Amundi Working Paper

WP-53-2016

March 2016

Which lever can enhance sustainability in emerging market countries? A stochastic approach to better grasp public debt dynamics

Anne-Charlotte Paret, Ph.D. Candidate at AMSE,
Strategy and Economic Research – Amundi

Which lever can enhance sustainability in emerging market countries? A stochastic approach to better grasp public debt dynamics

---

Anne-Charlotte PARET,

Ph.D. Candidate at AMSE,

Strategy and Economic Research - Amundi

anne-charlotte.paret@amundi.com

About the author

Anne-Charlotte PARET, Ph.D. Candidate at AMSE,
Strategy and Economic Research - Amundi

Anne-Charlotte Paret joined Amundi's Strategy and Economic Research team in 2014, working on Emerging market countries' exposure to sovereign risk. She is a Ph.D. Candidate at Aix-Marseille School of Economics (AMSE).

She holds a degree from ENSAE (2012) and Sciences Po (2012). She worked for two years at the French Treasury (Public Finances Outlook unit), on Medium-term budget forecasts, sustainability issues and budgetary European governance.

Abstract

This paper aims to investigate Emerging Market Countries' sustainability issues, looking at the impact of two specific policies aiming to improve the public finances outlook. The developed methodology consists in Monte-Carlo simulations building on an instrumented quantile regression fiscal reaction function (which allows countries to have different fiscal reactions to a change in their economic environment) and on a VAR model allowing the behavior of the economic variables having an impact on debt dynamics to be simulated. The idea is to investigate beyond the existing literature, which assumes a fiscal reaction common to all countries and no country- specific foreign currency risk premium, to see which lever (more responsive fiscal policy or lower reliance on foreign currency denominated debt) is the most appropriate to enhance sustainability.

JEL Classification Numbers : H68, E62, C53.

Keywords : Stochastic simulations, public debt forecast, fiscal policy, budget responsiveness, currency risk.

1 Introduction

1.1 How to grasp Emerging Countries' debt outlook ?

The question of the sustainability assessment of emerging market countries is a very wide and complex one. As emphasized by *Wyplosz* (2011, [20]), it is impossible to appraise it correctly and every attempt would lead to a "false" estimation in absolute terms, due to the forward-looking nature of sustainability. However, it is still possible to evaluate the relative impact on sustainability of some economic policies adopted by emerging market countries. To do so in a convincing way, one has to take into account the particularities of emerging countries to use an appropriate methodology, that cannot just be to replicate the one commonly used for developed countries. We believe three main headings have to be taken into account : i) First, emerging market countries are characterised by the "original sin", at the origin of a higher exposure to currency risk. This risk notably depends on the share of their debt that is denominated in foreign currency and can be exacerbated by investors' mimetic behaviours and sudden stops in capital flows (more frequent than for developed countries and causing a currency depreciation to be even sharper) ; ii) Second, their economic policies tend to be less credible, probably due to the lack of commitments of governments and monetary authorities ; iii) Finally, their economies are highly volatile (in terms of real growth rates and inflation for example). This feature is fed by the two other points, as significant currency depreciations can trigger wider crises and poor (or even procyclical) economic policies can exacerbate cyclical trends. Hence, the projections of debt trajectories cannot rely only on a reference scenario which would assume one given path for these macroeconomic variables, which are hardly predictable. On the contrary, it makes sense to integrate more than just a few risk scenarios in the debt sustainability assessment, as well as the probability of their occurrence.

Our objective is therefore to compute stochastic debt trajectories taking into account the three particularities mentioned above and investigate the sustainability impact of two possible policy changes. More specifically, we focus on the reduction of the exposure to currency risk and the commitment to be more responsive to an increase of the debt ratio. We want to determine, in a way that allows easy comparison between countries, which of these two levers is the most appropriate to enhance sustainability, depending on the country's historical fiscal reliability and on the composition of its debt. The methodology namely takes on board the fact that countries historically did not react the same way to changes in the economic cycle or deterioration of their public finances, have varying exposure to currency fluctuations and all pay a different risk premium when borrowing abroad.

1.2 How did the literature tackle the issue ?

The development of methods allowing for stochastic modelling of simulated debt paths has been a response to the standard Debt Sustainability Analysis (DSA) of the IMF and the World Bank. In fact, although this analysis has the advantage of being easily computed, one of its biggest drawbacks is that i) it relies on a baseline scenario based on rather arbitrary assumptions that do not reflect the difficulty of forecasting macroeconomic variables in the volatile environment faced by emerging market countries ; ii) it omits the linkages between the different types of shocks to which an economy is exposed (namely interest rate and exchange rate related risks) ; iii) it relies on stress tests for which no clue is given about the likelihood of them occurring (no stochastic aspect). *Akyüz* (2007,[2]) summarizes these caveats, notably recalling that the DSA fails to account for this interdependency (as variables of the central scenario are projected independently), does not give a probability of the given shocks occurring and also neglects the existence of possible contingent liabilities and of potentially high private external debt.

Burger, Stuart et al. (2011, [6]) and *Berti*'s (2013, [4]) methodologies in a way are in between the standard DSA analysis and the "pure" stochastic methodology, as they consider a distribution of possible scenarios around an independently-defined central scenario. In fact, *Berti* considers the forecast of the European Commission as the baseline scenario for 24 EU countries and accounts for uncertainty by applying shocks (extracted from the variance covariance matrix of historical shocks) to this reference case. *Burger*, in contrast, considers a unique central scenario for South Africa defined by fixed interest rate and growth rate values and applies shocks on the other variables to this central scenario.

As for authors having studied a "complete" stochastic framework, several variations have been computed, both on panel data and time series. *Medeiros*' work (2012, [18]) can be considered as the benchmark for developed countries. The general framework consists in two distinct pillars : a VAR estimation allowing for simulations of the macroeconomic variables entering into the evolution of the debt path (notably real growth rate and interest rate) and a fiscal reaction function describing the budget response of a country to a change in its debt level or to business cycle fluctuations. *Medeiros*' work fits into this well established framework to simulate debt trajectories for 15 European Union member states. He estimates a VAR model on inflation, real GDP growth rate, an average of short and long term real interest rates (both for the domestic country and for Germany) and real effective exchange rate, on panel data (for data availability issues). He simulates the errors with two different methods : errors supposed to be normally distributed (and presenting the covariances of the historical data) on the one hand and bootstrapped errors (based on the residuals estimated through the VAR) on the other hand. Finally, he tests for two different assumptions for the primary balance : constancy over the simulation horizon or fiscal reaction (notably to the output gap and the debt ratio). However, as he works on developed countries, *Medeiros* does not take into account either the share of the debt which is denominated in foreign currency or the different interest rate which is associated to this foreign currency debt. Before him, *Celasun, Debrun and Ostry* (2006, [8]) had developed a similar model (with a function reaction function estimated on panel data) to simulate debt paths for Argentina, Brazil, Mexico, South Africa and Turkey, adding the exchange rate in the determination of the debt ratio by taking into account the share of their public debt denominated in foreign currency. This work develops the so called fan-chart approach which enables the distribution of the probability of each possible scenario along the forecast horizon to be described. We essentially build on these two papers in the general framework of our simulations (see next sections), trying to modify the methodology so as to stick better to emerging market countries' economic reality. Last, many simulations of this type have also been applied to identified countries with a fiscal reaction function estimated on time series so as to more appropriately describe the fiscal behaviour of a specific country. *Ghatak* (2007, [13]) focusing on the countries' budgetary stance, estimates a fiscal reaction function separately for Peru, The Philippines, South Africa, Thailand and Venezuela, but does not infer simulations of debt paths thanks to these. *Hajdenberg and Romeu* (2010, [14]), *Burger, Stuart et al.* (2011, [6]), *Mupunga and Le Roux* (2015, [19]) and *Budina and v. Wijnbergen* (2008, [5]) respectively estimate a fiscal reaction function on Uruguay, South Africa, Zimbabwe and Turkey. But these estimations, even if they enable to focus on a specific country's fiscal reaction (which is not the case for a panel estimation that differentiates between countries only through fixed effects) generally lack robustness because of the short timespan for which annual data is available. For the sake of example, *Budina*'s estimation only relies on 15 annual observations. Lastly, away from some of these papers that do differentiate the debt service by currency denomination, there is to our knowledge no paper that genuinely focuses on the share of foreign currency denominated debt by considering the impact of a specific decrease in this share. As they look at the public debt trend, disentangling changes due to currency composition, exchange rate, and primary balance, *Acevedo, Alberola and Broto* (2008, [1]) seem to be the reference regarding this issue. Nevertheless, the debt path projections by *Acevedo et al.* are similar to a standard DSA analysis, as they only look at a few stressed scenarios compared to a baseline one.

1.3 Which factors can really enhance sustainability ?

As described, the assessment of Emerging countries' sustainability has already been widely investigated. However, the literature presents some shortcomings, which, in our view, are hiding important issues. First, apart from the less robust time series estimations, the fiscal policy reaction is always supposed to be identical for all countries, considering that their primary balance response only differs in terms of country fixed effects. Second, the way debt denominated in foreign currency affects the debt service is not satisfying, as no risk premium is integrated to differentiate between countries. In fact, to make a difference between the interest rate the country pays when borrowing in local and in foreign currency, most of the papers take the interest rates of the country's Treasuries (as a proxy for the local currency interest rate) and the US 10 year Treasury rate [1] (as a proxy for the foreign currency interest rate). However, i) the latter rather corresponds to a risk free rate in the light of a specific emerging economy. Taking it as the rate associated with foreign currency debt implies that borrowing abroad would always be beneficial, as the interest rate gain to borrow abroad always benefits debt service more than currency fluctuations weigh on it (in fact, there can be a huge gap between the country's rate and the US 10 year Treasury rate) ; ii) Each country pays a different interest rate when borrowing in foreign currency. This is not reflected at all in taking the same US rate for all countries, as a proxy for the foreign currency rate. These two remarks probably explain why the impact of a reduction in the share of foreign currency denominated debt has not been studied properly so far.

