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LONG – TERM INTEREST RATE AND FISCAL POLICY

Eduardo López E. Víctor Riquelme P. Ercio Muñoz S.

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Agustinas 1180, Santiago, Chile
Teléfono: (56-2) 3882475; Fax: (56-2) 3882231

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Eduardo López E.
Banco Central de Chile

Víctor Riquelme P.
Banco Central de Chile

Ercio Muñoz S.
Banco Central de Chile

Abstract

The financial crisis of 2008, the subsequent fiscal stimulus, and damage to the fiscal position –especially in the developed countries—, raised the concerns about their impact on long-term interest rates. Using a stylized model, we establish the link between long-term interest rates and the main fiscal policy variables, such as fiscal deficit and public debt. We estimate a panel data model of the long-term interest rate for the period 1990-2009, considering a sample of 54 emerging and developed economies. We find that, when the fiscal deficit expands by 1%, the long-term interest rate rises between 10 and 12 basis points. When we consider the role of monetary policy and its credibility and fiscal rules as stabilizers of the business cycle, we find that: (i) credibility helps maintain lower interest rate than otherwise, and ii) fiscal rules help attenuate the impact of fiscal deficit on long-term interest rates. Finally, it is found that fiscal policy explained nearly 40% of the long term interest rate for G7 countries during 2007-2010.

Resumen

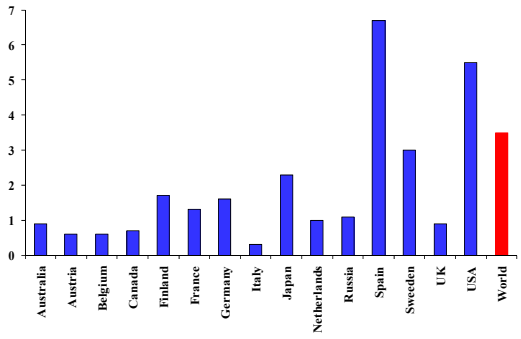
La crisis financiera del 2008, junto con las posteriores medidas de estímulo fiscal a nivel global y el deterioro fiscal de los gobiernos, ha aumentado la preocupación por el impacto alcista sobre las tasas de interés de largo plazo. A partir de un marco analítico estilizado, se establecen los vínculos entre las tasas de interés de largo plazo y sus principales determinantes, especialmente los asociados a la política fiscal: déficit fiscal y deuda pública. Se estima un modelo de panel dinámico para la tasa de interés de largo plazo con datos anuales entre 1990 y 2009 para 54 economías desarrolladas y emergentes. Respecto del impacto de la política fiscal, se encuentra que por cada punto porcentual adicional de déficit primario las tasas aumentan entre 10 y 12pb. Al analizar el rol del marco de política monetaria —y su credibilidad—, y de la reglas fiscales como mecanismos de atenuación de las fluctuaciones cíclicas, se encuentra que: (i) la credibilidad permite sostener tasas de interés más bajas que en su ausencia, y (ii) en países con regla fiscal el impacto del déficit primario sobre las tasas de interés de largo plazo se atenúa. Se observa que, en promedio, alrededor de dos quintos del nivel promedio de las tasas de largo plazo en los países del G7 durante el período 2007-2010 se explicó por factores asociados a la política fiscal.

1. Introduction

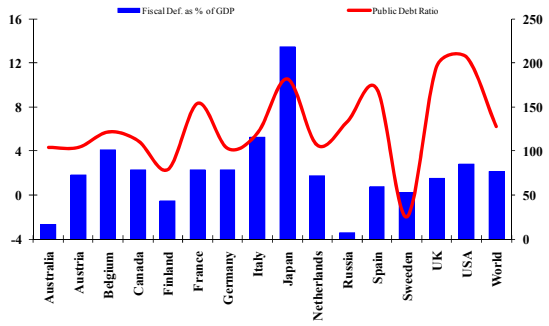
The financial crisis of 2007-2008 in advanced economies and its adverse impact on growth and employment locally and globally triggered a set of fiscal policy actions. Indeed, as of March 2009 over 40 governments announced packages of fiscal stimulus (IMF, 2009a) for about $2.18 trillion (3.5% of GDP, Figure 1a). These expansionary fiscal policy measures were generally accompanied -especially in 2009- by deterioration in the public debt position (Figure 1b).

Figure 1

a. Fiscal Stimulus Packages
(% of GDP)



b. Deficit and Fiscal Position 2009
(% of GDP)



Source: IMF (2009a).

The substantial deterioration of fiscal solvency ratios globally has raised the debate on the role and impact of fiscal policy on long-term interest rates. The impact of fiscal policy through the primary deficit and debt stock on interest rates is funneled by three short-term and long-term channels. First, a larger primary fiscal deficit causes additional pressure on the aggregate demand, generating upward pressure on real interest rates. A second transmission mechanism of fiscal policy on interest rates is channeled through the impact of the debt. On the one hand, to the extent that Ricardian equivalence is not fully fulfilled a higher stock debt increases the financial wealth available to the private sector and consequently on the aggregate expenditure, and interest rates. On the other hand, a larger debt stock impact on the perception of credit risk of the government, leading to an upward impact on long-term interest rates. A third channel is one of long-term and its effects take place through the adverse impact of higher ratios of debt on the stock of capital in the economy, which in turn raises the marginal return of the required capital and interest rates, reducing the economy's potential growth rate.

