F U N D A Ç Ã O
GETULIO VARGAS

EPGE

Escola de Pós-Graduação
em Economia

Ensaios Econômicos

Escola de

Pós-Graduação

em Economia

da Fundação

Getulio Vargas

The Risk Premium on Brazilian Government Debt, 1996-2002

André Soares Loureiro, Fernando de Holanda Barbosa

Junho de 2003

Os artigos publicados são de inteira responsabilidade de seus autores. As opiniões neles emitidas não exprimem, necessariamente, o ponto de vista da Fundação Getulio Vargas.

The risk premium on Brazilian government debt, 1996-2002

André Soares Loureiro
Fernando de Holanda Barbosa

Junho de 2003

The Risk Premium on Brazilian Government Debt, 1996-2002.[*]

André Soares Loureiro [†]   Fernando de Holanda Barbosa[‡]

May, 2003.

Abstract

The goal of this paper is to identify the determinants of the risk premium on Brazilian government debt. As the risk premium is a component of the interest rate set by the Brazilian central bank, its reduction would make it possible for the central bank to cut interest rates to levels compatible with a higher economic growth environment.

The empirical evidence presented in this paper does not reject the hypotheses that fiscal solvency and the size of the public debt affect the risk premium as measured by the spread over treasury bills of the Brazilian C-bond.

Keywords: risk premium, government debt

JEL Classification: E44, E62, F32, F34

1 Introduction

Government liabilities are considered in many countries to be risk free assets. Thus, financial market studies take the yield on government securities as a benchmark to measure risky assets issued by private agents. This assumption needs, however, to be revised in conditions of high and persistent imbalances in public sector finances, leading to rapid and substantial accumulation of public debt. As public debt increases, the market may start wondering whether or not the government intertemporal budget constraint will hold and the possibility of default on government debt may be explicitly considered by the market.

A case in point may be provided by the Brazilian experience during the Real Plan. The increase of the internal public sector net debt to GDP ratio from 23.5 % to 44.7 % between 1994 and 2002 led to a great resurgence of interest in the issue of public sector´s solvency. With the burden of interest payments becoming progressively heavier, increasing attention has been given to this issue and to the possible use of extraordinary measures to solve it.

The Brazilian external public debt to GDP ratio remained at 11 % during the above period. The principal instrument used by the market to measure the risk of this debt is the JP Morgan Emerging Market Bond Index Plus (EMBI+).[1] Figure 1 illustrates the behavior of the indexes EMBI+ Brazil and EMBI+ Emerging Markets, since 1999, when Brazil adopted a floating exchange rate regime.

FIGURE 1

---
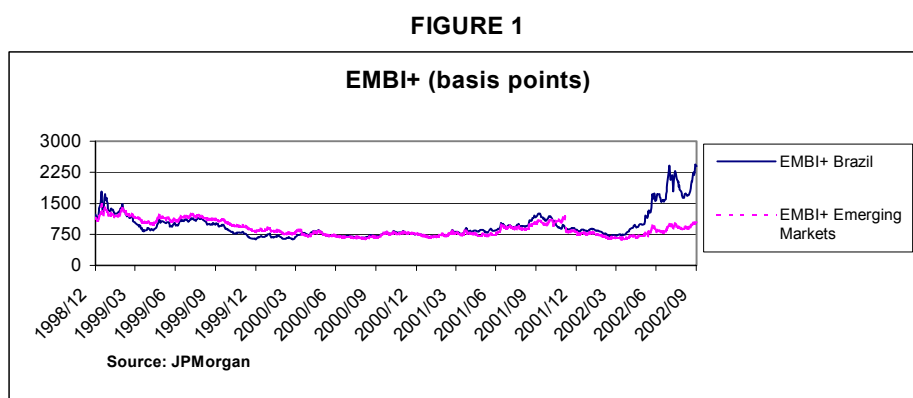
[1]The Emerging Markets Bond Index Plus (EMBI+) tracks total returns for traded external debt instruments in the emerging markets. The instruments include external-currency-denominated Brady bonds, loans and Eurobonds, as well as U.S. dollar local markets instruments. The EMBI+ expands upon Morgan's original Emerging Markets Bond Index, which was introduced in 1992 and covers only Brady bonds.