1. Or another type of US rate.

This is why we will build on previous work as regards the general methodology, but investigate this topic further, trying to remedy these flaws. The contribution of this paper is the following. First, we establish a well described methodology allowing stochastic debt trajectories to be simulated (Section 4) integrating differentiated budget responsiveness (Section 2) and risk premiums that are specific to each country (Section 3). Second, we use this improved methodology to look at the impact on sustainability of two possible economic policies sharing the same objective (Section 5) : i) the reduction in the share of foreign currency denominated debt. This policy would enhance sustainability only if the effect of the currency depreciation on debt service is greater than the interest rate differential the country suffers from when it borrows in local currency ; ii) an accrued but credible budget responsiveness (i.e. similar to the one of the most virtuous countries). Moreover, as this paper aims at building a methodology that can be replicated across several countries (for purpose of comparison), we make sure to use institutional or easily affordable data (and not national sources), so as to allow for convenient replication.

In the end, we manage to identify sensitive countries characterised either by a very high volatility of their economies or by a debt path that is expected to rise (in our case, Argentina and Russia). We show that countries do not necessarily benefit from a reduction in the share of their debt denominated in foreign currency in the medium term, which is not an obvious conclusion. On the contrary, we demonstrate that there is a potentially very important enhancement in sustainability achievable through the adoption of fiscal reponsiveness which is similar to that adopted in virtuous countries (like Poland, Ukraine or Argentina).

2 Assessing responsiveness and cyclical stance of fiscal policies

2.1 To which factors does fiscal policy really react ?

Emerging Market countries certainly do not present the same fiscal policy features as their advanced peers. In fact, they at least differ in their reliance on external borrowing, in the level of their public debt and in their capacity to raise taxes and set up restrictive fiscal policies when the debt burden becomes too high. They therefore do not settle and implement their fiscal policies the same way, and these do not impact the economy the same way either. To our knowledge, the fiscal reaction literature so far has focused on the cyclical stance of their fiscal policy more than on the degree of budget responsiveness, i.e. on the output gap more than on the debt coefficient of the estimated primary balance. We see two reasons for this : i) the sign of the output gap coefficient determining the pro- or countercyclical stance of the fiscal policy is less obvious to determine than the one of the debt coefficient (which is expected to be positive) ; ii) previous estimations of fiscal reaction functions do not provide for a differentiation of the fiscal reaction function between countries (and therefore do not underline different degrees of budget responsiveness).

Studies pointing to a procyclical stance of emerging countries' fiscal policy aren't rare (see for example *Budina and v. Wijnbergen*, [5] and *Bergman and Hutchison*, [3]). This procyclical bias has notably been investigated by *Ilzetski and Végh* (2008, [16]), working on 49 developing countries through the period 1960-2006. They have recourse to GMM estimations, Granger causality tests and impulse response functions so as to tackle endogeneity issues and get rid of simultaneity bias. Focusing on the spending side of the budget balance, they confirm the "when it rains, it pours" story (*Kaminsky, Reinhart and Végh*, 2005, [17]) for developing countries. According to the story, countries prone to procyclical fiscal policies would exacerbate the business cycle fluctuations as they tighten their fiscal policy in bad times and extend it in good times. *Ilzetski et al.* mention two main reasons for this type of country to present this feature : the fact that an imperfect credit market prevents EM countries from borrowing during bad times and the fact that a favorable economic environment stimulates rent-seeking behaviors and fiscal dilapidation. However, the focus on the spending side of the primary balance due to data availability issues leads to a conclusion that does not tell the entire story in the end. In fact, faced with an economic dowturn, a country can present decreasing expenditures (due to less dilapidation for example) but at the same time decide to decrease corporate taxes so as to stimulate private investment. In this case the whole primary balance would not necessarily present a procyclical stance, the latter would rather be ambiguous. *Cevik and Teksoz* (2014, [9]) estimate a fiscal reaction function based on cyclically adjusted primary balance (CAPB), and, as expected, do not reach the same results. Looking at the structural part of the primary balance and therefore correcting for the automatic stabilizers and revenue wind- and shortfalls, they not surprisingly find the fiscal policy to be more procyclical for advanced countries than for emerging market economies. As for *Burger et al.* (2011, [6]), they find the primary balance to react rather countercyclically (i.e. increasing when the economic environment gets better) for South Africa. This is also the case for *Celasun et al.*, who worked on a panel of 34 countries between 1990 and 2004. *Ghatak and Sanchez-Fung* (2007, [13]) tell us more about the subtle nature of this cyclical stance, as they underline the fact that some emerging countries can be able to smooth macroeconomic fluctuations (Thailand, The Philippines and South Africa) whereas others are unable to do so, presenting a pro-cyclical bias (Peru, Venezuela). *Favero, Giavazzi and Perego* (2011, [12]) would rather attest this view, as they support the idea that countries do not all present the same fiscal reaction function. Moreover, as there can be heterogeneity of fiscal reaction functions between countries, EM countries can also see their fiscal reaction change over time.

They could be able to reduce this pro-cyclicality bias, some of them even getting counter-cyclical fiscal policies, which happen to signal sound economic policies and a capacity to preserve healthy and sustainable public finances. In particular, it is also argued that the capacity of a country to conduct countercyclical policies is closely linked to the degree of institutional development, government effectiveness and the implementation of fiscal rules (*Calderon, Duncan and Schmidt-Hebbel*, 2014, [7], *Bergman and Hutchison*, 2014, [3]).

2.2 Panel Fiscal Reaction Function

As far as the fiscal reaction function estimation is concerned, the aim of this paper is to differentiate among different levels of primary balances. In fact, if anything, the literature tells us that the difficulty to determine a clear stance for emerging market countries' fiscal policy could be due to the fact that they do present heterogeneity. This is why we draw on quantile (and IV quantile) regressions whereas most of the fiscal reaction functions estimated in the literature are estimated based on panel data through OLS or GMM essentially. Hence, contrary to previous studies assuming that the primary balance will react the same way to changes in output gap and lagged debt and apparently having difficulty to conclude towards a "standard" fiscal behaviour, we try to differentiate this response along the primary balance distribution. Our belief is that countries do not react the same way in terms of fiscal policy, depending on the necessity to tackle their public finance issues. This should be confirmed looking at the impact of changes in the economic environment on the entire primary balance distribution thanks to a quantile regression.

We begin by studying the reaction of the primary balance through the following general framework :

$$pb_{it} = \alpha_0 + \alpha_1 pb_{it-1} + \alpha_2 d_{it-1} + \alpha_3 OG_{it} + \mu_i + u_{it} \tag{1}$$

Where pb_{it-1} is the lagged primary balance, d_{it-1} the lagged debt ratio, OG_{it} the contemporaneous output gap, μ_i the country fixed effects, and u_{it} the error term.

We begin estimating this equation through the standard estimation methods (OLS, GMM and Instrumental Variables) in order to compare our results to those of the literature (see Table 1). We work on annual panel data, stretching from 1989 to 2013 in the main estimation. Our panel includes 48 countries, from BRICS countries to less advanced ones. Data comes from the IMF and the World Bank. See Annex A.1.1 for further details. In the GMM and Instrumental Variables estimations, we instrument the contemporary output gap whereas lagged primary balance and lagged debt are considered to be exogenous. This choice has been made also by *Celasun et al.* in the estimation they finally use for their debt simulations. The instruments used in the IV regression are the lagged output gap first difference, the nominal exchange rate and the government effectiveness from the Worldwide Governance Indicators database (World Bank).

We expect α_1 and α_2 to be positive if there is persistence in the primary balance and if countries do react to an increase in their debt by tightening their fiscal policy. On the contrary, as seen in the previous section, α_3 is the coefficient likely to be the least straightforward to determine. In fact, a positive (resp. a negative) α_3 would point to countercyclical (resp. procyclical) fiscal policies, meaning that both signs would make economic sense. Moreover, as the size of the output gap can lead to fiscal tightening (or easing), which in turn can have an impact on growth and therefore on output gap, α_3 may be subject to a simultaneity bias.
Looking at our results (Table 1), it can be observed that the lagged primary balance coefficient (α_1) is always positive and significant, pointing to a robust persistency of the primary balance. As for lagged debt (α_2), it plays significantly in almost all the regressions, showing that countries do present some budget responsiveness, tightening their budget when their debt is on an increasing trend. Lastly, the results do not allow us to determine with certainty a sign for the output gap, though it is positive

and significant for the instrumental variables regression. This reveals the presence of a negative simultaneity bias on the output gap coefficient (due to the negative impact of fiscal tightening on growth) which is corrected for in the IV estimation. It shows that it is not straightforward to conclude whether the fiscal policy is pro- or counter-cyclical and strengthens our will to investigate this point further with (instrumented) quantile regressions.