The relationship between fiscal policy and real interest rates has been widely studied in the literature[1], particularly the impact of levels of debt ratios. The evidence tends to find

[1] See Evans (1985), Laubach (2003), Gale y Orszag (2004) for the U.S. economy, Codogno et al. (2003), Friedman (2005), Ardagna et al. (2007). See Baldacci and Kumar (2010) for cross-country evidence.

that there is a direct and non-linear dependence of long-term interest rates on debt ratios. In particular, Engen and Hubbard (2004), using U.S. data, find that a 1% increase on the debt to GDP ratio raises real interest rates in around 2-3bp. Ardagna (2007), based on a sample of 16 developed countries, finds that a 1% increase of the primary deficit ratio on GDP increases the 10-year nominal interest rate by 10bp. In addition, he outlines that the response of the interest rate to a 1% change in the stock of debt to GDP is low, both in countries with extremely low or high values of public debt. Baldacci and Kumar (2010) find that the impact of a 1% increase in the deficit on the real interest rate is around 30-34bp; and 3-4bp from a 1% increase of the debt stock.

In this paper we study the impact of the fiscal deterioration in long-term real interest rates for a sample of developed and emerging countries. To this end, we enhance the analytical framework of previous studies by incorporating two variables that may potentially affect the course of long-term real interest rates, but so far have been absent from the literature, that is the role of the monetary policy credibility, and fiscal rules. In addition we seek to find differential effects on real interest rate from changes in the fiscal position *vis-a-vis* changes in the deficit or surplus.

The paper continues as follows. In section 2 we develop a stylized theoretical framework that allows identifying the main channel of transmission for the relationship between debt and deficit and long-term real interest rates. In section 3 we present estimations of this model using panel data techniques, focusing on the impact of monetary and fiscal policy frameworks on long-term interest rates, and an exercise of breakdown the relative role of several determinants on the recent course of the long-term rates for a selected set of countries, and finally, in section 4 we conclude.

2. Analytical framework for the impact of public debt and deficit on long-term real interest rates

In order to clarify the mechanisms that determine long-term interest rates in this section we consider a stylized macro model. Mc Callum and Nelson (1999), Gali (2002), Clarida, Galí and Gertler (2001,2002) and Walsh (2003), among others, have shown that this model follows from a micro founded model consisting of consumers who supply labor, purchase goods and hold liquid assets and short-term and long-term bonds. The firms for its part hire workers and produce and sell differentiated products in a monopolistically competitive goods market. Both consumers and firms behave maximizing their intertemporal utility function and their benefits, respectively. Government collects taxes and issues long-term bonds, by which finances its spending. There is also a monetary authority which controls the short-term nominal interest rate. Thus, the stylized model corresponds to the linearization of this micro-founded model, and is described by the following equations:

(1) $R_t - D(R^e_{t+1} - R_t) = i_t - \pi^e_{t+1} + \theta(b_t)$

(2) $x_t = \beta_0 x_{t+1}^e - \beta_1 R_t + \beta_2 F + \beta_3 w_t$

(3) $\pi_t = \pi_{t+1}^e + \gamma \cdot x_t$

Equation (1) represents the equilibrium condition of the asset market, reflecting the arbitrage between the real return on long-term bonds (R) and a short-term bond (i-π^e). D is the Mac Caulay duration measure[2], i is the short-term nominal interest rate, and θ is a credit risk premium, which is a non-linear function of the debt stock, b[3]. Equation (2) characterizes aggregate demand, which relates the output gap (x) with the expected output gap (x^e), the long-term real interest rate (R), a measure of fiscal impulse (F) and the financial wealth available to the private sector (w)[4].

The model is closed with equation (3) that characterizes the aggregate supply where inflation depends positively on expected inflation (π^e) and on the output gap.

Rewriting (1) we have:

(4) $R_t = \lambda R_{t+1}^e + (1-\lambda)\left[(i_t - \pi_t) - (\pi_{t+1}^e - \pi_t) + \theta(b_t)\right]$, where $\lambda = \dfrac{D}{1+D}$.

Substituting (2) into (3), and this result into (5), we obtain a semi-reduced expression for the long-term real interest rate (R):

(5) $R_t = \alpha_0 R_{t+1}^e + \alpha_1 x_{t+1}^e + \alpha_2 (i_t - \pi_t) + \alpha_3 F + \alpha_4 w_t + \alpha_5 \theta(b_t)$

Where α_0, α_1, α_2, α_3, α_4, $\alpha_5 > 0$, which are defined as:

$$\alpha_0 = \frac{\lambda}{1+\Gamma\beta_1},\ \alpha_1 = \frac{\Gamma\beta_0}{1+\Gamma\beta_1},\ \alpha_2 = \frac{1-\lambda}{1+\Gamma\beta_1},\ \alpha_3 = \frac{\Gamma\beta_2}{1+\Gamma\beta_1},\ \alpha_4 = \frac{\Gamma\beta_3}{1+\Gamma\beta_1},\quad \alpha_5 = \alpha_1,$$
$$\Gamma = (1-\lambda)\gamma$$

Equation (5) underlines the importance of demand factors on the determination of the level of long term interest rate. These factors are, on the one hand, short-term interest

[2] For a definition of duration see Shiller (1990). Duration is a measure of the average term of a bond, but it is also interpreted as the sensibility of a bond value to changes in the expected yield, e.g. interest rates. Therefore, duration is a measure of the capital gain component of a bond's rate of return.

