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Abstract

The aim of this article is to assess the role of real effective exchange rate volatility on long-run economic growth for a set of 82 advanced and emerging economies using a panel data set ranging from 1970 to 2009. With an accurate measure for exchange rate volatility, the results for the two-step system GMM panel growth models show that a more (less) volatile RER has significant negative (positive) impact on economic growth and the results are robust for different model specifications. In addition to that, exchange rate stability seems to be more important to foster long-run economic growth than exchange rate misalignment.

Key Words: Exchange Rate Volatility, Economic Growth, and Panel Data Analysis

JEL Classification: F31, O47, C33

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1. Introduction

There has been a growing literature trying to shed some light on the importance of the relationship between real exchange rate (RER[1]) and economic growth. Some of the works have focused on studying export-led growth strategies[2] and others are dedicated to studying RER misalignments[3]. However, not only is the level of RER important (and its deviation from the long run equilibrium), but also its volatility, which may hinder investment and trade.

Regardless of the results from the literature, which are mixed, there is a widespread use of measures of exchange rate volatility based on non-conditional standard deviation, which imposes well known limitations to the empirical analysis. This can be seen as a restriction on the empirical research for the role of exchange rate volatility on growth. As well as that, a vast literature has been developed making use of distinct measures of exchange rate misalignment, but they also have some limitations. On the one hand, when misalignment is calculated as the deviation of the observed exchange rate with respect to an estimated one, some problems arise in estimating the equilibrium exchange rate. On the other hand, misalignment calculations are not usually able to identify when the economy is facing appreciation or depreciation of the exchange rate and for how long. Frequently, economies with higher economic growth rates, such as the Asian countries, use (depreciated) exchange rate policies in the sense that they follow an outward growth strategy. In such cases there is still a possibility to have exchange rate misalignment (with appreciation movements).

This article aims to shed some light on the role of RER volatility on long-run economic growth. We argue that both emerging and developed countries have difficulties in their economic growth process due to a series of factors, including RER volatility. Our panel data consists of 82

[1] In this study we actually use the real effective exchange rate (REER) instead of the RER for the reasons discussed ahead.
[2] See Balassa (1978), Chow (1987), Bahmani-Oskooee; Mohtadi & Shabsigh (1991), Ahmad & Kwan (1991), Oxley (1993), Ahmad & Harnhirun (1995), Krueger (1998), Alguacil; Cuadros & Orts (2002).
[3] See Edwards (1988), Krumm (1993), Rodrik (2008), Eichengreen (2008), Aghion et. al (2009), Berg & Miao (2010).

emerging and advanced countries for the period between 1970 and 2009. Our results show that a more (less) volatile RER has significant negative (positive) impact on economic growth and the results are robust for different model specifications. In addition to that, exchange rate stability seems to be more important to foster long-run economic growth than exchange rate misalignment.

The next section presents the literature on the relationship between real exchange rate volatility and long-run economic growth. Section 3 describes the methodology of measuring RER volatility as part of contribution of this research. Section 4 presents the empirical model and additional issues related to the econometric methodology. Section 5 summarizes the empirical results and section 6 brings some concluding.

2. The Literature

The relationship between growth and RER volatility has been approached by the economic literature through different perspectives and channels, such as trade, investment, unemployment, and productivity, besides direct effects and causalities. In relation to trade and exchange rate volatility, the theory goes on both directions. For instance, Cushman (1986) and Peree & Steinherr (1989) show that more exchange rate volatility is related to negative effects on trade, whilst Viaene & de Vries (1992) find little effect between the two variables. Franke (1991) and Sercu & Vanhulle (1992) construct models showing that trade can be even benefited from higher currency volatility. Ambiguous results go beyond theory and are also encountered in empirical results. For instance, Caballero & Corbo (1989) and Peree & Steinherr (1989) find a negative consequence between exchange rate volatility and trade, while positive effects are reported by Franke (1991), Sercu & Vanhulle (1992), Doyle (2001) and Bredin, Fountas & Murphy (2003), among other articles.

In relation to investment and exchange rate volatility, results are also mixed. For instance, Campa & Goldberg's (1995) results show that exchange rate volatility brings uncertainty on investment volatility in the U.S. data, but has not effect for the Canadian data. From another standpoint, Darby et al.(1999) analyze the case of France, Germany, Italy, the UK and the USA, showing that exchange rate volatility affects negatively (and strongly) investment. Similar results are found by Bleaney & Greenaway (2001) and Serven (2002). Report

Among the works that find some relationship between RER variability and growth, Dollar (1992) analyzes 95 developing countries over the period 1976–1985 and reports evidence of a negative relationship between the two variables. Bosworth et al. (1996) analyze the economic growth experiences of 88 countries (developing and industrial) over the period 1960-1992. Their results strongly support that export-oriented trade policies promote economic growth and also show that RER volatility influences negatively output growth by slowing increases in total factor productivity. Bleaney & Greenaway (2001) study the influence of RER volatility on investment and growth in 14 sub-Saharan African countries over the period from 1980 to 1995. According to their results, RER volatility does affect investment but not economic growth. A similar outcome was reported in a previous article by Ghura & Grennes (1993) for 33 Sub-Saharan countries. Schnabl (2009) focuses on the effects of exchange rate volatility on growth in Emerging Europe and East Asia. The author comes to the conclusion that exchange rate volatility has a negative influence on growth for those regions.