Dependent variable : primary balance pb			
	OLS	System GMM	IV
$L.pb$	0.606***	0.582***	0.607***
	(10.70)	(13.80)	(12.68)
$L.d$	0.0211*	0.0373*	0.0377**
	(1.86)	(1.75)	(2.42)
og	0.0176	0.0335	0.0888*
	(0.78)	(0.97)	(1.67)
constant	0.136	-1.989	
	(0.11)	(-1.05)	
N	800	800	705
adj. R-sq	0.628		0.436

TABLE 1 – Fiscal Reaction Function
Note : The estimations from column 1 to 3 respectively correspond to the following estimation methods : ordinary least squares, system generalized method of moments and instrumental variables. All of them include country dummies and are robust to heteroskedasticity. GMM and IV estimations instrument the output gap. In the IV estimation, the instruments are the following : lagged first order difference of the output gap, nominal exchange rate and the Government Effectiveness from the Worldwide Governance Indicators 2014 database (World Bank). For each estimate presented, we report the number of observations and the adjusted R-squared, when available.
T-statistics in parentheses. * p-value < 0.10, ** p-value < 0.05, *** p-value < 0.01.

To verify the validity of our instruments and the robustness of the IV estimation, we reestimated the equation, removing one of the three instruments each time. Coefficients of lagged primary balance and debt hardly change and keep their significance. As for the output gap coefficient, it remains positive and significant, with the same order of magnitude, although it becomes insignificant in one of the estimations. For all these IV estimations (including the main one), the instruments pass the tests to ensure there is neither underidentification, weak instrument nor overidentification. See Annex A.1.3 for the robustness estimations and for the results of the tests associated with each of the IV estimation.

2.3 Quantile Fiscal Reaction Function

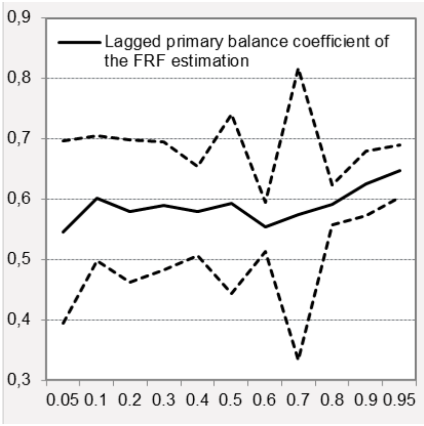
Table 2 shows the results of the standard and instrumented quantile regressions. The instrumental variable quantile regression follows the estimation methods developed by *Chernozhukov and Hansen* (2006, [10], 2008, [11]). These correspond to the quantile analog of a two stage least squares estimation. The instruments used are the same as the ones underlined in the previous section and proven to pass the different tests. Figure 1 shows the coefficients of the lagged primary balance, of the lagged debt and of the output gap corresponding to each decile of the distribution of the primary balance.

Dependent variable : primary balance pb			
	Quantile regression		
	Q1	Q2	Q3
$L.d$	0.0383***	0.0288***	0.0213***
	[0.0208,0.0558]	*[0.0118,0.0459]*	*[0.00550,0.0370]*
$L.pb$	0.611***	0.656***	0.647***
	[0.478,0.745]	*[0.554,0.758]*	*[0.528,0.765]*
og	0.0253	0.0195	0.00250
	[-0.0142,0.0647]	*[-0.0133,0.0523]*	*[-0.0307,0.0357]*
constant	-3.475**	-0.717	2.783*
	[-6.674,-0.276]	*[-3.827,2.393]*	*[-0.0576,5.624]*
N	800	800	800
	Instrumented quantile regression		
	Q1	Q2	Q3
$L.d$	0.0566***	0.0552***	0.0323***
	[0.0265,0.0867]	*[0.0216,0.0889]*	*[0.0162,0.0485]*
$L.pb$	0.587***	0.593***	0.595***
	[0.463,0.711]	*[0.444,0.741]*	*[0.561,0.628]*
og	0.0797*	0.0903*	0.0281
	[-0.00494,0.164]	*[-0.00561,0.186]*	*[-0.0368,0.0929]*
constant	-4.046***	-2.229	2.025***
	[-5.794,-2.298]	*[-5.071,0.613]*	*[0.512,3.537]*
N	705	705	705

TABLE 2 – Fiscal reaction function : Quantile regressions

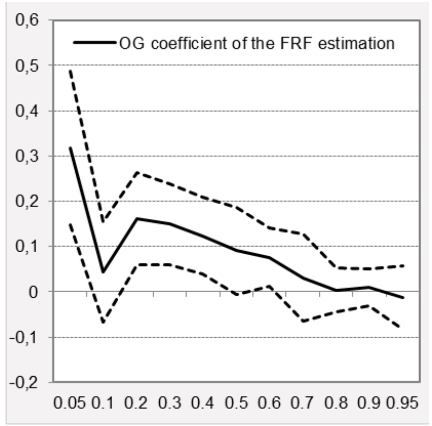
Note : The estimations from column 1 to 3 respectively correspond to the 0.25th, 0.50th and 0.75th percentile. Quantile regression are presented at the top of the Table, whereas estimations on the bottom are the instrumented quantile regressions (computed thanks to the *ivqreg* Stata command, according to *Chernozhukov and Hansen*'s estimations methods). All of them include country dummies and are robust to heteroskedasticity. Instrumented quantile regressions instrument the output gap with the following instruments : lagged first order difference of the output gap, nominal exchange rate and the Government Effectiveness from the Worldwide Governance Indicators 2014 database (World Bank). For each estimate presented, we report the number of observations and the pseudo R-squared.

95% confidence intervals in brackets. * p-value < 0.10, ** p-value < 0.05, *** p-value < 0.01



1. Fiscal policy persistence (α_1)

2. Budget responsiveness (α_2)



3. Fiscal cyclicality (α_3)

FIGURE 1 – Fiscal reaction function : Coefficients corresponding to the deciles of the primary balance

Note : The solid line connects the coefficients associated with each decile (and also the 5th and the 95th percentiles). The dotted lines connect the 95% confidence intervals around these coefficients.

Lagged primary balance coefficients are of the same order of magnitude in both types of quantile regressions, instrumented or not : Primary balance happens to be persistent across the whole distribution. It seems that it is slightly more persistent for higher primary balance values than for lower ones, but this is not necessarily confirmed when looking at the confidence intervals of the coefficients (in dotted lines on Figure 1). Lagged debt coefficients are still positive, meaning that the countries do present budget responsiveness. However, this is due essentially to the first and second quartile (to a lesser extent) of the primary balance, corresponding to negative primary balances (see Annex A.1.2 for the distribution of the primary balance). These are shifted to the right when there is a debt increase, whereas positive primary balances would change to a lesser extent. This means that this reaction to debt increase is tangible for the countries having a primary deficit. Here again, when the output gap is instrumented, its coefficients are positive and significant, but only for deteriorated primary balances. Looking at the distribution of the latter, we can affirm that countries for which the primary balance is lower than 1% of GDP present countercyclical behavior, in the sense that an improvement in the economic cycle (i.e. a narrowing of the output gap) leads the country to strengthen its fiscal policy. In fact, a country should have more fiscal leeway to implement pro-cyclical fiscal policy when its primary surplus is high. On the contrary, a country whose public finances are more deteriorated is expected to tighten its fiscal policy in good times to anticipate future financing needs, i.e. to be more "virtuous". Here, we show that countries presenting a significant primary surplus (higher than 1% of GDP) do not present this virtue.

All in all, it appears that countries in primary deficit (i.e. whose budgetary position is more worrisome) show more budget responsiveness (i.e. higher budget contraction when debt increases) and tend to have more countercyclical budget policies than the others, making their primary balance slightly less persistent. On the contrary, countries having a sound primary surplus show slightly more persistence in their budgetary policy, as they do not react significantly to an increase in their debt or to a cyclical downturn (or improvement).

3 VAR estimation

The aim of this section is to identify the historical linkages between the macroeconomic variables influencing the debt ratio trend, namely the real growth rate, the real effective exchange rate and both interest rates paid by the country when it borrows in local and in foreign currency (see Annex A.2.1 for the description of the data). We follow *Celasun et al.* ([8], 2006) as for the methodology, but importantly differ regarding the choice of the data. In fact, in contrast to *Celasun et al.*, we do not consider the US 10 year Treasury rate to be a satisfactory proxy for the interest rate an emerging country pays on its debt denominated in foreign currency. We rather consider it close to a risk-free interest rate that does not integrate the risk premium paid by the country compared to the United States. This said, high macroeconomic volatility and investors' assessment of the default risk through the "assignation" of a risk premium play an important role in debt distress episodes (*Hostland*, [15], 2005), and also tend to increase the difficulty for governments and central banks to commit to specific economic policies in such countries. For this reason, we consider that the omission of this risk premium would falsify the results or at least not enable us to properly study the role of the exchange rate on emerging market countries' debt dynamics. We therefore created a proxy taking this risk premium into account. Our "foreign" interest rate (corresponding to the interest rate paid by the country on its foreign currency denominated debt) is the following :

$$i_t^{EMBI} = spread_t^{EMBI} + i_t^{US10Y} \tag{2}$$

Where $spread_t^{EMBI}$ is the blended spread of the JP Morgan Emerging Market Bond Index of the country's dollar denominated sovereign bonds and i_t^{US10Y} the interest rate of the US 10 year Treasury bond. Using this data should enable us to differentiate between countries (as each country pays a different risk premium) and to more accurately assess the debt service associated with the foreign currency denominated debt.