[3] Under the contingent-claim analysis of credit risks first developed by Merton (1973), and later applied by Gray y Merton (2000) to several countries, public debt credit spread can be modeled as a put option, whose value depends on risk-free external rate, the average term of the debt stock, the volatility of the rate of return on government assets and the public debt-to-asset ratio.

[4] Following Walsh (2003) we have $w_t = m_t + (1-\psi)b_t$, which means that when $\psi = 1$ Ricardian equivalence is not fulfilled and, therefore public debt is not perceived as part of private wealth.

rates adjusted by inflation (i-π), and looking forward variables such as the expected long-term real interest rates (R^e) and output gap (x^e). On the other hand, the impact of fiscal policy is through two channels. The first one is through F, proxied by the primary fiscal deficit (g-t). The second channel is related to the public debt (b) which operates, on one hand, through the impact of private sector's financial (w), under no Ricardian equivalence, and on the other hand, through the non lineal effect of debt on credit risk premium (θ).

We can extend this simple macro model to incorporate the role of two policy arrangements that prevails in the economies considered in the sample: i) the monetary policy regime and its credibility, and ii) the existence of fiscal rules as stabilizers of the business cycle. With that in mind, let's assume that the monetary authority sets the short term interest rate accordingly to a standard Taylor's rule:

(6) $i = \bar{i} + \phi_0 x + \phi_1(\pi - \pi^*)$

π^* is the inflation target set by the authority. Reformulating (6) yields:

(6') $i = \bar{i} + \phi_0 x + \phi_1(\pi - \pi^e_{t+1}) - \phi_1(\pi^* - \pi^e_{t+1})$, and using (3) we obtain:

(6'') $i = \bar{i} + (\phi_0 + \phi_1\gamma)x - \phi_1(\pi^* - \pi^e_{t+1})$

Let also suppose that the fiscal authority sets a fiscal rule. For simplicity, we assume a rule in the spirit of the Chile's fiscal rule, which defines an objective for the fiscal deficit (F^*). Given that t is the Tax-GDP elasticity, the fiscal rule turns out to set an upper bound to the public spending, i.e.: $g=F^*+ty^*$. As a result, the primary fiscal deficit is:

(7) $F = F^* - tx$

By replacing (7) in (2) we obtain:

(2') $x_t = \beta_0' x^e_{t+1} - \beta_1' R_t + \beta_2' F + \beta_3' w_t$, where $\beta_i' = \dfrac{\beta_i}{1 + \beta_2 t}$

Finally, substituting (2') and (6'') in (1), and solving for R, we get the following semi reduced expression:

(8) $R_t = \alpha_0 R^e_{t+1} + \alpha_1 x^e_{t+1} + \alpha_2(\bar{i}_t - \pi^e_{t+1}) - \alpha_3(\pi^* - \pi^e_{t+1}) + \alpha_4 F^* + \alpha_5 w_t + \alpha_6\theta(b_t)$

Equation (8) differs from equation (5) in two ways. First, it can be notice that the coefficient associated to the effective fiscal deficit disappears of the equation, as only we consider the policy parameter related to structural deficit. Second, a new variable: (π^*-π^e) comes up, which incorporates the impact of the monetary policy credibility on the long term interest rates. On this vein, Bomfin and Redebusch (2000) defines

credibility of the monetary policy as the degree in which the inflation target's announce is believed by the private agents in their long term expectation formation. Accordingly, these expectation would be a weighted average between the inflation target and the last period effective inflation:

$$(9)\quad \pi^{e}_{t+1} = \chi\pi^{*} + (1-\chi)\pi_{t-1}$$

Where χ stands for the degree of credibility of the monetary authority. If χ=1, the credibility is perfect, and the expectation is equal to the inflation target. If χ=0, then the authority has no credibility, and the inflation target is ignored when the agents defines their expectation. By considering this line of reasoning we obtain:

$$(10)\quad \pi^{*} - \pi^{e}_{t+1} = (1-\chi)(\pi^{*} - \pi_{t-1})$$

i.e. the departure of inflation expectation from the inflation target is inversely related to the degree of credibility of the monetary authority. If we use (10) in (8), the equation for *R* would be:

$$(11)\quad R_t = \alpha_0 R^{e}_{t+1} + \alpha_1 x^{e}_{t+1} + \alpha_2(\bar{i}_t - \pi^{e}_{t+1}) - \alpha_3(1-\chi)(\pi^{*} - \pi_{t-1}) + \alpha_4 F^{*} + \alpha_5 w_t + \alpha_6\theta(b_t)$$

In (11), we can note that the more credible monetary policy is, the lesser is the impact (damage) of the departure of the inflation expectation from the inflation target. Therefore, the inclusion of monetary and fiscal policy regimes affects long term real interest rates in 3 ways. First, the magnitude of the coefficients change, and the impact of the fiscal and monetary policies on *R* are reduced. Second, in contrast with equation (6), the key policy variables are now unobservable: neutral interest rate and structural deficit. Finally, the model now includes a term associated to the degree of credibility of the monetary policy, which indicates that, *ceteris paribus,* a higher degree of credibility helps sustain lower long term interest rates.