Belke & Kaas (2004) analyze data related to Central and Eastern European emerging countries and their results reveal that exchange rate volatility lowers employment growth. Feldmann (2011) makes use of data related to 17 industrial countries over the period 1982-2003, with controls for country-specific characteristics. Their conclusion is that a higher exchange rate volatility increases unemployment rate, despite the magnitude of the effect being small. For a data set consisting of 83 countries for the period 1960-2000, Aghion et al. (2009) find evidence that RER volatility is negatively associated with long-term productivity growth in countries with underdeveloped financial markets only. Bagella et al. (2006) shows that RER volatility has considerable impact on growth of per capita income.

Ghosh et al. (1997) do not find any significant relationship between observed exchange rate variability and economic growth for a sample of 140 countries over 30 years, even though investment seems higher and trade growth lower under pegged regimes. Aristotelous (2001) analyzes the impact of exchange-rate regime and volatility on the British exports to the USA for the period 1889–1999 and finds that neither different exchange rate regimes nor volatility affected British exports to the USA.

As it can be seen, the empirical literature related to the topic has not been able to come up with a final answer regarding the relationship between growth and RER volatility. In fact, Eichengreen (2008, p. 04) argues that, even though there has not been strong statistical evidence related to RER and its volatility, the fact is that RER matters: "*keeping it at appropriate levels and avoiding excessive volatility enable a country to exploit its capacity for growth and development*."

3. The Measure of Exchange Rate Volatility

One of the contributions of this work is an accurate measure of exchange rate volatility, which is based on data for real effective exchange rate (REER) defined as:

$$REER_{it} = \frac{P_{it}}{\left(\frac{s_{it}}{s_{io}}\right)\prod_{k=1}^{n}\left[\frac{P^*_{kt}}{s_{kt}} \Big/ \frac{P^*_{k0}}{s_{k0}}\right]^{\omega_k}} \qquad (1)$$

where: *i*) s_{it} is the nominal exchange rate of country '*i*' in period '*t*', expressed as units of U.S. dollars relative to the domestic currencies; *ii*) P_{it} is the consumer price index of country '*i*' in period '*t*'; *iii*) s_{kt} is the nominal exchange rate of the trade partner '*k*' of country '*i*' in period '*t*'; and *iv*) P^*_{it} is the consumer price index of the trade partner '*k*' of country '*i*' in period '*t*'.

The monthly database includes 82 countries from January 1970 to December 2009, except for Zimbabwe's REER, with data up to December 2006. The base year is 2002 and Box 1 in the appendix describes all countries used in our estimation.

Box 1 here

The volatility measures are calculated from the returns of the natural log of the REER, $r_{it} = q_{it} - q_{it-1}$, where $q_{it} = ln(REER_{it})$ based on three steps: *i*) a unit root test for the return of the series; *ii*) a model for the conditional average; *iii*) and a model for the conditional variance.

Before we talk about the three steps, it is worth mentioning that, in deriving our monthly volatility measure, the choice was to model each time series based on ARMA+XARCH structures rather than a VAR+Multivariate Volatility Model. In fact, modeling series by series has become the preferred strategy since the limitation of the software[4] used in our calculation does not allow imposing different structures for each country time series.

Therefore, we develop a unit root test for the return time series for each country and examine the correlogram (autocorrelation and partial autocorrelation functions) in order to determine the maximum order for the average structure, which was modeled by the ARMA process.

The second step is to model the conditional average of the return through an ARMA process. The estimation method used is the MPL (Modified Profile Likelihood). We compare the different models controlling for the sample size and use the Schwarz Criteria to select the optimal structure. Once the selection is made, we model the return series using the average structure. After saving the standardized residuals, we create the squared residuals and examine the correlogram in order to evaluate the maximum order for the variance structure, which is modeled using a XARCH procedure.

The next step was to model the conditional variance of the return series by the XARCH (GARCH, IGARCH, EGARCH, APARCH e GJR) structure using the average conditional

[4] OxMetrics.

structure obtained from one of the steps described prevously. The estimation approach is a maximum likelihood with a quasi-Newton method (BFGS) developed by Broyden (1970), Fletcher (1970), Goldfarb (1970) and Shanno (1970). Four distributions are considered for the standard errors of each model: Gaussian, t-student, GED (Generalized Error Distribution) and skewed t-student. We compare the models that presented convergence, controlling for the sample size and selecting the optimal structure by the Schwarz Criteria. The chosen model needs to converge and also to satisfy all the moment conditions from the XARCH structure. If the chosen model has no significant conditional average structure (AR or MA), the necessary simplifications are implemented and the choice of the reduced model is based on the Schwarz Criteria. Next, we use Box/Pierce tests for the standardized residuals and the squared standardized residuals, as well as the ARCH test.