Although Brazil has a high share in the EMBI[+] Emerging Markets (about 28 %), the behavior of the indexes shows that the risk premium on Brazilian government securities is strongly correlated with the risk premium on securities of other emerging economies, except for moments of domestic crises like the change in the exchange rate regime in 1999 and last year´s electoral cycle.

This paper aims at identifying the factors that explain the movements of the risk premium on Brazilian government debt. It is organized as follows: Section 2 presents a model where the risk premium is a function of the debt size and a set of variables that represents a confidence crisis in the sustainability of the public debt; Section 3 describes the data and presents the empirical evidence based on the econometric analysis; Section 4 concludes the paper.

2 Model

The basic model is based on Dornbusch´s CAPM portfolio selection model (1983) and its extension to the Italian case by Cottarelli and Mecagni (1990). The former captures the relative supply effect while the latter introduces the default probability in the expected yield of a government security.

2.1 Relative Supply Effect

The model is a two-period expected utility maximization for an individual faced with two securities with random real returns. The random returns on these securities are characterized in terms of their means and variances-covariances and the portfolio composition can be stated in terms of the parameters of risk aversion and the structure of returns.

Let w, r, r^* and x be the initial level of real wealth, the random returns on private and government securities and the portfolio share of government securities respectively. End of period wealth is random and equal to:

$$\tilde{w} = w(1 + r) + xw(r^* - r) \tag{1}$$

Utility is function of the mean and variance of end of period wealth:

$$U = U(\bar{w}, \sigma^2_{\tilde{w}}) \tag{2}$$

The mean and variance of wealth are defined as:

$$\bar{w} = w(1 + \bar{r}) + xw(\bar{r}^* - \bar{r}) \tag{3}$$

$$\sigma^2_{\tilde{w}} = w^2[(1-x)^2\sigma^2_r + x^2\sigma^2_{r*} + 2x(1-x)\sigma_{rr*}] \tag{4}$$

where $\bar{a} = E(a)$. Maximizing utility (Eq. (2)) with respect to x yields the optimal portfolio share :

$$x = \frac{(\bar{r}^* - \bar{r}) + \theta(\sigma^2_r - \sigma_{rr*})}{\theta\sigma^2} \quad ; \sigma^2 \equiv (\sigma^2_r + \sigma^2_{r*} - 2\sigma_{rr*}) \tag{5}$$

where $\theta = \dfrac{-U_2 w}{U_1}$ is the coefficient of risk aversion and σ^2 the risk premium variance.

Equation (5) shows that portfolio selection depends on yield differentials, risk aversion, and the variance-covariance structure of the returns. As pointed out in Kouri [(1978a) *apud* Dornbusch], the portfolio share can be divided into two components:

$$x = \frac{(\bar{r}^* - \bar{r})}{\theta\sigma^2} + \alpha \; ; \alpha \equiv \frac{(\sigma^2_r - \sigma_{rr*})}{\sigma^2} \tag{6}$$

The first is a speculative component and the second component corresponds to the share of a minimum variance portfolio. It is readily shown that α is the share of the government security in a portfolio chosen to minimize the variance of wealth.[2] Thus, investors allocate their wealth to a minimum variance portfolio and issue one of the securities using the proceeds to hold another as a speculative portfolio.

The optimal portfolio share in Eq. (6) is for an individual asset holder. To proceed to the condition of market equilibrium we have to aggregate across investors, all of whom share

---

[2]Speculative holdings of the other security are $\frac{-(\bar{r}^* - \bar{r})}{\theta\sigma^2}$ so that across assets the speculative portfolio sums to zero. The minimum variance portfolio is independent of risk aversion, of course, and its composition depends only on the relative riskiness of the two bonds.