3. Empirical Analysis

Based on a simple macroeconomic model developed in section 2 the following semi reduced equation identifies the main determinants of long term interest rates (*R*):

$$(5)\quad R_t = \alpha_0 R^{e}_{t+1} + \alpha_1 x^{e}_{t+1} + \alpha_2(i_t - \pi_t) + \alpha_3 F + \alpha_4 w_t + \alpha_5\theta(b_t) + \alpha_6 b_t\sigma$$

Where all the parameters of the equation are positive and correspond to non-linear combinations of parameters related to the balance of assets, risk premium, elasticity of aggregate demand to interest rate, the tradeoff between inflation and output gap, among others.

There are two important considerations regarding the analytical framework. First, in the long term the interest rates are determined to ensure to the savings-investment equilibrium, therefore, the public debt and its impact on the stock of capital and long-term growth are an important transmission channel. Due to insufficient data to test this hypothesis in long-term, we believe that the current analytical framework best fits the available data. Second, the basic assumption of this model is that the macroeconomic equilibrium characterizes a closed economy.

We used annual data for 54 developed and emerging economies for the period 1990-2009. Real long-term interest rate corresponds to annualized nominal rate of a 10 years bond, adjusted for inflation. Real short-term interest rate corresponds to one year Treasury Bill. Both series are obtained from the IMF. It addresses also the primary fiscal balance and public debt as a percentage of GDP, the first of these series is obtained from Moody's and IMF, while the information of public debt to GDP is taken from a recent study by Abbas et al. (2010) published by the IMF, where it collects and presents an extensive database that contains historical information of public debt. To calculate the output gap series we used real GDP data obtained from the World Bank, which are then filtered using a HP filter to obtain a trend. The volatility of public assets return, given the lack of a better indicator available to countries in our sample is approximated by the volatility of real GDP growth, which is estimated at 5-year moving windows, from real GDP detailed above.

The estimation method corresponds to a GGM based dynamic panel data methodology developed by Arellano and Bond (1991). Although this method may be subject to the problem of weak instruments[5] (Roodman, 2009), it allows us to address some bias problems such as omitted variables, endogeneity associated to dynamic panel bias (as in this case), and measurement errors (when instruments are not correlated with these errors). We use a 2-stage method in order to obtain a covariance matrix which is robust to autocorrelation and heteroskedasticity (Windmeijer (2005). This correction also helps us dealing with the problem of short time dimension (17 years) and long cross-section dimension (54 countries). The model is estimated in levels[6].

Given the presence of forward-looking variables we need to include instrumental variables. Hansen J statistic[7] allows us to test whether instrument are valid and consistent. The results indicates that we cannot reject the null hypothesis that the full set of orthogonality conditions is valid, i.e. the instruments as a group are exogenous (p value obtained from 0.22 to 0.38), and therefore the tests detected no problems with the

[5] To avoid the proliferation of instruments we adopted as a rule that the number of instruments does not exceed the number of groups (countries).

[6] The model can be estimated in levels without problems, because the series used don't have problems of unit root, according to Fisher-ADF, Im-Pesaran-Shin and Levin-Lin-Chu tests designed the first two to measure this in individual series and the last for panel data; the results of such tests are not included but can be obtained from the authors.

[7] This statistic is preferred over Sargan because it is robust to heteroskedasticity and autocorrelation.

validity of the instruments used (lags of the logarithm of the real long-term interest rate).

Table 1
Determinants of Long Term Interest Rate
Dependent Variable: *R*
Annual Data for 1990-2009

	Eq 1	Eq 2	Eq 3	Eq 4
R_{t+1}	0.73***	0.71***	0.68***	0.70***
R_{t-1}	0.23***	0.22***	0.24***	0.21***
x_{t+1}	0.20***	0.23***	0.22***	0.21***
$(i-\pi)_{t-1}$	0.26***	0.26***	0.28***	0.27***
F_{t-1}	0.11***	0.10***	0.10***	
$b\,\sigma$		0.50***	0.44***	0.54***
b_t	0.00***	0.20***	0.19***	0.18***
$(b_t)^2$		-0.27***	-0.27***	-0.24***
$(b_t)^3$		0.09***	0.09***	0.07***
$r_{t-1}(1-\chi)$			0.06**	
DF				0.21***
*DF*rf*				-0.59***
SF				-0.25***
*SF*rf*				0.13**
J Statistic	*54.48*	*46.31*	47.98	47.70
p Value	*0.27*	*0.38*	0.28	0.22
N° of Obs.	*618*	*618*	616	618

Significant at 10% (*), Significant at 5% (**), Significant at 1% (***). The instruments used in all the equations are the lags of ln(R).