In order to get a group of countries presenting different profiles both in terms of foreign currency denominated debt and also primary balance level, we decided to focus on the Philippines, Argentina, Russia, Turkey and Brazil (ranked in descending order in terms of foreign currency denominated debt share). Moreover, as we have been careful to use international sources essentially (or at least easily affordable data), this method could easily be replicated to other countries. For each of these, we estimate an unrestricted VAR model on quarterly data (in order to get more observations, as the timespan for which data is available remains relatively limited for emerging market countries). We test for the presence of a unit root of the time series and estimate the VAR on stationary variables (with those of order 1 previously differentiated). Then, we also check for the preferred lag order of the VAR using the Schwarz information criteria. As nearly each VAR calls for a 1 order lag (apart from Argentina and Russia) we choose this specification for all countries, for the sake of simplicity. Together with the VAR estimation results, we also display the variance covariance matrix of the estimated residuals and the implied steady state value for the real growth rate (which then serves as a proxy for the potential growth to construct the simulated output gap). See Annex A.2.2 to A.2.4.

4 Stochastic debt simulations

The computation of a distribution of public debt trajectories is the result of the estimated fiscal reaction function (instrumented quantile regression by deciles), of the simulated trajectories of macroeconomic variables issued from the VAR estimation and of the following deterministic equation of public debt. Starting from the simplest equation of debt evolution :

$$D_t = (1 + i_t)D_{t-1} - PB_t \tag{3}$$

Where D_t is the current public debt , PB_t is the current primary balance, and i_t the interest rate. Dividing by current GDP and denoting ratios on GDP by lower cases, we get :

$$d_t = \frac{(1+i_t)d_{t-1}}{1+g_t} - pb_t \approx (1+i_t-g_t)d_{t-1} - pb_t \tag{4}$$

The evolution of public debt can then be described by the following equation :

$$\triangle\, d_t = (i_t - g_t)d_{t-1} - pb_t \tag{5}$$

Looking at this evolution, it can be observed that, assuming that the primary balance is in equilibrium, debt remains sustainable (in the sense that it does not keep on increasing) as long as the interest rate remains lower than the country's GDP growth. This globally applies to developed countries, but emerging ones, as a significant share of their public debt is denominated in foreign currency, also face a currency risk, which has to be added into the evolution path. In fact, considering that the interest rate applying to public debt is not the same depending on the currency denomination, we can break down the interest rate :

$$i_t = ((1-\alpha)i_t^d + \alpha(i_t^f + \triangle s_t)) \tag{6}$$

With i_t^d, i_t^f, and $\triangle s_t$ respectively being the interest rate paid by the country on its local currency denominated debt, the interest rate paid by the country on its foreign currency denominated debt and the change in the log of the real effective exchange rate (an increase in the exchange rate meaning a currency depreciation, weighing on foreign currency denominated debt service) and α being the share of public debt denominated in foreign currency. This gives :

$$d_t \approx (1 + (1-\alpha)i_t^d + \alpha(i_t^f + \triangle s_t) - g_t)d_{t-1} - pb_t \tag{7}$$

To compute the debt simulations, α is supposed to be constant [2], $\triangle s_t$, g_t, i_t^d and i_t^f are obtained through the simulations based on the VAR estimation (notably the

2. Being equal to the share of the last year before simulations begin (mean of the quarterly shares released by the World Bank, see Annex A.1.1).

variances and covariances) and pb_t is the result of the fiscal reaction function estimation.

The simulated values for $Y_t = A_0 + A_1 Y_{t-1} + \epsilon_t$ are the result of the estimated VAR (defining A_0 and A_1) and a Monte Carlo simulation assuming normality of the simulated errors. Here, we follow *Celasun*'s method as we compute these values through simulations of errors $\epsilon_t \sim N(0, \Omega)$, Ω being the variance-covariance matrix of the estimated of residuals of the VAR estimated in the second section. More precisely, we simulate standard normal errors $v_t \sim N(0,1)$ and compute the $\epsilon_t = W v_t$ with W being the Cholesky factorization of Ω (i.e. such that $W'W = \Omega$). Y_t provides a path of quarterly values of the macroeconomic variables entering into the debt evolution (which may have been differentiated for the sake of the VAR estimation), taking into account shocks consistent with the historical ones and also the linkages between these variables. As the simulations are done using quarterly data, we then annualize them (taking means of the variables which may have been recomputed in levels) to get an annual simulated path for $(\triangle s_t, g_t, i_t^d, i_t^f)$.

The evolution of the debt ratio is then computed iteratively, taking into account these simulations, and the forecasted fiscal reaction function :

$$pb_t = \alpha_0 + \alpha_1 pb_{it-1} + \alpha_2 d_{it-1} + \alpha_3 OG_{it} + \mu_i \tag{8}$$

The coefficients α_i ($i = 1 \ldots 4$) are the instrumented quantile regression coefficients and therefore differ depending on the lagged level of primary balance. Here, the methodology differs from *Celasun et al.*'s one (2006, [8]), as we allow countries not to react the same way to an increase in their debt ratio or an evolution of their economic situation, and also not to show the same persistence of the primary balance (see Section 2.3) [3]. The coefficients attributed to an observation are a linear interpolation

3. Moreover, contrary to *Celasun et al.*, we do not apply any stochastic shock to the primary balance (which could for example account for the unexpected materialization of some contingent liabilities). We make this choice of no fiscal policy shock inorder to focus on the macroeconomic disturbances that are likely to happen and their impact on the public debt path.

of the coefficients corresponding to the deciles of primary balance surrounding this observation [4]. Besides, the simulated output gap is computed with the simulated path of the real growth rate of GDP issued from the VAR and considering that the potential growth is the steady state value for growth resulting from the estimated VAR [5].

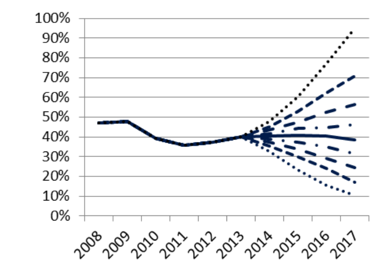
Simulations have been made with 1000 replications, giving a distribution of simulated debt paths (corresponding to different shocks on the macroeconomic variables evolving together, but also to different fiscal reaction functions, depending on the country's state) and allows frequency statistics to be derived giving an insight on the debt path the country is likely to face if it keeps implementing its fiscal policy, at a constant share of foreign currency denominated public debt. The results are summarized in the "fan-charts" presented in Figure 2. These fan-charts represent the different deciles of the distribution of the simulated debt trajectories. As the external dotted lines of the cone correspond to the 10th and 90th percentile of the debt ratio distribution, the debt levels situated outside of the cone correspond to situations happening with a probability lower than 20%. The other dotted lines correspond to the other deciles of the primary balance distribution, and the solid line to the median debt path of the distribution.

The first striking observation is that there is a huge difference in the variance of the debt trajectories. While Argentina's debt distribution presents a huge variance, reflecting the extreme volatility of its economy, other countries like Brazil, The Philippines and Russia present a much more limited variance. Brazil, in contrast to Argentina (or Turkey, to a lesser extent) present very low variance, which is brought to light by the fan-charts. Second, we can observe that the countries in primary surplus at the beginning of the simulation exercise are the ones presenting a downward

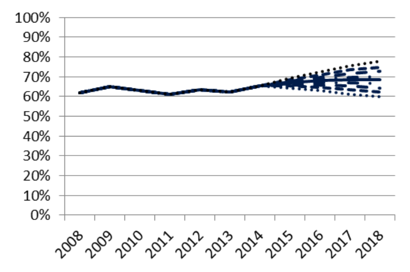
4. However, in order not to replicate outliers' behavior, the observations corresponding to the first (resp. last decile) of primary balance get the coefficients of the 5th percentile (resp. 95th percentile).

5. $OG_{it} = OG_{it-1} + g_t - g_t^\star$

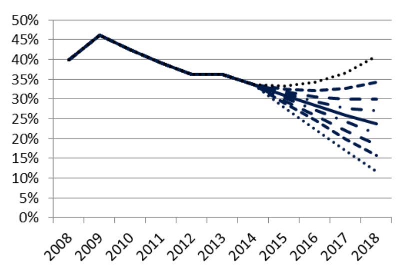
trend in the debt ratio. This seems quite obvious, but is due to the persistence of the primary balance. It means that apart from this type of simulations, the level of the primary balance can give a good insight on the trend a debt ratio is likely to take for emerging countries if they continue with a consistent fiscal policy (see Figure 3 for the level of primary balance at the beginning of the simulation exercise). Looking at these charts and despite the high volatility of some economies, we can state that some countries (in particular Argentina and Brazil) present the same probability of seeing their debt ratio increase or decrease on a 4-year horizon, independently from this volatility. Other countries are more likely to see their debt ratio decrease on this horizon. Turkey for example (even if presenting high volatility) presents between a 70% and 80% chance of seeing its debt ratio decrease, continuing with a consistent fiscal policy. On the contrary, Russia rather presents an unsustainable path in the sense that it is slightly more likely to see its ratio increase than decrease on this horizon, maintaining its "historical" fiscal policy stance.