the same information, but may differ in their wealth or risk aversion. Nominal demand for asterik-type bonds (government securities) is $x_j W_j$.[3] Denoting the nominal supply of government bonds by V, the market equilibrium condition becomes $V = \sum x_j W_j$. Using the definition of aggregate nonmonetary wealth, $\bar{W} = \sum W_j$, the equilibrium condition can be expressed as:

$$\left[\frac{(\bar{r}^* - \bar{r})}{\boldsymbol{\theta}\sigma^2} + \alpha \right] \bar{W} = V \tag{7}$$

where $\boldsymbol{\theta} = \sum \dfrac{\theta_j}{\frac{W_j}{\bar{W}}}$ now denotes the market coefficient of relative risk aversion, being a wealth-weighted average of the individuals coefficients. Equation (7) can be solved for the market equilibrium real yield differential:

$$\bar{r}^* - \bar{r} = \boldsymbol{\theta}\sigma^2 \left(\frac{V}{\bar{W}} - \alpha \right) \tag{8}$$

This yield differential has three determinants. The higher risk aversion, $\boldsymbol{\theta}$, the larger the yield differential. In the same direction works an increase in relative yield variability, σ^2. The third determinant is the relative asset supply. It takes the interesting form of a yield differential proportional to the difference between the actual relative supply, $V/\bar{W}$, and the share of the asset in the minimum variance portfolio, α.

Following the mean-variance approach to portfolio choice, the increase in the yield differential required to accomodate a change in relative supply may also be interpreted as an increasing risk premium because it offsets the utility loss occurring when investors move away from the minimum variance portfolio. Clearly, however, this risk premium has a different nature from a default risk premium.

2.2 Default risk

When there is a positive default probability, the expected yield on any security i can be expressed as $E(r_i) = r_i^{Ne} - p_i t_i$, where r_i^{Ne} is the expected yield in the absence of default and $p_i t_i$ the expected cost of default. Since $\bar{r}^* = E(r_g)$ is the expected yield on a government

---

[3]Here x_j depends on the investor´s risk aversion and W_j denotes her nominal, nonmonetary wealth.

security and $\bar{r} = E(r_p)$ is the expected yield on a private security, equation (8) can be rewritten as:

$$r_g^{Ne} - r_p^{Ne} = \boldsymbol{\theta}\sigma^2 \left(\frac{V}{\bar{W}} - \alpha \right) + p_g t_g - p_p t_p \tag{9}$$

This equation shows that the yield differential under the hypothesis of no default is a function of the expected differential cost of default $(p_g t_g - p_p t_p)$. The default probabilities p_g and p_p are not observed; while it is assumed that p_p is constant, p_g is supposed to be correlated to a set of default risk indicators that could trigger a confidence crisis. The literature suggests the average maturity of government debt, the amount of debt coming to maturity in each period, the deficit to GDP ratio and the debt to GDP ratio as indicators that would capture the behavior of economic fundamentals.[4] The average maturity and the amount of debt coming to maturity are not good indicators because they are in large measure a consequence of the confidence crisis. The size of the deficit per se, as well as the debt ratio, does not say much about the financial ability of the government to pay its debt. Instead of using these variables, we assume that the probability of government default depends upon the solvency conditions for the public sector and external debt. Thus,

$$p_g = \lambda_0 - \lambda_1 DSG - \lambda_2 DSE \tag{10}$$

where the signs of the coefficients λ_1 and λ_2 are positive, and DSG refers to the government and DSE to the external constraint.[5] By substitution of (10) into (9) we obtain the the the risk premium on a government security:

$$SPR = r_g^{Ne} - r^{Ne} = \varphi_0 + \varphi_1 \frac{V}{\bar{W}} - \varphi_2 DSG - \varphi_3 DSE \tag{11}$$

where $\varphi_0 = t_g \lambda_0 - p_p t_p$, $\varphi_1 = \boldsymbol{\theta}\sigma^2$, $\varphi_2 = \lambda_1 t_g$ and $\varphi_3 = \lambda_2 t_g$.

---

[4]See Cottarelli and Mecagni(1990) and the references cited there.

[5]These variables are defined in the next section.