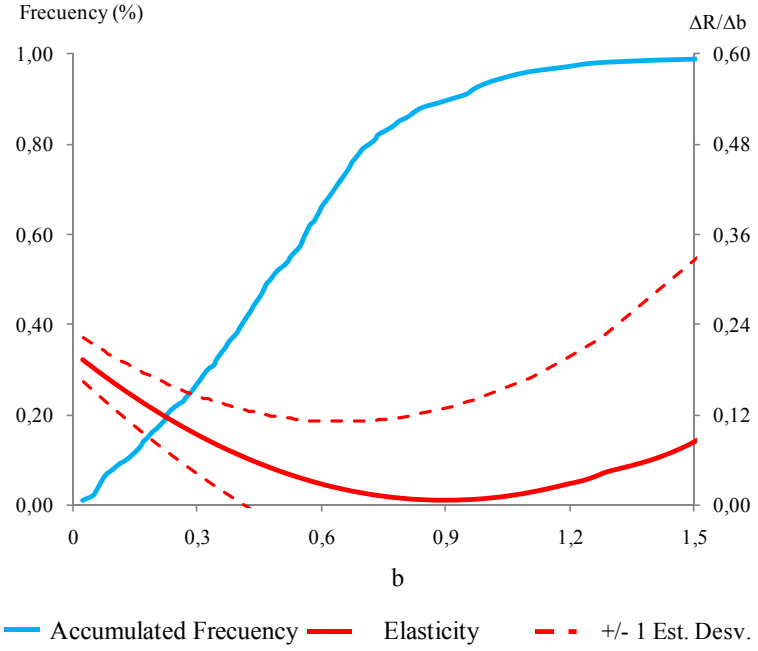
The dynamic panel data estimation yields statistically significant robust and theoretically consistent results (Table 1, equation 1 and 2). In particular the coefficients of the basic determinants (R^e, $i-\pi$, x^e, F, b,σ) is robustly coherent with theoretical expected signs.

First, the results in Table 1 show the importance of factors related to fiscal policy, described by F-in equation 1 and 3. In particular, it can be noted that each additional percentage point of the primary deficit increase rates between 10 and 12bp, respectively.

Second, the results robustly confirm the hypothesis of nonlinearity in the relationship between real long-term interest rates and debt ratios, enhanced by the effect of volatility. Equation 1, which assumes a linear relationship between interest rates and debt rates, yields a parameter close to 0, but significant, which can be interpreted as weak evidence favourable to the hypothesis of nonlinearity. Equation 2 and 4 assumes

that the parameter sensitivity of the debt ratio *R* corresponds to a second order polynomial in debt, adding an additional effect from volatility. The results show how the marginal impact of a unit increase in the debt ratio changes according to its prevailing level. Figure 2 illustrates this point. We plot, debt-ratio cumulative frequency function on the left axis, the one-unit marginal impact of debt ratio on *R* within a confidence band of ± 1 standard deviation on the right axis. For example, for countries in the middle of the sample, whose ratio of debt is equivalent to 48% of GDP, a 1-point increase in the debt ratio increases the long term interest rate around 5bp. For countries in the first quartile, whose debt threshold is about 28%, a marginal increase in the debt ratio increases the real long-term interest rates by around 7-8bp.

Figure 2
Sensitivity of Long Term Interest Rate to Public Debt ratio to GDP



Source: Author's Elaboration.

Third, the marginal impact of volatility on real interest rates, considering the average debt ratio of the sample of 51% of GDP is an increase of between 19 and 26bp.Regarding the impact of other fundamentals, Table 1 indicates in general that the effects of key determinants (*i, π, x, F*) are robustly significant, and have the previously expected sign according to our theoretical model. For example, a 100bp increase in the expected gap pushes up the rate in just over 20bp, a 100bp increase in real short-term interest rate increases the long term interest rate in 26bp.

Alternatively, we consider equation (11) to evaluate de impact of policy regimes. i.e.:

$$(11) \qquad R_t = \alpha_0 R^e_{t+1} + \alpha_1 x^e_{t+1} + \alpha_2 (\bar{i}_t - \pi^e_{t+1}) - \alpha_3 (1-\chi)(\pi^* - \pi_{t-1}) + \alpha_4 F^* + \alpha_5 w_t + \alpha_6 \theta(b_t)$$