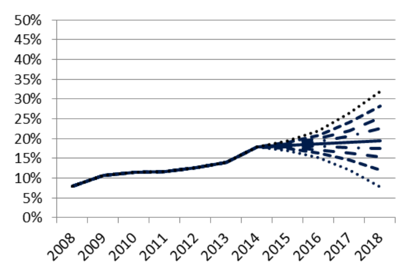
1. Argentina



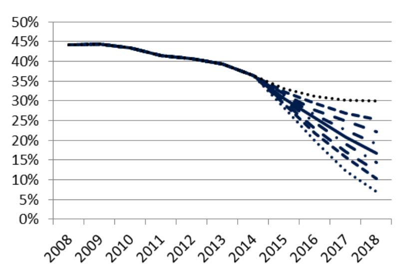
2. Brazil



3. Turkey



4.Russia



5. The Philippines

FIGURE 2 – Debt path simulations

Note : The fan-charts represent the distribution of the debt simulations. On each chart, the external dotted lines of the cone correspond to the 10% and 90% percentiles. The other dotted lines from the outside to the middle of the cone respectively correspond to the 20% and 80%, 30% and 70% and 40% and 60% percentiles. Finally, the solid line corresponds to the median distribution of the simulated debt path. This means that, according to this model, there should be a 80% probability that the debt ratio evolves within the cone, and a 50% probability that it remains under the solid line. For each country, the simulations begin the year for which data is not yet available.

5 What lever can enhance sustainability ?

As underlined by *Wyplosz*, simulated debt trajectories are always subject to errors, essentially due to their forward-looking nature. This is exacerbated for emerging market countries that sometimes have particularly volatile economies. For this reason, we have tried to find a solution to some shortcomings in the literature in order to stick closer to the emerging market countries' reality and try to better catch the possible evolutions of their sovereign debt. However, another way to go beyond the difficulty to assess sustainability in absolute terms is to look at the impact of a specific change in economic policy, in relative terms compared to a reference situation. In this framework, we focus on three alternative scenarios : i) a scenario in which the country chooses to keep its primary balance unchanged ; ii) a scenario in which the country reduces the share of its debt denominated in foreign currency, so as to try to decrease the exposure to currency risk [6] ; iii) a scenario in which the country adopts a very responsive fiscal policy (i.e. responds to an increase in the debt ratio by tightening its primary balance as the most virtuous countries of the panel would [7]). For each of our five countries, we plot the median distribution of the debt path associated with these different scenarios, see Figure 4. The aim of this exercise is to determine to what extent a change in fiscal policy or debt structure could enhance a country's sustainability and if we can identify a wiser choice between the two.

5.1 Unchanged Primary balance

The first alternative scenario is the one which is the most straightforward, and also the widespread practice for debt sustainability analysis. Adopting a constant

6. A reduction of 30 percentage points, as it corresponds to a feasible reduction (Russia for example decreased its share of foreign currency debt from 0.8 in 2005 to 0.35 in 2014). Specifically for Brazil, we apply a 5 percentage point reduction, as 95% of its debt is already denominated in local currency.

7. More precisely, affecting the country the highest coefficient on lagged debt in the fiscal reaction function, among the coefficients corresponding to the different deciles presented in Figure 1.

primary balance can either benefit sustainability or penalize it, depending on two main factors : the level of the initial primary balance (which is kept unchanged) and the degree of indebtedness. In light of the fiscal reaction function, a constant primary balance is beneficial for countries whose initial primary balance is high and (unexpectedly) having a low debt ratio (see Figure 3 for the initial primary balance level). In fact, countries that are responsive to their debt level react less if this ratio is low (making an unchanged primary balance possibly more favorable). In fact, it can be observed that this scenario is beneficial to Russia (having the lowest debt ratio) and the Philippines (whose initial primary balance level is the highest). On the contrary, it is harmful especially for Brazil, which presents the highest debt ratio, and to a lesser extent for the other countries, whose debt ratios still lie around 35%-40%.

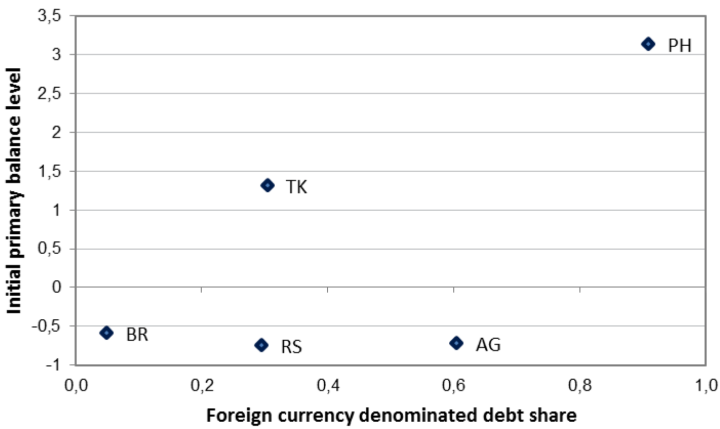


FIGURE 3 – Initial primary balance level and exposition to foreign exchange fluctuations

5.2 Reduced exposure to currency risk

A reduction in the share of foreign currency denominated debt could also potentially play in two opposite ways. In fact, supposing that the country reduces its foreign currency denominated debt share by $\triangle\alpha$ ($0 < \triangle\alpha < 1$), the resulting change in debt (recalling equation (7)) would be :

$$\triangle d_t = \triangle\alpha[i_t^d - (i_t^f + \triangle s_t)]d_{t-1} \tag{9}$$

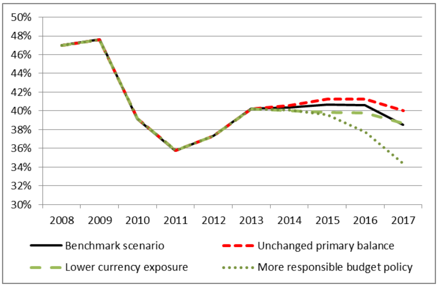
All other things being equal, the debt ratio would therefore decrease only if the interest rate differential the country benefits from when borrowing in foreign currency ($i_t^d - i_t^f$) alleviates the debt burden less than foreign currency fluctuations ($\triangle s_t$) weigh on it.

In practice, we can observe that both terms seem to have weighted more or less equally on the whole for the Philippines, Russia and Turkey as their debt path does not change significantly after a reduction in currency risk exposure, compared to the benchmark scenario. However, it seems that by borrowing in foreign currency, Brazil has benefitted more from the local-foreign currency interest rate differential in the past than it has suffered from currency risk, so as to let the debt ratio increase due to a reduction in itsshare of foreign currency denominated debt [8] (leading to an overall higher interest rate on debt which becomes totally "local currency denominated" in this scenario). On the contrary, Argentina, which has been more heavily affected by currency depreciations (compared to the interest rate benefit to borrow in foreign currency) could somehow enjoy a decrease in the debt ratio after reducing its share of foreign currency denominated debt.

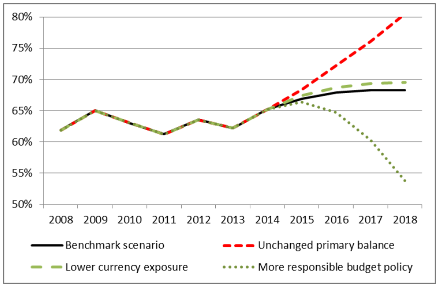
5.3 More responsive fiscal policy

Here, we look at the effect of a country becoming more responsive in terms of fiscal policy. More specifically, we affect to a country the reaction to a debt increase of the most responsive countries of the sample and assess the impact on its debt ratio. The obtained result therefore shows the "maximum" potential decrease in the debt ratio to which a more responsive -but still feasible, as it corresponds to the reaction

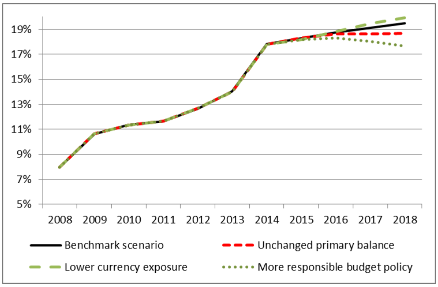
8. For Brazil, we apply a reduction of only 0.05 in the foreign currency denominated debt share, as the country already has 95% of its debt denominated in local currency.



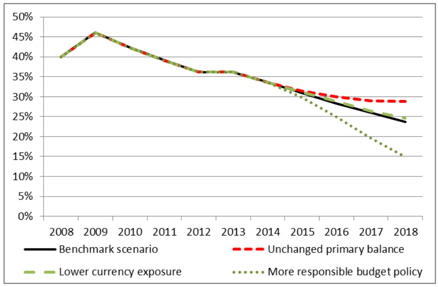
1. Argentina



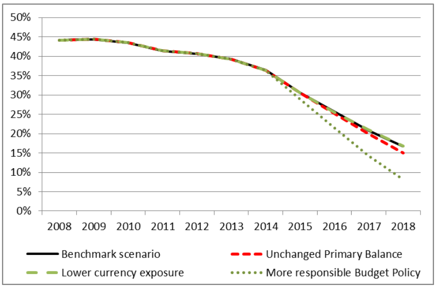
2. Brazil



3. Russia



4. Turkey



5. The Philippines

FIGURE 4 – Median debt path for alternative scenarios

Note : For each country, we present the median debt path of the simulations associated with : i) the benchmark scenario ; ii) a scenario in which the primary balance is supposed to be constant over time ; iii) a scenario in which the country has a lower share of foreign currency denominated debt ; iv) a scenario in which the country is more responsive as regards reaction to a public debt increase (for more details on the different cases, see section 5.

of some countries of the sample- fiscal policy could lead. This effect is expected to be always positive for sustainability. However, the scale of the debt decrease is going to be all the more important if the country is highly indebted (see the significant decrease for Brazil and limited one for Russia on Figure 4). For more or less the same levels of public debt, the reduction would be more significant for countries that are historically less responsive to a debt increase (i.e. presenting higher primary balances), like the Philippines and Turkey (compared to Argentina). All in all, what we can observe though, is that the adoption of a virtuous fiscal policy can be very profitable in terms of debt reduction, and in particular much more than a debt management policy which would consist in reducing the share of foreign currency denominated debt.