3 Empirical evidence

The model presented in the last section shows that the risk premiun on government debt depends upon country economic fundamentals and the relative supply effect which measures the size of the stock of public sector securities in relation to some benchmark. This section describes the data and the econometric methods we use to test this model.[6]

3.1 Data

We use C-Bond spread over the American treasury bill as a measure for risk premium, since this is the most liquid bond issued by the Federal Republic of Brazil in international capital markets. We use monthly data from January/96 to May/02 (see Figure 2) and this sample was chosen due to availability of the data.[7]

Our risk premium measure is supported by a recent study by Araújo and Guillén (2002). In their paper they decompose three possible measures of Brazilian risk premium (deviation from uncovered interest parity, C-Bond spread over treasury bill and deviation from covered interest parity) into transitory and trend components, following Vahid and Engle (1993) methodology. They conclude that C-Bond risk premium is greatly influenced by the behavior of the trend component. Thus, if this long run component is associated with economic fundamentals, the authors suggest that these fundamentals would be the main determinants of C-Bond spread over treasury.

---

[6]In the case of Italy, bonds issued by Special Credit Institutions (SCI) were taken as the benchmark. SCI are financial intermediaries specialized in long-term credit for industrial and real estate investment.

[7]The FLIRB "C" (known as C-Bond) was issued on 04/15/1994 and has the following characteristics: Maturity: 04/15/2014; Original value: US\$ 7,407,002,000.00; Term: 20 years; Grace Period: 10 years.; Amortization: 21 six-month payments; Interest rate (six-month coupon): 1st and 2nd years – 4% per annum; 3rd and 4th years – 4.5% ; 5th and 6th years – 5% ; from 7th year on – 8%.
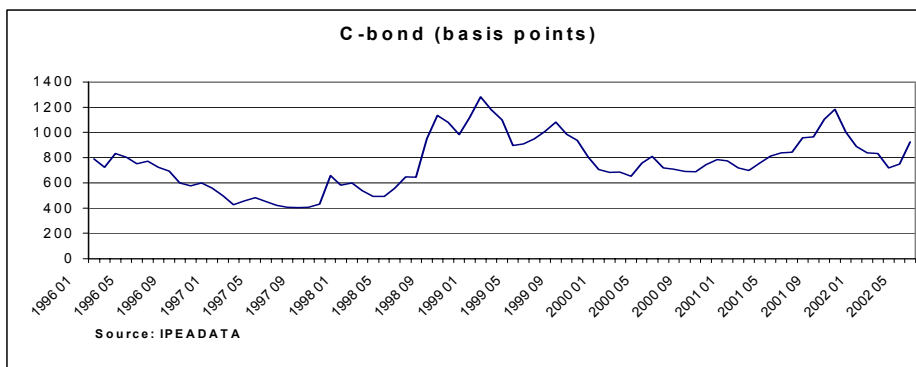
We define variables that embed public sector solvency condition and external debt solvency condition of the Brazilian economy to take into account country economic fundamentals. The solvency condition of the public sector is obtained from the government intertemporal budget constraint:[8]

$$\sum_{i=0}^{\infty} \frac{E_{t+i}}{\prod_{j=1}^{i}\left(1+r_{t+j}\right)} \leq \sum_{i=0}^{\infty} \frac{T_{t+i}}{\prod_{j=1}^{i}\left(1+r_{t+j}\right)} - (1+r_t) * D_{t-1} \tag{12}$$

where E_{t+i}, T_{t+i} e D_t are public sector expenditures, taxes and debt, respectively. Defining primary surplus as $S_{t+i} = T_{t+i} - E_{t+i}$, we have:

$$\sum_{i=0}^{\infty} \frac{S_{t+i}}{\prod_{j=1}^{i}\left(1+r_{t+j}\right)} \geq (1+r_t) * D_{t-1} \tag{13}$$

When interest rates are constant $r_{t+j} = r_t$, output grows at constant rate $g_{t+j} = g_t$ and the rate of interest is greater than the rate of output growth $r_t \geq g_t$, the above equation as a percentage of GDP can be written as:

$$(1+r_t) * \frac{D_{t-1}}{Y_t} \leq \sum_{i=0}^{\infty} \frac{S_{t+i}}{Y_t * (1+r)^i} = s_t * \sum_{i=0}^{\infty} \frac{(1+g_t)^i}{(1+r_t)^i} = s_t * \frac{1+r_t}{r_t - g_t} \tag{14}$$

---

[8]For a detailed analysis of this solvency condition, see Goldfajn (2002).