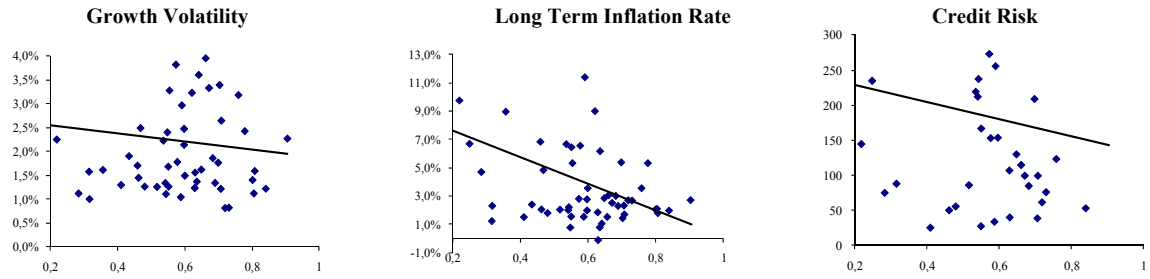
On the impact of fiscal policy within this setup, the theoretical model presented in (11) sets that the multipliers are lower when exists a countercyclical fiscal rule, and that the key fiscal variable in this case is the structural target deficit. Nevertheless, it is important to clarify that we have interpreted equation (11) only as a stylized result derived from a policy setup characterized by countercyclical fiscal rules and credibility concerned monetary policy. In fact, there are few countries in our sample that responds strictly to this characterization. A more pragmatic, let alone reasonable, interpretation of the equation (11) would be one that considers the impact of the inclusion of this policy regime. Along these lines, comparing equation (5) and (11) we clearly see that (i) the effect of the fiscal deficit exists but is diminished by the use of a fiscal rule with any countercyclical degree; (ii) the target fiscal deficit is the variable that actually impacts on interest rates; (iii) a variable associated to credibility issues is required to be included in the specification, and (iv) there should be some sort of interaction between credibility and inflation targets.

To consider this theoretically less strict interpretation of (11), we have opted for including the effective fiscal deficit in our empirical specifications, adding also a dummy variable for the existence of a fiscal rule in a country. This dummy takes the value 1 if the country has any kind of fiscal rule and 0 otherwise. This dummy interacts with the fiscal deficit, and we expect that have a negative (and similar to the associated parameter to fiscal balance) sign on *R*, because in that way the effective balance has no impact on *R*. For verifying if the effect of the fiscal rule is symmetric in countries with fiscal surplus or deficit, we divide the sample between those that have one or another. The inflation target is approximated by the long term inflation rate, obtained from the estimation of a VAR model that includes past values of actual and expected inflation rates. The index of credibility is obtained by using a Kalman filter over the equation of Bonfim and Redebush (2000)[8]. This term has been incorporated in the model interacting with the short term real interest rate. We expect that this new interacting variable have a positive coefficient, because we include a measure of (1-χ).

In figure 3 we can see the inverse association between our credibility index and the volatility of economic growth, the long term inflation rate, and a indicator of credit risk (in this case we use the *credit default swaps*).

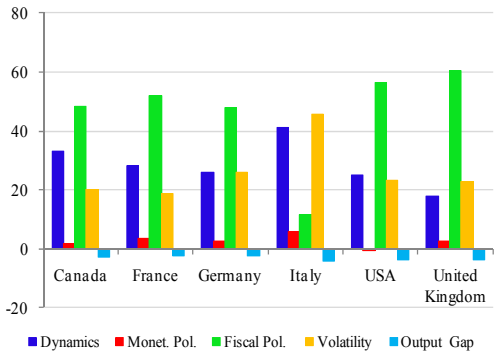
Figure 3
Credibility: Some Useful Correlations
(Averages 2000-2010)

[8] See Annex 2 for more detailed description.



The estimates are reported in the table 1, equations 3 and 4. First, we can see that the estimated parameters for the dynamics of *R*, short term real interest rate and output gap do not change significantly respect the previous columns. Second, the credibility variable has the expected positive sign. Third, we note that the parameter associated to the fiscal interaction reduces the magnitude of the parameter related to the fiscal balance; so that in countries with a countercyclical rule the effect of the primary fiscal deficit on *R* is lower than otherwise. This last conclusion is also valid for countries with a primary fiscal surplus.

Table 2
Long Term Interest Rate in 2007-2010
(% the Predicted Variation)



		Fundamentals			
	Dynamics	*Monet. Pol.*	*Fiscal Pol.*	*Volatility given Debt Ratio*	*Output Gap*
Canada	33.2	1.6	48.2	20.0	-3.0
France	28.1	3.5	51.9	18.7	-2.2
Germany	26.0	2.8	48.0	25.8	-2.2
Italy	41.2	5.7	11.6	45.8	-4.2
USA	24.8	-0.6	56.3	23.4	-3.9
United Kingdom	17.9	2.4	60.5	22.9	-3.8

Although the estimated models presented above represent averages effects estimates in base to our sample, we can try to use it for calculating the relative importance of the diverse determinants over the recent behavior of the long term interest rates for G-7 ex Japan[9] countries.

We therefore use the estimated parameters presented in the table 1, column 4, and consider the 2007-2010 period. The table 2 reports the participation of each factor over the predicted variation projected by the model. We have grouped the factors related to short term real interest rate and credibility under the "Monetary Policy" category, and

[9] Japan has been excluded of the exercise because his ratio of public debt to GDP is so deviated respect the average, invalidating the use of the estimated parameters.

the factors related to fiscal deficit and public debt are grouped under the "Fiscal Policy" category.

We observe that nearly 40% of the level average of the long term interest rate has been explained by factors related to fiscal policy, and a third is explained by macroeconomic volatility given the public debt ratio to the GDP. The business cycle and factors related to monetary policy has explained nearly 10%.

