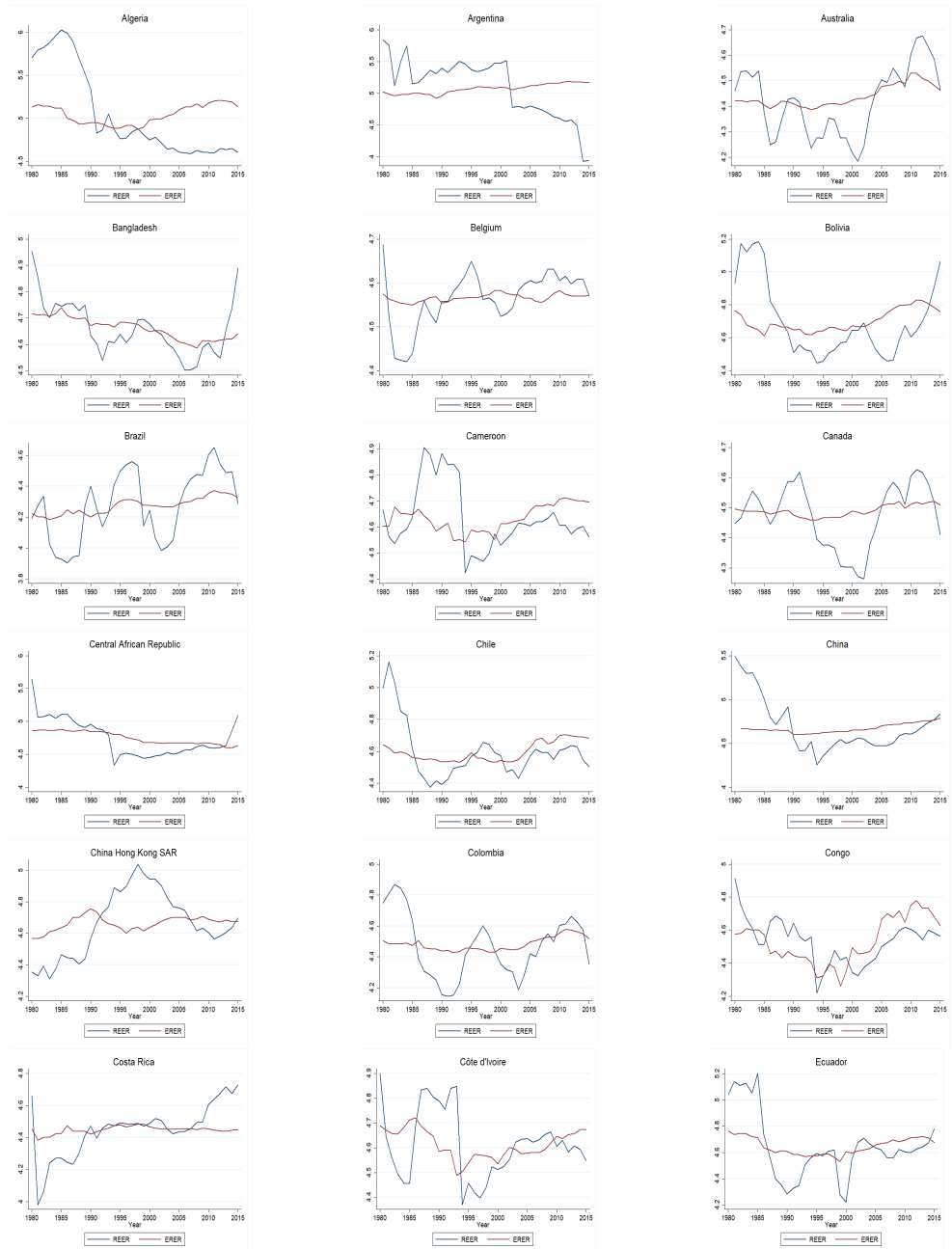
Table 12: Currency crisis episodes

Country	Year of currency crisis	Country	Year of currency crisis
Algeria	1988, 1994	Madagascar	1984, 1994, 2004
Argentina	1981, 1987, 2002	Mauritania	1993
Bolivia	1981	Mexico	1982, 1995
Brazil	1982, 1987, 1992, 1999	Morocco	1981
Cameroon	1994	Mozambique	1987
Central African Republic	1994	New Zealand	1984
Chile	1982	Niger	1994
Colombia	1985	Paraguay	1984, 1989, 2002
Congo	1994	Nigeria	1983, 1989, 1997
Costa Rica	1981, 1991	Philippines	1983, 1998
Côte d'Ivoire	1994	Senegal	1994
Ecuador	1982, 1999	South Africa	1984
Egypt	1979, 1990	Spain	1983
Ethiopia	1993	Sri Lanka	1978
Gabon	1994	Sweden	1993
Ghana	1983, 1993, 2000, 2009	Thailand	1998
Greece	1983	Togo	1994
Guatemala	1986	Trinidad and Tobago	1986
Honduras	1990	Turkey	1978, 1984, 1991, 1996, 2001
Indonesia	1979, 1998	Venezuela	1984, 1989, 1994, 2002, 2010
Israel	1980, 1985		
Jordan	1989		
Kenya	1993		
Korea Rep	1998		

Source: [Laeven and Valencia \(2013\)](#).