Primary surplus as a percentage of GDP is constant, $s_t = s_{t+i} = \dfrac{S_{t+i}}{Y_t * (1 + g_t)^i}$, in a steady state path, and this primary surplus attends the following inequality for the solvency condition to be met:

$$s \geq s^* = \frac{(r - g) * d}{(1 + g)} \tag{15}$$

We capture the effect of this condition over government debt risk (measured by C-Bond spread over treasury bill) building a variable called degree of public sector debt sustainability defined as the difference between the actual primary surplus and the primary surplus required by the solvency condition :[9]

$$dsg = s - s^*$$

We proceeded as follows to build this variable: i) For the real interest rate, r, we consider two cases which result in two distinct series for this variable. In case 1, r is constructed from Selic (overnight interest rate) adjusted by IPCA (consumer price index), where inflation is calculated as the mean of this month and the three previous months inflation rates in order to avoid seasonal adjustment problems; in case 2, r is equal to 20.75 % per annum from Jan/96 to Dec/98 (fixed exchange rate regime) and is equal to 11.80 % from Jan/01 to May/02 (floating exchange rate regime). ii) Faced by the difficulty of calculating a monthly GDP growth rate, we used the mean of the period, approximately 2.5 % per annum. iii) Our variable d was defined as total net public sector debt as a percentage of GDP while s was defined as primary surplus accumulated in 12 months as a percentage of GDP. Figure 3 shows the behavior of this variable for both cases we consider in this paper.

---

[9]The primary surplus is the net cash flow available to be used by the government to service the debt. We assume that the price of government debt depends upon the expected value of this cash flow. Thus, the assumption underlying this variable is that it provides information for this expected value.

FIGURE 3

Degree of public sector debt sustainability (dsg)

Source: Central Bank of Brazil
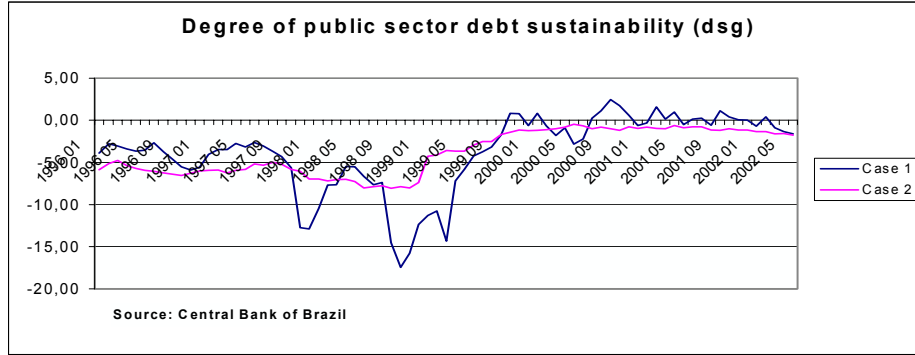
Similarly, we can derive an external solvency condition for the Brazilian economy, considering balance of payments´s trade balance, cc^*, required to maintain Brazilian external debt in a sustainable path:[10]

$$cc \geq cc^* = \frac{(r - g) * d^e}{(1 + g)} \tag{16}$$

where d^e is net external debt as a percentage of GDP. [11]

In the same way we construct a variable called degree of external solvency, dse, as shown in Figure 4, incorporating the condition stated above:

$$dse = cc - cc^*,$$

which measures the difference between effective balance of payments current account (accumulated in 12 months as a percentage of GDP), cc, and the one required by the external solvency condition, cc^*, in each period of time. [12]

---

[10]Current account was used as a proxy for the amount of output the Brazilian economy would transfer to foreigners (trade balance).

[11]This variable includes financial and non-financial public and private sectors debt.

[12]Real interest rate, r, and GDP growth rate, g, are defined in the same way we did when we stated the public sector debt sustainability condition.