4. Conclusion

The substantial deterioration of fiscal solvency ratios around the world, especially in the developed countries, has opened the question about the impact of fiscal variables on the long term interest rate. On the basis of a stylized model for this rate, and using annual data for 54 emerging and developed economies for the 1990-2009 period, we have been estimated a dynamic panel. The main conclusions of this study are:

- On to the impact of the fiscal policy, we found that when the fiscal deficit expands by 1%, the long term interest rate rises between 10 and 12 basis points. The impact of public debt on the long term interest rate depends of macroeconomic volatility and of non linearity in the level of the debt. Indeed, we found that a second order polinomial term for the debt ratio interacting with a linear effect associated to volatility is a good representation for the sensibility of the long term interest rate to the debt ratio. For median countries in the median of the sample (48% debt ratio), a 1% increase of debt ratio over GDP raises the long term interest rate by nearly 5 bps. For a 1st-quartile country (28% debt ratio), the impact of a 1% rise in debt ratio on the rate is about 7-8 bps. We found that an increase of 1% in the macroeconomic volatility raises the long term interest rate between 19 and 26 basis points, when we assume a public debt ratio value of 51%, the average in our sample.

- An increase of 1% in the output gap generates an increase of the long term interest rate in nearly 20 basis points. An increase of 1% in the short term real interest rate elevates the long term interest rate in 26 basis points. Finally, an increase of 1% in the primary fiscal deficit expands the long term rate between 10 and 12 basis points.

- When we include the impact of the monetary policy regime and its credibility, and the role of a countercyclical fiscal rule we proved the robustness of our previous estimates, and additionally, we found that: (i) credibility, in the sense of the existence of a monetary policy committed with a inflation target, helps sustain lower long term interest rate than otherwise, and (ii) in countries with countercyclical fiscal rules, the impact of primary fiscal deficit over the rates are lower than otherwise. This result underlines the importance of fiscal responsibility to ensure lower level of long term interest rate.

- Finally, nearly 40% of the average long term real interest rate in 2007-2010 period has been explained by factors related to fiscal policy, and a third by the macroeconomic volatility prevailing during the period.

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Annex 1

A. Countries in the Sample

Argentina	Germany	Luxembourg	Slovak Rep.
Australia	Greece	Malasya	Slovenia
Austria	Hong Kong	Malta	South Africa
Belgium	Hungary	Mexico	Spain
Brazil	Iceland	Netherlands	Sweeden
Bulgary	India	New Zealand	Switzerland
Canada	Indonesia	Norway	Taiwan
Chile	Ireland	Pakistan	Thailand
China	Israel	Phillipines	Turkey
Czech Rep.	Italy	Poland	United Kingdom
Denmark	Japan	Portugal	United States
Estonia	Korea	Romania	Venezuela
Finland	Latvia	Russia	
France	Lithuania	Singapore	

B. Descriptive Statistics of Key Variables Used in the Estimation

Variable	Observations	Average	Est. Desv.	Min	Max
Long Term Interest Rate	844	0.03	0.04	-0.42	0.34
Short Term Interest Rate	1004	0.09	0.14	0.00	1.90
Inflation Rate	1054	0.22	1.57	-0.09	29.48
Real Output Gap	1080	0.00	0.04	-0.21	0.27
Primary Fiscal Balance	878	0.01	0.04	-0.13	0.18
Public Debt as % of GDP	1049	0.51	0.32	0.00	2.90
Volatilidad	1056	0.03	0.02	-0.11	0.18
Credibility Indicator	1029	0.48	0.25	0.00	0.92

C. Average of Used Variables, Selected Countries

Country	Real Output GAP (%)	Primary Fiscal Balance (% Real GDP)	Public Debt Ratio (% GDP)	Long Term Interest Rate (%)	Short Term Interest Rate (%)
Canada	-2.80	1.25	84.01	4.41	2.01
France	-1.60	-1.00	56.89	3.91	2.44
Germany	-1.35	0.24	58.10	3.52	1.96
Italy	-1.90	2.20	109.77	4.31	2.50
United Kingdom	-2.62	-1.56	42.78	4.00	2.96
United States	-1.79	-0.71	63.03	2.99	0.89

D. Countries With Any Type of Fiscal Rule as of 2009

Argentina	Estonia	Japan	Poland
Australia	Finland	Latvia	Portugal
Austria	France	Lithuania	Romania
Belgium	Germany	Luxembourg	Slovak Rep.
Brazil	Hungary	Malasya	Slovenia
Bulgary	Iceland	Mexico	Spain
Canada	India	Netherlands	Sweeden
Chile	Indonesia	New Zealand	United Kingdom
Czech Rep.	Ireland	Norway	United States
Denmark	Italy	Pakistan	Venezuela

Fuente: Bjerkholt y Niculescu (2004), Braun y Gadano (2007), Buiter y Patel (2010), IMF (2009b), García (2005), Iizuka et al (2008), Kennedy y Robbins (2003), Lozano et al (2008), Mohanty y Scatigna (2002), OCDE Economics Department (2006), Oxford Analytica (2006). Perry (2002), Robinson (2000), Vijayalecdchumy (2002).

Annex 2
Measuring Credibility and Inflation Target

The purpose of this annex is to describe the measure of two variables which characterizes the monetary policy regime: Credibility and Inflation Target.