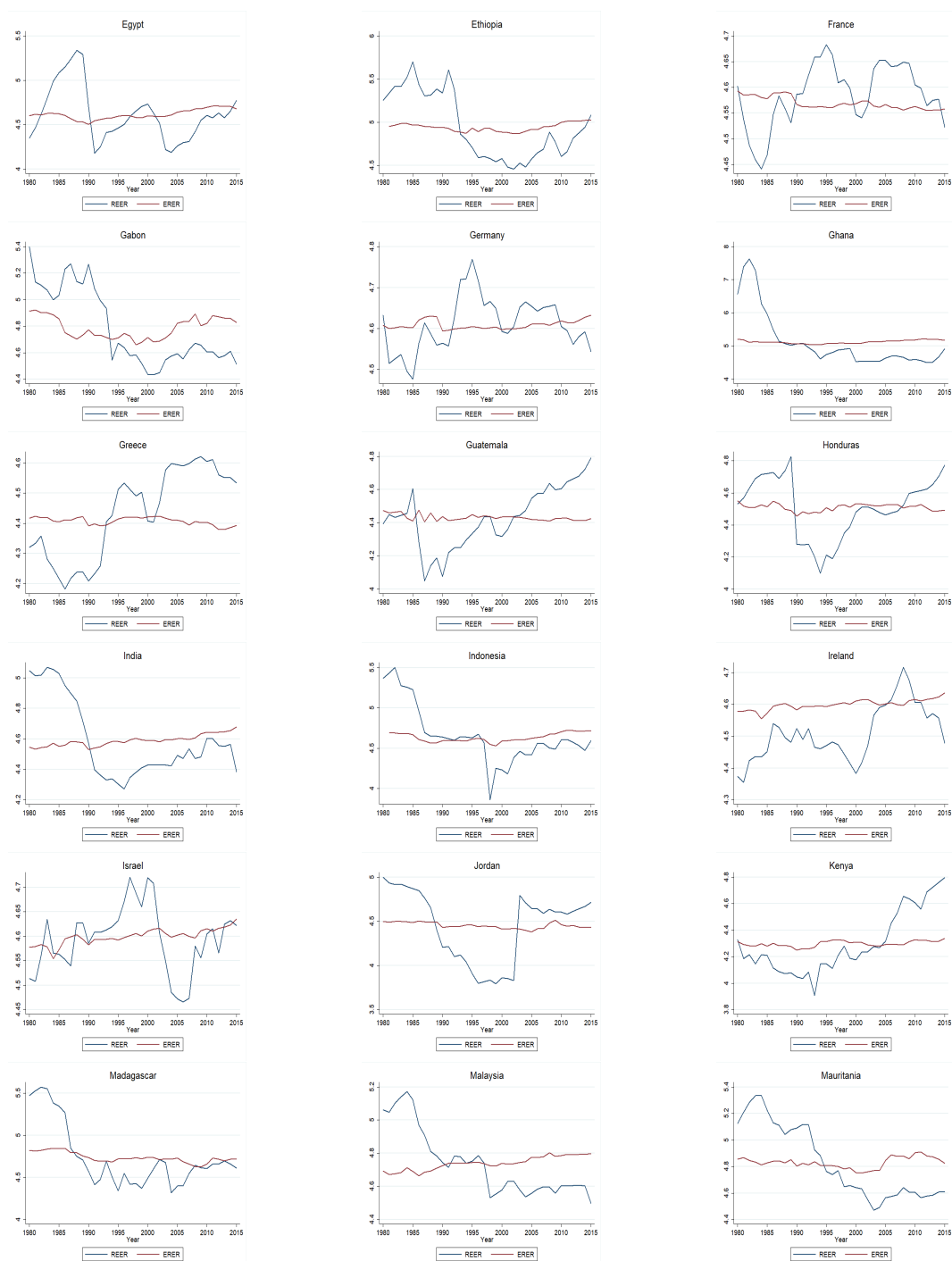
## 9. Figures appendix

**Figure 1: REER and ERER**



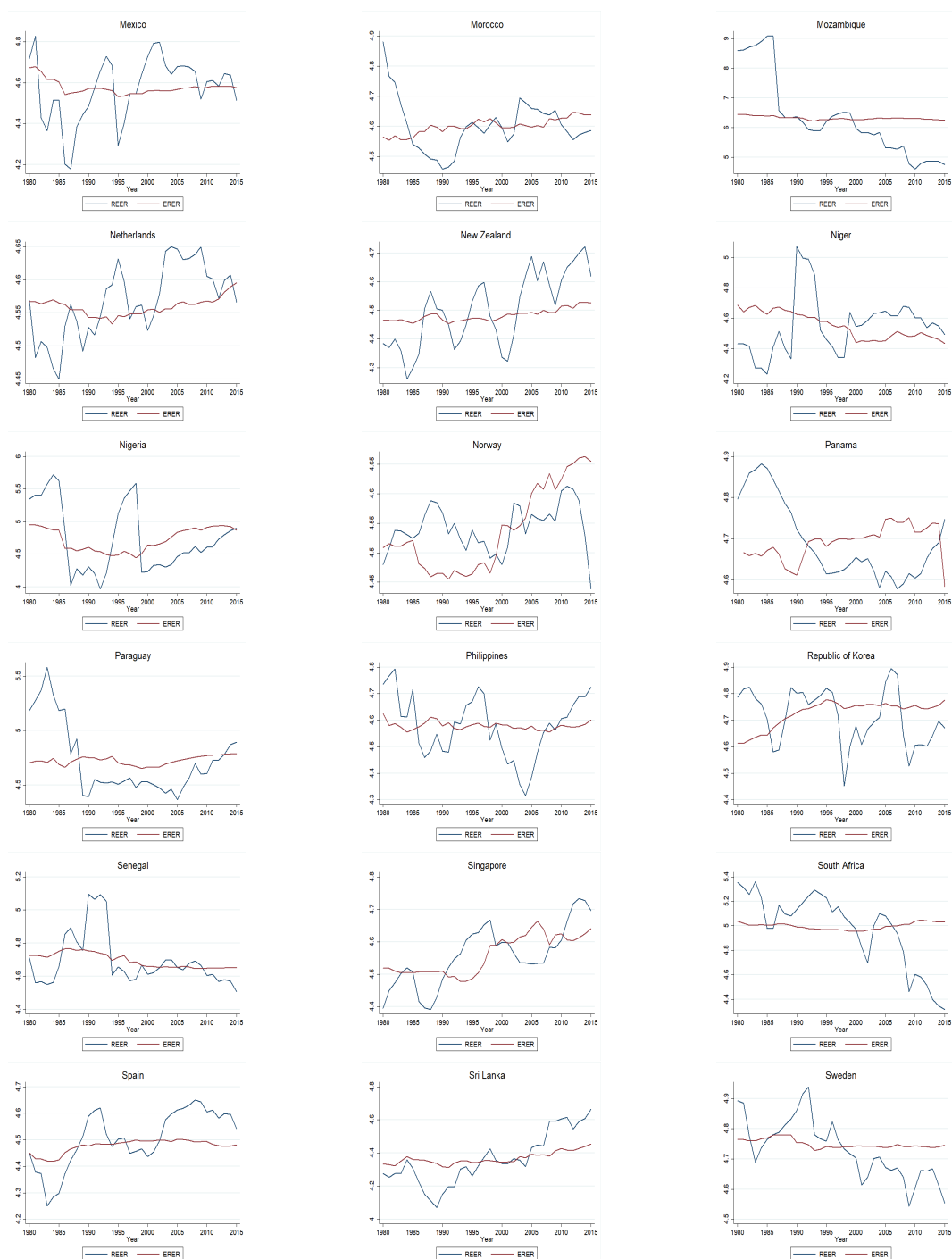
Note: REER (resp. ERER) indicates the logarithm of the Real Effective Exchange Rates (resp. Equilibrium Real Exchange Rate). A decrease (resp. increase) of the real effective exchange rate indicates a depreciation (resp. appreciation).