FIGURE 4

Degree of external solvency (des)

Source: Central Bank of Brazil
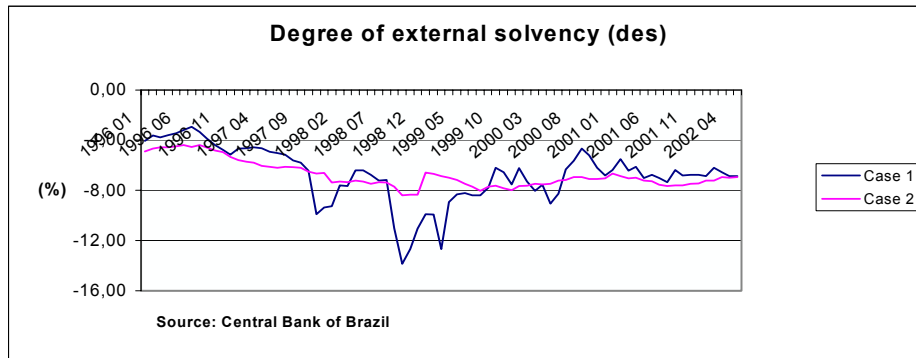
Due to the fact that Brazil does not have analogous institutions to Italians SCI's, we had to construct a proxy to capture the 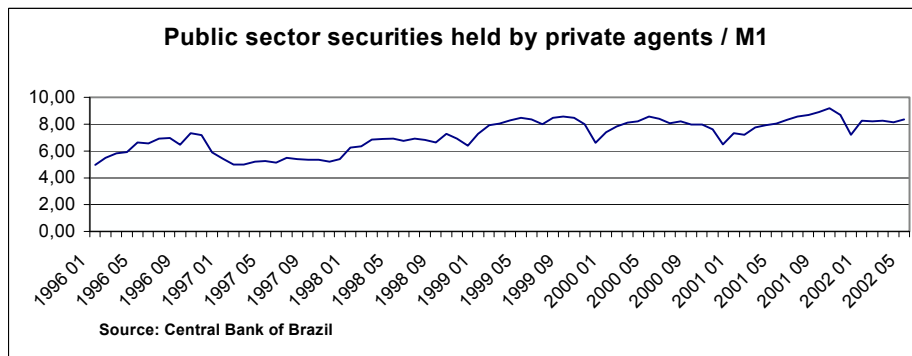relative supply effect. We use the ratio between public sector securities held by the private sector and money supply defined by the M1 concept as a proxy for the relative supply effect (see Figure 5).

FIGURE 5

Public sector securities held by private agents / M1

Source: Central Bank of Brazil

The idea behind this variable is that when it increases, asset holders are giving up present liquidity for future liquidity, and to do so they demand higher interest rates, as noticed by Martins et al. (1980).[13] Since risk premium is one of the determinants of interest rate it should be positively correlated with our proxy variable that measures the relative supply effect.

---

[13]This idea is also implicit in Tobin (1956)'s theory of money demand.

10

3.2 Econometric Analysis

The variables we use in the econometric analysis are defined as follows: i) $SPR = \ln(1 + spr/100)$, where spr is C-Bond spread over treasury bills (in basis points). ii) $DSG = \ln(1 + dsg/100)$, where dsg is the degree of public sector debt sustainability (percentage). iii) $DSE = \ln(1 + \text{des}/100)$, where dse is the Brazil's degree of external solvency (percentage), and iv) $TM = \ln(tm)$, where tm is defined as the ratio between public sector securities held by the private sector and money supply (M1).

Firstly, the Augmented Dickey-Fuller unit root test, reported in Table 1, shows that, at 1% confidence level, we cannot reject the unit root hypothesis for each variable defined above. This means that our variables are non-stationary according to the critical values tabulated by MacKinnon. In order to test the presence of only one unit root, we tested the first difference of the series as well, and the hypothesis that the first difference of the variables has a unit root was rejected.