This procedure will result in obtaining the monthly conditional variance measure modeled through the optimal ARMA+XARCH structure described above. The final output has 479 observations for 81 countries and 443 for Zimbabwe. The conditional volatility measure (Conditional Volatility) is the squared root of the conditional variance measure.

Table 1 summarizes the models for each of the 82 return time series. There is a predominance of models with the IGARCH (1,1) structure, and also GARCH (0,1) and IGARCH (1,2) models to a lesser extent. There is only one APARCH (1,1) model for the conditional variance of Peru and no EGARCH or GJR model was selected. For the average structure, there is the predominance of MA(1) and AR(1) with occasional cases of ARMA (1,1) and AR(2). Regarding the selected distributions, the majority is represented by either t-student or asymmetric t-student and, in a few cases, by GED (Generalized Error Distribution). The normal distribution was not selected for any of the series.

As described before, no EGARCH or GJR model was selected, which can be considered an unexpected result, to some extent, since the stylized fact of asymmetric shocks in financial assets is frequently observed. We have not used control variables in the equation for the conditional average (ARMA) or the conditional variance (XARCH), but it should be mentioned that the level changes indicated by the predominance of IGARCH models could have been controlled and so the asymmetric effects of shocks would be more likely to be captured.

Table 1 here

The annual conditional volatility for country '*i*' in year '*t*' is the twelve-month average (January to December) of the monthly volatility, and its equation is given by:

$$condVannual_{i,t} = \sum_{k=1}^{12} condVmonthly_{i,t.k} \tag{2}$$

where '*t*' refers to year, '*i*' to country and '*k*' to month (k = 1, January, … k = 12, December).

Descriptive statistics for the annual conditional volatility are presented in Table 2. The four highest observations are lower compared to monthly conditional volatilities, which is a sign that the peaks are absorbed once we apply the standard deviation. On the other hand, the four lowest observations are higher since the information on the valleys are lost.

The four lowest averages (from the lowest to the highest) are Portugal 2007, Spain 2007, Portugal 2008 and Spain 2006. As suggested before, we also have Austria 2007 and 2006 as one of the European nations with predominance among the economies with low volatility. In recent years, Denmark has been another example of a country with low volatility. Up to the 32^{nd} observation, only Portugal, Spain, Austria and Denmark are part of the country list.

The four highest measures of volatility (from the highest to the lowest) are Nicaragua 1988 (currency change and peak inflation of 63776%), Zimbabwe 2003 (inflation of 431%), Bolivia 1985 (black market premium of 2023% in August and inflation of 11749%) and the Democratic Republic of Congo 2001. Nicaragua, South American countries with history of high inflation and African countries with histories of significant devaluation and high inflation are next on the country list.

One can observe that, except for the 99% percentile, for the remaining percentiles the first observation increases while the asymmetry, kurtosis and variance significantly decrease. This is associated to the absorption of the higher and lower observations when using the standard deviation, which makes the data distribution more centered.

Table 2 here

4. The Empirical Strategy

The goal of this work is to investigate the role of real exchange rate volatility in long-run economic growth. A general representation for the growth model, including all control variables, is given by the following equation:

$$GROWTH_{it} = \beta_0 + \beta_1 LGROWTH_{it} + \beta_2 GDPINITIAL_{it} + \beta_3 COND.\ VOLATILITY_{it} + \beta_4 LREER_{it} + \beta_5 REERHP_{it} + \beta_6 LINF_{it} + \beta_7 LEDUC_{it} + \beta_8 LGOV_{it} + \beta_9 LTRADE_{it} + \varepsilon_{it} \quad (3)$$

where:

i) *GROWTH* = real GDP growth rate;

ii) *LGROWTH* = lagged real GDP Growth;

iii) *GDP INITIAL* = real GDP per capita level in the 1st year of each five-year period;

iv) *COND. VOLATILITY* = estimated conditional REER volatility;

v) *LREER* = log of real effective exchange rate (REER Index 2000 = 100)[5];

vi) *REERHP* = measure of REER misalignment (HP Filtered);

vii) *LINF* = log of (1 + CPI inflation);

viii) *LEDUC* = log of secondary schooling years of the total population aged 15 and overin the 1st year of each five-year period;

ix) *LGOV* = log of government consumption (% GDP);

x) *LTRADE* = log of trade openness (sum of exports and imports relative to GDP)[6].

We also include an interaction variable between REER volatility and initial per capita GDP in order to evaluate if such volatility in rich (poor) countries may cause low (high) economic growth, in line with the convergence literature which argues that the higher the initial

[5] The construction of the Real Effective Exchange Rate index uses nominal exchange rate as units of U.S. dollar relative to domestic currency, meaning that a higher (lower) value is associated to REER appreciation (depreciation).
[6] Source: IFS, Penn World Table, WDI (2010), Barro & Lee (2000).