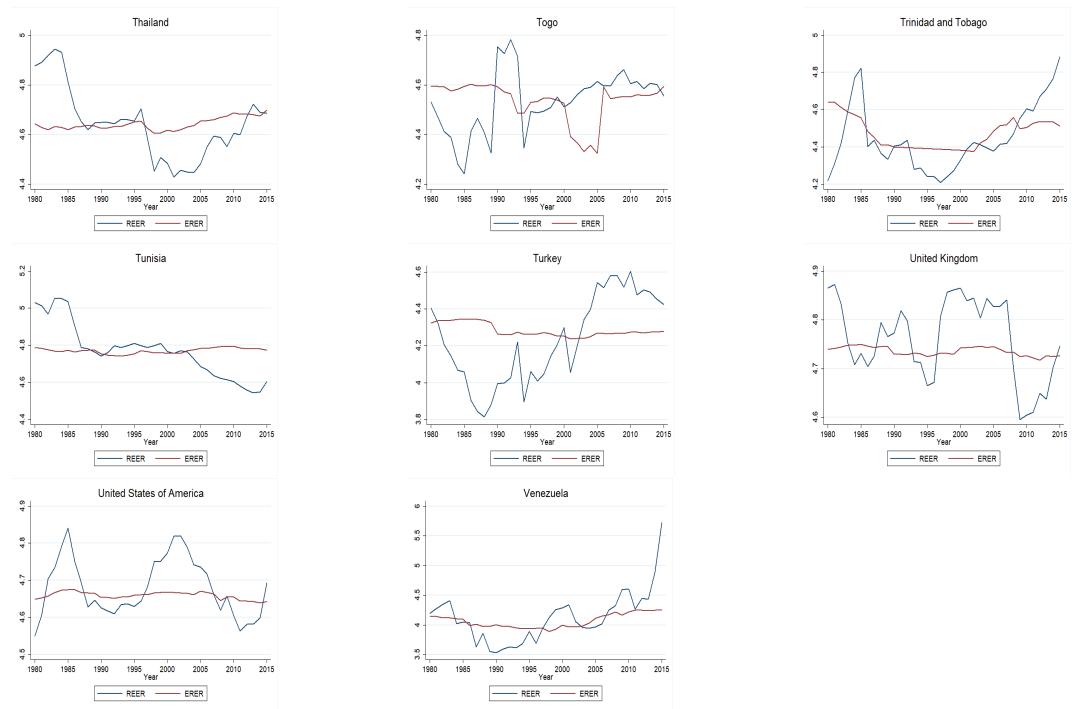
**Figure 1— Continued.**

Note: REER (resp. EREER) indicates the logarithm of the Real Effective Exchange Rates (resp. Equilibrium Real Exchange Rate). A decrease (resp. increase) of the real effective exchange rate indicates a depreciation (resp. appreciation).



**Figure 1— Continued.**

Note: REER (resp. EREER) indicates the logarithm of the Real Effective Exchange Rates (resp. Equilibrium Real Exchange Rate). A decrease (resp. increase) of the real effective exchange rate indicates a depreciation (resp. appreciation).



**Figure 1— Continued.**

Note: REER (resp. EREER) indicates the logarithm of the Real Effective Exchange Rates (resp. Equilibrium Real Exchange Rate). A decrease (resp. increase) of the real effective exchange rate indicates a depreciation (resp. appreciation).