TABLE 1

ADF Unit Root Test

		SPR	TM	DSG		DES	
				Case 1	Case 2	Case 1	Case 2
ADF Test Statistic	level	-2,18	-2,23	-1,87	-0,78	-2,41	-1,85
	first difference	-6,05	-8,74	-7,77	-7,24	-8,30	-8,25
Critical values**	1%	-3,52					
	5%	-2,90					
	10%	-2,58					

* All tests include an intercept and lags were selected by AIC criteria

** MacKinnon critical values for rejection of the unit root hypothesis

Before the application of Johansen cointegration procedure, we have to choose the order of the vector autoregression (VAR). We use the information criteria of Hannan-Quinn, Schwarz and Akaike as reported in Table 2 to determine the lag lengths. With the exception of case 1, where real interest rate was constructed from Selic rate adjusted by IPCA inflation rate, convergence in terms of best lag was the rule. We also use the Likelihood Ratio test (LR) for case 1 that suggested 2 lags as the order of the VAR. Taking into account diagnosis tests (from residuals) which indicated no serial correlation, we decide to use two lags in case 1

and one lag in case 2.

TABLE 2

VAR Selection

	LR	Information Criteria		
		HQ	SC	AIC
Case 1	2	2	1	2
Case 2	1	1	1	1

After having defined the lag lengths of theVAR, the next step was to test the hypothesis that there is a long run relationship amongst the four variables through cointegration procedure. Johansen test results indicated that our variables did not cointegrate when jointly analysed. Next, we separated the four variables into two sets and we applied Johansen test to each of them alternating DSG and DSE as proxies for Brazilian fundamentals.[14] In the set that includes DSG cointegration was not rejected as shown in Tables 3 and 4.

TABLE 3

Johansen Test: Case 1

Hypothesized No. of CE(s)	Eingenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None*	0.22	32.30	29.68	35.65
At most 1	0.14	13.91	15.41	20.04
Normalized cointegration coefficients: one cointegration equation				
	SPR	TM	DSG	
	1	-0.13	0.27	
		(0.02)	(0.07)	

* (**) denotes rejection of the hypothesis at the 5% (1%) level

---

[14]Once again, Var order selection criteria indicated two lags for case 1 and one for case 2.

TABLE 4

Johansen Test: Case 2

Hypothesized No. of CE(s)	Eingenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None*	0.23	30.20	29.68	35.65
At most 1	0.11	10.07	15.41	20.04
Normalized cointegration coefficients: one cointegration equation				
	SPR	TM	DSG	
	1	-0.12	0.30	
		(0.02)	(0.14)	

* (**) denotes rejection of the hypothesis at the 5% (1%) level

The trace statistics of Johansen procedure does not reject the hypothesis that the series cointegrate with one cointegration vector in each case at a 5 % confidence level. The following estimated cointegration equations present significant statistics and results that support the model presented in the last section:[15]

$$SPR = \underset{(0.02)}{0.13}TM - \underset{(0.07)}{0.27}DSG + z \qquad (17)$$

$$SPR = \underset{(0.02)}{0.12}TM - \underset{(0.14)}{0.30}DSG + z \qquad (18)$$

where z is the cointegration error term.

The coefficient of the variable TM supports the results obtained by Martins et al. (1980) that agents demand higher interest rates when government increases the stock of public debt. Robust results for the TM variable coefficient suggest that a decrease in the stock of public debt reduces risk premium, highlighting the presence of relative supply effect in Brazilian risk premium during the period analysed here. The results for the DSG coefficient do not reject the hypothesis that when country fundamentals improve, risk premium on public sector debt decreases. In particular, a positive fiscal shock, which increases the primary surplus above

---

[15]LR test indicated that all coefficients of the estimated cointegration vector are statiscally different from zero.

the minimum level required to maintain public sector debt to GDP ratio at a sustainable path, reduces risk premium.

In the set which contains DSE variable, we were not able to reject the hypothesis of no cointegration. Although we expected that this variable would influence risk premium behavior, the absence of cointegration only indicates that there is no long run linear relation among DSE' stochastical trend and other variables' stochastical trends. Thus we decided to apply Johansen test to SPR and DSE variables only, where we noticed cointegration relations in case 1, as shown in Table 5.[16]

TABLE 5

Johansen Test: Case 1

Hypothesized No. of CE(s)	Eingenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None*	0.14	17.33	15.41	20.04
At most 1	0.07	6.03	3.76	6.65
Normalized cointegration coefficients: two cointegration equations				
	SPR	DES		
	1	0.36		
		(0.20)		

* (**) denotes rejection of the hypothesis at the 5% (1%) level

Despite the fact that Johansen test shows two estimated cointegration relations among the variables (given by the trace statistics test at a 5% confidence level), only one has economic rationale:[17]

$$SPR = -\underset{(0.20)}{0.36}DSE + z \tag{19}$$

This equation shows that current account sustainability influences risk premium level, but this hypothesis is sensitive to the confidence level chosen.[18]

---

[16]VAR order selection criteria suggested two lags as the best specification.