GDP the lower the GDP growth[7], regardless of showing low (higher) volatility. Additional control variables include dummies to address possible regional differences, such as a dummy for Asian economies (DUAsia), a dummy for G7 (DUG7) and a dummy for Latin American economies (DULatin).[8]

Equation 3 is estimated using panel data for a sample of 82 countries for the period 1970-2009. The variables are expressed as five-year averages (1970-1974, 1975-1979, 1980-1984, 1985-1989, 1990-1994, 1995-1999, 2000-2004, 2005-2009) so as to minimize business cycle effects and autocorrelated error terms. The exceptions are LEDUC and GDP INITIAL, both expressed by the first year value of each five-year period.

To this purpose, we begin by estimating a series of static panel data models, with fixed and random effects[9]. We then estimate a dynamic panel data growth models, via system GMM (two-step). This method is useful because *i*) it takes into account the time series dimension of the data; *ii*) it deals with non-observable country specific effects; *iii*) it treats all explanatory variables as endogenous.

It has to be mentioned that one of the challenges of this empirical investigation is how to deal with the use of weak instruments, since it is associated with an asymptotical increase in the coefficient of variance and, in small samples, such coefficients can be biased.[10] To reduce the potential bias and inaccuracy associated with the use of Difference GMM, Arellano & Bond (1991), Arellano & Bover (1995) and Blundell & Bond (1998) develop a system of regressions in differences and levels. The instruments for the regression in differences (in levels) are the lagged levels (differences) of the explanatory variables. They can be considered appropriate under the assumption that, despite a possible correlation between the levels of the explanatory variables and

[7] See Barro & Sala-i-Martin (1991, 1992, 1995), Romer (1986), Lucas (1988).
[8] DULatin: Argentina, Brazil, Chile, Mexico, Peru, Ecuador, Paraguay, Uruguay, Colombia, Bolivia, Nicaragua, Costa Rica, Panama, Dominican Republic, El Salvador, Guatemala, Honduras, Haiti, Trinidad and Tobago, Venezuela and Jamaica. DUG7: Canada, France, Germany, Italy, Japan, United States, United Kingdom. DUAsia: South Korea, China, India, Sri Lanka, Bangladesh, Malaysia, Pakistan, Philippines, Singapore, Thailand and Indonesia.
[9] Fixed and random effects models are not reported here for convenience, but the results are available upon request.
[10]Table 4 for all estimated system GMM growth models report the overidentification tests (Hansen and Hansen-in-Difference).

the country-specific effect, such correlation does not exist when those variables are in differences.

Another empirical concern is the problem of instrument proliferation in GMM estimations. Roodman (2009a, 2009b) develops a detailed analysis on this issue, emphasizing the symptoms of an excessive use of instruments. The idea is that as the time dimension increases, the number of instruments can be too large compared to the sample size, invalidating some asymptotic results and specification tests. Too many instruments can overfit endogenous variables and fail to expunge their endogenous components, resulting in biased coefficients. Another argument is that the Hansen and Difference-in-Hansen tests can be weak in the presence of overidentification.

Our system GMM estimation follows two empirical strategies to deal with too many instruments (Roodman, 2009b). The first one is to use the *collapse* sub option for the *xtabond2* command in Stata. The idea is to combine instruments by adding smaller sets, without dropping any lags, meaning that there is the creation of one instrument for each variable and lag distance, rather than one for each time period, variable, and lag distance. The final outcome is to divide the GMM-style moment conditions into groups and sum the conditions in each group to form a smaller set. At the end, we have a set of collapsed instruments where one is made for each lag distance, with zero substituted for any missing values. The second empirical strategy (Laglimits) forces the use of only certain lags instead of all available lags for instrument.[11] What is common to both empirical choices is that they reduce the number of instruments and also are linear in T.

But before moving to the econometric estimations, we turn to the basic statistics reported on Table 3. The average growth in real GDP for the whole dataset is 1.77%, but with a standard deviation of 2.86, almost twice as the mean. The minimum growth rate detected (-12.10%) refers to Zaire for the period 1990-1994. On the other hand, the maximum growth rate (16.08%) refers to Botswana for the period 1970-1974.

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[11] We have set the Laglimits to (1 1). A more detailed presentation of both methods to reduce the number of instruments, including matrix notation, can be found in Roodman (2009b), p.148-149.

The second variable to be examined in Table 3 is the GDP INITIAL, which is the real GDP per capita level in the 1st year of each five-year period. The mean value is 6769.32, with a considerable standard deviation (8972.03). The reason for such discrepancy occurs because the minimum value is 84.71, which belongs to Zaire for the period 2000-2004, and the maximum value is 40617.83, belonging to Norway for the period 2005-2009.

Table 3 also shows that the estimated conditional REER volatility has a mean value of 0.03, with a standard deviation of 0.04. Denmark (2005-2009) has the lowest volatility (0.0066) and Nicaragua (1985-1989) has the highest (0.58). As for the log of the REER (mean = 4.77 and standard deviation = 0.65), Zaire holds the lowest value (3.45) for the period 2005-2009, and Nicaragua the highest (13.57) for the period 1985-1989. Nicaragua is also linked to the measure of REER misalignment in both extremes. The highest level was found in the country in the period 1980-1984 and the lowest level was also found in Nicaragua in 1985-1989.