A. Inflation Target

Demertzis et al (2008) present a methodology for estimate the inflation target of a given country, based in a fixed value of λ, the parameter that indexes the degree of anchorness of inflation expectations. By doing this, we need to estimate a VAR for each economy that includes the effective annualized monthly inflation rate and its corresponding expectation, calculated as the 24 months moving average of the actual and past effective inflation rate. In selecting the lag length, we employ the Akaike criterion, as usual. We obtain that the best specification includes 6 lags.

Having estimated the VAR, we obtain our estimation of π* following the fifth equation presented in Demertzis's paper. Of course, for doing that we need to calculate the value of the λ parameter; we obtain this by using the methodology presented in the Annex of that paper. Table A contains the value of both parameters for each economy in the sample.

Table A1. π* for the countries in the sample.

Economías Avanzadas				Economías Emergentes			
	π*		π*		π*		π*
Alemania	1.5%	Islandia	4.8%	Argentina	6.2%	Rumania	5.3%
Australia	2.7%	Israel	1.7%	Brasil	6.6%	Sudáfrica	6.4%
Austria	1.8%	Italia	2.0%	Bulgaria	6.7%	Tailandia	3.0%
Bélgica	2.0%	Japón	-0.1%	Chile	3.0%	Turquía	6.7%
Canadá	1.8%	Korea	3.5%	China	4.7%	Venezuela	31.9%
Dinamarca	2.0%	Luxemburgo	2.0%	Estonia	2.8%		
Eslovaquia	5.3%	Malta	2.7%	Filipinas	5.4%		
Eslovenia	3.5%	Noruega	2.1%	Hungría	2.0%		
España	2.3%	Nva Zelanda	2.3%	India	6.8%		
Estados Unidos	2.3%	Portugal	1.8%	Indonesia	11.4%		
Finlandia	1.5%	Reino Unido	2.7%	Letonia	9.0%		
Francia	1.5%	Rep. Checa	2.4%	Lituania	1.4%		
Grecia	2.2%	Singapur	1.5%	Malasia	2.5%		
Holanda	2.0%	Suecia	1.2%	México	9.8%		
Hong Kong	1.0%	Suiza	0.8%	Pakistán	9.0%		
Irlanda	2.8%	Taiwán	0.7%	Polonia	2.8%		

B. Credibility Index

We used the Kalman filter Methodology to estimate a time-varying credibility index. The Kalman filter is an algorithm that using an efficient recursive solution of least squares method allows to calculate a linear estimator, unbiased and optimal of the state of a discrete process at each point in time based on information available at time t-1, and update those estimates as additional information is available at time t. This method allows us to estimate time-varying parameters.

The system is represented in state-space form, with two equations, first a measurement equation that corresponds in our exercise:

$$\pi_t^e = \chi\pi^* + (1-\chi)\pi_{t-1} + e_t$$

Where π_t^e corresponds to expected inflation, π^* inflation target, π_{t-1} one-lag inflation rate and χ the time-varying credibility index (state-vector). Second, a transition equation:

$$\chi_t = \chi_{t-1} + \varepsilon_t$$

That aims to represent the state vector at t, where e_t and ε_t are iid residuals, normally distributed with mean zero and variances equal to σ_e^2 and σ_ε^2 respectively. The ratio $Q = \frac{\sigma_e^2}{\sigma_\varepsilon^2}$ is called "signal-to-noise", where e_t corresponds to measurement error, ε_t is the signal and define the stochastic behaviour of the model that changes over time. The value of Q is arbitrary, since there is no universally accepted rule of how to impose such a restriction. We preferred to choose Q=0.25 for all countries, allowing the variance of the coefficient state was 25% the variance of measurement error.

The Kalman filter operates in two stages:

1. The procedure of the filter accumulates projections as new information on observable variables is available. If a_t is the best estimate of the state variable (credibility) and P_t the matrix of variance/covariance, then given a_{t-1} and P_{t-1} the Kalman filter could be written as:

$$a_{t+1|t} = (T - K_{tZ)a_{t|t-1}} + K_t(y_t - d_t)$$

With $K_t = TP_{t|t-1}Z'F_t^{-1}$ y $F_t = ZP_{t|t-1}Z + H$

and $P_{t+1|t} = T(P_{t|t-1} - P_{t|t-1}Z' F_t^{-1} ZP_{t|t-1})T'+Q$

These equations allow us to compute the forecast errors for period t as:
$v_t = y_t - Za_{t|t-1} - RD_t$

To use in the likelihood function:
$$l_t = -\frac{1}{2}\log 2\pi - \frac{1}{2}\log | F_t | - \frac{1}{2} v_t F_t^{-1} v_t$$
The series $\{a_t\}$ that maximize this function give us a best estimate of credibility.

2. The smoothing procedure uses information available from the full sample. This is done through a recursive process which starts back in t produces a smoothed estimate in the order T, ..., 1,

$a_{t|T} = a_t + P_t^*(a_{t+1|T} - T_{t+1}a_t)$

$P_{t|T} = P_t + P_t^*(P_{t+1|T} - P_{t+1|t})P_t^*$

$P_t^* = P_t T_{t+1}^{'} P_{t+1|t}^{-1}$

With $a_{T|T} = a_T$ y $P_{T|T} = P_T$

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