[17]Again, LR test indicated that all coefficients of the estimated cointegration vector are statiscally different from zero.

[18]We also tested the possibility of DSG and DSE be cointegrated. In the light of Mundell-Fleming model,

Comparatively, our results show that fiscal effects, captured by the DSG variable and by the proxy for relative supply effect, are statiscally more robust in relation to changes in the specification of the estimated equation. Thus our tentative conclusion is that a positive public sector fiscal effort would be the best strategy to reduce risk premium on public sector debt. We do not disregard actions that would reduce the external vulnerability through current account improvement, but the empirical evidence we present in this paper is not robust to this hypothesis.

4   Conclusion

The paper provides evidence that the fiscal policy stance, as measured by the primary surplus, and the size of the public debt affect the risk premium on Brazilian government debt. The results show that, although current account affects risk premium, the effect of fiscal variables is statistically more robust and quantitatively more important.

These findings have implications for fiscal policy and debt management. In order to reduce risk premium, the fiscal adjustment must be sustained over time, so as to allow for the proper adjustment in the stock of public debt.

---

budgetary deficits should induce trade balance deficits. In this case, we applied Engle-Granger methodology, which consists of two steps. In the first one, we estimated long run relations through OLS method. In the next step, we applied a unit root test to residuals obtained in step 1; if this series results to be stationary, variables are cointegrated. We obtained the following results:

$$DSG = \underset{\substack{(0.01) \\ [4.06]}}{0.05} + \underset{\substack{(0.17) \\ [7.55]}}{1.31}\,DSE$$

Clearly, our results indicated a spurious regression. Applying to residuals, $\hat{e}$, a unit root test of the form $\Delta\hat{e} = a_1\hat{e}_{t-1} + \in_t$, we could not reject the null hypothesis $H_0 : a_1 = 0$, i.e., residuals present a unit root and variables are not cointegrated.

References

[1] ARAUJO, C., GUILLÉN, O. (2002). Componentes de Curto e Longo Prazo das Taxas de Juros no Brasil. Working Paper # 55. Central Bank of Brazil.

[2] COTTARELLI, C., MECAGNI, M. (1990). The Risk Premium on Italian Government Debt, 1976-88. WP/90/38. IMF, European Department.

[3] DORNBUSCH, R. (1983). Exchange Rate Risk and the Macroeconomics of Exchange Rate Determination. In Hawkins, G., Levich, R., Wihlborg, C. (eds.). The Internationalization of Financial Markets and National Economic Policy. JAI Press, Greenwich.

[4] ENDERS, W. (1994). Applied Econometric Time Series. John Wiley & Sons.

[5] GOLDFAJN, I. (2002) Há Razões Para Duvidar que a Dívida Pública no Brasil é Sustentável ? Technical Note nº 25. Central Bank of Brazil.

[6] HAMILTON, J. (1994). Time Series Analysis. Princeton University Press.

[7] MARTINS, M., FARO, C., BRANDÃO, A. (1991). Juros, Preços e Dívida Pública: A Teoria e o Caso Brasileiro. Série Pesquisas EPGE/FGV nº 3.

[8] TOBIN, J. The Interest-Elasticity of Transactions Demand for Cash. Review of Economics and Statistics, 38(3), 1956.[

[9] VAHID, F., ENGLE, R.F. (1993). Common Trends and Common Cycles. Journal of Applied Econometrics, 8, 341-360.

[10] VAHID, F., ENGLE, R.F. (1993). Codependent Cycles. Journal of Econometrics, 80, 199-221.