The log of inflation rate shows a considerable dispersion (16.58) around an average of 7.07. Again, African countries are responsible for the lowest value (Niger 1985-1989) and highest (Zimbabwe 2005-2009). The log of education, measured as the log of secondary schooling years of the total population aged 15 and over in the 1st year of each five-year period, shows that the standard deviation (0.82) doubles its mean. Niger has the lowest value (-3.11), found in the period 1970-1974, and Germany has the highest (2.012), for the period 2005-2009.

The log of government consumption (% GDP) has an average of 2.65. Dominican Republic is responsible for the lowest value (1.40), over the period 1990-1994, and Gambia for the highest (3.70), for the period 1980-1984. The log of trade openness, which is the sum of exports and imports relative to GDP, turns us to the Asian countries. According to our dataset, China has the minimum value (1.98), for the period 1970-1974, and Singapore has the maximum (6.05), for the period 2005-2009.

Table 3 here

5. The Empirical Results

The empirical strategy is to first estimate a simple growth model with our measure of REER volatility, which is the variable of interest, and then extend this model with the inclusion of control variables such as: *i*) the level of REER; *ii*) a proxy for REER misalignment (REER HP Filtered); *iii*) a proxy of human capital (education); *iv*) variables of fiscal discipline (government consumption), macroeconomic stability (inflation) and trade openness.

We also run specifications including an interaction variable between initial per capita GDP and conditional volatility, and dummies to deal with regional differences (DUG7, DUAsia, and DULatin)

As for the dynamic estimations[12], Table 4 reports the results related to the two-step system GMM models[13]. As in Dollar (1992), Bosworth et al. (1996) and Schnabl (2009), the estimated coefficients for conditional volatility (REER) are negative in all regressions, ranging from -10.15 to -39.5 (and 8 out of the 12 estimated coefficients vary from -14.7 to -22.7). In most "robust" estimated models the coefficients are statistically significant, except for the simple Model 2, which collapses the number of instruments. Once we use the Jacknife procedure, the estimated coefficients for REER volatility are not significant, with the exception of Model 1, which does not deal with instrument proliferation.[14]

Based on the estimated coefficients, one can say that a 1% increase in the average (five-year) annual REER volatility will reduce the average (five-year) annual real GDP growth ranging

[12] Actually, the first set of empirical results is for fixed and random effects (robust and bootstrap), which are not reported for convenience. But they are available upon request. The crucial empirical result from them is that all estimated coefficients for the conditional REER volatility are negative and statistically significant, regardless of changes in model specification and the correction (robust or bootstrap) in the standard error of the regression coefficient. Such outcome indicates that countries with lower (higher) REER volatility face higher (lower) long-run growth over time and it is in line with other works, such as Dollar (1992). The fixed and random effect estimations do not include lagged growth or initial GDP level (convergence) as explanatory variables. All estimated models include time dummy variables.

[13] The GMM estimators have one and two-step variants. The two-step is asymptotically more efficient but the reported standard errors tend to be downward biased (Arellano & Bond, 1991; Blundell & Bond, 1998). To deal with this problem, our estimated models (Table 4) use a finite sample correction to the covariance matrix (Windmeijer, 2005) to make two-step robust estimations more efficient.

[14] The *Jacknife* method with the *cluster* option in Stata is used by clustering on the panel identifier variable (countries) in order to drop each observational unit in turn.

from 0.1 to 0.39 percentage point for the whole set of estimated coefficients and from 0.14 to 0.22 percentage point for eight out of the twelve estimated coefficients.

All models have no problems of second order autocorrelation since we do not reject the null for the AR(2) probability (Robust and Jacknife) in Table 4. Regarding the Hansen overidentification tests, once restrictions to the number of instruments are imposed (collapse and laglimits), there is evidence that the set of instruments are not valid, except for Model 9. The Hansen-Diff statistics gives us a clear indication that there is need to control for instrument proliferation since the probabilities are equal to 1.000 for all models without restricting the number of instruments (Models 1, 4 and 7).

The tradeoff faced in our empirical analysis is that controlling for an excessive number of instruments means that we are more likely to have invalid instruments, while not limiting the instruments is associated to problems of not being able to expunge the endogenous components of the variables, resulting in biased coefficients.

Table 4 here

Concluding Remarks

This article investigated the empirical relationship between the real effective exchange rate volatility and long-run economic growth for a set of 82 advanced and emerging economies using panel growth models, either fixed/random effects or system GMM, for a data set ranging from 1970 to 2009. Most models reveal that not only are the estimated coefficients negative but also statistically significant, with the only exception when using the Jacknife instead of the robust standard error correction for the system two-step GMM. Therefore, a general lesson to be drawn from the estimations is that, even after controlling for country-specific characteristics, there is strong evidence of a negative and relevant relation between real effective exchange rate volatility and long-run growth.