6 Conclusion

As already emphasized, we are conscious that grasping the sustainability "degree" of targeted emerging market countries is a difficult task, as there is no true answer to this issue. However, it still seems important to be able to develop tools that enable us to understand the future possible evolution of a country's debt path as effectively as possible, so as to better anticipate the effects of a change in debt management or fiscal policy. This is why the first objective of this paper is to improve the methodology of debt simulations in order to stick more closely to the emerging market countries' economic reality. In particular, we take into account : i) the differentiated fiscal policy response between countries through an instrumented quantile fiscal reaction function ; ii) the fact that each country borrowing in foreign currency pays a specific interest rate reflecting its own risk premium, which is different from one country to another. The second objective is to bring forward some elements helping countries to make their decisions between different ways likely to enhance their sustainability. In an environment characterized by major monetary policy challenges and significant capital flows (which can lead to important currency fluctuations for emerging markets), it becomes all the more crucial to have an idea of the potential impact of debt structure changes as regards currency denomination, compared to other policies. This is why we focus on the effects of both the reduction in exposure to currency risk and the adoption of a more responsive fiscal policy.

The development of this improved methodology and the tested scenarios teach us number of things. We first confirm that the level of primary balance tells us a lot about both the fiscal reaction of the countries (looking back into emerging market countries' history) and the direction of the trend the debt path is likely to take in the future. It is able to discriminate between countries being more reactive to a debt increase and setting up more countercyclical policies and countries whose fiscal policy is slightly more persistent because they are less prone to further tightening their fiscal policies when they face a deterioration of their debt ratio or a cyclical improvement of their economy. Then, it shows us that a reduction in the exposure to currency risk does not always enhance sustainability, which is not necessarily expected. In fact, the interest rate differential the countries suffer from when borrowing in local currency can sometimes weigh sufficiently to offset the positive effects of not assuming the currency risk themselves (because investors, which accept to assume it when lending in the country's currency, also charge a higher interest rate for this reason). Finally, it shows us that the adoption of a fiscal policy which is similar to the one of the most budget responsive emerging countries can be very profitable in terms of sustainability (compared to the potential gain brought by a currency risk reduction). This clearly emphasizes the crucial role of fiscal responsiveness and its capability to help design a more sustainable debt outlook through commitments really put into practice.

In the end, one has to bear in mind the fragility of such types of simulations. However, more than pretending to be able to quantify the exact level of debt ratio a country is going to reach in a few years, this paper aims at better understanding the determining factors behind public debt trends and the effects of different policies governments could be willing to implement to enhance sustainability. This is particularly important for emerging market countries who are prone to less effective economic policies and to some extent more exposed to global economic changes and sometimes the behaviour of irrational investors. A key drawback of this method is not to take into account the response of economic growth to fiscal tightening (which is difficult to assess notably because of less robust fiscal data on a quarterly basis). It would therefore be a great step to find a way to tackle this issue. Another way to further investigate this topic would be to study the impact on sustainability of corruption and tax evasion, which also play a great role in the definition of a healthy, credible and reliable fiscal policy.

A Appendix

A.1 Fiscal reaction function

A.1.1 Data

Number	Country	Code
1	Algeria	AA
2	Argentina	AG
3	Brazil	BR
4	Bulgaria	BL
5	Chile	CL
6	China	CH
7	Colombia	CB
8	Croatia	CT
9	Czech Republic	CZ
10	Egypt	EY
11	Estonia	EO
12	Greece	GR
13	Hong Kong	HK
14	Hungary	HN
15	India	IN
16	Indonesia	ID
17	Israel	IS
18	Kenya	KN
19	Kuwait	KW
20	Latvia	LV
21	Lebanon	LB
22	Lithuania	LN
23	Malaysia	MY
24	Mauritius	MU
25	Mexico	MX
26	Morocco	MC
27	Nigeria	NG
28	Pakistan	PK
29	Peru	PE
30	Philippines	PH
31	Poland	PO
32	Qatar	QA
33	Romania	RM
34	Russia	RS
35	Saudi Arabia	SI
36	Singapore	SP
37	Slovakia	SX
38	Slovenia	SJ
39	South Africa	SA
40	South Korea	KO
41	Thailand	TH
42	Tunisia	TU
43	Turkey	TK
44	Ukraine	UR
45	United Arab Emirates	UA
46	Uruguay	UY
47	Venezuela	VE
48	Vietnam	VI

TABLE A.1 – Emerging market countries taken into account in the panel estimations of the fiscal reaction function

Annual data : Description

General government debt (% of GDP)

Definition : Gross debt consists of all liabilities that require payment or payments of interest and/or principal by the debtor to the creditor at a date or dates in the future. This includes debt liabilities in the form of SDRs, currency and deposits, debt securities, loans, insurance, pensions and standardized guarantee schemes, and other accounts payable. Thus, all liabilities in the GFSM 2001 system are debt, except for equity and investment fund shares and financial derivatives and employee stock options.

Source : IMF WEO

Time period : 1990-2014 except for IN (91-14), AG (93-14), CH, PO (95-14), MX, TH (96-14), VE (98-14), RS, SI, UA (99-14), BR, ID, IS, NG, SA (00-14), TK (01-14).

General government primary balance (% of GDP)

Definition : Primary net lending/borrowing is net lending (+)/borrowing (-) plus net interest payable/paid (interest expense minus interest revenue).

Source : IMF WEO

Time period : 1990-2014 except for UA (91-14), ID (93-14), AG, PO, KO (95-14), RS (98-14), SI (99-14), IS,NG, SA, TH (00-14), BR (01-14) and TK (02-14).

GDP (constant prices, local currency)

Definition : Expenditure-based GDP is total final expenditures at purchasers' prices (including the f.o.b. value of exports of goods and services), less the f.o.b. value of imports of goods and services.

Source : IMF WEO

Time period : 1990-2014 except for RS (92-14)

Output gap

Definition : With potential GDP (GDP^*) computed thanks to a HP filter, we calculate :

$$OG = \frac{(GDP - GDP^*) \times 100}{GDP^*} \tag{10}$$

Government Effectiveness Indicator (used as an instrument in the IV estimations)

Definition : Government Effectiveness (GE) indicator, capturing perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.

Source : World Bank Worldwide Governance Indicators, 2014 Update

Time period : 1996-2013. For 1997, 1999 and 2001, means of the years before and after have been taken for each country. Before 1996, the score of 1996 is attributed.

Exchange rate (used as an instrument in the IV estimations)

Definition : US dollar per National Currency exchange rate

Source : IMF IFS.

Time period : 1980-2014 except for UA (80-81, 97-98 & 04-07), QA (80-81, 99-00, 02-03 & 06-07), GR (80-00), SI (80-87 & 05-08), KW (80-89 & 92-14), LB (80-03 & 06-07), NG (80-96 & 99-14), MY (80-99 & 05-14), PK (82-14), VE (84-06 & 10-14), BL (86-14), VI (87-14), EY (89-14), SJ (92-06), LN (93-95 & 02-14), LV (93-13), CT (93-14), SX (94-08), EO (94-10), CZ, RS, UR (94-14).

Foreign currency denominated debt share (used in the debt simulations)

Definition : Computed with domestic and foreign currency debt of the Quarterly Public Sector Debt datasource. General government debt composition (or Central Government debt composition if not available).

Source : Quarterly Public Sector Debt, World Bank.

Time period : Data of the year preceding the beginning of the simulations. During the simulations, the share of foreign currency debt is considered constant (except for the alternative scenario corresponding to a lower exposure to currency risk).

A.1.2 Distribution of the primary balance

Primary balance			
Percentile	Centile	[95% Conf. Interval]	
5	-5.416	-6.083668	-4.989712
10	-4.1536	-4.491805	-3.744747
20	-2.4242	-2.710321	-2.147375
30	-1.3071	-1.483965	-1.040139
40	-.5938	-.7506959	-.3834942
50	.084	-.1246083	0.3485891
60	.9858	0.6938273	1.285479
70	1.9604	1.702483	2.307816
80	3.2422	2.872625	3.713552
90	5.8331	4.935695	7.075866
95	10.883	8.860958	11.86742

TABLE A.2 – Distribution of the primary balance

A.1.3 Instrumental variable estimations : Robustness

Instrumental Variables Estimates Dependent variable : primary balance pb				
og	0.0888*	0.0879	0.0969*	0.143**
	(1.67)	(1.62)	(1.71)	(2.12)
$L.pb$	0.607***	0.607***	0.619***	0.613***
	(12.68)	(12.72)	(11.27)	(11.95)
$L.d$	0.0377**	0.0376**	0.0366**	0.0474***
	(2.42)	(2.34)	(2.41)	(2.82)
N	705	705	799	706
adj. R-sq	0.436	0.436	0.399	0.401
Instruments :	$L.\triangle$og	$L.\triangle$og	$L.\triangle$og	
	ER	ER		ER
	Gov. Eff.		Gov. Eff.	Gov. Eff.
Underidentification test (Null : Underidentified), p-value	0.000	0.000	0.000	0.000
Weak identification test (Null : weakly identified), KP statistic	43	57	48	28
Hansen overidentification test (Null : Instruments exogenous), p-value	0.48	0.23	0.68	0.57

TABLE A.3 – Instrumental variables estimations of the Fiscal Reaction Function

Note : The estimation in column 1 is the main estimation, for which the following instruments are used to instrument the output gap : lagged first order difference of the output gap, nominal exchange rate and the Government Effectiveness from the Worldwide Governance Indicators 2014 database (World Bank). The other estimations are computed to test the robustness of the main equation. They are estimated through the same estimation method, but each time removing one of these three instruments. For each estimate presented, we report the number of observations, the adjusted R-squared, and the results of the tests. For the underidentification test we report the p-value associated with the Kleibergen-Paap LM statistic. The null assumption corresponds to underidentification. For the weak identification test we report the Kleibergen-Paap Wald F statistic. For the overidentification test, we report the p-value associated to the Hansen J statistic. The null assumption corresponds to exogenous instruments. All the estimations pass these three different tests.