One additional empirical result to be mentioned is that neither the level of exchange rate (real effective) nor the measure of exchange rate misalignment are statistically significant once we incorporate the exchange rate volatility in the growth model. In other words, based on the international experience, exchange rate stability seems to be more important to foster long-run economic growth than exchange rate misalignment, which can be associated with macroeconomic instability without being able to reveal outward-oriented growth strategies. Regarding the lack of robustness of the estimated coefficients of the other control variables, this fact can be seen as an additional support for the absence of consensus in the empirical literature, specially the role of openness or the role of the public sector in promoting economic growth.

Therefore, the policy recommendation that can be taken from this research is that avoiding processes of volatility in the real exchange rate is advisable, once they can hinder economic growth in the long run.

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Appendix

Box 1. Country Sample and Codes

ARG	Argentina	**GMB**	Gambia	**NZL**	New Zealand
AUS	Australia	**GRC**	Greece	**PAK**	Pakistan
AUT	Austria	**GTM**	Guatemala	**PAN**	Panama
BEL	Belgium	**HND**	Honduras	**PER**	Peru
BFA	Burkina Faso	**HTI**	Haiti	**PHL**	Philippines
BGD	Bangladesh	**IDN**	Indonesia	**PNG**	Papua New Guinea
BOL	Bolivia	**IND**	India	**PRT**	Portugal
BRA	Brazil	**IRL**	Ireland	**PRY**	Paraguay
BWA	Botswana	**IRN**	Iran	**SEN**	Senegal
CAN	Canada	**ISL**	Iceland	**SGP**	Singapore
CHE	Switzerland	**ISR**	Israel	**SLE**	Sierra Leone
CHL	Chile	**ITA**	Italy	**SLV**	El Salvador
CHN	China	**JAM**	Jamaica	**SWE**	Sweden
CIV	Cote d'Ivoire	**JOR**	Jordan	**SYR**	Syria
COG	Congo, Rep.	**JPN**	Japan	**TGO**	Togo
COL	Colombia	**KEN**	Kenya	**THA**	Thailand
CRI	Costa Rica	**KOR**	Korea, Rep.	**TTO**	Trinidad and Tobago
DEU	Germany	**LKA**	Sri Lanka	**TUN**	Tunisia
DNK	Denmark	**MAR**	Morocco	**TUR**	Turkey
DOM	Dominican Republic	**MDG**	Madagascar	**URY**	Uruguay
DZA	Algeria	**MEX**	Mexico	**USA**	United States
ECU	Ecuador	**MWI**	Malawi	**VEN**	Venezuela
EGY	Egypt	**MYS**	Malaysia	**ZAF**	South Africa
ESP	Spain	**NER**	Niger	**ZAR**	Congo, Dem. Rep.
FIN	Finland	**NGA**	Nigeria	**ZMB**	Zambia
FRA	France	**NIC**	Nicaragua	**ZWE**	Zimbabwe
GBR	United Kingdom	**NLD**	Netherlands		
GHA	Ghana	**NOR**	Norway		

Table 1.Exchange Rate Volatility Models (82 Countries)

ARG	IGARCH(1,1)-skwt	AUS	MA(1)+IGARCH(1,1)-skwt
AUT	AR(1)+IGARCH(1,1)-skwt	BEL	AR(1)+IGARCH(1,1)-skwt
BFA	MA(1)+IGARCH(1,1)-t	BGD	IGARCH(1,1)-t
BOL	AR(1)+IGARCH(1,1)-t	BRA	MA(1)+IGARCH(1,1)-t
BWA	IGARCH(1,1)-t	CAN	AR(1)+GARCH(1,1)-t
CHE	MA(1)+GARCH(0,1)-skwt	CHL	AR(1)+IGARCH(1,1)-t
CHN	IGARCH(1,2)-t	CIV	IGARCH(1,1)-t
COG	IGARCH(1,1)-skwt	COL	IGARCH(1,1)-t
CRI	AR(1)+IGARCH(1,1)-skwt	DEU	AR(1)+IGARCH(1,1)-skwt
DNK	MA(1)+IGARCH(1,1)-t	DOM	MA(1)+IGARCH(1,1)-skwt
DZA	AR(1)+IGARCH(1,1)-t	ECU	IGARCH(1,1)-skwt
EGY	IGARCH(1,1)-t	ESP	MA(1)+IGARCH(1,1)-t
FIN	AR(1)+IGARCH(1,1)-t	FRA	MA(1)+IGARCH(1,1)-t
GBR	MA(1)+IGARCH(1,1)-GED	GHA	MA(1)+IGARCH(1,1)-skwt
GMB	IGARCH(1,1)-t	GRC	AR(2)+IGARCH(1,1)-t
GTM	AR(2)+IGARCH(1,1)-t	HND	ARMA(1,1)+IGARCH(1,1)-t
HTI	IGARCH(1,1)-t	IDN	MA(1)+IGARCH(1,2)-t
IND	AR(1)+GARCH(0,1)-t	IRL	MA(1)+IGARCH(1,1)-t
IRN	IGARCH(1,1)-t	ISL	MA(1)+IGARCH(1,1)-skwt
ISR	AR(2)+IGARCH(1,1)-t	ITA	MA(1)+IGARCH(1,1)-t
JAM	MA(1)+IGARCH(1,1)-skwt	JOR	IGARCH(1,2)-t
JPN	AR(1)+IGARCH(1,1)-t	KEN	MA(1)+IGARCH(1,2)-t
KOR	MA(1)+IGARCH(1,1)-skwt	LKA	MA(1)+GARCH(0,1)-t
MAR	GARCH(0,1)-t	MDG	MA(1)+IGARCH(1,1)-t
MEX	AR(1)+IGARCH(1,1)-t	MWI	MA(1)+IGARCH(1,1)-skwt
MYS	AR(1)+GARCH(0,1)-t	NER	GARCH(0,1)-t
NGA	IGARCH(1,1)-t	NIC	IGARCH(1,2)-t
NLD	MA(1)+GARCH(0,1)-t	NOR	MA(1)+IGARCH(1,1)-t
NZL	MA(1)+IGARCH(1,1)-t	PAK	MA(1)+ARCH(1)-t
PAN	AR(1)+IGARCH(1,1)-t	PER	APARCH(1,1)-t
PHL	AR(1)+IGARCH(1,1)-t	PNG	MA(1)+IGARCH(1,1)-t
PRT	IGARCH(1,2)-t	PRY	MA(1)+IGARCH(1,1)-t
SEN	IGARCH(1,1)-t	SGP	ARMA(1,1)+IGARCH(1,1)-t
SLE	MA(1)+IGARCH(1,1)-skwt	SLV	AR(1)+IGARCH(1,1)-t
SWE	AR(1)+IGARCH(1,1)-t	SYR	AR(1)+IGARCH(1,1)-t
TGO	IGARCH(1,1)-t	THA	MA(1)+IGARCH(1,1)-t
TTO	MA(1)+IGARCH(1,1)-t	TUN	IGARCH(1,1)-GED
TUR	IGARCH(1,1)-skwt	URY	IGARCH(1,1)-t
USA	MA(1)+IGARCH(1,1)-t	VEN	AR(1)+IGARCH(1,1)-skwt
ZAF	AR(1)+IGARCH(1,1)-t	ZAR	IGARCH(1,1)-t
ZMB	MA(1)+IGARCH(1,1)-t	ZWE	ARMA(1,1)+IGARCH(1,1)-skwt

Note: selected distributions: skwt= skewed t-student; t =t-student GED =Generalized Error Distribution

Table 2. Basic Statistics – Annual Exchange Rate Volatility

Percentiles				
1%	0.00711			
5%	0.0087			
10%	0.01031	**Obs**	3195	
25%	0.01404	**Sum of Wgt.**	3195	
50%	0.02129	**Mean**	0.03166	
		Std.Dev.	0.0517	
75%	0.03396			
90%	0.05455	**Variance**	0.00267	
95%	0.0841	**Skewness**	20.845	
99%	0.19338	**Kurtosis**	734.76	
Smallest	0.00576	0.0057774	0.00588	0.00598
Largest	0.46648	0.5786188	0.60698	2.04283

Table 3. Basic Statistics – Dataset

VARIABLE	OBS	MEAN	STD. DEV.	MIN	MAX
GROWTH	651	1.77	2.86	-12.10	16.08
GDP INITIAL	650	6769.32	8972.03	84.71	40617.84
COND. VOLATILITY	656	0.03	0.04	0.0066	0.58
LREER	656	4.77	0.65	3.45	13.57
REERHP	656	0.00	1407.63	-28765.15	16783.21
LINF	633	7.07	16.58	-1.33	193.97
LGOV	639	2.65	0.38	1.40	3.70
LEDUC	632	0.40	0.82	-3.11	2.012
LTRADE	641	4.02	0.53	1.98	6.05

Table 4: Real GDP Growth Models (System GMM)