T-statistics in parentheses. * p-value < 0.10, ** p-value < 0.05, *** p-value < 0.01.

A.2 VAR estimation

A.2.1 Data description (quarterly)

Real Effective Exchange Rate (based on Consumer Price Index)
Source : International Monetary Fund, International Financial Statistics or J.P. Morgan if not available

Real GDP growth rate (by expenditure, real, year-on-year percentage change)
Source : International Monetary Fund, International Financial Statistics

Domestic real interest rate
Definition : Proxy for the real interest rate paid by the country on its local currency denominated debt. Real interest rate calculated as following, using nominal domestic interest rate and CPI inflation :

$$r_t = ((1 + i_t^{nom}))/((1 + \pi_t)) - 1 \tag{11}$$

Where i_t^{nom} is the domestic 3-month Treasury bill interest rate (Source : IMF IFS or Oxford Economics government securities interest rate if not available) at quarterly frequency and π_t is the year-on-year inflation rate (Source : IMF IFS).

Foreign real interest rate
Definition : Proxy for the interest rate paid by the country on its foreign currency denominated debt. It is computed thanks to JP Morgan EMBI blended spreads (on sovereign US$ denominated debt) :

$$i_t^{EMBI,nom} = spread_t^{EMBI} + i_t^{US10Y,nom} \tag{12}$$

This nominal rate is then corrected for inflation as is the domestic rate.

A.2.2 Unit root tests

	With Intercept only		With Intercept and Trend	
Argentina				
Time period : 1982Q3-2014Q4	With Intercept only		With Intercept and Trend	
Variable	t-statistic	p-value	t-statistic	p-value
$\triangle$ log(REER)	-4.20	0.0010	-4.19	0.0062
g	-3.21	0.0227	-3.18	0.0947
$\triangle r^{dom}$	-7.19	0.0000	7.17	0.0000
$\triangle r^{for}$	-8.86	0.0000	-8.81	0.0000
Brazil				
Time period : 1982Q3-2014Q4	With Intercept only		With Intercept and Trend	
Variable	t-statistic	p-value	t-statistic	p-value
$\triangle$ log(REER)	-4.00	0.0019	-4.03	0.0100
g	-3.40	0.0142	-3.48	0.0497
r^{dom}	-2.22	0.2009	-5.66	0.0001
r^{for}	-15.55	0.0001	-9.74	0.0001
The Philippines				
Time period : 1982Q3-2014Q4	With Intercept only		With Intercept and Trend	
Variable	t-statistic	p-value	t-statistic	p-value
$\triangle\triangle$ log(REER)	-5.28	0.0001	-5.25	0.0001
g	-3.16	0.0247	-3.70	0.0260
r^{dom}	-4.29	0.0007	-4.49	0.0023
r^{for}	-2.58	0.1020	-3.99	0.0138
Russia				
Time period : 1982Q3-2014Q4	With Intercept only		With Intercept and Trend	
Variable	t-statistic	p-value	t-statistic	p-value
$\triangle$ log(REER)	-4.25	0.0010	-4.28	0.0055
g	-4.06	0.0020	-4.024	0.0119
r^{dom}	-2.98	0.0446	-4.2640	0.0008
r^{for}	-4.70	0.0003	-5.3936	0.0002
Turkey				
Time period : 1982Q3-2014Q4	With Intercept only		With Intercept and Trend	
Variable	t-statistic	p-value	t-statistic	p-value
$\triangle$ log(REER)	-4.27	0.0007	-4.36	0.0035
g	-4.16	0.0012	-4.12	0.0080
$\triangle r^{dom}$	-5.40	0.0000	-5.42	0.0001
$\triangle r^{for}$	-4.20	0.0013	-8.28	0.0001

TABLE A.4 – Unit Root Augmented Dickey-Fuller tests

A.2.3 Lag order criteria

Lag	Argentina	Brazil	Philippines	Russia	Turkey
0	27.26797	23.18946	17.21092	19.04538	21.91617
1	25.17916	20.55646*	14.23521*	16.05723	21.26239*
2	24.73271*	21.11431	15.04529	15.48054*	21.74944
3	25.18279	21.45863	15.30232	16.12411	22.19006
4	25.79894	21.67625	15.86658	16.64663	22.55829
N	75	66	55	44	69

TABLE A.5 – VAR Lag order criteria
Note : Schwarz information criterion (* indicates the order chosen at the 5% level).

A.2.4 VAR Results

Coefficients				
	$\triangle$ log(REER)	g	$\triangle r^{dom}$	$\triangle r^{for}$
$\triangle log(REER)_{-1}$	0.773765	-0.024678	0.075001	0.088184
	[9.98743]	[-0.92062]	[2.00344]	[2.87455]
g_{-1}	0.524312	0.805983	-0.060876	-0.033655
	[2.47628]	[11.0015]	[-0.59500]	[-0.40142]
$\triangle r^{dom}_{-1}$	-0.106894	-0.099359	0.531667	0.845685
	[-0.24935]	[-0.66985]	[2.56656]	[4.98187]
$\triangle r^{for}_{-1}$	-0.353249	0.035545	-0.531736	-0.905186
	[-0.74583]	[0.21690]	[-2.32338]	[-4.82651]
Constant	-2.166053	0.392758	0.234387	0.204535
	[-1.32984]	[0.69690]	[0.29780]	[0.31713]
R-squared	0.683635	0.659081	0.130204	0.313804
Adjusted R-squared	0.666300	0.640401	0.082544	0.276205
Residual Covariance Matrix				
	$\triangle$ log(REER)	g	$\triangle r^{dom}$	$\triangle r^{for}$
$\triangle$ log(REER)	159.4654	9.693229	21.43335	24.51622
g	9.693229	19.09116	-2.118039	0.008268
$\triangle r^{dom}$	21.43335	-2.118039	37.23412	25.68735
$\triangle r^{for}$	24.51622	0.008268	25.68735	25.00328
Implied Steady-state value for the real growth rate				
g	2.514416			
Sample (adjusted) : 1994Q3 2013Q4				
Included observations : 78 after adjustments				

TABLE A.6 – Vector Autoregressive Estimates : Argentina
Note : T-statistics in square brackets. All variables included in the VAR has been tested for the presence of a unit root and is considered stationary according to augmented Dickey-Fuller tests (see Annex A.2.2).

Coefficients				
	$\triangle$ log(REER)	g	r^{dom}	r^{for}
$\triangle log(REER)_{-1}$	0.669123	0.065788	0.072033	0.053800
	[7.58682]	[3.31932]	[3.16874]	[3.64325]
g_{-1}	-0.459706	0.367105	-0.062874	-0.171699
	[-1.02005]	[3.62474]	[-0.54126]	[-2.27542]
r^{dom}_{-1}	0.237514	-0.115368	0.769289	0.132879
	[0.87613]	[-1.89370]	[11.0095]	[2.92744]
r^{for}_{-1}	-0.983382	0.270441	0.083676	0.689811
	[-2.20698]	[2.70082]	[0.72858]	[9.24613]
Constant	1.674780	2.448347	1.883812	-0.126973
	[0.60597]	[3.94194]	[2.64440]	[-0.27438]
R-squared	0.586996	0.418242	0.772503	0.774586
Adjusted R-squared	0.562339	0.383511	0.758921	0.761128
Residual Covariance Matrix				
	$\triangle$ log(REER)	g	r^{dom}	r^{for}
$\triangle$ log(REER)	94.45234	6.973100	-2.637445	-2.520899
g	6.973100	4.770029	-0.420618	-0.050962
r^{dom}	-2.637445	-0.420618	6.275034	0.396412
r^{for}	-2.520899	-0.050962	0.396412	2.647926
Implied Steady-state value for the real growth rate				
g	3.223925			
Sample (adjusted) : 1996Q2 2014Q4				
Included observations : 72 after adjustments				

TABLE A.7 – Vector Autoregressive Estimates : Brazil
Note : T-statistics in square brackets. All variables included in the VAR has been tested for the presence of a unit root and is considered stationary according to augmented Dickey-Fuller tests (see Annex A.2.2).