Models	1	2	3	4	5	6	7	8	9	10	11	12
Dealing with Instrument Proliferation	**No Restriction**	**Collapse**	**Laglimits**	**No Restriction**	**Collapse**	**Laglimits**	**No Restriction**	**Collapse**	**Laglimits**	**No Restriction**	**Collapse**	**Laglimits**
LGROWTH	0.165	0.094	0.142	0.183	0.119	0.157	0.162	0.013	0.126	0.111	0.021	0.106
Robust	(3.01) ***	(1.12)	(1.74) *	(3.16) ***	(1.81) *	(2.42) **	(2.29) **	(0.20)	(1.82) *	(1.62)	(0.34)	(1.52)
Jacknife	(2.29) **	(0.91)	(1.49)	(0.16)	(0.90)	(1.94) *	(1.41)	(0.20)	(1.50)	(0.61)	(0.23)	(1.19)
GDP INITIAL	-9.17E-06	4.71E-06	-9.53E-07	-1.17E-05	1.00E-05	3.22E-06	-5.00E-05	-1.29E-06	-5.90E-05	-7.10E-05	-6.60E-06	-2.90E-05
Robust	(-0.74)	(0.25)	(-0.06)	(-0.89)	(0.69)	(0.21)	(-3.58) ***	(-0.03)	(-2.32) **	(-2.40) **	(-0.12)	(-0.87)
Jacknife	(-0.71)	(0.19)	(-0.05)	(-0.03)	(0.40)	(0.16)	(-1.69) *	(-0.02)	(-1.47)	(-0.45)	(-0.04)	(-0.57)
COND. VOLATILITY	-21.175	-21.608	-22.724	-19.241	-18.872	-16.33	-14.693	-39.556	-10.814	-17.166	-36.439	-10.151
Robust	(-2.98) ***	(-1.45)	(-2.92) ***	(-2.55) **	(-2.23) **	(-2.12) **	(-1.95) *	(-2.02) **	(-1.66) *	(-2.48) **	(-2.16) **	(-1.52)
Jacknife	(-2.43) **	(-0.74)	(-1.64)	(-0.23)	(-0.73)	(-1.16)	(-0.75)	(-1.25)	(-0.94)	(-0.68)	(-1.18)	(-0.93)
LREER				-0.241	0.088	-0.298	-1.306	-2.04	-1.351	-1.159	-1.562	-1.571
Robust				(-1.39)	(0.17)	(-1.87) *	(-2.72) ***	(-2.09) **	(-3.10) ***	(-2.81) ***	(-1.83) *	(-3.59) ***
Jacknife				(-0.17)	(0.07)	(-0.72)	(-1.24)	(-1.15)	(-1.87) *	(-0.59)	(-0.41)	(-2.33) **
REERHP				-0.00006	-1.37E-06	-0.00004	0.014	-0.02	0.028	0.035	0.0009	0.059
Robust				(-0.98)	(-0.02)	(-0.64)	-0.18	(-0.42)	(0.43)	(0.50)	(0.02)	(0.79)
Jacknife				(-0.00)	(-0.00)	(-0.00)	-0.12	(-0.27)	(0.31)	(0.15)	(0.01)	(0.58)
LINF							-0.031	-7.00E-03	-0.031	-0.027	-0.011	-0.026
Robust							(-2.10) **	(-0.36)	(-2.57) ***	(-1.85) *	(-0.60)	(-2.02) **
Jacknife							(-0.97)	(-0.21)	(-1.34)	(-1.16)	(-0.34)	(-1.10)
LEDUC							1.097	0.148	1.359	1.028	0.403	1.259
Robust							(3.63) ***	(0.20)	(3.73) ***	(2.67) ***	(0.61)	(3.38) ***
Jacknife							(1.56)	(0.14)	(2.09) **	(0.56)	(0.26)	(2.21) **
LGOV							-0.659	-1.552	-0.321	-0.191	-1.827	-0.124
Robust							(-1.09)	(-1.55)	(-0.35)	(-0.32)	(-1.52)	(-0.14)
Jacknife							(-0.53)	(-1.01)	(-0.25)	(-0.14)	(-0.66)	(-0.09)
LTRADE							-0.243	1.273	-0.173	-0.214	0.84	-0.468
Robust							(-0.72)	1.43	(-0.35)	(-0.54)	(1.11)	(-0.97)
Jacknife							(-0.33)	(-1.20)	(-0.21)	(-0.12)	(0.26)	(-0.66)
COND.VOLAT. * GDP INITIAL										4.00E-04	2.50E-05	-0.0008
Robust										(0.37)	(0.02)	(-0.65)
Jacknife										(0.09)	(0.01)	(-0.41)
DUASIA										1.685	1.449	1.619
Robust										(2.50) **	(1.61)	(2.54) *
Jacknife										(0.71)	(1.13)	(1.75) *
DULATIN										-0.583	-0.46	-0.293
Robust										(-1.20)	(-0.73)	(-0.69)
Jacknife										(-0.41)	(-0.34)	(-0.41)
DUG7										-0.566	-0.239	-1.003
Robust										(-0.83)	(-0.38)	(-1.69) *
Jacknife										(-0.30)	(-0.08)	(-1.22)
AR(2)	0.747	0.521	0.632	0.884	0.625	0.845	0.738	0.068	0.612	0.427	0.084	0.499
Hansen	0.666	0.001	0.023	1.000	0.003	0.053	1.000	0.082	0.979	1.000	0.181	0.999
Hansen-Diff	1.000	0.021	0.296	1.000	0.290	0.533	1.000	0.288	1.000	1.000	0.529	1.000
Number of Groups	82	82	82	82	82	82	79	79	79	79	79	79
Number of Instruments	95	29	44	149	43	68	257	71	116	294	82	132

Note: *i*) t-stats in parenthesis; *ii*) *, ** and *** indicate significance at 10%, 5% and 1% respectively.; *iii*)all estimated models are System GMM Two Step and all include time dummies.