Coefficients				
	$\triangle\triangle$ log(REER)	g	r^{dom}	r^{for}
$\triangle\triangle log(REER)_{-1}$	0.149907	0.061344	0.051252	0.027873
	[1.26267]	[1.40745]	[1.45973]	[0.80117]
g_{-1}	-0.201768	0.659517	-0.107811	-0.050946
	[-0.81217]	[7.23121]	[-1.46739]	[-0.69980]
r^{dom}_{-1}	0.493637	-0.254577	0.680833	-0.001751
	[2.02760]	[-2.84829]	[9.45595]	[-0.02454]
r^{for}_{-1}	-0.709205	0.233858	0.286350	0.920113
	[-2.55974]	[2.29914]	[3.49471]	[11.3328]
Constant	2.910462	1.358714	-0.132093	0.426233
	[2.18974]	[2.78451]	[-0.33605]	[1.09433]
R-squared	0.221956	0.678595	0.867488	0.822035
Adjusted R-squared	0.166382	0.655637	0.858023	0.809323
Residual Covariance Matrix				
	$\triangle\triangle$ log(REER)	g	r^{dom}	r^{for}
$\triangle\triangle$ log(REER)	13.23094	-0.333848	-0.702550	-1.227396
g	-0.333848	1.783243	0.019685	0.000122
r^{dom}	-0.702550	0.019685	1.157207	0.657590
r^{for}	-1.227396	0.000122	0.657590	1.136181
Implied Steady-state value for the real growth rate				
g	5.80145			
Sample (adjusted) : 1998Q2 2014Q4				
Included observations : 61 after adjustments				

TABLE A.8 – Vector Autoregressive Estimates : Philippines
Note : T-statistics in square brackets. All variables included in the VAR has been tested for the presence of a unit root and is considered stationary according to augmented Dickey-Fuller tests (see Annex A.2.2).

Coefficients				
	$\triangle$ log(REER)	g	r^{dom}	r^{for}
$\triangle log(REER)_{-1}$	0.487726	-0.051278	0.084774	0.118359
	[2.46965]	[-0.53819]	[1.97067]	[2.52611]
g_{-1}	0.353710	0.937951	-0.141272	-0.116162
	[1.58647]	[8.71995]	[-2.90893]	[-2.19605]
r^{dom}_{-1}	-0.682575	-0.060488	1.037308	0.323337
	[-0.81376]	[-0.14947]	[5.67736]	[1.62478]
r^{for}_{-1}	0.496101	0.260644	-0.192688	0.460501
	[0.49729]	[0.54154]	[-0.88672]	[1.94563]
Constant	0.875229	1.098785	-0.248065	-1.319322
	[0.32421]	[0.84366]	[-0.42186]	[-2.05992]
R-squared	0.500190	0.780775	0.865393	0.739375
Adjusted R-squared	0.452589	0.759896	0.852573	0.714553
Residual Covariance Matrix				
	$\triangle$ log(REER)	g	r^{dom}	r^{for}
$\triangle$ log(REER)	22.91433	5.313720	-0.478771	0.235573
g	5.313720	5.333493	-0.371224	-0.257276
r^{dom}	-0.478771	-0.371224	1.087235	1.022335
r^{for}	0.235573	-0.257276	1.022335	1.289806
Implied Steady-state value for the real growth rate				
g	3.5111			
Sample (adjusted) : 2003Q2 2014Q4				
Included observations : 47 after adjustments				

TABLE A.9 – Vector Autoregressive Estimates : Russia

Note : T-statistics in square brackets. All variables included in the VAR has been tested for the presence of a unit root and is considered stationary according to augmented Dickey-Fuller tests (see Annex A.2.2).

Coefficients				
	$\triangle$ log(REER)	g	$\triangle r^{dom}$	$\triangle r^{for}$
$\triangle log(REER)_{-1}$	0.730007	0.067030	0.112980	0.083601
	[6.42330]	[1.30808]	[3.14401]	[2.65953]
g_{-1}	-0.096242	0.702263	-0.025344	-0.062967
	[-0.46539]	[7.53169]	[-0.38760]	[-1.10086]
$\triangle r^{dom}_{-1}$	-0.451733	-0.226976	0.100722	0.316955
	[-0.60935]	[-0.67904]	[0.42969]	[1.54576]
$\triangle r^{for}_{-1}$	-0.194094	0.031577	0.063456	-0.043354
	[-0.23236]	[0.08384]	[0.24026]	[-0.18765]
Constant	1.272364	1.142523	0.290956	0.491826
	[0.98059]	[1.95287]	[0.70917]	[1.37041]
R-squared	0.425337	0.547686	0.236085	0.270134
Adjusted R-squared	0.391029	0.520682	0.190478	0.226560
Residual Covariance Matrix				
	$\triangle$ log(REER)	g	$\triangle r^{dom}$	$\triangle r^{for}$
$\triangle$ log(REER)	71.35435	12.38457	5.875322	7.112146
g	12.38457	14.50609	2.100965	1.028057
$\triangle r^{dom}$	5.875322	2.100965	7.133816	5.356189
$\triangle r^{for}$	7.112146	1.028057	5.356189	5.458761
Implied Steady-state value for the real growth rate				
g	3.970125			
Sample (adjusted) : 1997Q1 2014Q4				
Included observations : 72 after adjustments				

TABLE A.10 – Vector Autoregressive Estimates : Turkey
Note : T-statistics in square brackets. All variables included in the VAR has been tested for the presence of a unit root and is considered stationary according to augmented Dickey-Fuller tests (see Annex A.2.2).

References

[1] Acevedo, P., Alberola, E., Broto, C., 2008. Local Debt Expansion and Vulnerability Reduction : an Assessment for Six Crisis-prone Countries. BIS Papers No. 36.

[2] Akyüz, Y., 2007. Debt Sustainability in Emerging Markets : A Critical Appraisal. DESA Working Paper No. 61.

[3] Bergman, U.M., Hutchison, M., 2015. Fiscal Rules and Government Efficiency in Reducing Procyclicality in Emerging and Developing Economies.

[4] Berti, K., 2013. Stochastic Public Debt Projections Using the Historical Variance-Covariance Approach for EU Countries. European Economy, Economic Papers 480.

[5] Budina, N., van Wijnbergen, S., 2008. Quantitative Approaches to Fiscal Sustainability Analysis : A Case Study of Turkey since the Crisis of 2001. The World Bank Economic Review, Volume 23, Issue 1, 119-140.

[6] Burger, P., Stuart, I., Jooste, C. Cuevas, A., 2011. Fiscal Sustainability and the Fiscal Reaction Function for South Africa. IMF Working Paper, WP/11/69.

[7] Calderon, C., Duncan, R., Schmidt-Hebbel, K., 2014. Do Good Institutions Promote Counter-Cyclical Macroeconomic Policies ? Peruvian Economic Association Working Paper, No. 3.

[8] Celasun, O., Debrun, X., Ostry, J.D., 2006. Primary Surplus Behavior and Risks to Fiscal Sustainability in Emerging Market Countries : A "Fan-Chart" Approach. IMF Staff Papers, Vol. 53, No. 3, 401-425.

[9] Cevik S., Teksoz, K., 2014. Deep Roots of Fiscal Behavior. Journal of Banking and Financial Economics No. 2(2)2014, 5-33.

[10] Chernozhukov, V., Hansen, C., 2006. Instrumental Quantile Regression Inference for structural and Treatment Effect Models. Journal of Econometrics 132 (2006) 491-525.

[11] Chernozhukov, V., Hansen, C., 2008. Instrumental Variable Quantile Regression : A Robust Inference Approach. Journal of Econometrics 142 (2008) 379-398.

[12] Favero, C., Giavazzi, F., Perego J., 2011. Country Heterogeneity and the International Evidence on the Effects of Fiscal Policy. IMF Economic Review Vol. 59, No. 4.

[13] Ghatak, S, Sanchez-Fung, J.R., 2007. Is Fiscal Policy Sustainable in Developing Economies ? Review of Development Economics, 11(3), 518-530.

[14] Hajdenberg, A., Romeu, R., 2010. Parameter Estimate Uncertainty in Probabilistic Debt Sustainability Analysis. IMF Staff Papers, Vol. 57, No. 1, 61-83.

[15] Hostland, D., Karam, P., 2005. Assessing Debt Sustainability in Emerging Market Economies Using Stochastic Simulation Methods. IMF Working Paper, WP/05/226.

[16] Ilzetzki, E., Végh, C.A., 2008. Procyclical Fiscal Policy in Developing Countries : Truth or Fiction ? NBER Working Paper No. 14191.

[17] Kaminsky, G.L., Reinhart, C.M., Vegh, C.A., 2005. When it Rains, it Pours : Procyclical Capital Flows and Macroeconomic Policies. NBER Working Paper No. 10780.

[18] Medeiros, J., 2012. Stochastic Debt Simulation Using VAR Models and a Panel Fiscal Reaction Function : Results for a Selected Number of Countries. European Economy, Economic Papers 459.

[19] Mupunga, N., Le Roux, P., 2015. Stochastic Simulation Analysis of Sustainable Public Debt in Zimbabwe. Journal of Economics and International Finance, Vol. 7(5), 98-111.

[20] Wyplosz C., 2005. Debt Sustainability Assessment : Mission Impossible. Review of Economics and Institutions, Vol.2, No.3, Fall 2011, Article 1.

Chief Editors:

Pascal Blanqué
Deputy Chief Executive Officer
Head of Institutional Investors and Third Party Distributors
Group Chief Investment Officer

Philippe Ithurbide
Global Head of Research, Strategy and Analysis

Amundi Working Paper

WP-53-2016

March 2016

research-center.amundi.com